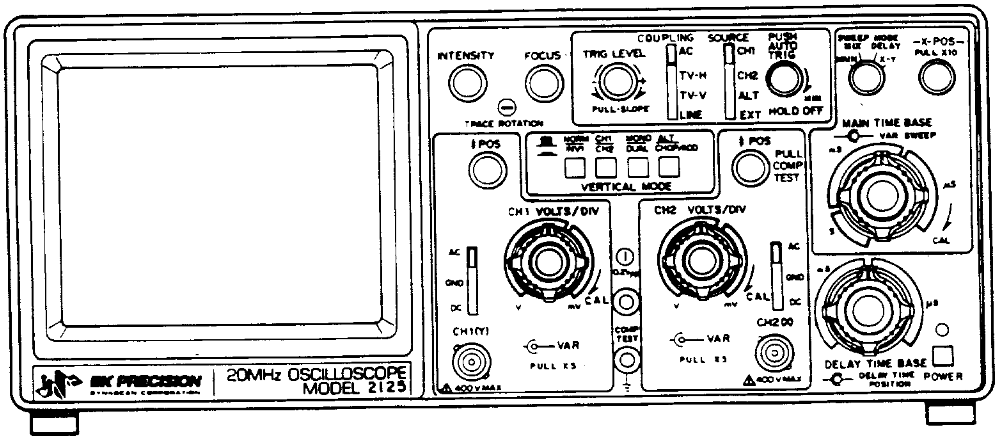
INSTRUCTION MANUAL

B+K PRECISION®

MODEL 2125

20 MHz, Dual Time Base
DUAL-TRACE OSCILLOSCOPE



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TEST INSTRUMENT SAFETY

WARNING

Normal use of test equipment exposes you to a certain amount of danger from electrical shock because testing must often be performed where exposed high voltage is present. An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Voltage as low as 35 volts dc or ac rms should be considered dangerous and hazardous since it can produce a lethal current under certain conditions. Higher voltage poses an even greater threat because such voltage can more easily produce a lethal current. Your normal work habits should include all accepted practices that will prevent contact with exposed high voltage, and that will steer current away from your heart in case of accidental contact with a high voltage. You will significantly reduce the risk factor if you know and observe the following safety precautions:

1. Don't expose high voltage needlessly in the equipment under test. Remove housings and covers only when necessary. Turn off equipment while making test connections in high-voltage circuits. Discharge high-voltage capacitors after removing power.
2. If possible, familiarize yourself with the equipment being tested and the location of its high voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.
3. Use an insulated floor material or a large, insulated floor mat to stand on, and an insulated work surface on which to place equipment; make certain such surfaces are not damp or wet.
4. Use the time-proven "one hand in the pocket" technique while handling an instrument probe. Be particularly careful to avoid contacting a nearby metal object that could provide a good ground return path.
5. When using a probe, touch only the insulated portion. Never touch the exposed tip portion.
6. When testing ac powered equipment, remember that ac line voltage is usually present on some power input circuits such as the on-off switch, fuses, power transformer, etc. any time the equipment is connected to an ac outlet, even if the equipment is turned off.
7. Some equipment with a two-wire ac power cord, including some with polarized power plugs, is the "hot chassis" type. This includes most recent television receivers and audio equipment. A plastic or wooden cabinet insulates the chassis to protect the customer. When the cabinet is removed for servicing, a serious shock hazard exists if the chassis is touched. Not only does this present a dangerous shock hazard, but damage to test instruments or the equipment under test may result from connecting the ground lead of most test instruments (including this oscilloscope) to a "hot chassis". To make measurements in "hot chassis" equipment, always connect an isolation transformer between the ac outlet and the equipment under test. The **B+K Precision** Model TR-110 or 1604 Isolation Transformer, or Model 1653 or 1655 AC Power Supply is suitable for most applications. To be on the safe side, treat all two-wire ac powered equipment as "hot chassis" unless you are sure it has an isolated chassis or an earth ground chassis.
8. Never work alone. Someone should be nearby to render aid if necessary. Training in CPR (cardio-pulmonary resuscitation) first aid is highly recommended.

Instruction Manual

for

B+K PRECISION®

Model 2125

20 MHz, Dual Time Base

Dual-Trace Oscilloscope

This symbol on oscilloscope means "refer to instruction manual for further precautionary information". This symbol appears in the manual where the corresponding information is given.

B+K PRECISION®

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FEATURES

DUAL TIME BASE FEATURES

Dual Sweep Generators

Main sweep gives normal waveform display, delayed sweep may be operated at faster sweep speed to expand a portion of the waveform.

Four Sweep Modes

Choice of main sweep only, delayed sweep only, main sweep and delayed sweep sharing the trace (percentage of main/delayed sweep adjustable), or X–Y.

Adjustable Start Of Delayed Sweep

DELAY TIME POSITION control allows start of delayed sweep to be adjusted.

DUAL TRACE FEATURES

Dual Trace

Model 2125 has two vertical input channels for displaying two waveforms simultaneously. Selectable single trace (either CH 1 or CH 2) or dual trace. Alternate or chop sweep selectable at all sweep rates.

Sum and Difference Capability

Permits algebraic addition or subtraction of channel 1 and channel 2 waveforms, displayed as a single trace. Useful for differential voltage and distortion measurements.

CRT FEATURES

Rectangular CRT

Rectangular CRT with large 8 x 10 centimeter viewing area.

Convenience

Trace rotation electrically adjustable from front panel. 0%, 10%, 90%, and 100% markers for rise time measurements.

VERTICAL FEATURES

High Sensitivity

5 mV/div sensitivity for full bandwidth. 1 mV/div sensitivity with PULL X5 at reduced bandwidth.

Calibrated Voltage Measurements

Accurate voltage measurements (±3%) on 10 calibrated ranges from 5 mV/div to 5 V/ div. Vertical gain fully adjustable between calibrated ranges.

SWEEP FEATURES

Calibrated Time Measurements

Accurate (±3%) time measurements. The main sweep has 23 calibrated ranges from 2.0 s/div to 0.1 μs/div. The delayed sweep has 19 calibrated ranges from 0.1 s/div to 0.1 μs/div. Main sweep time is fully adjustable between calibrated ranges.

X10 Sweep Magnification

Allows closer examination of waveforms, increases maximum sweep rate to 10 ns/div.

TRIGGERING FEATURES

Two Trigger Modes

Selectable normal (triggered) or automatic sweep modes.

Triggered Sweep

Sweep remains at rest unless adequate trigger signal is applied. Fully adjustable trigger level and (+) or (–) slope.

AUTO Sweep

Selectable AUTO sweep provides sweep without trigger input, automatically reverts to triggered sweep operation when adequate trigger is applied.

Five Trigger Sources

Five trigger source selections, including CH 1, CH 2, ALT, EXT, and LINE. In ALT mode, each waveform becomes its own trigger (alternate triggering).

Three Trigger Coupling Choices

Selectable AC, TV H (Line), or TV V (Frame) trigger coupling. TV H position can also be used as low frequency reject and TV V position can be used as high frequency reject.

Video Sync

Frame (TV V) or Line (TV H) triggering selectable for observing composite video waveforms.

Variable Holdoff

Trigger inhibit period after end of sweep adjustable. Permits stable observation of complex pulse trains.

OTHER FEATURES

Component Test Function

Built-in X–Y type component tester applies fixed level ac signal to components for display of signature on CRT.

X–Y Operation

Channel 2 can be applied as horizontal deflection (X-axis) while channel 1 provides vertical deflection (Y-axis).

Built-In Probe Adjust Square Wave

A 0.2 V p-p, 1 kHz square wave generator permits probe compensation adjustment.

Channel 1 Output

A buffered 50Ω output of the channel 1 signal is available at the rear panel for driving a frequency counter or other instruments. The output is 50 mV/div into 50Ω .

Supplied With Two Probes

Low Boy Configuration

Low profile housing saves bench space and allows oscilloscope to be carried like a briefcase.

SPECIFICATIONS

CRT:

Type:
Rectangular with internal graticule.

Display Area:
8 x 10 div (1 div = 1 cm).

Accelerating Voltage:
2 kV.

Phosphor:
P31.

VERTICAL AMPLIFIERS (CH 1 and CH 2)

Sensitivity:
5 mV/div to 5 V/div.
1 mV/div to 1 V/div at PULL X5.

Attenuator:
10 calibrated steps in 1-2-5 sequence. Vernier control gives fully adjustable gain between steps, adjustment range 1/1 to 1/2.5.

Accuracy:
±3%, ±5% at PULL X5.

Input Resistance:
1 MΩ ±2%.

Input Capacitance:
40 pF ±5 pF.

Frequency Response:
5 mV to 5 V/div:
DC to 20 MHz (–3 dB).
1 mV/div to 1 V/div (PULL X5):
DC to 10 MHz (–3 dB).

Rise Time:
Approximately 17.5 ns, 35 ns at PULL X5.

Operating Modes:

CH 1:	CH 1, single trace.
CH 2:	CH 2, single trace.
ALT:	dual trace, alternating.
CHOP:	dual trace, chopped.
ADD:	algebraic sum of CH 1 + CH 2.

Polarity Reversal:
CH 1 only.

Maximum Input Voltage:
400 V dc + ac peak.

Maximum Undistorted Amplitude:
DC-to-20 MHz: 4 divisions.
DC-to-10 MHz: 8 divisions.

HORIZONTAL AMPLIFIER

(Input through channel 2 input)

X–Y mode: switch selectable using X–Y switch.
CH 1: Y axis.
CH 2: X axis.

Sensitivity:
Same as vertical channel 2.

Accuracy:
Y-Axis: ±3%.
X-Axis: ±6%.

Input Impedance:
Same as vertical channel 2.

Frequency Response:
DC to 2 MHz typical (–3 dB) (to 6 divisions horizontal deflection).

X–Y Phase Difference:
Approximately 3° at 50 kHz.

Maximum Input Voltage:
Same as vertical channel 2.

SWEEP SYSTEM

Operating Modes:
Main, Mix (both main sweep and delay sweep displayed), or Delay (only delay sweep displayed), X–Y.

Main Sweep Speed:
0.1 μs/div to 2.0 s/div in 1-2-5 sequence, 23 steps. Vernier control provides fully adjustable sweep time between steps.

Accuracy:
±3%.

Sweep Magnification:
X10, ±5% (0.1 μs and 0.2 μs/div sweep speeds uncalibrated when X10 mag selected).

Delayed Sweep Speed:
0.1 μs/div to 0.1 s/div in 1-2-5 sequence, 19 steps.

Holdoff:
Continuously variable for Main sweep up to 10 times normal.

Delay Time Position:
Continuously variable to control percentage of display that is devoted to main and delay sweep.

TRIGGERING

Trigger Modes:
AUTO (free run) or NORM.

Trigger Source:
CH 1, CH 2, ALT, EXT, LINE.

Maximum External Trigger Voltage:
200 V dc + ac peak.

Trigger Coupling:
AC:
30 Hz to 30 MHz.
HF/TV-H:
Used for triggering from horizontal sync pulses. Low frequencies attenuated.
DC/LF/TV-V:
Used for triggering from vertical sync pulses. DC coupled. High frequencies attenuated.

Trigger Sensitivity:

Internal:	0.5 div.
External:	500 mV.

COMPONENT TESTER

Components Tested:
Resistors, Capacitors, Inductors, and Semiconductors.

Test Voltage:
12 V rms maximum (open).

Test Current:
30 mA maximum (shorted).

Test Frequency:
Line Frequency (60 Hz in USA).

OTHER SPECIFICATIONS

Calibrating Voltage:
1 kHz (±10%) Positive Square Wave,
0.2 V p-p (±2%).

CH 1 Output (on rear panel):

Output Voltage:
Nominal 50 mV/div (into 50-ohm load).

Output Impedance:
Approximately 50 ohms.

Frequency Response:
20 Hz to 10 MHz, –3 dB, into 50 Ω
20 Hz to 20 MHz, –6 dB, into 1 MΩ

Trace Rotation:
Electrical, front panel adjustable.

Power Requirements:
115 V/230 V ±10%, 50/60 Hz, approximately 40 W.

Dimensions:
320 x 130 x 361 mm (12.6 x 5.1 x 14.2").

Weight:
Approximately 6.8 kg (15 lbs).

Environment:

Operating:

+10°C to +35°C, 80% maximum relative humidity for full specifications.

0°C to +40°C, 80% maximum relative humidity, full operating range.

Storage:

–30°C to +70°C, 90% maximum relative humidity.

SUPPLIED ACCESSORIES:

Two Probes.
Schematic Diagram and Parts List.
AC Power Cord.

OPTIONAL ACCESSORIES:

Deluxe 10:1/Direct Probe, Model PR-37.
100:1 Probe, Model PR-100.
Carrying Case, Model LC-210

CONTROLS AND INDICATORS

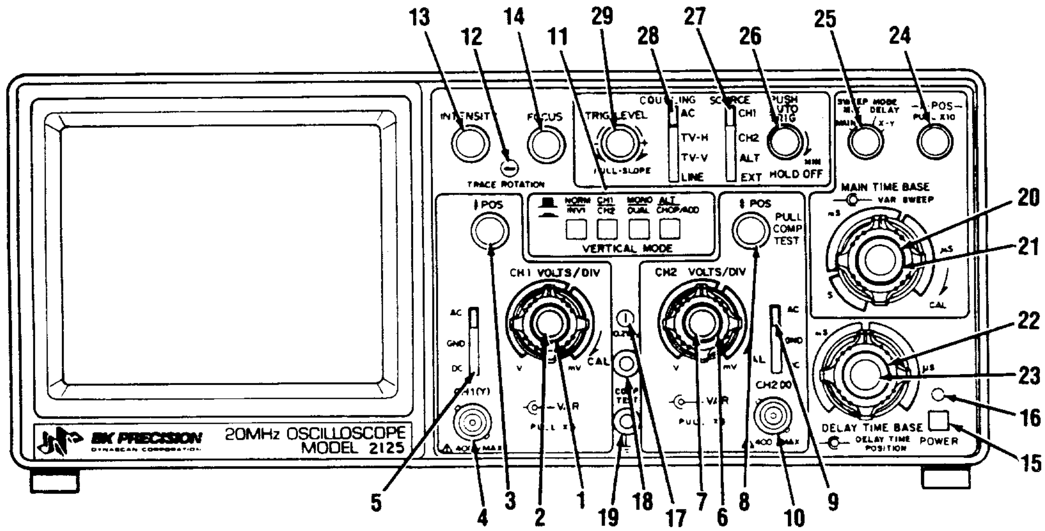

Fig. 1. Front Panel Controls and Indicators.

VERTICAL CONTROLS

CHANNEL 1 CONTROLS

1. **CH 1 VOLTS/DIV Control.** Vertical attenuator for channel 1. Provides step adjustment of vertical sensitivity. When channel 1 **VARiable** control is set to **CAL**, vertical sensitivity is calibrated in 10 steps from 5 mV/div to 5 V/div in a 1-2-5 sequence. When the X–Y mode of operation is selected, this control provides step adjustment of Y-axis sensitivity.

2. **VAR/PULL X5 Control.**

   VARiable: Rotation provides vernier adjustment of channel 1 vertical gain. In the fully clockwise **CAL** position, the vertical attenuator is calibrated at the maximum gain point. Counterlockwise rotation decreases gain. In X–Y operation, this control becomes the vernier Y-axis gain control.

   PULL X5 (Push-Pull Switch): Multiplies the channel 1 gain five times; for example, 5 mV/div sensitivity becomes 1 mV/div sensitivity.

3. ♦ **POSition Control.** Rotation adjusts vertical position of channel 1 trace. In X–Y operation, rotation adjusts vertical position of display.

4. **AC-GND-DC Switch.** Three-position lever switch which operates as follows:

   AC Position:

   Channel 1 input signal is capacitively coupled; dc component is blocked.

   GND Position:

   Opens signal path and grounds input to vertical amplifier. This provides a zero-volt base line, the position of which can be used as a reference when performing dc measurements.

   DC Position:

   Direct coupling of channel 1 input signal; both ac and dc component of signal produce vertical deflection.

5. **CH 1 (Y) Input Jack.** Vertical input for channel 1. Y axis input for X–Y operation.

CHANNEL 2 CONTROLS

6. **CH 2 VOLTS/DIV Control.** Vertical attenuator for channel 2. Provides step adjustment of vertical sensitivity. When channel 2 **VARiable** control is set to **CAL**, vertical sensitivity is calibrated in 10 steps from 5 mV/div to 5 V/div in a 1-2-5 sequence. In X–Y operation, this control provides step adjustment of X-axis sensitivity.
7. **VAR/PULL X5 Control.**

   VARiable: Rotation provides vernier adjustment of channel 2 vertical gain. In the fully clockwise **CAL** position, the vertical attenuator is calibrated at the maximum gain point. Counterclockwise rotation decreases gain. In X–Y operation, this control becomes the vernier Y-axis gain control.

   PULL X5 (Push-Pull Switch): Multiplies the channel 2 gain five times; for example, 5 mV/div sensitivity becomes 1 mV/div sensitivity.
8. **⬍ POSition/PULL TEST COMPonent Control.** When control is pushed in, rotation adjusts vertical position of channel 2 trace. Pulling the control out selects the Component Test Mode of operation and disables all other controls except **INTENSITY, FOCUS, SWEEP MODE,** and **X POS/PULL X10.** The **SWEEP MODE** switch should be in the **MAIN** position for the Component Test Mode of operation.
9. **AC-GND-DC Switch.** Three-position lever switch which operates as follows:

   AC Position:
   Channel 2 input signal is capacitively coupled; dc component is blocked.

   GND Position:
   Opens signal path and grounds input to vertical amplifier. This provides a zero-volt base line, the position of which can be used as a reference when performing dc measurements.

   DC Position:
   Direct coupling of channel 2 input signal; both ac and dc component of signal produce vertical deflection.
10. **CH 2 (X) Input Jack.** Vertical input for channel 2. X-axis input in X–Y operation.
11. **VERTICAL MODE Switch Assembly.**

    NORM/INV 1 Switch:
    When this switch is released, the polarity of the channel 1 signal is normal. When this switch is engaged, the polarity of the channel 1 input signal is reversed, thus inverting the waveform.

    CH 1/CH 2 Switch:
    When this switch is released, the channel 1 signal is displayed. When this switch is engaged, the channel 2 signal is displayed.

    MONO/DUAL Switch:
    When this switch is released, the single-trace mode is selected and the signal selected by the **CH 1/ CH 2** switch will be displayed (or the sum of channels 1 and 2 if the **ALT/CHOP** switch is engaged). When this switch is engaged, both the channel 1 and channel 2 signals will be displayed.

    ALT/CHOP/ADD Switch:
    When this switch is released in the dual-trace mode, the channel 1 and channel 2 inputs are alternately displayed (normally used at faster sweep speeds). When this switch is engaged in the dual-trace mode, the channel 1 and channel 2 inputs are chopped and displayed simultaneously (normally used at slower sweep speeds). When this switch is released in the single-trace mode, only the signal selected by the **CH 1/CH 2** switch will be displayed. When this switch is engaged in the single-trace mode, the input from channel 1 and channel 2 are summed and displayed as a single signal. When the **INV 1** switch is also engaged, the input from channel 1 is subtracted from channel 2 and the difference is displayed as a single signal.
12. **TRACE ROTATION Control.** Screwdriver adjustment that allows trace to be adjusted perfectly horizontal.
13. **INTENSITY Control.** Adjusts brightness of trace.
14. **FOCUS Control.** Adjusts trace focus.
15. **POWER Switch.** Turns oscilloscope on and off.
16. **POWER Indicator.** Lights when oscilloscope is on.
17. **CAL Terminal.** This terminal provides a 1 kHz, 0.2-volt peak-to-peak square wave signal. This is useful for probe compensation adjustment and a general check of oscilloscope calibration accuracy.
18. **COMPonent TEST Jack.** Positive polarity input jack for connection to component in the Component Test Mode of operation.
19. **⏚ Jack.** Oscilloscope chassis ground, and earth ground via three-wire ac power cord. Also serves as negative polarity (common) jack for connection to component in the Component Test Mode of operation.

HORIZONTAL CONTROLS

SWEEP CONTROLS

20. **MAIN TIME BASE Control.** Provides step selection of sweep rate for the main time base. When the **VAR SWEEP** control is set to **CAL**, sweep rate is calibrated. This control has 23 steps from 0.1 µs/div to 2.0 s/div, in a 1-2-5 sequence.
21. **VAR SWEEP Control.** Rotation of control is vernier adjustment for sweep rate. In fully clockwise (**CAL**) position, sweep rate is calibrated.
22. **DELAY TIME BASE Control.** Provides step selection of sweep rate for delayed sweep time base. This control has 19 steps from 0.1 µs/div to 0.1 s/div, in a 1-2-5 sequence.
23. **DELAY TIME POSITION Control.** Sets starting point of delayed sweep. Counterclockwise rotation causes delayed sweep to begin earlier.
24. **◄► X POSition/PULL X10 Control.**

    ◄► X POSition:
    Horizontal position control.

    PULL 10X MAG:
    Selects ten times sweep magnification when pulled out, normal when pushed in. Increases maximum sweep rate to 10 ns/div.
25. **SWEEP MODE Switch.** Four position switch used to select desired sweep (horizontal) mode as follows:

    MAIN Position:
    Only the main sweep operates, with the delayed sweep dromant.

    MIX Position:
    The main and delayed sweep share a single trace with the main sweep occupying the left portion of the display and the delayed sweep occupying the right portion of the display. The **DELAY TIME POSITION** control determines the percentage of the display that is main sweep and the percentage of the display that is delayed sweep (the main sweep is brighter than the delayed sweep). The delayed sweep speed can not be slower than the main sweep speed.

    DELAY Position:
    Only the delayed sweep operates with the main sweep dormant. The **DELAY TIME POSITION** control determines the starting point of the delayed sweep.

    X–Y Position:
    The **X–Y** mode of operation is selected. The channel 1 input becomes the Y-axis and the channel 2 input becomes the X-axis. The Trigger **SOURCE** and Trigger **COUPLING** controls are disabled when the **X–Y** switch is engaged. The **VERTICAL MODE** switches should all be disengaged when the **X–Y** mode of operation is selected.

TRIGGERING CONTROLS

26. **PUSH AUTO TRIG/HOLD OFF Control.**

    PUSH AUTO TRIG:
    When this control is pushed in, the automatic triggering mode is selected. In the automatic triggering mode, the oscilloscope generates sweep (free runs) in absence of an adequate trigger; it automatically reverts to triggered sweep operation when an adequate trigger signal is present. Auto triggering is applicable to both the main sweep and delayed sweep. When this control is pulled out, normal triggered sweep operation is selected. A sweep is generated only when an adequate trigger signal is present. When the oscilloscope is set up for multiple trigger sources (**ALT** trigger mode), all the trigger sources must be present to obtain a sweep.

    HOLDOFF:
    Rotation of this control adjusts holdoff time (trigger inhibit period beyond sweep duration). When control is rotated fully clockwise, the holdoff period is **MIN**imum (normal). The holdoff period increases progressively with counterclockwise rotation.
27. **Trigger SOURCE Switch.** Selects source of sweep trigger. Four position lever switch with the following positions:

    CH 1:
    The channel 1 input signal becomes the sweep trigger, regardless of the **VERTICAL MODE** switch setting.

    CH 2:
    The channel 2 signal becomes the sweep trigger, regardless of the **VERTICAL MODE** switch setting.

    ALT:
    The trigger source follows the **VERTICAL MODE** switch setting for single trace operation (for dual trace operation, the triggering source alternates between channel 1 and channel 2). This mode permits each waveform viewed to become its own trigger signal. For dual-trace and **NORM** trigger mode, triggering is impossible unless input signals (with sufficient triggering level) are applied to both input jacks. Triggering is also

impossible when **CHOP** dual-trace operation and **NORM** triggering mode are selected and adequate trigger signals are not applied to both inputs.

EXT:

Signal from **EXT TRIG** jack (located on the rear panel) becomes sweep trigger.

28. **Trigger COUPLING Switch.** Selects trigger coupling. Four-position lever switch with the following positions:

AC:

Trigger is capacitively coupled; dc component is blocked.

HF/TV-H:

Used for triggering from horizontal sync pulses. Also serves as low frequency reject trigger coupling.

DC/LF/TV-V:

Used for triggering from vertical sync pulses. Also serves as high frequency reject trigger coupling. Direct coupled for very low-frequency signals.

LINE:

Signal derived from input line voltage (50/60 Hz) becomes trigger.

29. **TRIG LEVEL/PULL—SLOPE Control.**

TRIG LEVEL Control:

Trigger level adjustment, determines the point on the triggering waveform where the sweep is triggered. Rotation in the (–) direction (counterclockwise) selects more negative point of triggering, and rotation in the (+) direction (clockwise) selects more positive point of triggering.

PULL—SLOPE Switch:

Two-position push pull switch. The pushed in position selects a positive-going slope and the pulled out position selects a negative-going slope as triggering point for main sweep.

REAR PANEL CONTROLS

30. **EXT TRIG Jack.** External trigger input for single and dual-trace operation.
31. **CH 1 OUTPUT Jack.** Output terminal where sample of channel 1 signal is available. Amplitude of output is nominally 50 mV per division of vertical deflection seen on CRT when terminated into 50 Ω. Output impedance is 50 Ω.
32. **Power Cord Receptacle.**
33. **Fuse Holder/Line Voltage Selector.** Contains fuse and selects line voltage.

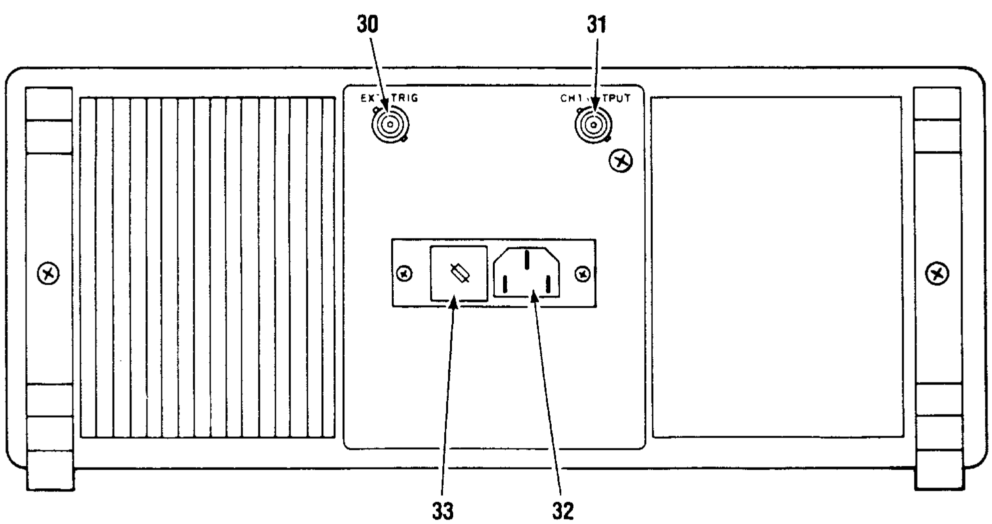

Fig. 2. Rear Panel Controls.

OPERATING INSTRUCTIONS

SAFETY PRECAUTIONS

WARNING

The following precautions must be observed to help prevent electric shock.

1. When the oscilloscope is used to make measurements in equipment that contains high voltage, there is always a certain amount of danger from electrical shock. The person using the oscilloscope in such conditions should be a qualified electronics technician or otherwise trained and qualified to work in such circumstances. Observe the TEST INSTRUMENT SAFETY recommendations listed on the inside front cover of this manual.
2. Do not operate this oscilloscope with the case removed unless you are a qualified service technician. High voltage up to 2,000 volts is present when the unit is operating with the case removed.
3. The ground wire of the 3-wire ac power plug places the chassis and housing of the oscilloscope at earth ground. Use only a 3-wire outlet, and do not attempt to defeat the ground wire connection or float the oscilloscope; to do so may pose a great safety hazard.
4. Special precautions are required to measure or observe line voltage waveforms with any oscilloscope. Use the following procedure:
   a. Do not connect the ground clip of the probe to either side of the line. The clip is already at earth ground and touching it to the hot side of the line may "weld" or "disintegrate" the probe tip and cause possible injury, plus possible damage to the scope or probe.
   b. Insert the probe tip into one side of the line voltage receptacle, then the other. One side of the receptacle should be "hot" and produce the waveform. The other side of the receptacle is the ac return and no waveform should result.

EQUIPMENT PROTECTION PRECAUTIONS

CAUTION

The following precautions will help avoid damage to the oscilloscope.

1. Never allow a small spot of high brilliance to remain stationary on the screen for more than a few seconds. The screen may become permanently burned. A spot will occur when the scope is set up for X–Y operation and no signal is applied. Either reduce the intensity so the spot is barely visible, apply signal, or switch back to normal sweep operation. It is also advisable to use low intensity with **AUTO** triggering and no signal applied for long periods. A high intensity trace at the same position could cause a line to become permanently burned onto the screen.
2. Do not obstruct the ventilating holes in the case, as this will increase the internal temperature.
3. Excessive voltage applied to the input jacks may damage the oscilloscope. The maximum ratings of the inputs are as follows:

   CH 1 and CH 2:
   400 V dc + ac peak.
   EXT TRIG:
   200 V dc + ac peak.

   Never apply external voltage to the **COMP TEST** *or* **CH 1 OUTPUT** *jacks.*
4. Always connect a cable from the ground terminal of the oscilloscope to the chassis of the equipment under test. Without this precaution, the entire current for the equipment under test may be drawn through the probe clip leads under certain circumstances. Such conditions could also pose a safety hazard, which the ground cable will prevent.
5. The probe ground clips are at oscilloscope and earth ground and should be connected only to the earth ground or isolated common of the equipment under test. To measure with respect to any point other than the common, use CH 2—CH 1 subtract operation (**ADD** mode and **INV 1**), with the channel 2 probe at the point of measurement and the channel 1 probe at the point of reference. Use this method even if the reference point is a dc voltage with no signal.
6. Never apply a voltage to the **COMP TEST** jacks. Only non-powered circuits should be tested with this unit. Testing powered circuits could damage the instrument and increase the risk of electrical shock.
7. Always discharge capacitors (by shorting the leads together) before testing. If not discharged, capacitors might retain a high enough voltage to damage the oscilloscope or increase the risk of electrical shock.

OPERATING TIPS

The following recommendations will help obtain the best performance from the oscilloscope.

1. Always use the probe ground clips for best results, attached to a circuit ground point near the point of measurement. Do not rely solely on an external ground wire in lieu of the probe ground clips as undesired signals may be induced.
2. Avoid the following operating conditions:
   a. Direct sunlight.
   b. High temperature and humidity.
   c. Mechanical vibration.
   d. Electrical noise and strong magnetic fields, such as near large motors, power supplies, transformers, etc.
3. Occasionally check trace rotation, probe compensation, and calibration accuracy of the oscilloscope using the procedures found in the MAINTENANCE section of this manual.
4. Terminate the output of a signal generator in its characteristic impedance to minimize ringing, especially if the signal has fast edges such as square waves or pulses. For example, the typical 50 Ω output of a square wave generator should be terminated into an external 50 Ω terminating resistor and connected to the oscilloscope with 50 Ω coaxial cable.
5. Probe compensation adjustment matches the probe to the input of the scope. For best results, compensation should be adjusted initially, then the same probe always used with the same channel. Probe compensation should be readjusted when a probe from a different oscilloscope is used.
6. When using the component test function, make sure that you do not touch the component's leads or the test lead tips. Doing so will place your body in parallel with the device being tested and could greatly affect the display.

INITIAL STARTING PROCEDURE

Until you familiarize yourself with the use of all controls, the settings shown in Fig. 3 may be used as a reference point to obtain a trace on the CRT in preparation for waveform observation.

1. Press the **POWER** switch; the unit will be turned on and the pilot light will be illuminated.
2. The **CH 1/CH 2** switch should be set to **CH 1** (disengaged), the **SWEEP MODE** switch set to **MAIN**, and the **TRIG LEVEL** control should be set to **AUTO** (pushed in).
3. A trace should appear on the CRT. Adjust the trace brightness with the **INTENSITY** control, and the trace sharpness with the **FOCUS** control.

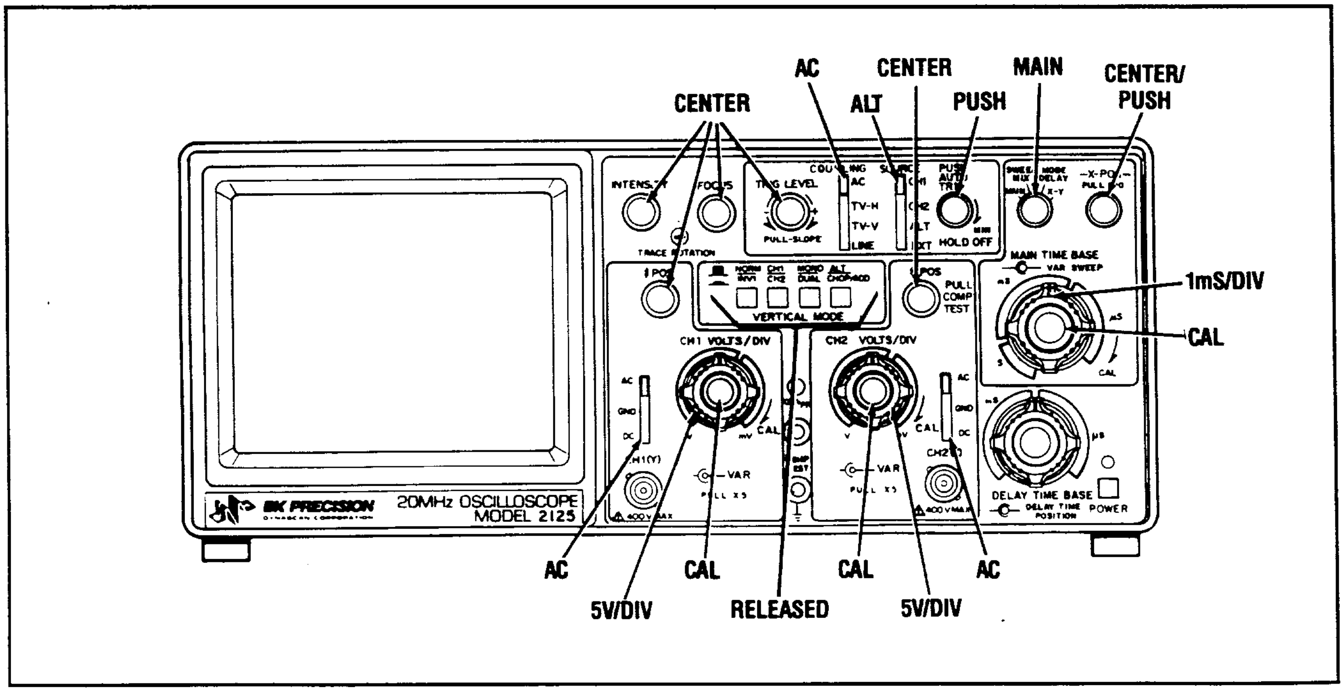

Fig. 3. Initial Control Settings.

SINGLE TRACE DISPLAY

Either channel 1 or channel 2 may be used for single-trace operation. The advantage of using channel 1 is that the waveform on the display can be inverted with the **INV 1** switch if desired.

1. Perform the steps of the "Initial Starting Procedure" with the **CH 1/CH 2** switch set to **CH 1**.
2. Connect the probe to the **CH 1 (Y)** input jack.
3. Connect the probe ground clip to the chassis or common of the equipment under test. Connect the probe tip to the point of measurement.
4. If no waveforms appear, increase the sensitivity by turning the **CH 1 VOLTS/ DIV** control clockwise to a position that gives 2 to 6 divisions vertical deflection.
5. The display on the CRT may be unsynchronized. Refer to the "Triggering" paragraphs in this section for procedures on setting triggering and sweep time controls to obtain a stable display showing the desired number of waveforms.

DUAL TRACE DISPLAY

In observing simultaneous waveforms on channel 1 and 2, the waveforms are usually related in frequency, or one of the waveforms is synchronized to the other, although the basic frequencies are different. If the two waveforms have no phase or frequency relationship, there is seldom reason to observe both waveforms simultaneously. However, when the trigger **SOURCE** switch is set to the **ALT** position, two waveforms not related in frequency or period can be simultaneously viewed.

1. Connect probes to both the **CH 1 (Y)** and **CH 2 (X)** input jacks.
2. Connect the ground clips of the probes to the chassis or common of the equipment under test. Connect the tips of the probes to the two points in the circuit where waveforms are to be measured.
3. When the **MONO/DUAL** switch is set to **MONO** and the **ALT/CHOP/ADD** switch is set to **ADD**, the algebraic sum of CH 1 + CH 2 is displayed as a single trace. When the **INV 1** switch is also engaged, the algebraic difference of CH 2—CH 1 is displayed.
4. To view both waveforms simultaneously, set the **MONO/DUAL** switch to **DUAL** and select either **ALT** (alternate) or **CHOP** with the **ALT/CHOP/ADD** switch.
5. In the **ALT** mode, one sweep displays the channel 1 signal and the next sweep displays the channel 2 signal in an alternating sequence. Alternate sweep is normally used for viewing high-frequency or high-speed waveforms at sweep times of 1 ms/div and faster, but may be selected at any sweep time.
6. In the **CHOP** mode, the sweep is chopped and switched between channel 1 and channel 2. Chop sweep is normally used for low-frequency or low-speed waveforms at sweep times of 1 ms/div and slower.
   a. If chop sweep is used at sweep times of 0.2 ms/div and faster, the chop rate becomes a significant portion of the sweep and may become visible in the displayed waveform. However, you may select chop sweep at any sweep time for special applications. For example, the only way to observe simultaneous events on a dual-trace scope at any sweep rate is with chop sweep.
   b. Note that this oscilloscope is not intended to be used with the **CHOP** display mode and the **ALT** triggering source mode selected simultaneously. It will probably be impossible to synchronize the display with this combination. Use the **ALT** display mode instead or select trigger **SOURCE** of **CH 1** or **CH 2**.
7. Adjust the channel 1 and 2 ⬍ **POSition** controls to place the channel 1 trace above the channel 2 trace.
8. Set the **CH 1** and **CH 2 VOLTS/DIV** controls to a position that gives 2 to 3 divisions of vertical deflection for each trace. If the display on the screen is unsynchronized, refer to the "Triggering" paragraphs in this section of the manual for procedures for setting triggering and sweep time controls to obtain a stable display showing the desired number of waveforms.

TRIGGERING

The Model 2125 Oscilloscope provides versatility in sync triggering for ability to obtain a stable, jitter-free display in single-trace, or dual-trace operation. The proper settings depend upon the type of waveforms being observed and the type of measurement desired. An explanation of the various controls which affect synchronization is given to help you select the proper setting over a wide range of conditions.

PUSH AUTO TRIG Switch

1. The pulled out position provides normal triggered sweep operation. The sweep remains at rest until the selected trigger source signal crosses the threshold level set by the **TRIG LEVEL** control. The trigger causes one sweep to be generated, after which the sweep again remains at rest until triggered. In the normal triggering mode, there will be no trace unless an adequate trigger signal is present. In the **ALT VERTICAL MODE** of dual trace operation with the **SOURCE** switch also set to **ALT**, there will be no

trace unless both channel 1 and channel 2 signals are adequate for triggering. Typically, signals that produce even 1/2 division of vertical deflection are adequate for normal triggered sweep operation.

2. In the **AUTO** position (pushed in), automatic sweep operation is selected. In automatic sweep operation, the sweep generator free runs to generate a sweep without a trigger signal. However, it automatically switches to triggered sweep operation if an acceptable trigger source signal is present. The **AUTO** position is handy when first setting up the scope to observe a waveform; it provides sweep for waveform observation until other controls can be properly set. Once the controls are set, operation is often switched back to the normal triggering mode, since it is more sensitive. Automatic sweep must be used for dc measurements and signals of such low amplitude that they will not trigger the sweep.

Trigger SOURCE Switch

The trigger **SOURCE** switch (**CH 1**, **CH 2**, etc.) selects the signal to be used as the sync trigger.

1. If the **SOURCE** switch is set to **CH 1** (or **CH 2**) the channel 1 (or channel 2) signal becomes the trigger source regardless of the **VERTICAL MODE** selection. **CH 1**, or **CH 2** are often used as the trigger source for phase or timing comparison measurements.
2. When the **ALT** position is selected, the trigger source is dependent upon the **VERTICAL MODE** selection. In this manner, each waveform being observed becomes its own trigger signal.
   a. When the vertical mode is changed from **CH 1** to **CH 2**, the trigger source is also changed from **CH 1** to **CH 2**, and vice versa. This is very convenient for single trace operation.
   b. When the **ALT** dual-trace **VERTICAL MODE** is selected, the trigger source alternates between **CH 1** and **CH 2** with each sweep. This is convenient for checking amplitudes, waveshape, or waveform period measurements, and even permits simultaneous observation of two waveforms which are not related in frequency or period. However, this setting is not suitable for phase or timing comparison measurements. For such measurements, both traces must be triggered by the same sync signal.
   c. When the **CHOP** dual-trace **VERTICAL MODE** is selected, synchronization of the display is not always possible. Use the **ALT** mode instead, or change the **SOURCE** switch setting to **CH 1**, or **CH 2**.
3. If the **SOURCE** switch is set to the **EXT** position, the signal applied to the **EXT TRIG** jack becomes the trigger source. This signal must have a timing relationship to the displayed waveforms for a synchronized display.

TRIG LEVEL and SLOPE Controls
(Refer to Fig. 4)

A sweep trigger is developed when the trigger source signal crosses a preset threshold level. Rotation of the **TRIG LEVEL** control varies the threshold level. In the + direction, the triggering threshold shifts to a more positive value, and in the – direction, the triggering threshold shifts to a more negative value. When the control is centered, the threshold level is set at the approximate average of the signal used as the triggering source. Proper adjustment of this control usually synchronizes the display.

The **TRIG LEVEL** control adjusts the start of the sweep to almost any desired point on a waveform. On sine wave signals, the phase at which sweep begins is variable. Note that if the **TRIG LEVEL** control is rotated toward its extreme + or – setting, no sweep will be developed in the normal trigger mode because the triggering threshold exceeds the peak amplitude of the sync signal.

When the **SLOPE** control is set to the + position (pushed in), the sweep is developed from the trigger source waveform as it crosses a threshold level in a positive-going direction. When the **SLOPE** control is set to the – position (pulled out), a sweep trigger is developed from the trigger source waveform as it crosses the threshold level in a negative-going direction.

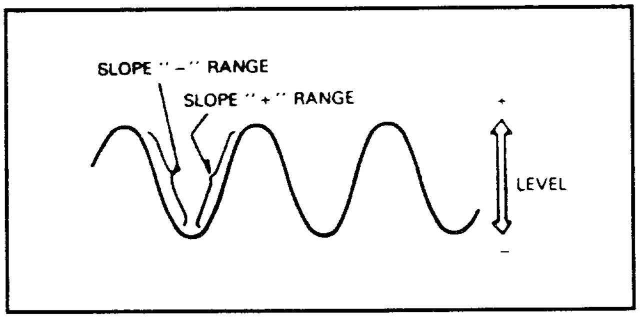

Fig. 4. Function of Slope and Level Controls.

Trigger COUPLING Switch

1. Use the **AC** position for viewing most types of waveforms. The trigger signal is capacitively coupled and may be used for all signals from 30 Hz to 30 MHz.
2. The **TV H** and **TV V** positions are primarily for viewing composite video waveforms. Horizontal sync pulses are selected as trigger when the trigger **COUPLING** switch is set to the **TV H** position, and vertical sync pulses are selected as trigger when the trigger **COUPLING** switch is set to the **TV V** position. The

TV H and TV V positions may also be used as low frequency reject and high frequency reject coupling respectively (with a cut off frequency of about 400 Hz). Additional procedures for observing video waveforms are given later in this section of the manual.

3. If the **COUPLING** switch is set to the **LINE** position, triggering is derived from the input line voltage (50/60 Hz) and the trigger **SOURCE** switch is disabled. This is useful for measurements that are related to line frequency.

MAIN TIME BASE Control

Set the **MAIN TIME BASE** control to display the desired number of cycles of the waveform. If there are too many cycles displayed for good resolution, switch to a faster sweep time. If only a line is displayed, try a slower sweep time. When the sweep time is faster than the waveform being observed, only part of it will be displayed, which may appear as a straight line for a square wave or pulse waveform.

HOLDOFF Control

(Refer to Fig. 5)

A "holdoff" period occurs immediately after the completion of each sweep, and is a period during which triggering of the next sweep is inhibited. The normal holdoff period varies with sweep rate, but is adequate to assure complete retrace and stabilization before the next sweep trigger is permitted. The **HOLDOFF** control allows this period to be extended by a variable amount if desired.

This control is usually set to the **MIN** position (fully clockwise) because no additional holdoff period is necessary. The **HOLDOFF** control is useful when a complex series of pulses appear periodically such as in Fig. 5A. Improper sync may produce a double image as in Fig. 5B. Such a display could be synchronized with the **VAR SWEEP** control, but this is impractical because time measurements are then uncalibrated. An alternate method of synchronizing the display is with the **HOLDOFF** control.

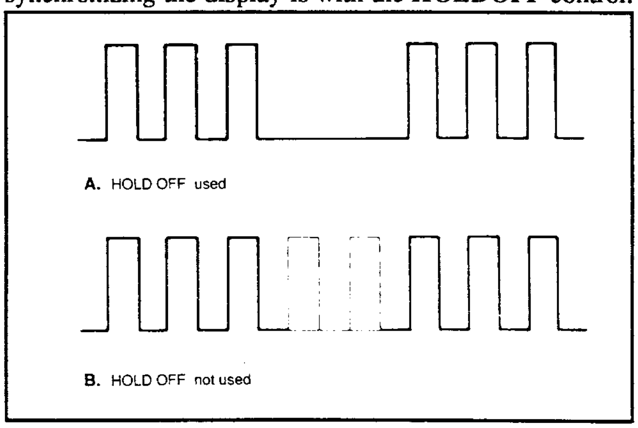

Fig. 5. Use of HOLDOFF Control.

The sweep speed remains the same, but the triggering of the next sweep is "held off" for the duration selected by the **HOLDOFF** control. Turn the **HOLDOFF** control counterclockwise from the **MIN** position until the sweep starts at the same point of the waveform each time.

MAGNIFIED SWEEP OPERATION

Since merely shortening the sweep time to magnify a portion of an observed waveform can result in the desired portion disappearing off the screen, magnified display should be performed using magnified sweep.

Using the ◀▶ **X POS**ition control, adjust the desired portion of waveform to the center of the CRT. Pull out the **PULL X10** knob to magnify the display ten times. For this type of display the sweep time is the **MAIN TIME BASE** control setting divided by 10. Rotation of the ◀▶ **X POS**ition control can then be used to select the desired portion of the waveforms.

DELAYED SWEEP OPERATION

(Refer to Fig. 6)

Delayed sweep operation is achieved by use of both the main sweep and the delayed sweep and allows any portion of a waveform to be magnified for observation. Unlike **X10** magnification, delayed sweep allows selectable steps of magnification.

1. Set the **SWEEP MODE** switch to the **MAIN** position and adjust the oscilloscope for a normal display.
2. Set the **SWEEP MODE** switch to the **MIX** position. The display will show the main sweep on the left portion (representing the **MAIN TIME BASE** control setting) and the delayed sweep on the right portion (representing the **DELAY TIME BASE** control setting). The **MAIN TIME BASE** portion of the trace will be brighter than the delayed time base portion. Fig. 6 shows a typical display for the **MIX** display mode.

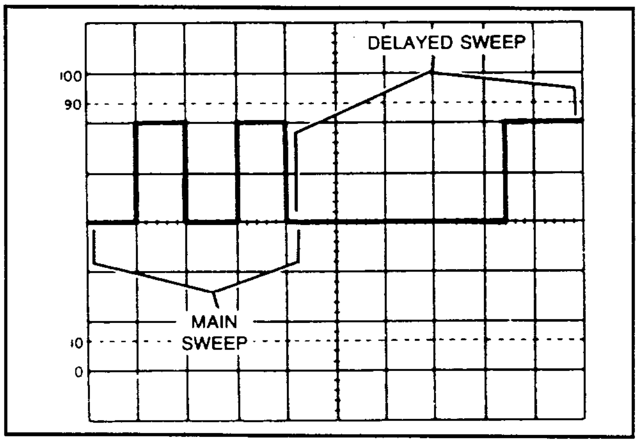

Fig. 6. MIX SWEEP MODE Display.

3. Shift the percentage of the display that is occupied by the main sweep by changing the **DELAY SWEEP POSITION** control setting. Clockwise rotation causes more of the display to be occupied by the main sweep and counterclockwise rotation causes more of the display to be occupied by the delayed sweep.
4. Set the **SWEEP MODE** switch to the **DELAY** position to display only the magnified delayed sweep portion of the display.

NOTE

In order to obtain meaningful results with delayed sweep, the **DELAY TIME BASE** control must set be set to a faster sweep speed than the **MAIN TIME BASE** control. Because of this, the oscilloscope automatically prevents (electrically) the **DELAY TIME BASE** from being set to a slower sweep speed than the **MAIN TIME BASE**. For example, if the **MAIN TIME BASE** control is set to **0.1 ms/div**, the slowest possible **DELAY TIME BASE** sweep speed is also **0.1 ms/div**, even if the control is set slower.

X–Y OPERATION

X–Y operation permits the oscilloscope to perform many measurements not possible with conventional sweep operation. The CRT display becomes an electronic graph of two instantaneous voltages. The display may be a direct comparison of the two voltages such as stereoscope display of stereo signal outputs. However, the **X–Y** mode can be used to graph almost any dynamic characteristic if a transducer is used to change the characteristic (frequency, temperature, velocity, etc.) into a voltage. One common application is frequency response measurements, where the Y axis corresponds to signal amplitude and the X axis corresponds to frequency.

1. Set the **SWEEP MODE** switch to the **X–Y** position. In this mode, channel 1 becomes the Y axis input and channel 2 becomes the X axis input. All **VERTICAL MODE** switches should be disengaged for X–Y operation.
2. The X and Y positions are now adjusted using the ◀▶ **X POSition** and the channel 1 ⬍ **POSition** controls respectively.
3. Adjust the amount of vertical (Y axis) deflection with the **CH 1 VOLTS/DIV** and **VARiable** controls.
4. Adjust the amount of horizontal (X axis) deflection with the **CH 2 VOLTS/DIV** and **VARiable** controls.

COMPONENT TEST OPERATION

CAUTION

Do not apply an external voltage to the **COMP TEST** *jacks. Only non-powered circuits should be tested with this unit. Testing powered circuits could damage the instrument and increase the risk of electrical shock.*

The component test function produces a component "signature" on the CRT by applying an ac signal across the device and measuring the resulting ac current. The display represents a graph of voltage (X) versus current. The component test function can be used to view the signatures of resistors, capacitors, inductors, diodes, and other semi-conductor devices. Devices may be analyzed in-circuit or out-of-circuit and combinations of two or more devices may be displayed simultaneously. Each component produces a different signature and the components can be analyzed as follows:

Resistors

A purely resistive impedance produces a signature that is a straight line. A short circuit produces a vertical line and an open circuit causes a horizontal line. Therefore, the higher the resistance, the closer to horizontal the trace will be. Values from 10 Ω to about 5 kΩ are within measurement range. Values below 10 Ω will appear to be a dead short while values above 5 kΩ will appear to be an open circuit. Fig. 7 shows some typical resistance signatures.

To test a resistor, insert the resistor's leads into the red and black **COMP TEST** jacks (make sure that the leads touch the metal walls inside the jacks). To test in-circuit, a pair of test leads can be used to connect the **COMP TEST** jacks to the component(s).

Capacitors

CAUTION

Be sure to discharge capacitors (by shorting the leads together) before connecting them to the **COMP TEST** *jacks. Some capacitors might retain a voltage high enough to damage the instrument.*

A purely capacitive impedance produces a signature that is an ellipse or circle. Value is determined by the size and shape of the ellipse. A very low capacitance causes the ellipse to flatten out horizontally and become closer to a straight horizontal line and a very high capacitance causes the ellipse to flatten out vertically and become closer to a straight vertical line. Values from about 0.33 µF to about 330 µF are within measurable range. Values below 0.33 µF

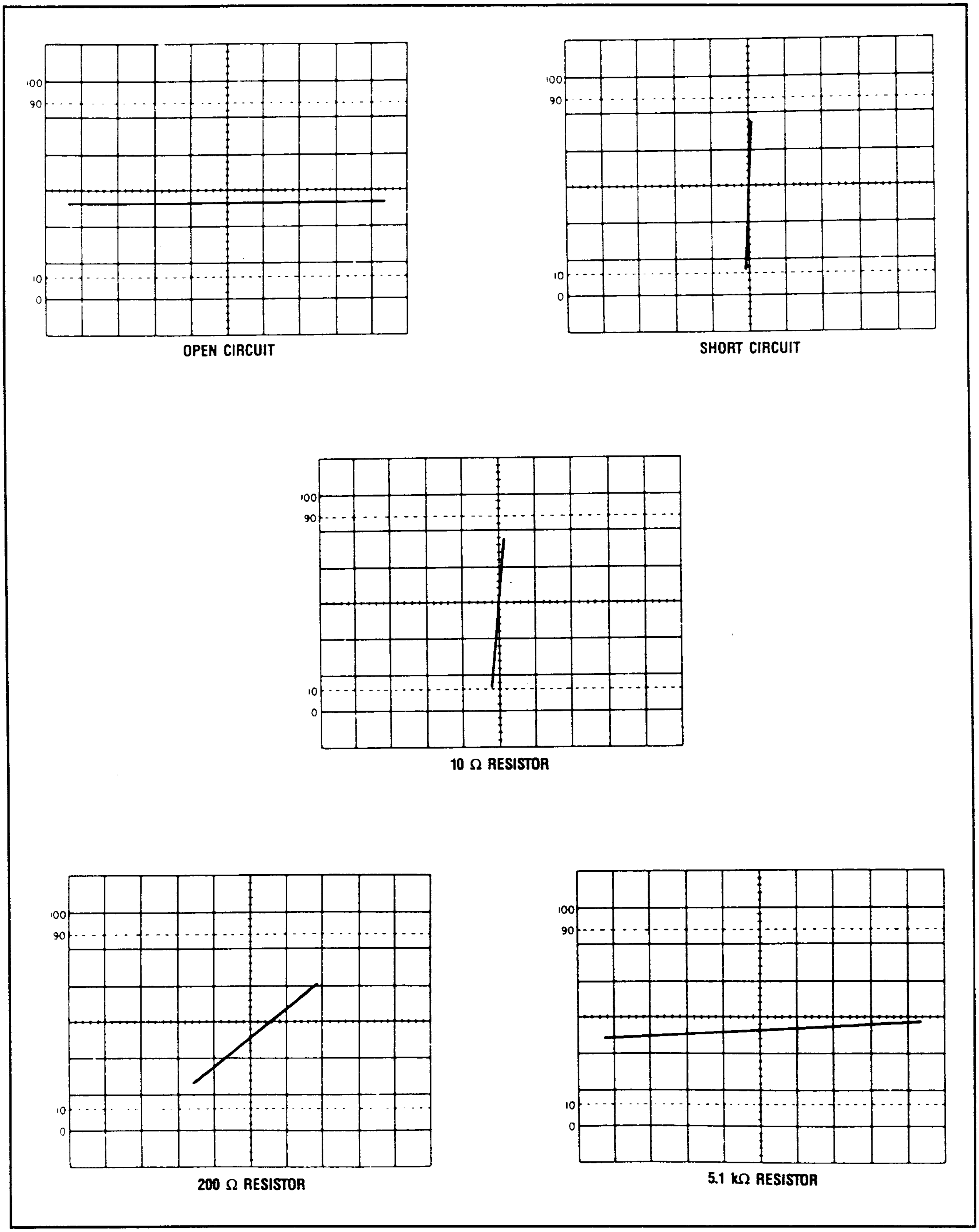

Fig. 7. Typical Resistance Signatures.

will be hard to distinguish from an open circuit and values above 330 µF will be hard to distinguish from a short circuit. Fig. 8 shows several typical capacitance signatures.

To test a capacitor, insert the capacitor's leads into the red and black **COMP TEST** jacks (make sure that the leads touch the metal walls inside the jacks). To test in-circuit or to test a capacitor with leads that are too short to fit into the **COMP TEST** jacks, a pair of test leads can be used to connect the **COMP TEST** jacks to the component(s).

Inductors

Like capacitance, a purely inductive impedance produces a signature that is an ellipse or circle and value is determined by the size and shape of the ellipse. A very high inductance causes the ellipse to flatten out horizontally and a very low inductance causes the ellipse to flatten out vertically. Values from about 0.05 H to about 5 H are within measurement range. Values below 0.05 H will be hard to distinguish from a short circuit and values above 5 H will be hard to distinguish from an open. Fig. 9 shows several typical inductance signatures.

To test an inductor, insert the inductor's leads into the red and black **COMP TEST** jacks (make sure that the leads touch the metal walls inside the jacks). To test in-circuit or to test an inductor with leads that are too short to be inserted into the **COMP TEST** jacks, a pair of test leads can be used to connect the **COMP TEST** jacks to the component(s).

Semiconductors

Purely semiconductor devices (such as diodes and transistors) will produce signatures with straight lines and bends. Regular diodes produce a single bend with a horizontal and vertical line as shown in Fig. 10. Zener diodes produce a double bend with two vertical and one horizontal line as shown in Fig. 11 (value is determined by the distance of the left most vertical component from the center graduation on the CRT). The maximum zener diode observable on this feature is about 15 V. It is also possible to test transistors and IC's by testing one pair of pins at a time.

NOTE

When testing diodes it is important to connect the diode's cathode to the black **COMP TEST** jack and the anode to the red jack. Reversing the polarity will not damage the device but the horizontal and vertical components of the signature will appear in different quadrants of the display.

To test semiconductors, insert the diode's or transistor's leads (only two at a time) into the red and black **COMP TEST** jacks (make sure that the leads touch the metal walls inside the jacks). To test in-circuit or to test IC's or devices with leads too short to insert into the **COMP TEST** jacks,

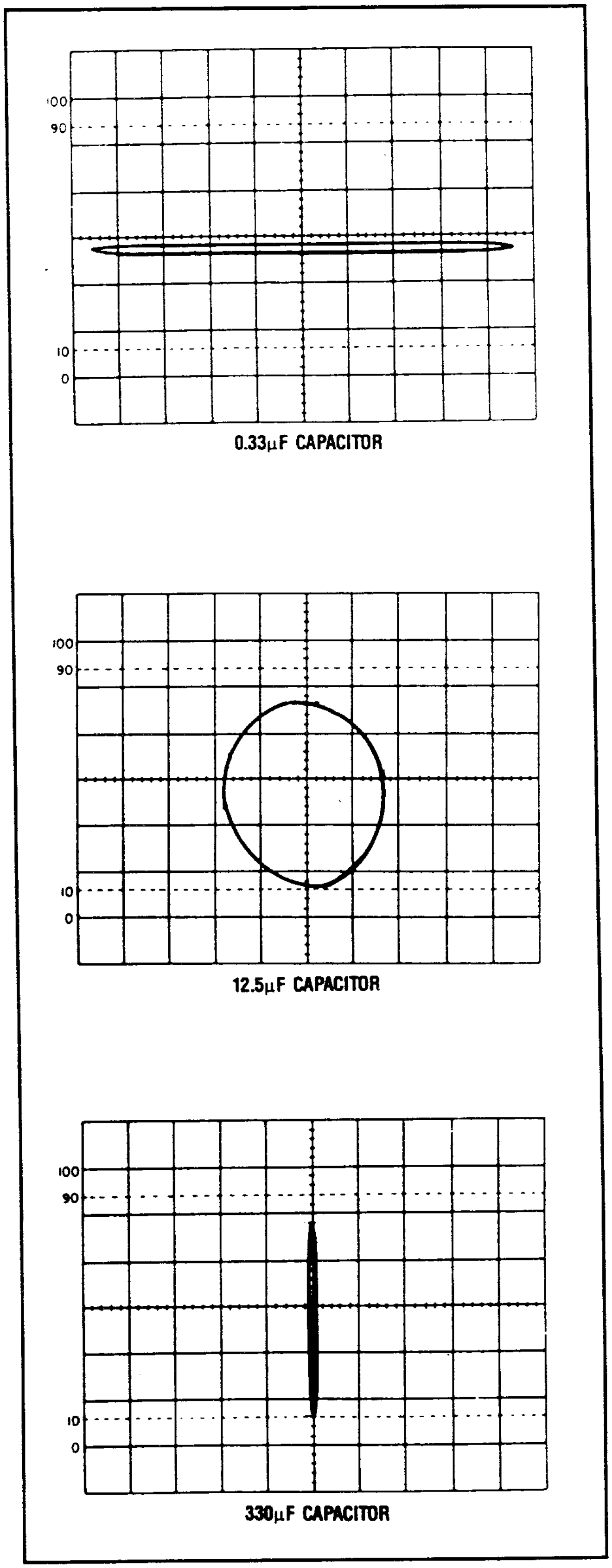

Fig. 8. Typical Capacitance Signatures.

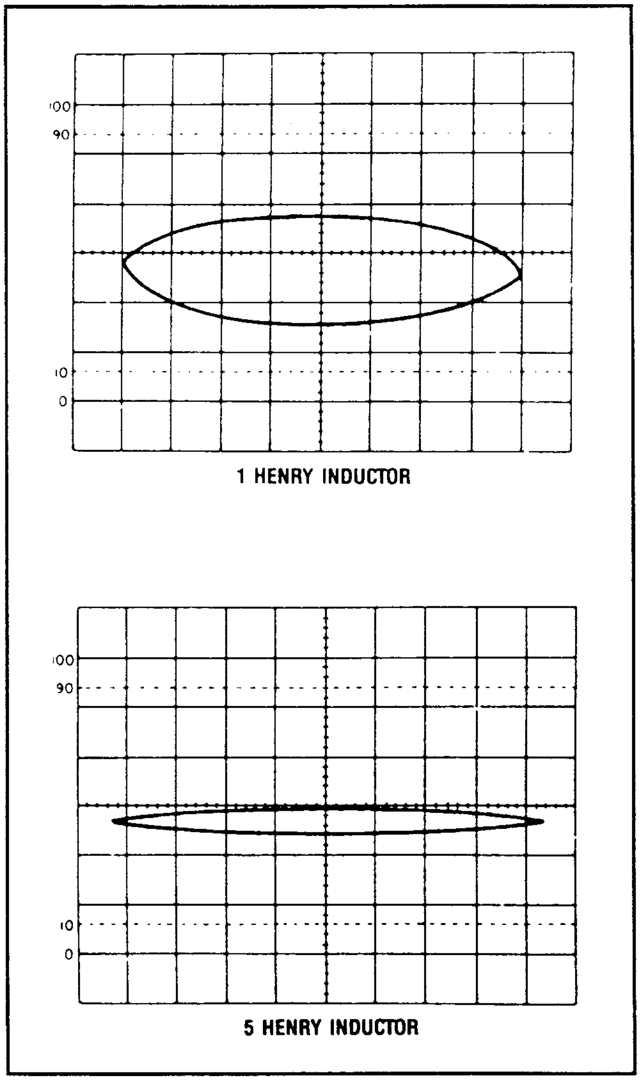

Fig. 9. Typical Inductance Signatures.

a pair of test leads can be used to connect the **COMPTEST** jacks to the component(s).

Combinations of Components

Using the component test feature it is also possible to observe the signatures of combinations of components. Combinations cause signatures that are a combination of the individual signatures for each component. For example, a signature for a resistor and capacitor in parallel will produce a signature with the ellipse of the capacitor but the resistor would cause the ellipse to be at an angle (determined by the value of the resistor). When testing combinations of components it is important to make sure that all the components being connected are within measurement range.

VIDEO SIGNAL OBSERVATION

Setting the **COUPLING** switch to the **TV H** or **TV V** position permits selection of horizontal or vertical sync

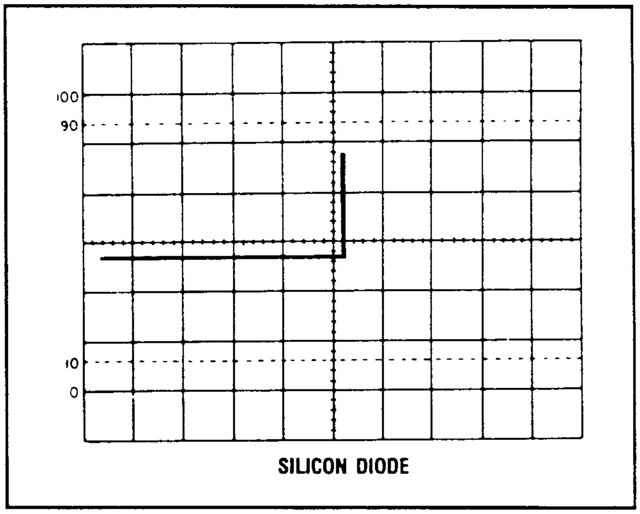

Fig. 10. Typical Diode Signature.

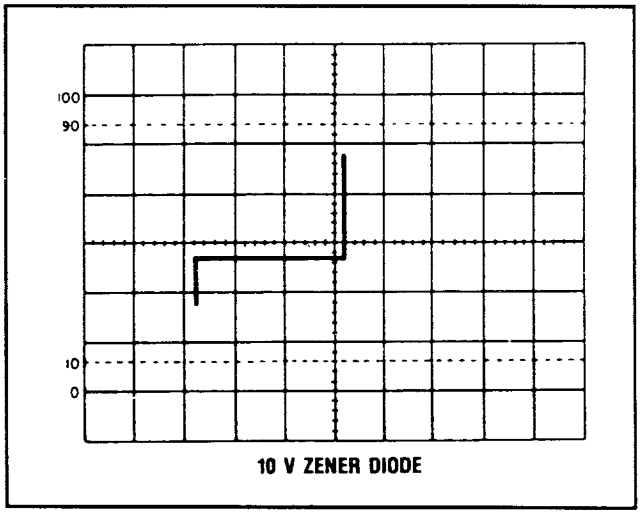

Fig. 11. Typical Zener Diode Signature.

pulses for sweep triggering when viewing composite video waveforms.

When the **TV H** mode is selected, horizontal sync pulses are selected as triggers to permit viewing of horizontal lines of video. A sweep time of about 10 μs/div is appropriate for displaying lines of video. The **VAR SWEEP** control can be set to display the exact number of waveforms desired.

When the **TV V** mode is selected, vertical sync pulses are selected as triggers to permit viewing of vertical fields and frames of video. A sweep time of 2 ms/div is appro priate for viewing fields of video and 5 ms/div for complete frames (two interlaced fields) of video.

At most points of measurement, a composite video signal is of the (–) polarity, that is, the sync pulses are negative and the video is positive. In this case, use (–) **SLOPE**. If the waveform is taken at a circuit point where the video waveform is inverted, the sync pulses are positive and the video is negative. In this case, use (+) **SLOPE**.

APPLICATIONS

B+K Precision offers a "Guidebook to Oscilloscopes" which describes numerous applications for this instrument and important considerations about probes. It also includes a glossary of oscilloscope terminology and an understanding of how oscilloscopes operate. It nay be obtained free of charge by filling out and mailing the postage-free coupon card enclosed with the instrument.

WARNING

The following instructions are for use by qualified service personnel only. To avoid electrical shock, do not perform any servicing other than contained in the operating instructions unless you are qualified to do so.

High voltage up to 2,000 volts is present when covers are removed and the unit is operating. Remember that high voltage may be retained indefinitely on high voltage capacitors. Also remember that ac line voltage is present on line voltage input circuits any time the instrument is plugged into an ac outlet, even if turned off. Unplug the oscilloscope and discharge high voltage capacitors before performing service procedures.

FUSE REPLACEMENT

If the fuse blows, the pilot light will go out and the oscilloscope will not operate. The fuse should not normally open unless a problem has developed in the unit. Try to determine and correct the cause of the blown fuse, then replace only with the correct value fuse. For 120 V line voltage operation, use a **630** mA, 250 V fuse. For 230 V line voltage operation, use a **315** mA, 250 V fuse. The fuse is located on the rear panel adjacent to the power cord receptacle.

Remove the fuseholder assembly as follows:

1. Unplug the power cord from the rear of scope.
2. Insert a small screwdriver in fuseholder slot (located between fuseholder and receptacle). Pry fuseholder away from receptacle.
3. When reinstalling fuseholder, be sure that the fuseholder is installed so that the correct line voltage is selected (see LINE VOLTAGE SELECTION).

LINE VOLTAGE SELECTION

To select the desired line voltage, simply insert the fuse and fuse holder so that the appropriate voltage is at the top (pointed to by the arrow). Be sure to use the proper value fuse (see label on rear panel).

PERIODIC ADJUSTMENTS

Probe compensation and trace rotation adjustments are given below.

Probe Compensation

Connect probes to **CH 1** and **CH 2** input jacks. Repeat procedure for each probe.

Touch tip of probe to **CAL** terminal.

Adjust oscilloscope controls to display 3 or 4 cycles of **CAL** square wave at 5 or 6 divisions amplitude.

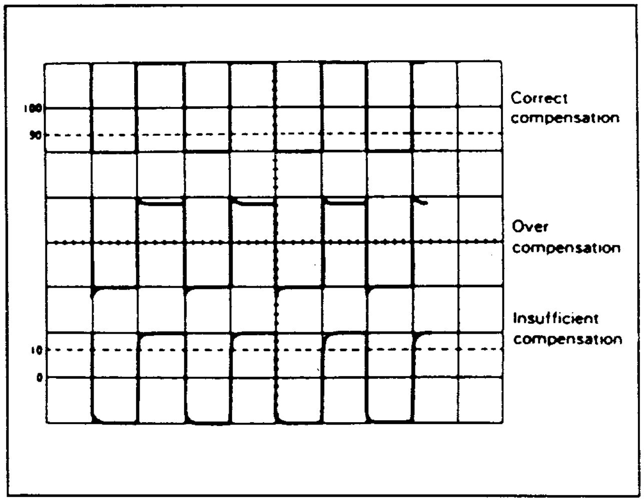

Fig. 12. Probe Compensation Adjustment.

Adjust compensation trimmer on probe for optimum square wave (minimum overshoot, rounding off, and tilt). Refer to Fig. 12.

Trace Rotation Adjustment

1. Set oscilloscope controls for a single trace display in **CH 1** mode, and with the channel 1 **AC-GND-DC** switch set to **GND**.
2. Use the channel 1 ⇕ **POSition** control to position the trace over the center horizontal line on the graticule scale. The trace should be exactly parallel with the horizontal line.
3. Use the **TRACE ROTATION** adjustment on the front panel to eliminate any trace tilt.

CALIBRATION CHECK

A general check of calibration accuracy may be made by displaying the output of the **CAL** terminal on the screen. This terminal provides a square wave of 0.2 V p-p. This signal should produce a displayed waveform amplitude of four divisions at 50 mV/div sensitivity for both channel 1 and 2 (with probes set for direct). With probes set for 10:1, there should be four divisions amplitude at ±5 mV/div sensitivity. The **VARiable** controls must be set to **CAL** during this check.

The **CAL** signal may be used only as a general check of calibration accuracy, not as a signal source for performing recalibration adjustments; a signal source of ±0.5% or better accuracy is required for calibration adjustments.

INSTRUMENT REPAIR SERVICE

Because of the specialized skills and test equipment required for instrument repair and calibration, many customers prefer to rely upon **B+K Precision** for this service. We maintain a network of **B+K Precision** authorized service agencies for this purpose. To use this service, even if the oscilloscope is no longer under warranty, follow the instructions given in the WARRANTY SERVICE INSTRUCTION portion of this manual. There is a nominal charge for instruments out of warranty.

APPENDIX I

IMPORTANT CONSIDERATIONS FOR RISE TIME AND FALL TIME MEASUREMENTS

Error In Observed Measurement

The observed rise time (or fall time) as seen on the CRT is actually the cascaded rise time of the pulse being measured and the oscilloscope's own risetime. The two rise times are combined in square law addition as follows:

$$T_{observed} = \sqrt{(T_{pulse})^2 + (T_{scope})^2}$$

The effect of the oscilloscope's rise time is almost negligible when its rise time is at least 3 times as fast as that of the pulse being measured. Thus, slower rise times may be measured directly from the CRT. However, for faster rise time pulses, an error is introduced that increases progressively as the pulse rise time approaches that of the oscilloscope. Accurate measurements can still be obtained by calculation as described below.

Direct Measurements

The Model 2125 oscilloscope has a rated rise time of 17.5 ns. Thus, pulse rise times of about 52.5 ns or greater can be measured directly. Most fast rise times are measured at the fastest sweep speed and using X10 magnification. For the Model 2522A, this sweep rate is 50 ns/div. A rise time of less than about one division at this sweep speed should be calculated.

Calculated Measurements

For observed rise times of less than 52.5 ns, the pulse rise time should be calculated to eliminate the error introduced by the cascaded oscilloscope rise time. Calculate pulse rise time as follows:

$$T_{pulse} = \sqrt{(T_{observed})^2 + (T_{scope})^2}$$

Limits Of Measurement

Measurements of pulse rise times that are faster than the scope's rated rise time are not recommended because a very small reading error introduces significant error into the calculation. This limit is reached when the "observed" rise time is about 1.3 times greater than the scope's rated rise time, about 23 ns.

Probe Considerations

For fast rise time measurements which approach the limits of measurement, direct connection via 50 Ω coaxial cable and 50 Ω termination is recommended where possible. When a probe is used, its rise time is also cascaded in square law addition. Thus the probe rating should be considerably faster than the oscilloscope if it is to be disregarded in the measurement.