OPERATING INSTRUCTIONS

This section is divided into four subsections. The first subsection, Preparation for Use, provides instructions for the user to follow before turning the instrument on, especially for the first time. Subsection two; Controls, Connectors, and Indicators; provides details on the operation of the front-panel controls. Subsection three, Operating Considerations, provides the user with some of the more general information on measurement techniques. The last subsection, Operators Checks and Adjustments, provides simple checks and adjustments to be made on a routine basis by the user.

PREPARATION FOR USE

SAFETY

This subsection tells how to prepare for and to proceed with the initial start-up of the TEKTRONIX 2225 Oscilloscope.

Refer to the Safety Summary at the front of this manual for power source, grounding, and other safety considerations pertaining to the use of the instrument. Before connecting the oscilloscope to a power source, read both this subsection and the Safety Summary.

CAUTION

This instrument may be damaged if operated with the LINE VOLTAGE SELECTOR switch (on the rear panel) set for the wrong applied ac source voltage or if the wrong fuse is installed.

LINE VOLTAGE SELECTION

The oscilloscope operates from either a 115-V or a 230-V nominal ac power line with any frequency from 48 Hz to 440 Hz. Before connecting the power cord to a power source, verify that the LINE VOLTAGE SELECTOR switch, located on the rear panel, is set correctly and that the proper line fuse is installed. Refer to Figure 2-1 and the instrument rear panel.

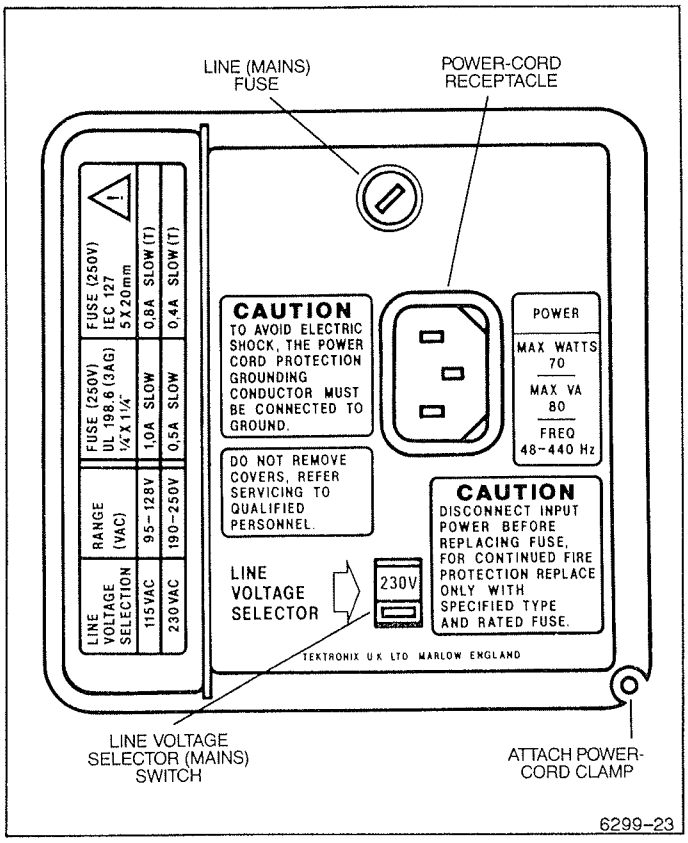


Figure 2-1. Voltage Selector switch, fuse, and power-cord receptacle.

To convert the 2225 for operation on another line voltage range, set the LINE VOLTAGE SELECTOR switch to the required position and install the appropriate fuse (listed on the rear panel). The detachable power cord may need to be replaced to match the particular power source. Power-cord option numbers are given in Figure 2-1; fuse part numbers are listed in Options and Accessories (Section 7).

LINE FUSE

The instrument fuse holder is located on the rear panel and contains the line (main) fuse. Use the following procedure to verify that the proper fuse is installed or to install a replacement fuse.

1. Unplug the power cord from the power-input source (if plugged in).

2. Press in the fuse-holder cap and release it with a slight counterclockwise rotation.

3. Pull the cap (with the attached fuse inside) out of the fuse holder.

NOTE

The two types of fuses listed on the rear panel are not directly interchangeable; they require different types of fuse caps.

4. Verify that the fuse is the same type listed on the back of the instrument.

5. Reinstall the fuse (or replacement fuse) in the fuse-holder cap.

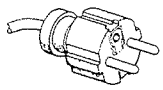
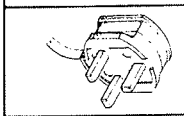
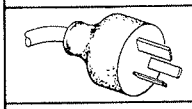
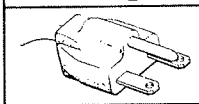
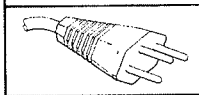
6. Reinstall the fuse and cap in the fuse holder by pressing in and giving a slight clockwise rotation of the cap.

POWER CORD

A detachable three-wire power cord with a three-contact plug is provided with each instrument for connecting to both the power source and protective ground. The protective-ground connector in the plug connects (through the protective-ground conductor) to the accessible metal parts of the instrument. For electrical-shock protection, insert this plug only into a power-source outlet that has a properly grounded protective-ground contact.

After plugging the power cord into its receptacle, secure it to the rear panel using the plastic clamp, screw, and washer provided.

Instruments are shipped with the power cord ordered by the customer. Available power-cord information is presented in Figure 2-2. Contact your Tektronix representative or local Tektronix Field Office for additional power-cord information.

Plug Configuration	Usage	Line Voltage	Reference Standards	Option Number
	North American 120V/ 15A	120V	ANSI C73.11 NEMA 5-15-P IEC 83	Standard
	Universal Euro 240V/ 10-16A	240V	CEE (7),II,IV,VII IEC 83	A1
	UK 240V/ 13A	240V	BS 1363 IEC 83	A2
	Australian 240V/ 10A	240V	AS C112	A3
	North American 240V/ 15A	240V	ANSI C73.20 NEMA 6-15-P IEC 83	A4
	Switzerland 220V/ 6A	220V	SEV	A5

Abbreviations:
ANSI — American National Standards Institute
AS — Standards Association of Australia
BS — British Standards Institution
CEE — International Commission on Rules for the Approval of Electrical Equipment
IEC — International Electrotechnical Commission
NEMA — National Electrical Manufacturer's Association
SEV — Schweizevischer Elektrotechischer Verein

(2931-21)6083-35

Figure 2-2. Power-cord and line-voltage data.

INSTRUMENT COOLING

To prevent instrument damage from overheated components, adequate internal airflow must be maintained at all times. Before turning on the power, verify that the air-intake holes on the sides and rear panel are free from any obstructions to airflow.

INITIAL START-UP

Up to now, you should have made the following preparations:

1. Read the safety information.

2. Verified that the LINE VOLTAGE SELECTOR switch is set for the source voltage to be used.

3. Verified the fuse for correct type and rating.

4. Attached the power cord.

5. Ensured that there is adequate ventilation around the instrument.

6. Plugged the power cord into the appropriate power-source outlet.

Now turn on your oscilloscope by pressing in the POWER button. Observe that the POWER-ON indicator, located below the button, is lit.

REPACKAGING

If this instrument is shipped by commercial transportation, use the original packaging material. Unpack the instrument carefully from the shipping container to save the carton and packaging material for this purpose.

If the original packaging is unfit for use or is not available, repackage the instrument as follows:

1. Obtain a corrugated cardboard shipping carton having inside dimensions at least six inches greater than the instrument dimensions and having a carton test strength of at least 275 pounds.
2. If the instrument is being shipped to a Tektronix Service Center for repair or calibration, attach a tag to the instrument showing the following: owner of the instrument (with address), the name of a person at your firm who may be contacted if additional information is needed, complete instrument type and serial number, and a description of the service required.
3. Wrap the instrument with polyethylene sheeting or equivalent to protect the outside finish and prevent entry of packing materials into the instrument.
4. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between the carton and the instrument, allowing for three inches of padding on each side (including top and bottom).
5. Seal the carton with shipping tape or with an industrial stapler.
6. Mark the address of the Tektronix Service Center and your return address on the carton in one or more prominent locations.

CONTROLS, CONNECTORS, AND INDICATORS

The following descriptions are intended to familiarize the operator with the location and function of the instrument's controls, connectors, and indicators.

Refer to Figure 9-14 in the foldout pages for the location of all controls mentioned.

POWER AND DISPLAY

(1) **INTENSITY Control**—Adjusts the brightness of all displayed waveforms.

(2) **BEAM FIND Button**—Compresses the vertical and horizontal deflection to within the graticule area and intensifies the display to aid the user in locating traces that are overscanned or deflected outside of the crt viewing area.

(3) **FOCUS Control**—Adjusts for optimum display definition. Once set, proper focusing is maintained over a wide range of display intensity.

(4) **TRACE ROTATION Control**—Permits alignment of the trace with the horizontal graticule line. This control is a screwdriver adjustment that, once set, should require little attention during normal operation.

(5) **POWER Switch**—Turns instrument power on or off.

(6) **Power On Indicator**—Lights up while instrument is operating.

VERTICAL

(7) **Channel 1 Vertical POSITION Control**—Controls the vertical display position of the Channel 1 signal. In X-Y mode the control is inactive.

(8) **TRACE SEP Control**—Permits the magnified traces that appear in Horizontal MAG Mode to be positioned up to three divisions above the associated Channel 1 or Channel 2 traces. Trace separation between the magnified and unmagnified traces is independent of the Channel POSITION control settings. In other Horizontal modes, the TRACE SEP control is inoperative.

(9) **Channel 2 Vertical POSITION Control**—Controls the vertical display position of the Channel 2 signal. In X-Y mode the control vertically positions the display.

(10) **Vertical MODE Switch CH 1-BOTH-CH 2**—Selects either a single channel for display or the dual-channel display mode.

CH 1—Selects only the Channel 1 input signal for display.

BOTH—Selects a combination of Channel 1 and Channel 2 input signals for display. The CH 1-BOTH-CH 2 switch must be in the BOTH position for ADD, ALT, and CHOP operation.

CH 2—Selects only the Channel 2 input signal for display.

(11) **CH 2 INVERT Switch**—Inverts the Channel 2 display when in the CH 2 INVERT position. With CH 2 inverted, the oscilloscope may be operated as a differential amplifier when the BOTH-ADD vertical mode is selected.

(12) **Vertical MODE Switch ADD-ALT-CHOP**—Sets the dual-channel vertical display mode.

ADD—Displays the sum of Channel 1 and Channel 2 input signals when BOTH is also selected. The difference of the Channel 1 and Channel 2 input signals is displayed when the Channel 2 signal is inverted.

ALT—Alternately displays the Channel 1 and Channel 2 input signals. The alternation occurs during retrace at the end of each sweep. ALT vertical mode is most useful for viewing both channel input signals at sweep rates of 0.5 ms per division and faster.

CHOP—Switches the display between the Channel 1 and Channel 2 vertical input signals during the sweep. The chopped switching rate (CHOP frequency) is approximately 500 kHz.

(13) **CH 1 and CH 2 VOLTS/DIV Switches**—Select the vertical channel deflection factors from 5 mV to 5 V per division in a 1-2-5 sequence.

1X—Front-panel marking that indicates the deflection factor set by the VOLTS/DIV switch when a 1X probe or a coaxial cable is attached to the channel input connector.

10X PROBE—Front-panel marking that indicates the deflection factor set by the VOLTS/DIV switch when a 10X probe is attached to the channel input connector.

(14) **Variable VOLTS/DIV and X10 Vertical Magnification Controls**—Provide continuously variable deflection factors between calibrated positions of the VOLTS/DIV controls and X1 or X10 vertical magnification of the displayed signal. The VOLTS/DIV sensitivity may be reduced by up to at least 2.5 times at the fully counterclockwise rotation of the variable (CAL) knob. A detent position at full clockwise rotation indicates the calibrated VOLTS/DIV position of the variable knob.

X10 vertical magnification of a displayed signal is obtained by pulling the variable (CAL) knob to the out position. A yellow ring is visible on the knob in the X10 Vertical Magnification position.

(15) **AC-GND-DC (Input Coupling) Switches**—Select the method of coupling the input signal from the CH 1 OR X and CH 2 OR Y connectors to the vertical amplifiers.

AC—Capacitively couples the input signal to the vertical deflection system. The dc component of the input signal is blocked. The lower -3 dB bandpass is 10 Hz or less.

GND—Grounds the input of the vertical deflection channel; provides a zero (ground) reference voltage display (does not ground the input signal).

DC—All frequency components of the input signal are coupled to the vertical deflection and signal acquisition systems.

(16) **CH 1 OR X and CH 2 OR Y Input Connectors**—Provide for application of signals to the inputs of the deflection systems.

In X-Y mode, the signal connected to the CH 1 OR X input controls the horizontal deflection, and the signal connected to the CH 2 OR Y input controls the vertical deflection.

HORIZONTAL

(17) **COARSE Horizontal POSITION Control**—Positions all the waveforms horizontally over a one-sweep-length range (for X1, X5, X10, or X50 Magnified).

(18) **FINE Horizontal POSITION Control**—Allows for fine adjustment of the horizontal position of displayed waveforms.

(19) **Horizontal MODE Switch**—Selects the horizontal mode of operation.

X1—This is the normal mode of operation with the waveform being unmagnified horizontally.

ALT—Displays the unmagnified waveform and the horizontally magnified waveform alternately.

MAG—Displays only the horizontally magnified waveform.

The amount of horizontal magnification is set by the Horizontal MAG switch (X5, X10, X50).

(20) **SEC/DIV Switch**—Selects calibrated sweep rates from 0.5 s to 0.05 μs per division in a 1-2-5 sequence of 22 steps. The X-Y position selects the X-Y mode; the CH 1 OR X input signal produces horizontal deflection for X-Y displays, and the CH 2 OR Y input signal produces vertical deflection.

(21) **Variable SEC/DIV Control**—Continuously varies the uncalibrated sweep time per division to at least 2.5 times the calibrated time per division set by the SEC/DIV switch. Full ccw rotation of the variable (CAL) knob increases the slowest sweep time per division to at least two seconds.

(22) **Horizontal MAG Switch**—Sets the amount of horizontal magnification to X5, X10, or X50 when the Horizontal MODE switch is set to either ALT or MAG.

(23) **GND Connector** (⏚)—Provides an auxiliary ground connection directly to the instrument chassis via a banana-tip jack.

(24) **PROBE ADJUST Terminal**—Provides an approximately 0.5-V, negative-going, square-wave signal (at about 1 kHz) for use in compensating voltage probes and checking the vertical deflection system. The PROBE ADJUST output signal is not intended as a reference for checking either the vertical or the horizontal accuracy of the instrument.

TRIGGER

(25) **Trigger SLOPE Switch**—Selects either the positive (⌐) or negative (¬) slope of the trigger signal to start the sweep.

(26) **Trigger LEVEL Control**—Selects the amplitude point on the trigger signal that produces triggering.

(27) **TRIG'D/READY Indicator**—A dual-function LED indicator. In P-P AUTO and NORM trigger modes, the indicator is turned on when triggering occurs. In SGL SWP trigger mode, the indicator turns on when the trigger circuit is armed, awaiting a triggering event; it turns off again as soon as the single sweep is triggered.

(28) **Trigger MODE Switch**—Determines the sweep triggering mode.

P-P AUTO—TV LINE—Triggering occurs on trigger signals having adequate amplitude and a repetition rate of about 20 Hz or faster. In the absence of a proper trigger signal, an autotrigger is generated, and the sweep freeruns.

NORM—Permits triggering at all sweep rates (an autotrigger is not generated in the absence of an adequate trigger signal). NORM trigger mode is especially useful for low-frequency and low-repetition-rate signals.

TV FIELD—Permits stable triggering on a television field signal (vertical sync). In the absence of an adequate trigger signal, the sweep freeruns. The instrument otherwise behaves as in P-P AUTO.

SGL SWP—Selects single sweep-operation.

(29) **SGL SWP RESET Button**—Arms the trigger circuit for a single sweep. Triggering requirements are the same as in NORM trigger mode. After the completion of a triggered sweep, pressing in the SGL SWP RESET button rearms the trigger circuitry to accept the next triggering event.

(30) **HOLDOFF Control**—Adjusts the variable holdoff time. Variable holdoff starts at the end of the sweep.

(31) **Trigger SOURCE Switches**—Determine the source of the internal and external trigger signal for the trigger generator circuits.

CH 1—Trigger signal is obtained from the CH 1 OR X input connector.

VERT MODE—Trigger signals are automatically obtained alternately from the CH 1 OR X and CH 2 OR Y input signals in ALT vertical mode. In CHOP vertical mode, the trigger signal source is the sum of the Channel 1 and Channel 2 input signals.

CH 2—Trigger signal is obtained from the CH 2 OR Y input. The CH 2 INVERT switch also inverts the polarity of the internal Channel 2 trigger signal when the Channel 2 display is inverted.

EXT—Selects external trigger source. The actual form these triggers take is selected by the second SOURCE switch.

LINE—Routes a sample of the ac-power-line signal to the trigger circuit.

EXT/10—Divides the external signal applied to the EXT INPUT OR Z connector by a factor of ten before applying it to the trigger circuit.

EXT—Routes an external signal applied to the EXT INPUT OR Z connector to the trigger circuit.

EXT=Z—Routes the signal applied to the EXT INPUT OR Z connector to the z-axis amplifier rather than the trigger circuit.

(32) **COUPLING Switch**—Determines the method of coupling the signal applied to the trigger circuit.

AC—Capacitively couples the input signal; the dc component of the signal is blocked.

HF REJ—Rejects (attenuates) the high-frequency components (above 30 kHz).

LF REJ—Rejects (attenuates) the low-frequency components (below 30 kHz).

DC—Directly couples all frequency components of the external signal to the trigger circuit.

(33) **EXT INPUT OR Z Connector**—Provides for connection of external signals either to the trigger circuit for external triggering or to the z-axis amplifier for intensity modulation of the crt display.

REAR PANEL

(34) **Fuse Holder**—Contains the ac-power-source fuse. See the rear-panel nomenclature for fuse rating and line-voltage range.

(35) **Detachable Power Cord Receptacle**—Provides the connection point for the ac-power source to the instrument.

(36) **Line Voltage Selector (Mains Switch)**—Selects the line voltage operating range of either 115 Vac or 230 Vac.

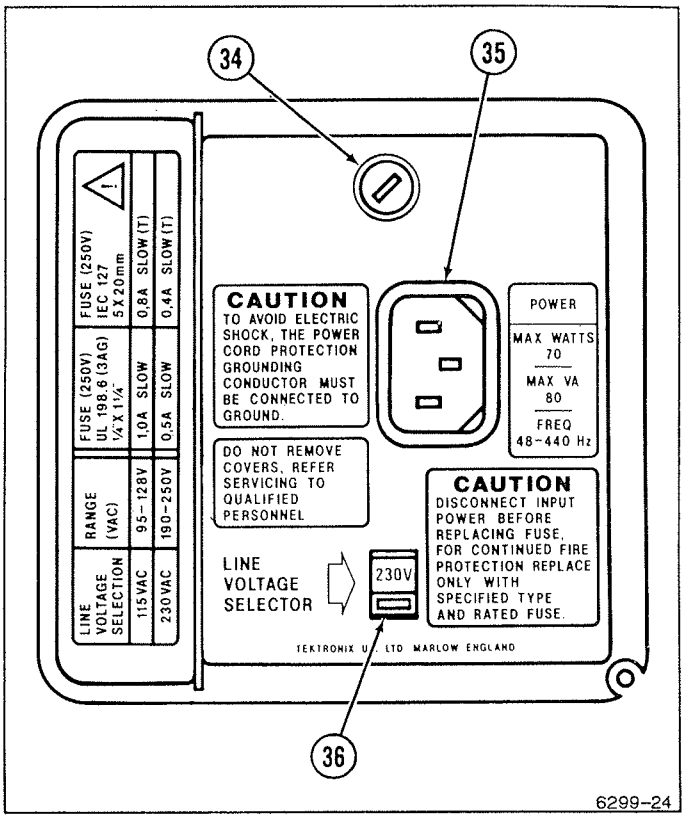


Figure 2-3. Rear Panel.

OPERATING CONSIDERATIONS

This part contains basic operating information and techniques that should be considered before attempting to make any measurements with the instrument.

GRATICULE

The graticule is internally marked on the faceplate of the crt to eliminate parallax-viewing errors and to enable measurements (see Figure 2-4). The graticule is marked with eight vertical and ten horizontal major divisions. In addition, each major division is divided into five subdivisions. The vertical deflection factors and horizontal timing are calibrated to the graticule so that accurate measurements can be made directly from the crt. Also, percentage marks for the measurement of rise and fall times are located on the left side of the graticule.

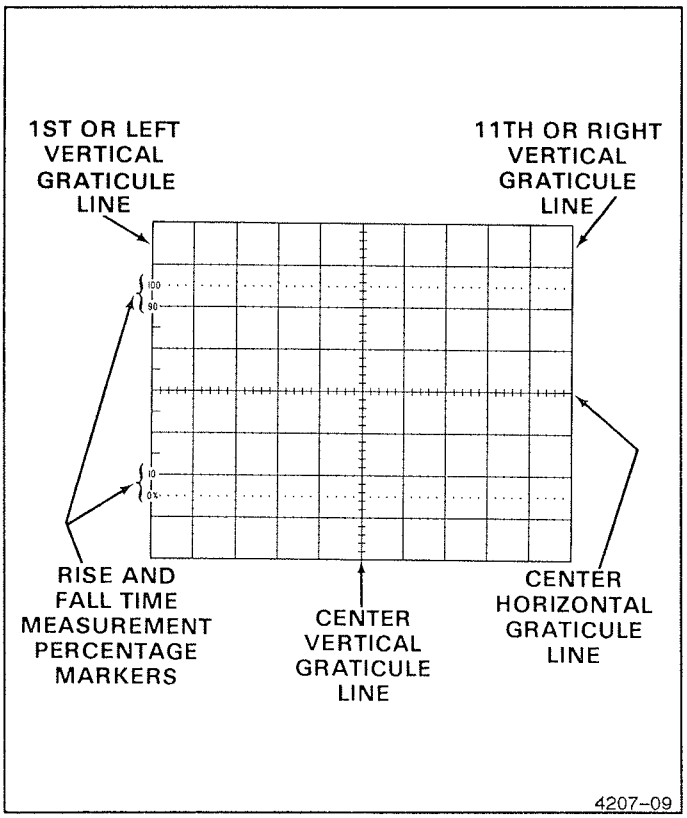


Figure 2-4. Graticule measurement markings.

GROUNDING

The most reliable signal measurements are made when the 2225 and the unit under test are connected by a common reference (ground lead) in addition to the signal lead or probe. The probe's ground lead provides the best grounding method for signal interconnection and ensures the maximum amount of signal-lead shielding in the probe cable. A separate ground lead can also be connected from the unit under test to the ground connector (⏚) located on the oscilloscope's front panel.

SIGNAL CONNECTIONS

Probes

Generally, the accessory probes supplied with the instrument provide the most convenient means of connecting a signal to the vertical inputs of the instrument. The probe and probe lead are shielded to prevent pickup of electromagnetic interference. The 10X attenuation factor of the probe offers a high input impedance that minimizes signal loading in the circuitry under test.

Both the probe itself and the probe accessories should be handled carefully at all times to prevent damage to them. Avoid dropping the probe body. Striking a hard surface can cause damage to both the probe body and the probe tip. Exercise care to prevent the cable from being crushed or kinked. Do not place excessive strain on the cable by pulling.

The standard-accessory probe is a compensated 10X voltage divider. It is a resistive voltage divider for low frequencies and a capacitive voltage divider for high-frequency signal components. Inductance introduced by either a long signal or ground lead forms a series-resonant circuit. This circuit will affect system bandwidth and will ring if driven by a signal containing significant frequency components at or near the circuit's resonant frequency. Oscillations (ringing) can then appear on the oscilloscope waveform display and distort the true signal waveshape. Always keep both the ground lead and the probe signal-input connections as short as possible to maintain the best waveform fidelity.

Misadjustment of probe compensation is a common source of measurement error. Due to variations in oscilloscope input characteristics, probe compensation should be checked and adjusted, if necessary, whenever the probe is moved from one oscilloscope to another or between channels. See the Probe Compensation procedure in Operator's Checks and Adjustments, or consult the instructions supplied with the probe.

Coaxial Cables

Coaxial cables may also be used to connect signals to the vertical input connectors, but they may have considerable effect on the accuracy of a displayed waveform. To maintain the original frequency characteristics of an applied signal, only high-quality, low-loss coaxial cables should be used. Coaxial cables should be terminated at both ends in their characteristic impedance. If this is not possible, use suitable impedance-matching devices.

INPUT-COUPLING CAPACITOR PRECHARGING

When the Input Coupling switch is set to the GND position, the input signal is connected to ground through the input-coupling capacitor and a high value resistance. This series combination forms a precharging circuit that allows the input-coupling capacitor to charge to the average dc voltage level of the signal applied to the input connector. Thus, any large voltage transients that may accidentally be generated are not applied to the vertical amplifier when the input coupling is switched from GND to AC. The precharging network also provides a measure of protection to the external circuitry by reducing the current level that is drawn from the external circuitry while the input-coupling capacitor is charging.

If AC input coupling is in use, the following procedure should be followed whenever the probe tip is connected to a signal source having a different dc level than that previously applied. This procedure becomes especially useful if the dc-level difference is more than ten times the VOLTS/DIV switch setting.

1. Set the AC-GND-DC (input coupling) switch to GND before connecting the probe tip to a signal source.

2. Touch the probe tip to the oscilloscope ground (⏚) connector.

3. Wait several seconds for the input-coupling capacitor to discharge.

4. Connect the probe tip to the signal source.

5. Wait several seconds for the input-coupling capacitor to charge to the dc level of the signal source.

6. Set the AC-GND-DC switch to AC. A signal with a large dc component can now be vertically positioned within the graticule area, and the ac component of the signal can be measured in the normal manner.

OPERATOR'S CHECKS AND ADJUSTMENTS

To verify the operation and basic accuracy of your instrument before making measurements, perform the following checks and adjustment procedures. If adjustments are required beyond the scope of these operator's checks and adjustments, refer the instrument to qualified service personnel.

For new equipment checks, before proceeding with these instructions, refer to Preparation for Use in this manual to prepare the instrument for the initial start-up before applying power.

INITIAL SETUP

1. Verify that the POWER switch is OFF (switch is in the out position), and the Line Voltage Selector switch is set for the correct source voltage. Then plug the power cord into the ac power outlet.

2. Press in the POWER switch (ON) and set the instrument controls to obtain a baseline trace:

Display

INTENSITY	Midrange
FOCUS	Best defined display

Vertical (Both Channels)

VERTICAL MODE	CH 1
POSITION (both)	Midrange
VOLTS/DIV (both)	10 mV
AC-GND-DC (both)	DC
VOLTS/DIV Variable (both)	CAL (in detent)
Magification (both)	X1 (CAL knobs in)

Horizontal

SEC/DIV	0.5 ms
SEC/DIV Variable	CAL (in detent)
POSITION	Midrange
MODE	X1

Trigger

HOLDOFF	MIN (fully counter-clockwise)
SOURCE	VERT MODE
MODE	P-P AUTO
SLOPE	Positive (⎍)
COUPLING	AC
LEVEL	For a stable display (with signal applied)

3. Adjust the INTENSITY and FOCUS controls for the desired display brightness and best focused trace.

4. Adjust the Vertical and Horizontal POSITION controls to position the trace within the graticule area.

5. Allow the instrument to warm up for 20 minutes before commencing the adjustment procedures. Reduce the INTENSITY level during the waiting time.

TRACE ROTATION ADJUSTMENT

NOTE

Normally, the trace will be parallel to the center horizontal graticule line, and TRACE ROTATION adjustment is not required.

1. Preset the instrument controls and obtain a baseline trace as described in Initial Setup.

2. Use the CH 1 POSITION control to move the baseline trace to the center horizontal graticule line.

3. If the baseline trace is not parallel to the center horizontal graticule line, use a small-bladed screwdriver or alignment tool to adjust the TRACE ROTATION control and align the trace with the graticule line.

PROBE COMPENSATION

Misadjustment of probe compensation is a source of measurement error. The attenuator probes are equipped with a compensation adjustment. To ensure optimum measurement accuracy, always check probe compensation before making

measurements. Probe compensation is accomplished by the following steps:

1. Preset the instrument controls and obtain a baseline trace as described in the Initial Setup.

2. Connect the two 10X probes (supplied with the instrument) to the CH 1 OR X and CH 2 OR Y input connectors.

3. Connect the Channel 1 probe tip to the PROBE ADJUST terminal.

4. Use the CH 1 POSITION control to vertically center the display. If necessary, adjust the Trigger LEVEL control to obtain a stable display on the positive (⌐) SLOPE.

NOTE

Refer to the instruction manual supplied with the probe for more complete information on the probe and probe compensation.

5. Check the waveform display for overshoot and rounding (see Figure 2-5); if necessary adjust the probe's compensation. Rotate the sleeve on the probe head to expose the adjustments (see Figure 2-6). Use a low-reactance alignment tool to adjust the LF comp capacitor for a square front corner on the waveform.

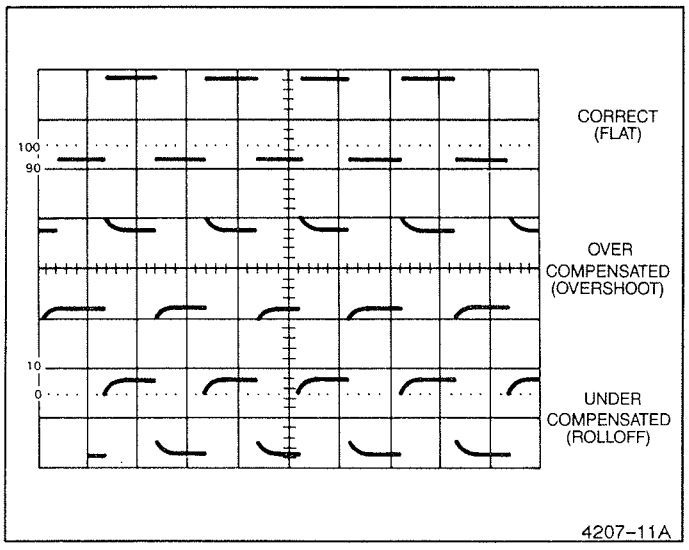


Figure 2-5. Probe compensation.

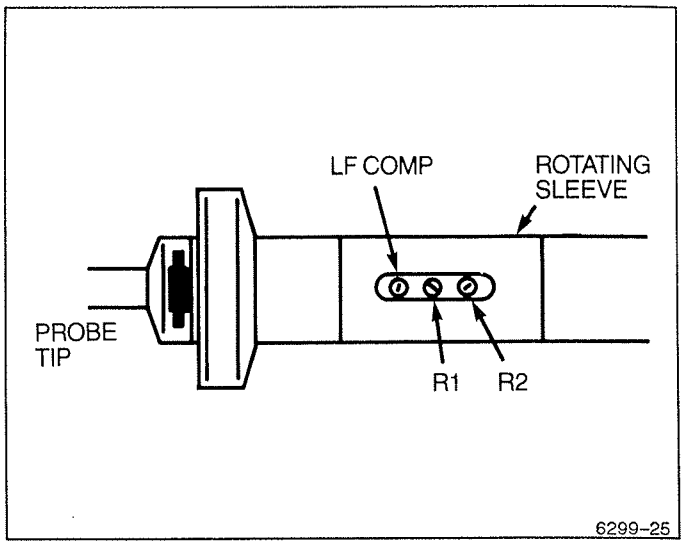


Figure 2-6. Probe compensation locations.

6. Disconnect the Channel 1 probe tip from the PROBE ADJUST terminal.

7. Connect the Channel 2 probe tip to the PROBE ADJUST terminal.

8. Set the Vertical MODE to CH 2.

9. Use the CH 2 POSITION control to vertically center the display.

10. Repeat step 5 for the Channel 2 probe.