Acquisition Modes

Acquiring signals involves accepting an analog electrical signal, sampling it, and producing a waveform. The 222PS allows you to specify how the instrument acquires the signal and constructs a waveform. This is the *acquisition mode* of the instrument.

Kinds of Acquisition Modes

The 222PS provides four acquisition modes: normal, average, envelope, and continuous envelope. These modes help you to examine and manage noisy signals.

Normal Acquisition Mode

Normal acquisition mode is the most common, and it is the instrument default.

In normal acquisition mode, the instrument displays a waveform with one sample point for each acquired point.

Average Acquisition Mode

Average acquisition mode displays a waveform that is the average of the last four waveforms acquired. This mode is useful for reducing random noise and displaying a cleaner signal.

NOTE

Average acquisition mode works only when the instrument is triggered. In auto level and auto-baseline trigger modes, untriggered displays appear identical to those using normal acquisition mode.

In auto baseline trigger mode, the instrument displays the last waveform acquired; it is unaveraged.

Envelope Acquisition Mode

In envelope mode, the instrument displays the positive and negative peak signal values that occur during a display sample interval. This mode is useful for detecting glitches such as unwanted peaks in a signal.

NOTE

Envelope acquisition mode functions only for time base settings between 20 µs and 20 s per division. If you set the instrument at a faster setting, it functions as if it were in normal acquisition mode.

Envelope mode samples the signal at 10 MHz, thereby acquiring many samples for each point it displays.

NOTE

Because of the 10 MHz sampling rate, the instrument cannot detect glitches that last less than 100 ns.

Continuous Envelope Acquisition Mode

Continuous envelope mode is similar to envelope mode. The difference is that *continuous* mode accumulates and displays peak values until you press the button labeled **INIT**.

NOTE

Continuous envelope acquisition mode functions only for time base settings between 20 µs and 20 s per division. If you specify a faster setting, the instrument functions as if it were in normal acquisition mode.

Changes to most front-panel control settings also act like the **INIT** button, discarding the old waveform data and starting the envelope sequence anew. The only front-panel controls that do not affect continuous envelope mode are the horizontal and vertical position knobs and the trigger level knob.

Figure 3-1 summarizes the effects of averaging and envelope modes on a signal.

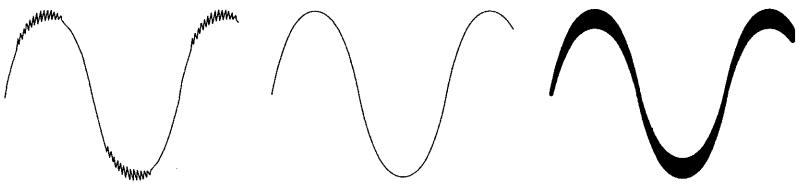

Figure 3-1: Normal, Average, and Envelope Signals

Selecting an Acquisition Mode

To choose an acquisition mode, follow these steps.

☐ **Step 1:** Press the **ACQ** button on the top panel to invoke the acquisition menu.

The normal acquisition mode is boxed (as in Figure 3-2) unless you have previously selected another acquisition mode.

☐ **Step 2:** Press the button next to the acquisition mode you wish to select. The acquisition mode takes effect, and the menu disappears.

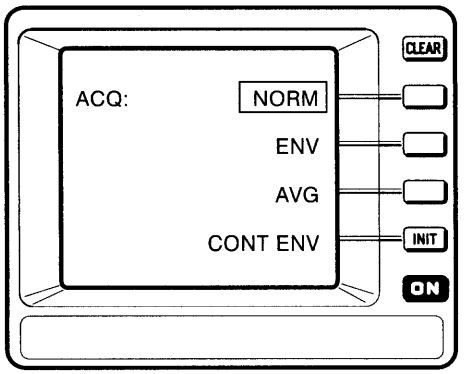

Figure 3-2: The Acquisition Menu

Auto Setup

The 222PS allows you to obtain a readable display of a waveform by pushing a single button. You can also set up the instrument in a specific way and then save the setting in memory (see page 3-55). This section discusses various automatic ways to set up the instrument.

Procedure

If you wish to view a signal quickly, follow these steps.

- ☐ **Step 1:** Connect the probe tip to the signal you wish to see.
- ☐ **Step 2:** Press the button marked **AUTO SETUP** on the front panel.

Pressing **AUTO SETUP** gets a quick, informative display of any signal between 20 Hz and 1 MHz.

Parameter Effects

The **AUTO SETUP** button has these effects on setup parameters.

Channels

When you press **AUTO SETUP**, the instrument first determines which channels to display. It checks both probe tips for a signal on either channel.

- If a channel is receiving a signal, the 222PS turns the channel on.
- If neither channel is receiving a signal, the 222PS turns on channel 1 and turns off channel 2.

Vertical Scaling

The 222PS then determines the characteristics of the signal, so it can produce a useful display.

The 222PS sets the vertical position to display the signal in the center of the screen. If both channels have a signal, the 222PS displays both signals.

The instrument also sets the volts per division to display each signal with several divisions of amplitude.

Horizontal Scaling

If only one channel is receiving a signal, the 222PS sets the horizontal position to display 1–5 waveform cycles. It determines the peak values and sets the trigger level at the midpoint.

If both channels have a signal, the instrument uses the channel 1 signal to set the seconds per division and trigger level. If the two signals are synchronized, they both appear stable. Otherwise, the channel 2 signal is untriggered.

Low and High Frequencies

AUTO SETUP avoids the time-base modes used with the slower time scales. It therefore does not set the seconds per division to 0.1 s or slower and does not produce a readable display for signals slower than 20 Hz.

For signals with frequencies above 100 kHz, **AUTO SETUP** always uses a seconds-per-division setting of 5 µs to minimize search time. The 222PS may display such high-frequency signals with too many or too few cycles on the screen; therefore, they may appear confusing. You may need to make small corrections to the seconds per division knob to get a useful display.

Table 3-1 shows all **AUTO SETUP** actions.

Table 3-1: Auto Setup Settings

Control	Setting After Auto Setup
VOLTS/DIV	As determined by signal
VOLTS/DIV VAR	Calibrated
Coupling	AC if in AC before, and if a signal exists; otherwise DC if a signal exists; otherwise OFF
Acquisition mode	Normal
STORE/NONSTORE	NONSTORE
Invert	Off (not inverted)
XY Display	Off
SEC/DIV	As determined by signal; 5 µs for signals above 100 kHz
Trigger source	Vertical
Trigger mode	Auto level
Trigger position	Post
Trigger slope	Plus
Trigger level	Midpoint of signal
X10 MAG	Off
Readouts	On
Selected channel	Channel 1 if signal exists, or if channel 2 has no signal

NOTE

AUTO SETUP does not disable the motor trigger selection.

Calibration

The 222PS has two built-in calibration features to maintain best balance and accuracy with temperature variations.

- a vertical channel self-calibration routine
- a test pattern display

Running the Self-Calibration Routine

To achieve the specified performance, you should recalibrate the 222PS any time the ambient temperature has changed by more than 5° C. If the trace jumps when you rotate the volts per division knob with no signal applied, the instrument probably needs recalibration.

To run the self-calibration routine, follow these steps.

☐ **Step 1:** Disconnect both probes from the signal source.

NOTE

To ensure that the self-calibration routine produces accurate results, do not run the self-calibration routine while either probe is connected to a signal source.

☐ **Step 2:** Press the **AUX FUNCT** button on the top panel to display the auxiliary functions menu. The display appears as shown in Figure 3-3.

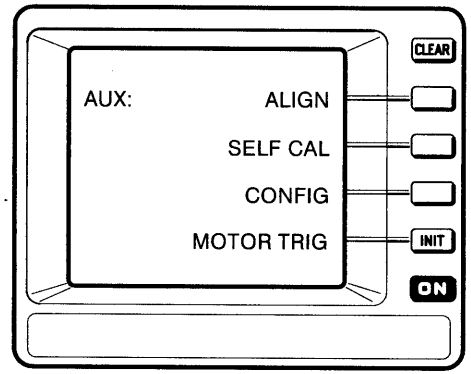

Figure 3-3: The Auxiliary Functions Menu

☐ **Step 3:** Press the menu button next to the **SELF CAL** menu item to access the calibration menu. The display now appears as shown in Figure 3-4.

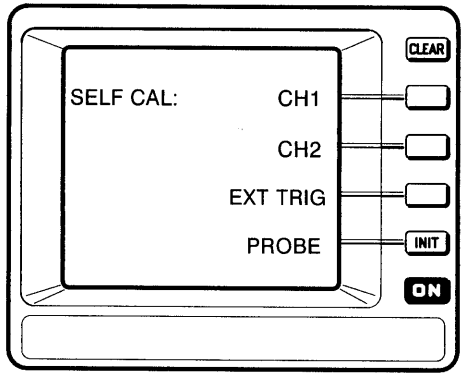

Figure 3-4: The Calibration Menu

NOTE

The PROBE selection on the SELF CAL menu is for use by qualified service personnel only.

☐ **Step 4:** To begin the self-calibration routine for channel 1, press the menu button next to **CH1**.

This routine takes about a minute to perform. When it is finished, the instrument displays PASS or FAIL.

If PASS appears on the screen, channel 1's recalibration was successful.

If FAIL appears on the screen, run the calibration routine again. If the failure persists, refer the instrument to a qualified service person.

If the self-calibration routine fails, the instrument sends a coded error message. To capture this message, connect the instrument to a terminal (or a PC emulating a terminal) through the RS-232 port on the rear panel and run the failed routine again. See *Appendix B: Remote Communications* for a discussion of the error codes.

☐ **Step 5:** Now calibrate channel 2. Invoke the menu again, and press the menu button next to **CH2**. Follow the procedure outlined in Step 4.

☐ **Step 6:** Now recalibrate the external trigger input. Before you start the calibration, connect the external trigger input connector to the trigger common reference connector on the rear panel. Use a jumper cable with a banana plug connector on each end.

NOTE

To calibrate the external trigger input, the **TRIG COM** *connector must be connected to the* **EXT TRIG INPUT** *connector.*

☐ **Step 7:** Invoke the menu again, and press the menu button next to **EXT TRIG**. A new menu appears on the display, as shown in Figure 3-5.

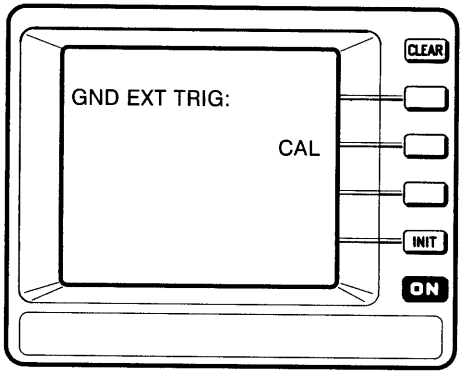

Figure 3-5: The Ground External Trigger Calibration Menu

☐ **Step 8:** Press the menu button next to **CAL** to begin the calibration. Follow the procedure outlined in Step 4.

☐ **Step 9:** When you are done, press the **CLEAR** button above the menu buttons to return the instrument to normal operation.

Testing Display Alignment

To determine if the display is properly aligned both horizontally and vertically, follow these steps.

☐ **Step 1:** Press the **AUX FUNCT** button on the top panel to display the auxiliary functions menu. The display appears as shown in Figure 3-3.

☐ **Step 2:** Press the top menu button. The display appears as shown in Figure 3-6.

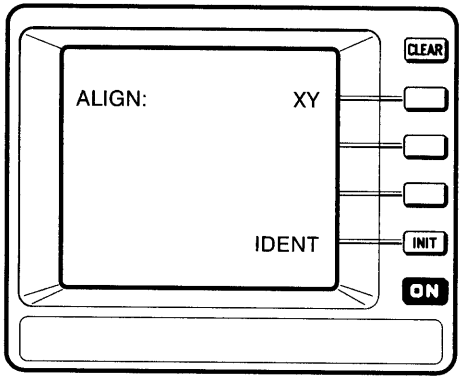

Figure 3-6: Display Alignment Menu

☐ **Step 3:** To access the alignment test pattern, press the menu button next to the item **XY**. The display now shows the test pattern. The + trigger indicator stays on the screen, but its location is irrelevant for checking the display alignment.

Figure 3-7 shows the test pattern. The test pattern must align precisely with the lines etched on the screen, as shown. If it does not, refer the instrument to a qualified service technician.

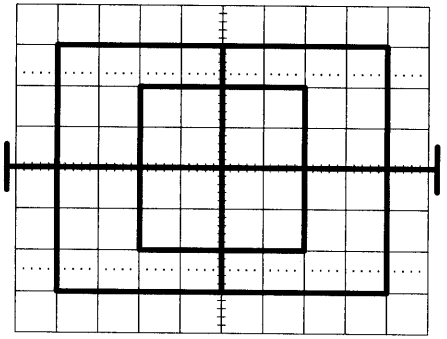

Figure 3-7: Display Alignment Test Pattern

☐ **Step 4:** Press the button labeled **CLEAR** to remove the test pattern when you are done.

Capturing Random Events

Capturing random electric events in circuits is difficult and time-consuming. You can use the 222PS's single sequence mode to make the task easier.

Single-sequence mode is one of four trigger modes you can use with the 222PS. In *single-sequence* mode, the instrument acquires one triggered signal. It then displays the signal and holds it until you press the button labeled **INIT** to start the sequence all over again. Changing a control that affects the signal acquisition also starts the sequence again.

The following procedure will help you use single-sequence mode to capture a random event.

- ☐ **Step 1:** Preset the instrument controls to display a baseline signal.
- ☐ **Step 2:** Apply a test signal to the channel 1 input to set the trigger level. Make sure the test signal is the same amplitude and general type (negative or positive pulse or sinusoidal) as the signal you want to trigger on.
- ☐ **Step 3:** Press **AUTO SETUP** to obtain a quick front-panel control setup for the test signal. If the resulting vertical or horizontal scaling result is not precisely what you want, adjust the volts-per-division and seconds-per-division controls as you wish. If necessary, reposition the trace vertically.
- ☐ **Step 4:** Set the trigger mode to normal.
- ☐ **Step 5:** Set the trigger source to channel 1.
- ☐ **Step 6:** Achieve a stable display by adjusting the trigger level control.
- ☐ **Step 7:** To set the trigger mode to single-sequence, Press the button labeled **MODE** on the front panel. Press the menu button next to the menu item **SSEQ**.

☐ **Step 8:** Check that the sweep triggers each time the **INIT** button is pressed. If it does not, readjust the trigger level control slightly until the sweep triggers each time you press **INIT**. The **TRIG'D** indicator lights when the instrument triggers.

☐ **Step 9:** Disconnect the test signal from the oscilloscope and apply the random signal to the input.

☐ **Step 10:** Press **INIT** to arm the trigger system. The instrument then waits for the trigger event. The **TRIG'D** indicator lights when the instrument triggers.

☐ **Step 11:** After the instrument triggers and completes the single sequence, press **INIT** again to acquire another signal.

In scroll mode, the single-sequence trigger mode is useful for capturing an event that occurs either randomly or infrequently. If the event is also very narrow, use the envelope mode as well.

Initialize the single-sequence function and let the oscilloscope watch for the event. The 222PS acquires data continuously up to the trigger point. When the trigger event occurs, the instrument acquires the data it needs to fill the rest of the display. It then halts the acquisition and displays the waveform (with the captured trigger event) until you press the **INIT** button again.

Channels

The 222PS has two fully isolated input channels with which you can make floating measurements. With signals of up to 600 VAC_{RMS} input, you can make measurements as you would with a volt meter.

This section explains how to select a channel, display the signal it acquires, and choose the right channel coupling.

Selecting a Channel

You must select a channel before you can change its settings using the front-panel controls. You can select only one channel at a time. The display indicates which channel is currently selected.

To select a channel, push the appropriate channel button (**CH1** or **CH2**) on the front panel.

Figure 3-8 shows the 222PS displaying signals for two channels. Channel 1 is selected.

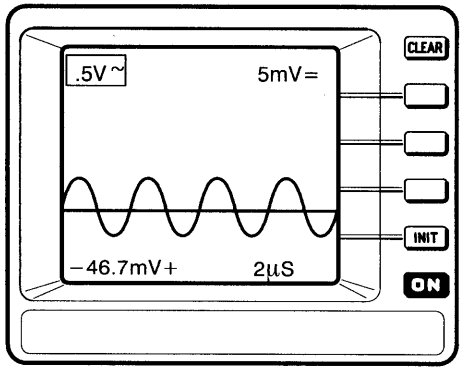

Figure 3-8: Channel One Selected

Displaying a Channel

When a channel is on, the 222PS displays any signal it acquires through that channel. When a channel is off, the 222PS does not display its signal. If either channel is off, the screen displays "OFF" instead of its volts-per-division value.

Even when a channel is off, the instrument can still use it as a trigger source.

By default, the 222PS displays both channels. To turn a channel off, follow these steps.

☐ **Step 1:** If the channel is not already selected, select it by pushing the appropriate channel button (**CH1** or **CH2**) on the front panel.

☐ **Step 2:** Press the channel button again to display the channel menu. The screen appears as shown below.

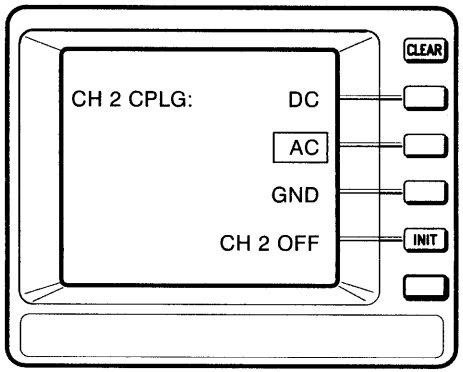

Figure 3-9: The Channel Menu

☐ **Step 3:** Press the button next to the bottom menu item, **CH 2 OFF**. This turns the selected channel off and clears the menu from the display. However, until you select channel 1 for another purpose, channel 2 is still the selected channel.

To display a channel you have turned off, repeat the above procedure until you see the menu on the screen. Then select the type of coupling you wish to use for the channel signal. The following section describes how to select the channel coupling.

NOTE

When a channel is off, you can still change its vertical settings with the **POS**, **VOLTS/DIV**, *or* **VAR VOLTS/DIV** *controls. First, select the channel. Then make the changes you wish. The changes take effect when you turn the channel back on.*

Setting Channel Coupling

There are three possible couplings for each channel:

- *DC coupling* passes all frequencies of the input signal up to the useful bandwidth of the instrument.
- *AC coupling* blocks any DC component of the signal and is the most commonly used.
- *Ground coupling* disconnects the input signal and grounds the input for the selected channel.

To select the coupling for a channel, follow these steps.

☐ **Step 1:** If the channel is not already selected, select it by pushing the appropriate channel button (**CH1** or **CH2**) on the front panel.

☐ **Step 2:** Press the channel button again to invoke the channel menu. The screen appears as in Figure 3-9.

☐ **Step 3:** Press the button next to the menu item representing the type of coupling you wish to use. For example, press the second button from the top to select **AC** coupling.

If the type of coupling you wish already appears boxed, it is already the selected coupling. Press the **CLEAR** button to remove the menu from the display.

The Display

The 222PS display shows you menus, signals, and readouts. This section explains how you can control the information displayed to you.

Readouts

Readouts include volts per division for each signal, seconds per division, and trigger level. The instrument also displays additional information, depending on the characteristics of the signal you display and the mode of the instrument.

Displaying and Clearing the Readouts

Unless you explicitly turn off the readouts, the 222PS displays them. If you wish to turn the readouts off and view only the signals, follow these steps.

☐ **Step 1:** Press the **DISPL** button on the top panel to access the display menu. Figure 3-10 shows the display menu.

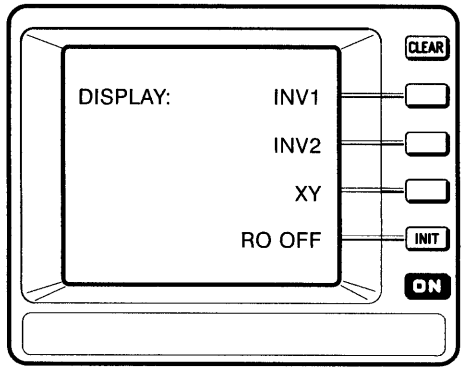

Figure 3-10: The Display Menu

☐ **Step 2:** Press the menu button next to the bottom menu item **RO OFF**. The menu disappears and the screen displays only the signal.

☐ **Step 3:** If you wish to turn the readouts back on again, repeat the above procedure. The next time you access the display menu, the **RO OFF** item appears boxed, indicating that it is selected and that readouts have therefore been turned off. Press the button again to deselect the menu item. The menu disappears and readouts again appear.

Inverting the Display

You can invert the waveforms displayed for either channel. Figure 3-11 shows an example of a normal and an inverted waveform.

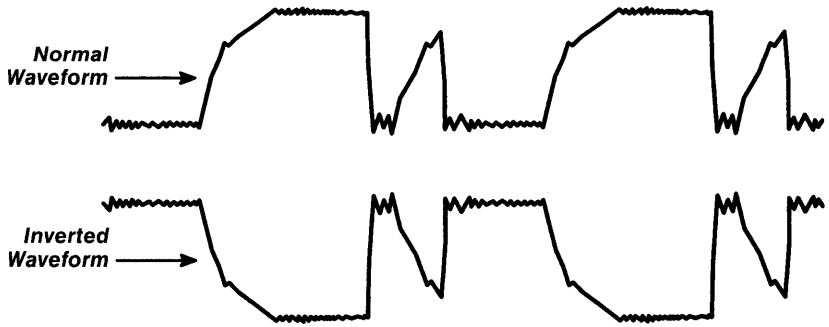

Figure 3-11: Normal and Inverted Waveforms

Some signal processing circuits, such as circuits that process composite video signals, automatically invert waveforms. While working on these circuits you may want to invert these signals to view them normally.

To invert a signal, follow these steps.

☐ **Step 1:** Press the **DISPL** button on the top panel to invoke the display menu. See Figure 3-10.

☐ **Step 2:** Press the button next to the menu item corresponding to the channel you wish to invert (**INV1** OR **INV2**).

After you press the menu button, the menu disappears and the inverted signal (if any) reappears on the screen. A small down-arrow appears in front of the volts per division readout for an inverted channel.

☐ **Step 3:** If you wish to display the channel normally, repeat the above procedure. The next time you access the display menu, the inverted channel item appears boxed, indicating that it is selected. Press the button again to deselect the menu item. The menu disappears, and the channel is no longer inverted.

Varying the Brightness

Use the intensity control on the back panel (labeled **INTEN**) to adjust the display's brightness.

To change the brightness, insert a small screwdriver into the center slot of the knob and rotate the knob until the display appears as you wish.

Horizontal Operation

This section discusses controlling the horizontal aspects of your signal. The knobs used to do this are at the bottom left of the front panel, as shown in Figure 3-12.

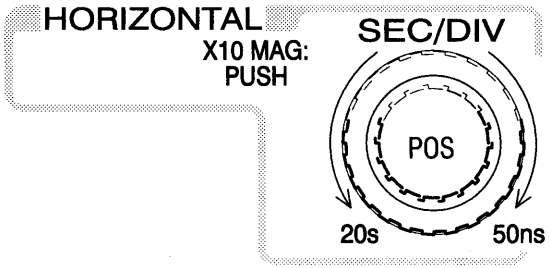

Figure 3-12: The Horizontal Controls

The horizontal controls affect signals acquired through both channels.

Horizontal Positioning

To position the signals horizontally, rotate the inner knob, labeled **POS**.

You can position the trace to the right or the left up to one-half the length of the screen. Readouts are not affected by horizontal positioning.

For information on the positioning of XY traces, see page 3-79.

When X10 magnification is on, the horizontal position control scrolls through the magnified waveform. For more information about magnifying waveforms, see page 3-29.

The horizontal position control affects the position of a saved waveform. The 222PS displays a saved waveform at the horizontal position presently in effect, not the horizontal position at which it was saved.

Seconds per Division

The 222PS can display a signal with a range of 20 s to 50 ns. If magnification is on, the instrument's range is 2 s to 5 ns. This means that the 222PS can display a waveform that represents as long a period as 200 seconds or as short a period as 50 ns (in the latter case, with magnification on).

To change the seconds-per-division setting, turn the outer knob (labeled **SEC/DIV**). The instrument displays the resulting seconds per division at the bottom of the screen. The 222PS uses a 1–2–5 switching sequence: this means that each click of the knob changes the time scale from, for example, 1 ms to 2 ms and then to 5 ms, before going to 10 ms.

NOTE

If you are using battery power at slow time bases, turn off the time-out feature described on page 3-37. Otherwise, the instrument may time out and turn itself off before it can completely acquire the signal.

Aliasing

Aliased waveforms are waveforms that appear to have a frequency much lower than is accurate.

Aliasing can occur when the seconds per division setting, and therefore the sample rate, is too low to display a high frequency waveform accurately. When this occurs, the instrument does not sample the signal often enough. The resulting waveform it displays is misleading. Figure 3-13 illustrates an aliased waveform.

A common symptom of aliasing is an unstable display even when the TRIG'D light is on.

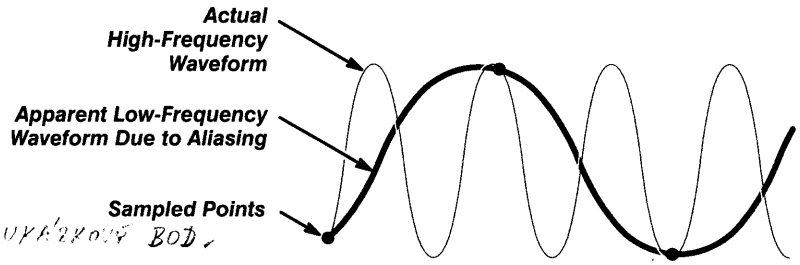

Figure 3-13: An Aliased Waveform

To avoid aliasing, make sure that your sample rate is fast enough for the frequency of the signal you wish to view — usually, at least twice as fast as the highest frequency component of the signal.

Time-Base Mode

When you choose a seconds per division setting, the instrument automatically selects the time-base mode required to display the resulting signal. The time-base mode can also depend on the trigger and acquisition modes. The 222PS uses four time-base modes: record, equivalent-time, scroll, and scroll-scan.

Record — For most seconds per division settings, the instrument uses the time-base mode you are most accustomed to: *record*. When a trigger occurs, the 222PS acquires and displays a full screen of the waveform in one pass.

Equivalent-time — However, when the seconds per division setting is too fast, the instrument cannot sample fast enough to capture all 512 samples and display them in one pass. Therefore, the instrument depends on successive repetitions of the same waveform to fill the display with samples.

Scroll and Scroll-scan — When the seconds per division setting is very slow, the display takes too long to fill using record time-base mode. Therefore, the instrument uses one of scrolling time-base modes.

The instrument uses *scroll* mode for slow time bases when either auto-level or auto-baseline trigger mode is in effect.

The instrument uses *scroll-scan* mode for slow time bases when normal or single sequence trigger mode is in effect.

Averaging and continuous envelope acquisition modes acquire several records of data before displaying a waveform. Therefore, if either of these acquisition modes is in effect, the instrument uses record time-base mode at slow time bases instead of a scrolling mode. Under these circumstances, the display updates slowly.

Table 3-2 shows these dependencies and the actual seconds-per-division settings associated with each time-base mode. The boundary between the medium and the slow ranges differs according to whether the instrument is in store or nonstore mode.

Table 3-2: Time-Base Modes

Store Mode	Seconds per Division	Acquisition Mode	Time-base Mode
On or off	*Fast*: 2 µs to 50 ns	Any	Equivalent-time
On Off	*Normal*: 50 ms to 5 µs 20 ms to 5 µs	Any	Record
On	*Slow*: 20 s to 0.1 s	Normal or Envelope	Scroll or Scroll-scan
Off	20 s to 50 ms	Averaging or Continuous Envelope	Record—slow update

Magnifying the Signal

You can magnify waveforms by ten times. To do so, push the inner horizontal control knob, labeled **POS**.

When magnification is on, each division contains five data points horizontally instead of the normal 50. The seconds-per-division readouts show corresponding values. Magnification also affects saved waveforms on the display and their seconds-per-division readouts.

To view the rest of the magnified waveform, turn the horizontal position knob. This action allows you to pan through the magnified waveform from side to side.

When you pan through a magnified waveform, you may also be moving the trigger position. The trigger position indicator, shown as a +, cannot move off the screen. Therefore, if you pan the trigger position off the screen to either side, the trigger position indicator remains at the edge of the screen to show the direction of the trigger point.

When magnification is on, a **10X** indicator appears at the bottom of the screen, to the right of the seconds per division readout. Figure 2-7 shows the bottom readouts.

NOTE

Displays in XY mode cannot be magnified.

When you magnify displays in scroll and scroll-scan time-base modes, they update only after the instrument completely acquires the waveform.

To turn off magnification, push the horizontal **POS** knob again.

Maintenance

The 222PS is covered by a standard Tektronix three-year warranty. If it fails during the warranty period, return it to Tektronix for free servicing (subject to the conditions of the warranty statement).

To arrange for warranty service or get an estimate for out-of-warranty repairs, call 1-800-TEK-WIDE (1-800-835-9433).

To help diagnose the problem, have the instrument serial number and firmware version number available. The serial number is located at the top right of the rear panel. To get the firmware identification number, follow the steps below.

If your instrument must be returned for servicing, package it as described on page 3-33.

Identifying the Firmware Version

To identify the 222PS firmware version, follow these steps.

☐ **Step 1:** Press the **AUX FUNCT** button on the top panel to access the auxiliary functions menu. The display now appears as shown in Figure 3-14.

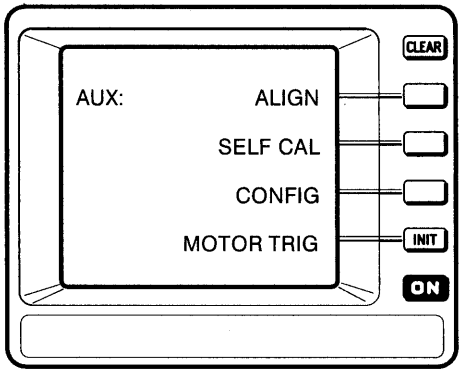

Figure 3-14: The Auxiliary Functions Menu

☐ **Step 2:** Press the menu button next to **ALIGN**. This calls up the XY Alignment Menu as shown in figure 3-15.

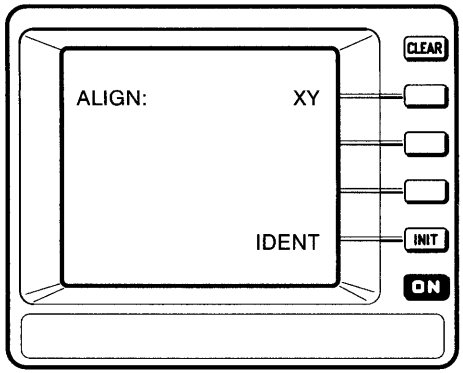

Figure 3-15: XY Alignment Menu

☐ **Step 3:** Press the menu button next to **IDENT**. A message appears in the middle of the display, identifying the instrument, as shown in Figure 3-16. The version number you see may differ.

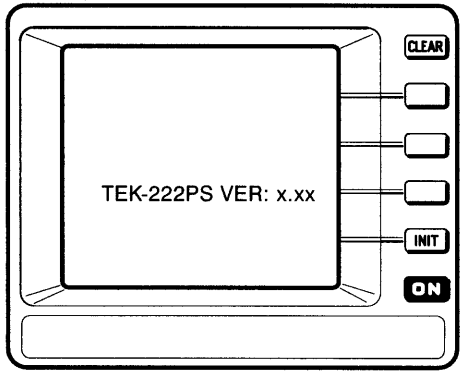

Figure 3-16: The Firmware Version

Repackaging for Shipment

Remember to put the instrument in its carry case before repacking. If the original packing materials are unfit or unavailable, then repackage the instrument in the following manner:

1. Use a corrugated cardboard shipping carton with a test strength of at least 125 kg (275 lb) and an interior size at least 15 cm (6 in) greater than the instrument size in all dimensions. See *Appendix D: Specifications* for instrument dimensions.
2. Enclose the following information:
   - the owner's name and address
   - the name and phone number of a contact person
   - the serial number of the instrument
   - the reason for returning the instrument
   - a complete description of the service required
3. Disconnect the battery before packing the instrument.
4. Completely wrap the instrument with polyethylene sheeting or its equivalent to protect the outside finish and keep harmful substances out of the instrument.

5. Cushion the instrument on all sides with three inches of padding material or urethane foam, tightly packed between the carton and the instrument.
6. Seal the shipping carton with an industrial stapler or strapping tape.
7. Call 1-800-TEK-WIDE (1-800-835-9433) for shipping instructions.

Power

You can operate the 222PS by using the internal battery or by plugging it into external power. This section explains how to do both. It also explains how to charge and change the battery when necessary.

Battery Operation

The 222PS comes supplied with a battery for use when portable operation is convenient. Completely recharge the battery as soon as possible after each use of the instrument under battery power.

NOTE

The instrument is shipped from the factory with the battery charged. However, the battery may not retain its charge while in transit to you. Therefore, we recommend that you charge the battery for three hours before operating the 222PS for the first time.

NOTE

Even when the instrument is off, current trickles slowly from the battery. If the current drawn off in this way depletes the battery below 7.32 V, the instrument cannot start on battery power. If this condition occurs, recharge the battery immediately. Instructions for charging the battery are on page 3-37.

Connecting the Battery

The battery is charged at the factory. It is shipped disconnected to prolong its shelf life. To connect the battery, follow these steps.

☐ **Step 1:** Place the oscilloscope on its left side as viewed from the front panel.

- ☐ **Step 2:** Open the probe pouch and disconnect the probes.
- ☐ **Step 3:** Slide the battery compartment cover and probe pouch toward the rear of the instrument to unlock the locking tabs.
- ☐ **Step 4:** Lift the battery compartment cover and remove it. The instrument now appears as shown in Figure 3-17.

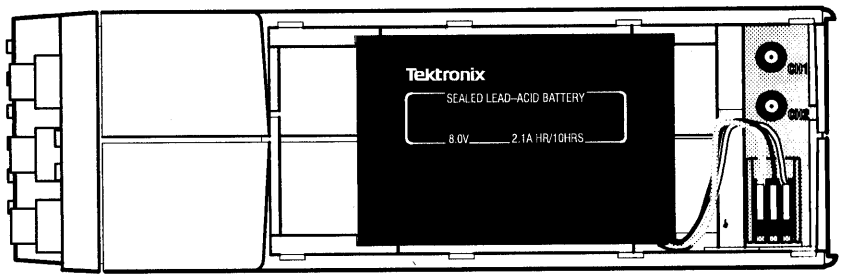

Figure 3-17: Side View Without Battery Cover

- ☐ **Step 5:** Connect the three-wire battery connector to the pins at the rear of the instrument. The orientation of the connector does not matter.
- ☐ **Step 6:** Replace the battery compartment cover. Position the cover locking tabs into the matching slots in the battery compartment. Make sure the locking tabs are all the way in the slots on both the top and the bottom. If the tabs do not seat easily, first seat the top tabs and then press on the bottom of the cover to seat the bottom tabs.
- ☐ **Step 7:** Push forward on the rear of the battery compartment cover to lock the tabs.
- ☐ **Step 8:** As soon as possible, charge the battery for three hours. See the following instructions for charging the battery.

Charging the Battery

During periods of heavy use in a harsh environment, you will need to recharge the battery after three hours of operation. Under better circumstances, it may need recharging less often. The battery will last longer if you recharge the instrument after each use.

When the battery charge is low, a low-battery indicator ⊟ appears in the upper right corner of the display. If the battery voltage drops below 7.32 V, the instrument automatically turns itself off.

In order to recharge the battery, plug in the External Power AC Adapter and leave the instrument turned off for three hours.

NOTE

The 222PS battery recharges whenever you plug it into external power. However, it recharges faster if the instrument is off.

Charging the Battery Externally

You can charge the battery outside the instrument using the external battery charger accessory. See the Optional Accessories information in Appendix E. You can also use any other charger that supplies 9.8 VDC at 20°C with the supply current limited to 1 A. For best results in various temperatures, thermally compensate the charging voltage by −10 mV per degree C.

For example, at 50°C, the charging voltage is

$$9.80\ V + [(50 - 20) \times -10\ mV] = 9.50\ V$$

To charge the battery, follow the steps on the data sheet that comes with the battery charger unit.

Time Out

An automatic time-out feature prevents the battery from losing power when the instrument is unattended for a long period. When you enable the time-out feature, the 222PS turns itself off after two minutes of operating under battery power with no changes to the controls.

You can disable the time-out feature so that the instrument stays on for the life of the battery's charger. You can also enable the time-out feature again when you wish. To do so, follow these steps.

☐ **Step 1:** Press the **AUX FUNCT** button on the top panel to display the auxiliary functions menu. Figure 3-18 shows the display.

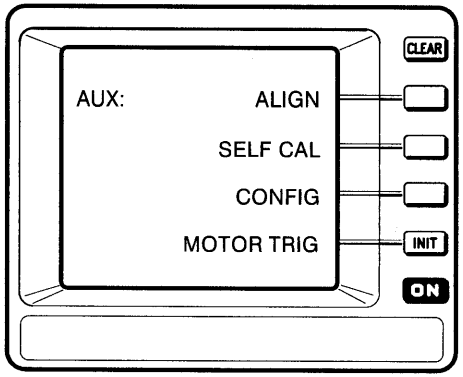

Figure 3-18: The Auxiliary Functions Menu

☐ **Step 2:** Press the menu button next to **CONFIG** to access the configuration menu. Figure 3-19 shows the configuration menu.

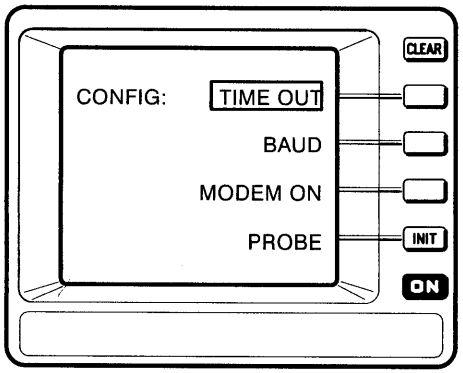

Figure 3-19: The Configuration Menu

☐ **Step 3:** The **TIME OUT** menu item appears boxed when the time-out feature is enabled. To disable the time-out feature press the top menu button.

This menu item is a toggle. Repeating this procedure re-enables the time-out feature and boxes the menu item again.

☐ **Step 4:** To clear the menu from the display, press the button labeled **CLEAR**.

Replacing the Battery

If you use the instrument on battery power often, you may wish to obtain and charge extra batteries to take with you. Then, when the battery charge inside the instrument gets low, you can switch to one of the fully charged spare batteries.

NOTE

Because the 222PS loses saved data after 30 s without power, have the spare battery handy before beginning this procedure.

To replace the battery, follow these steps:

☐ **Step 1:** Open the battery compartment. Follow the procedure on page 3-35.

☐ **Step 2:** Disconnect the battery from the three-wire battery connector.

☐ **Step 3:** Lift the battery pack out of the battery compartment.

☐ **Step 4:** Place the charged replacement battery into the battery compartment with the battery leads on the bottom facing toward the three-wire battery connector.

☐ **Step 5:** Connect the battery to the three-wire battery connector.

☐ **Step 6:** Close the battery compartment. Follow the procedure on page 3-35.

☐ **Step 7:** Recharge the low battery as soon as possible. See the procedure on page 3-37.

Storing the Instrument

When storing the instrument for a period shorter than two months, leave the battery connected. When the instrument is off, the current drawn from the battery is less than 1 mA. With the battery in place, waveform settings and front panel setups remain in memory; they are available when you turn the oscilloscope on again.

When storing the instrument for a period longer than two months, follow these steps to extend the life of your battery and instrument.

☐ **Step 1:** Charge the battery fully. Follow the instructions on page 3-37.

☐ **Step 2:** Remove the battery from the instrument. Use the procedure on page 3-35 to remove the battery cover.

☐ **Step 3:** Store the fully charged battery in a cool place.

Deep Discharge

Under certain circumstances, the battery can become deeply discharged. When in this state, the battery accepts a charge very slowly. In some cases, it may not accept a charge at all.

A deep discharge condition is caused by three situations:

- using the instrument until the battery charge is low and then storing it without recharging it
- storing the battery in a discharged state
- storing the instrument for over two months without removing the battery

If the battery becomes deeply discharged, you may be able to recover it with the following procedure.

☐ **Step 1:** Charge the battery for 24 hours. Follow the instructions on page 3-37.

☐ **Step 2:** If the battery does not accept the charge, remove it from the instrument and try again to charge it using a 20 V power supply that is current-limited to 100 mA.

☐ **Step 3:** During this operation, check the power supply frequently for a current-limited state. If the battery recovers from its state of deep discharge, it will cause the power supply to current-limit. Do not leave the battery connected to the external power supply without checking it frequently.

☐ **Step 4:** If the power supply shows that it is current-limited, reinstall the battery in the instrument.

☐ **Step 5:** Continue to recharge the battery.

☐ **Step 6:** If the battery does not recover, return it to Tektronix for safe disposal or dispose it in accordance with local environmental regulations.

External Power Operation

The 222PS has an external power input connector so that it need not use the battery power. You can connect the 222PS to a wall socket using the External Power AC Adapter or you can use your own external power source.

You can also operate the instrument on external power without the battery present. For instructions on removing the battery, see page 3-39.

AC Line Operation

The 222PS comes with an External Power AC Adapter. This adapter converts AC line voltage to the 16–20 VAC input voltage that the instrument requires. The adapter also recharges the 222PS's battery.

NOTE

In order to maintain the battery charge for times when you require portable operation, we recommend that you use the External Power AC Adapter whenever practical.

In order to operate the instrument from line power, follow these steps.

☐ **Step 1:** Plug the jack end of the External Power AC Adapter into the external power input on the rear panel of the instrument.

☐ **Step 2:** Plug the prong end of the External Power AC Adapter into an AC power source.

☐ **Step 3:** Press the **ON** button.

When the oscilloscope is operating under external power, an external power indicator appears in the upper right corner of the display.

Other Sources of External Power

You can operate the 222PS from your own external power source. The power source must supply at least 15 W or 16 volt-amperes.

- An AC power source must provide 16–20 VAC at 47–400 Hz.
- A DC power source must provide 12–28 VDC.

The external power input connector has two contacts. DC power of either polarity can be between contacts.

NOTE

To prevent blowing internal fuses, do not force either pin lower than .5 volts more negative than the instrument chassis. The instrument chassis is connected to the ground pin of the RS-232 communications port and to the external trigger connector common.

WARNING

To avoid possible injury or damage to the 222PS or equipment connected to it, do not float the external trigger common connector, the RS-232 communications port, or the external power input above 42 V peak. These inputs are not electrically isolated from each other.

Probes

The 222PS comes with two P850 10X probes. An additional 1X probe, the P400 probe, is available as an optional accessory.

The P850 probes provide high attenuation so that you can scale signals approaching 600 VAC_{RMS} for better display. They are also useful for measuring sensitive high-impedance electronic circuits or high-voltage divider circuits. The optional P400 probes measure low-level signals requiring high sensitivity.

CAUTION

To prevent improper operation and the risk of electric shock, use only Tektronix P400 or P850 probes with this instrument.

Actual probe attenuation factors are 3X for the P400 probe and 30X for the P850 probe. The instrument is calibrated to compensate for these attenuation factors. Other probes or input devices will therefore give incorrect amplitude displays.

The optional P400 1X probe limits the maximum deflection factor of the 222PS to 50 volts per division. It decreases the probe tip input impedance to 1 MΩ and is sufficient for minimal loading of sensitive circuits. The P400 probe also limits input frequency to 20 MHz.

WARNING

To avoid personal injury or damage to the 222PS or the probes, do not apply more than 850 V peak between probe tip and earth ground, between probe tip and probe common, or between probe common and earth ground.

Connecting the Probes

The input connectors for the probes are inside the pouch over the battery compartment, on the right side of the oscilloscope as you face the screen. You must unzip or remove the pouch to access the connectors.

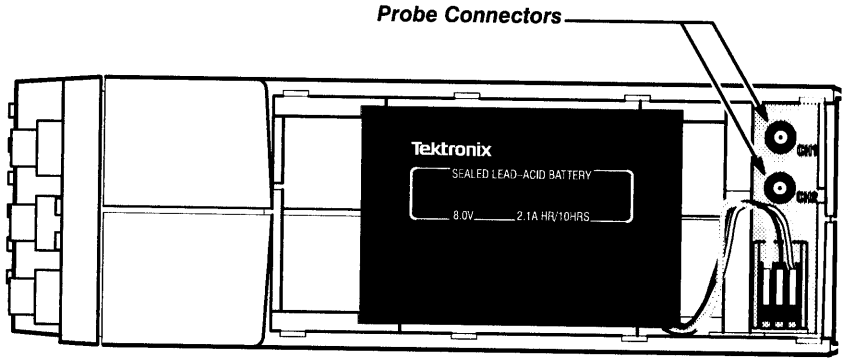

Figure 3-20: Side View Showing Probe Connectors (Pouch Removed)

To connect a probe, place its jack end into a channel input connector. Press until you feel the probe is firmly seated.

You do not need to disconnect the probes before storing them in the pouch.

CAUTION

The exposed probe tips are sharp for probing through solder-resin and oxide layers. When placing the probes in the side pouch, store them with the retractable hook tip attached to prevent unnecessary damage to the pouch.

Configuring the Probes

To ensure that the 222PS is operating with the correct settings, configure the instrument to match the probes you are using.

To set the probe configuration, follow these steps.

☐ **Step 1:** Press the **AUX FUNCT** button on the top panel to display the auxiliary functions menu, as shown in Figure 3-21.

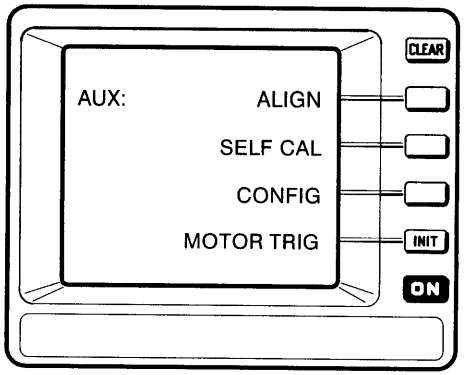

Figure 3-21: The Auxiliary Functions Menu

☐ **Step 2:** Press the menu button next to the **CONFIG** menu item to access the configuration menu. The display now appears as shown in Figure 3-22.

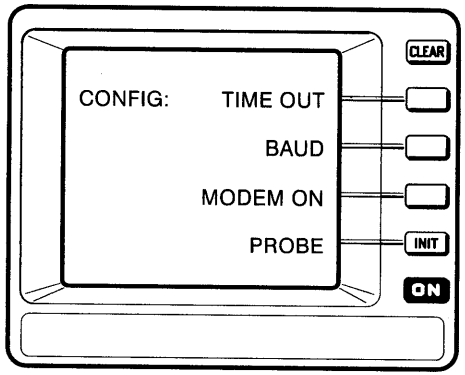

Figure 3-22: The Configuration Menu

☐ **Step 3:** Press the menu button next to the **PROBE** menu item to access the probe menu, as shown in Figure 3-23.

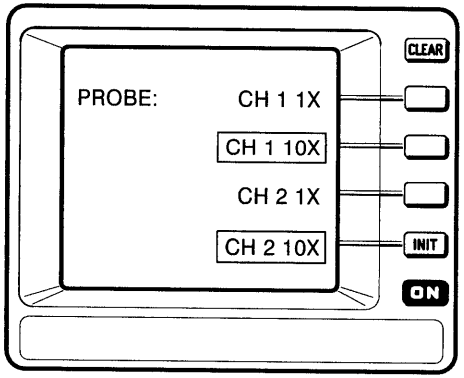

Figure 3-23: The Probe Menu

☐ **Step 4:** Boxes appear around the items that represent the current probe configuration. The default configuration for the 222PS assumes 10X probes on both channels. Therefore, those menu items appear boxed unless you have already changed the probe configuration.

Press the menu button or buttons next to the menu items corresponding to the configuration you need. If the current probe settings are appropriate, you need not press any buttons.

☐ **Step 5:** After you have configured the 222PS for the correct probes, press the **CLEAR** button to remove the menu from the display.

NOTE

The probe configurations are in the 222PS memory. They remain there until you change them again or until the memory loses power. If the probe configuration is lost, it returns to the default value of 10X probes for both channels.

Probe Accessories

The P850 probes come with four accessories (shown in Figure 3-24):

- a retractable hook tip
- an IC lead protection shroud
- a detachable probe common lead
- two cable-marker rings

NOTE

When removing the hook-tip assembly from the probe, you can accidentally disconnect the probe body from the probe cable. If this occurs, no signal can pass from the probe to the oscilloscope. To reconnect the probe body to the cable, insert the connector at the end of the cable into the probe body until it seats firmly.

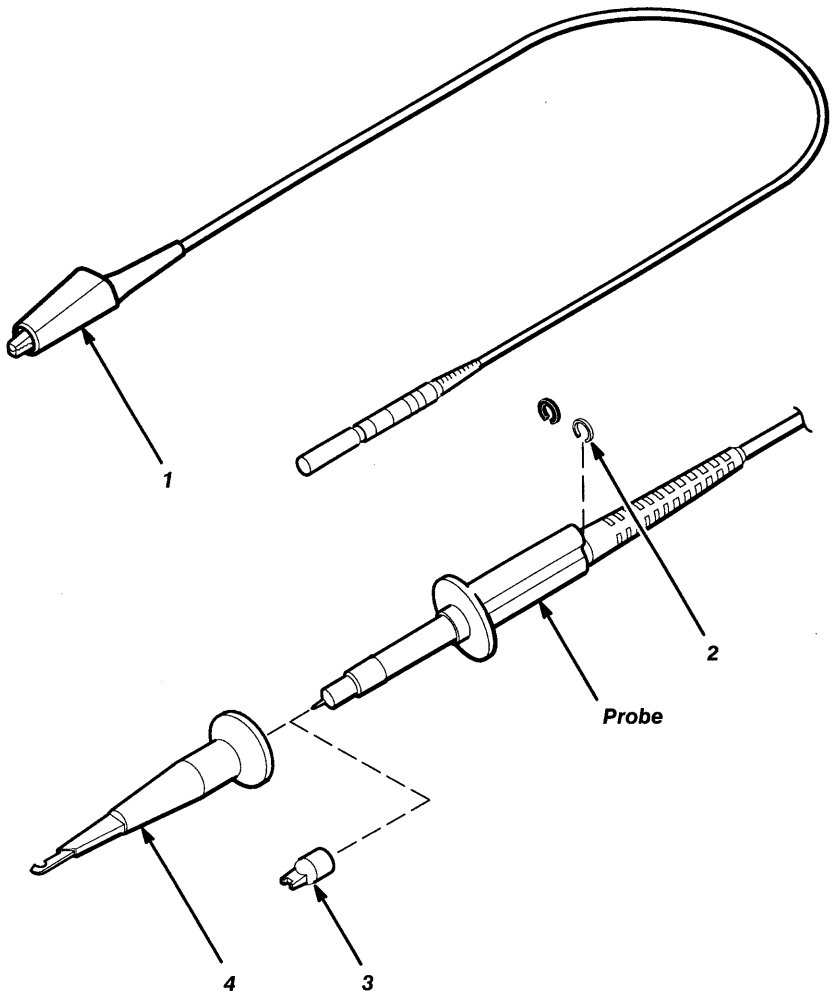

Figure 3-24: Probe and Accessories

1. You can use the detachable probe common lead shown in Figure 3-24 to connect the oscilloscope input common to the reference point of the circuit being tested. The probe common lead is not chassis ground and you can connect it to an active circuit component. You can therefore make a floating measurement across a component, with neither point connected to ground potential.

WARNING

To avoid personal injury or damage to the 222PS or the probes, do not apply more than 850 V peak between probe tip and earth ground, between probe tip and probe common, or between probe common and earth ground.

2. You can snap the colored cable marker rings shown in Figure 3-24 into the grooves on the probe cable to distinguish between the probes connected to channel 1 and channel 2.
3. When testing integrated circuit devices, remove the hook tip and use the IC lead protection shroud on the probe tip. The shroud shown in Figure 3-24 exposes the sharp probe tip, but it prevents the probe from creating a short circuit across adjacent IC leads.
4. The hook tip shown in Figure 3-24 can connect to accessible test points such as a component lead or test point connector. This accessory frees your hands for other tasks.

Saving and Recalling Data

The 222PS has memory to store saved waveforms and front-panel setups. Data in this memory remains as long as the instrument has access to one of these power sources:

- a battery with a charge greater than 7.32 V (see page 3-35 for a discussion of battery operation)
- line voltage coming through a power cord plugged into a wall socket through the external AC adapter (see page 3-41 for a discussion of line operation)
- power coming in from another external power source (see page 3-42 for a description of acceptable external power sources)

The instrument does not need to be on for it to access power for the memory. However, if you turn off the instrument, disconnect it from any external power source, and remove its battery, it will lose any data in memory after 30 s.

Waveforms

A saved waveform is a record of a single acquisition cycle. Think of it as a snapshot of a waveform. The 222PS lets you save up to four waveforms in memory. It can recall these at any time.

Saving a Waveform

Use these steps to save a waveform.

☐ **Step 1:** Select the channel whose waveform you wish to save or, if you wish, put the instrument in XY mode.

☐ **Step 2:** Using the selected channel, acquire and display the waveform you wish to save.

☐ **Step 3:** Position the waveform where you wish it to be saved.

☐ **Step 4:** Press the **SAVE** button on the top panel. Acquisition stops, the screen freezes, and a menu appears as shown in Figure 3-25.

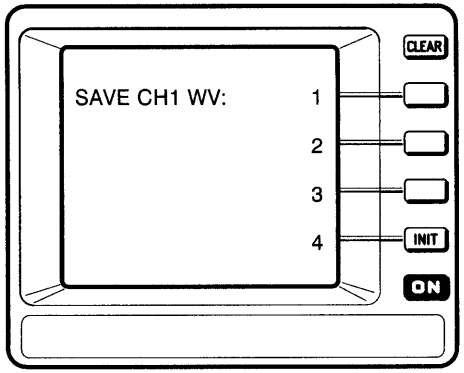

Figure 3-25: Saved Waveforms Menu

If the waveform you are saving uses channel 1, the menu name is SAVE CH1 WV:. If the waveform you are saving uses channel 2, the menu name is SAVE CH2 WV:. If the waveform you are saving uses XY mode, the menu name is SAVE XY WV:.

The example in Figure 3-25 assumes a waveform acquired using channel 1.

☐ **Step 5:** Press the button next to the memory location in which you wish to save the waveform.

NOTE

You can save only one waveform to each memory location; the 222PS can store only four waveforms. If you choose a memory location that already holds a waveform, the instrument replaces it with the one you are presently saving.

The 222PS displays readouts of the parameters of the saved waveform at the bottom of the screen, as shown in Figure 3-26.

In Figure 3-26, the waveform has been saved to memory location 1 and therefore named W1. Its vertical setting is 10 mV per division, its coupling is DC (as indicated by the =), and its horizontal setting is 10 ms per division.

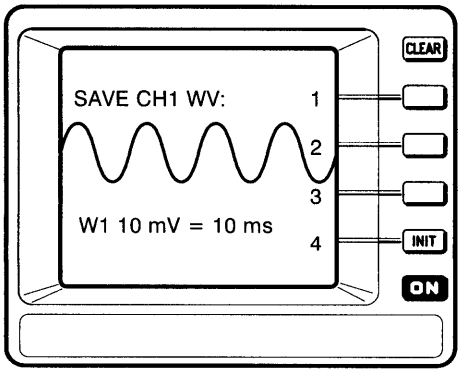

Figure 3-26: Saved Waveform Parameters

A waveform saved in XY mode shows the scale factor for the *x* axis (channel 1) in the position of the volts per division setting. The scale factor for the *y* axis (channel 2) appears in the position of the seconds per division setting.

☐ **Step 6:** To clear the menu, press the button labeled **CLEAR** or invoke another menu. Changing one of the following front-panel controls also clears the menu: volts per division, seconds per division, X10 magnification, or autolevel.

☐ **Step 7:** After clearing the menu, the 222PS continues to display the saved trace and its readout. To clear them, press the button labeled **CLEAR** again.

Recalling a Saved Waveform

To display a saved waveform, follow these steps.

☐ **Step 1:** Press the **RCL** button on the top panel. A menu appears as shown in Figure 3-27.

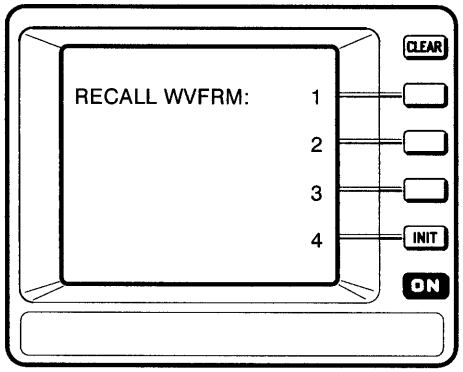

Figure 3-27: The Recall Waveforms Menu

☐ **Step 2:** Press the button next to the memory location that holds the waveform you wish to view. The menu disappears and the 222PS displays the waveform at the same position in which it was saved, with the same parameters in effect. The instrument also displays readouts of these parameters at the bottom of the screen.

If the instrument displays two saved waveforms, the last one you recall is the one whose parameters appear on the screen.

If the 222PS is already displaying a saved waveform, the memory location that holds it appears boxed in the menu. If you press a button next to a memory location holding an already displayed waveform, the waveform disappears from the screen.

If you press a button corresponding to an empty memory location, the instrument beeps and the menu remains displayed.

☐ **Step 3:** To clear the menu press the **CLEAR** button or invoke another menu.

☐ **Step 4:** After you clear the menu, the instrument continues to display the recalled waveform. To clear the recalled waveform, press the **CLEAR** button again. This action clears all recalled waveforms.

☐ **Step 5:** To erase a waveform from a memory location, save another waveform to the same location.

Setups

The 222PS can save four setups in its memory. If you often use the same front-panel setup to view certain signals, you may wish to save the setup. Saving a setup allows you to set the instrument up in the same way just by executing a menu item.

NOTE

You may wish to keep a list of the settings you have saved in each location. Such a list can be useful to refer to later.

NOTE

The 222PS setup save routine does not save vertical and horizontal positions, trigger level, or configuration menu settings.

Saving a Setup

To save a setup, follow these steps.

☐ **Step 1:** Set up the instrument exactly as you wish.

☐ **Step 2:** Press the **SETUP** button on the top panel to invoke the setup menu, as shown in Figure 3-28.

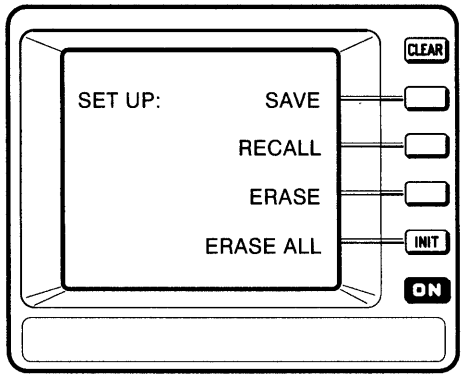

Figure 3-28: The Setup Menu

☐ **Step 3:** Press the button next to the menu item **SAVE**. A new menu appears, as shown in Figure 3-29.

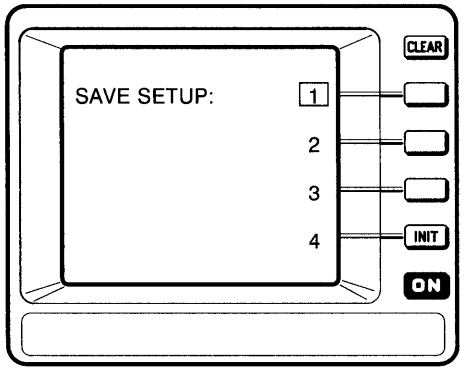

Figure 3-29: The Save Setup Menu

☐ **Step 4:** Choose the memory location to which you wish to save the setup. Press the button next to the number representing the memory location.

The 222PS saves the current instrument setup to the memory location you selected. The menu disappears; the display shows a signal again.

CAUTION

If one of the numbers appears boxed, as the number 1 does in Figure 3-29, the memory location already contains a setup. Saving a new setup to that location erases the previous setup. If you wish to keep the old setup, select an unboxed number, representing an unused memory location.

Recalling a Saved Setup

To recall a setup, follow these steps.

☐ **Step 1:** Press the **SETUP** button on the top panel to invoke the setup menu, as shown in Figure 3-28.

☐ **Step 2:** Press the button next to the menu item **RECALL**. A new menu appears, as shown in Figure 3-30.

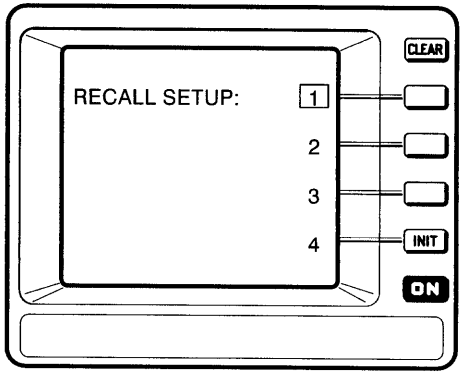

Figure 3-30: The Recall Setup Menu

☐ **Step 3:** Memory locations that contain instrument setups appear boxed. Select one of the boxed memory locations to recall the setup you saved in it. Press the button next to the number representing the memory location. The menu clears and the settings change to the saved values.

NOTE

If you choose an empty memory location, the instrument beeps and the menu remains. The instrument settings do not change.

Erasing a Saved Setup

You can erase a saved setup when it is no longer useful. To do so, follow these steps.

☐ **Step 1:** Press the **SETUP** button on the top panel to invoke the setup menu. The display appears as shown in Figure 3-28.

☐ **Step 2:** If you wish to erase all the saved setups, press the button next to the menu item **ERASE ALL**.

If you wish to erase only one setup, press the button next to the menu item **ERASE**. A new menu appears, as shown in Figure 3-31.

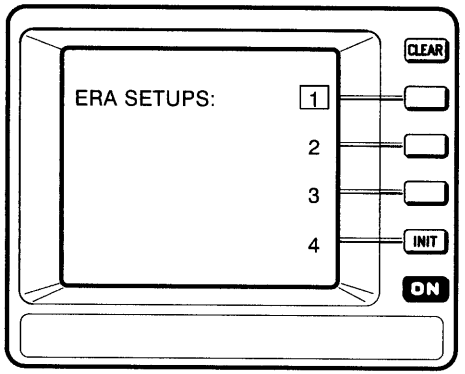

Figure 3-31: The Erase Setups Menu

☐ **Step 3:** Memory locations that contain instrument setups appear boxed. Select the boxed memory location whose setup you wish to erase. Press the button next to the number representing the memory location. The menu clears and the instrument erases the setup in that memory location.

NOTE

If you choose a memory location without a setup in it, the instrument beeps and the menu remains.

Store Mode

The 222PS can display signals in store and nonstore modes. In *store mode*, the instrument displays traces between trigger events. In *nonstore mode*, the 222PS displays traces only until the next display update (about 30 ms) or until the next trigger. If a trigger does not occur in 30 ms, the instrument blanks the display. Nonstore mode operates similarly to a conventional analog oscilloscope displaying a signal that is triggered at the beginning of the trace.

Single-sequence mode is the exception to this rule — when in single-sequence and nonstore modes, the 222PS displays the trace until you press the **INIT** button to reacquire the signal.

You can tell whether the instrument is in store or nonstore mode by looking at the bottom readouts. When the 222PS is in store mode, an s_t symbol appears in the middle of the bottom readout. In nonstore mode, this space is blank. Figure 3-32 shows a store mode readout.

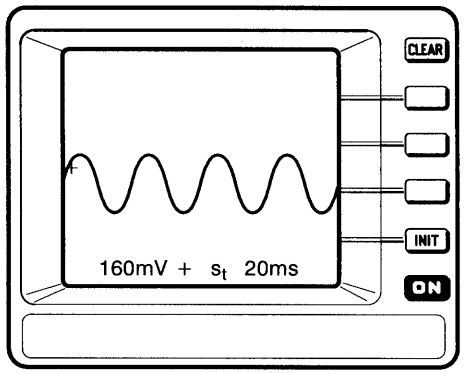

Figure 3-32: Horizontal Readouts in Store Mode

To place the 222PS in store mode, press the **STORE** button near the center of the top panel. This button is a toggle. To take the instrument out of store mode, press it again.

Triggering

The trigger controls are in the center of the front panel, as shown in Figure 3-33.

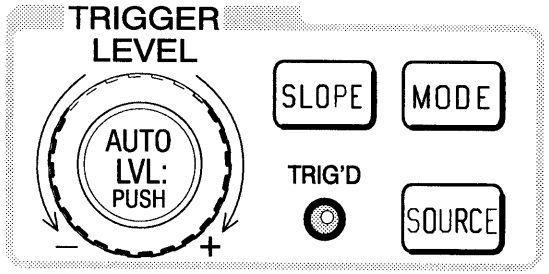

Figure 3-33: Trigger Controls

This section explains how to control the various aspects of the trigger so that the instrument displays the waveform in the manner you require.

The Trigger Light

When the 222PS is triggered, the **TRIG'D** LED lights.

NOTE

If the amplitude of your signal is less than 1/2 division, the instrument may not trigger. Readjust the volts per division setting so that your display amplitude is larger.

Trigger Source

The 222PS has the ability to use the signal from either channel as the trigger source. An external signal from the external trigger input connector can also serve as the trigger source.

To set the trigger source, follow these steps.

☐ **Step 1:** Press the **SOURCE** button in the trigger control area. A menu appears on the display, as shown in Figure 3-34.

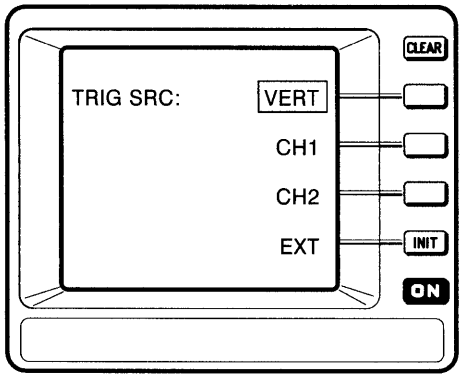

Figure 3-34: The Trigger Source Menu

- **VERT** is the default trigger source and therefore appears boxed unless you have previously selected another trigger source. This menu item indicates that the instrument triggers off the lowest-numbered active channel. If both channels are off, the instrument is untriggered.
- Selecting **CH1** specifies that the instrument use the signal from channel 1 as the trigger source. Channel 1 need not be displayed to serve as the trigger source.
- Selecting **CH2** specifies that the instrument use the signal from channel 2 as the trigger source. Channel 2 need not be displayed to serve as the trigger source.
- Selecting **EXT** specifies that the instrument use the signal from the external trigger input as the trigger source.

☐ **Step 2:** To select the trigger source, press the menu button next to the appropriate menu item.

You can also cycle through the menu choices by continuing to press the front-panel **SOURCE** button. The selected menu item appears boxed.

☐ **Step 3:** When you have selected a trigger source, press **CLEAR** to remove the menu from the screen.

External Triggering

The 222PS has the ability to trigger on an external signal, such as a clock pulse. The instrument acquires external trigger signals through the external trigger input and trigger common reference connectors on the rear panel. These connectors are shown in Figure 3-35.

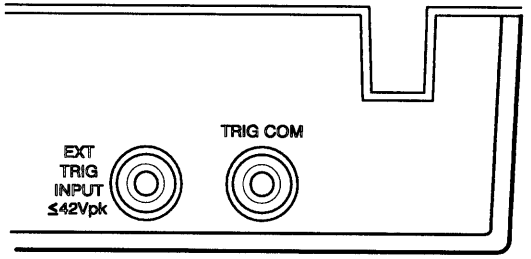

Figure 3-35: Rear Panel External Trigger Connectors

WARNING

To avoid injury, do not connect the trigger common reference input to voltages greater than 42 V peak. The trigger common reference input is not insulated.

WARNING

To avoid personal injury or damage to the 222PS or equipment connected to it, do not float the external trigger common connector, the RS-232 communications port, or the external power input above 42 V peak. These inputs are not electrically isolated from each other.

To trigger on an external signal, follow these steps.

NOTE

To make the appropriate external trigger connections, you will need either a BNC-to-banana-plug adapter or a pair of test leads such as those used with a digital multimeter.

- ☐ **Step 1:** Identify the signal you wish to use as an external trigger source.
- ☐ **Step 2:** Connect the external trigger signal to the external trigger input connector on the rear panel of the instrument.
- ☐ **Step 3:** Connect the ground of the external trigger signal to the trigger common reference input.
- ☐ **Step 4:** Invoke the trigger source menu. See page 3-64.
- ☐ **Step 5:** Select **EXT** to specify that the instrument use the external signal as the trigger source.
- ☐ **Step 6:** Press **CLEAR** to clear the menu from the display.
- ☐ **Step 7:** Adjust the trigger level. See page 3-69.

When you use an external trigger source, the + trigger position indicator does not appear on the screen. However, you can use the readout at the bottom left of the display to help you; it indicates the trigger voltage level. The **TRIG'D** light still turns on to indicate when the instrument is triggered.

If you have trouble acquiring a trigger, press the **AUTOLVL:PUSH** knob.

Motor Trigger Function

The motor trigger function responds to pulse bursts such as those produced by uninterruptable power supplies (UPS) and variable-frequency motor drives. This function triggers on the first pulse that occurs in each burst if the interval between the bursts is at least 2.5 ms. If the interval between bursts is less than 2.5 ms, the motor trigger function does not operate.

The motor trigger function also reduces noise on 50/60 Hz line signals resulting in cleaner triggering in noisy line environments.

The trigger source, slope, level, and mode functions still operate normally when you select MOTOR TRIG. Note, however, that even though the trigger source selections include EXT, motor trigger does not work with signals applied to the EXT TRIG INPUT.

Triggering on Motor Drive Signals

To trigger on the variable-frequency signal that drives a motor, use the following procedure:

- ☐ **Step 1:** Toggle MOTOR TRIG on and set the trigger level midway between the top and bottom of the desired pulse group.
- ☐ **Step 2:** Set the trigger slope to + for pulse groups separated by a "low" region (Figure 3-36). Set the trigger slope to – if the region separating the pulse groups is "high" (Figure 3-37).
- ☐ **Step 3:** Use normal trigger mode if the oscilloscope has trouble triggering on a slow motor speed.

Triggering on 50/60 Hz Line Signals

To trigger on 50/60 Hz line signals, toggle MOTOR TRIG on and set the other trigger controls to trigger either on the rising edge or the falling edge of the waveform. The motor trigger function suppresses stray trigger signals that result from line transients and noise.

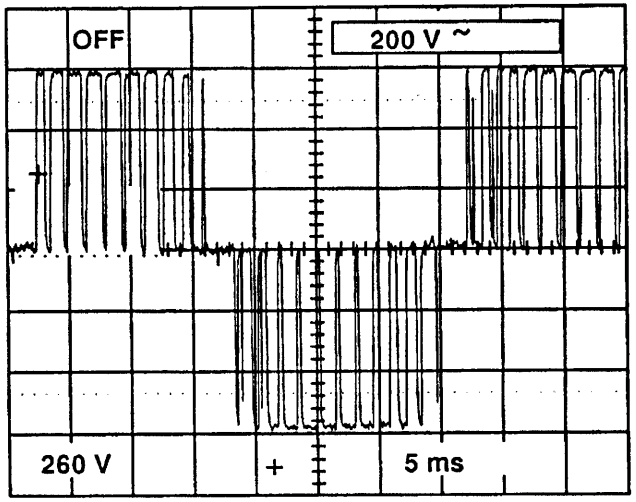

Figure 3-36: Motor Drive Signals Separated by a Low Region

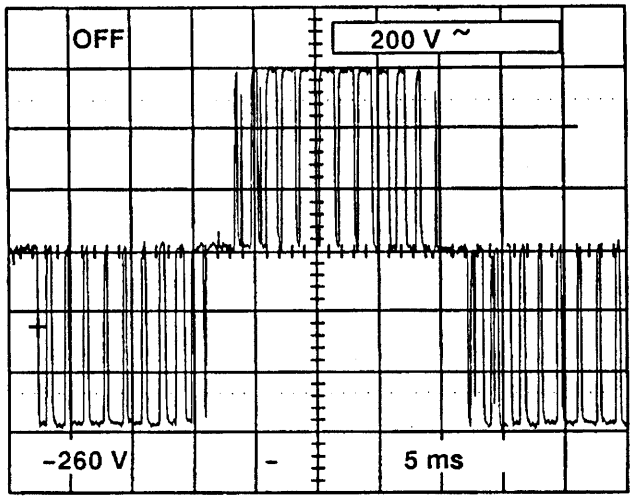

Figure 3-37: Motor Drive Signals Separated by a High Region

Trigger Coupling

In the 222PS, the coupling of the trigger source is the same as the coupling of the channel it is using. An external trigger is always DC-coupled.

Trigger Slope

To determine the trigger slope presently in use, look at the bottom readouts. At the left is the trigger level in volts. Immediately to its right is the trigger slope indicator. A plus (+) indicates a positive slope; a minus (−) indicates a negative slope.

To change the trigger slope, press the **SLOPE** button in the front-panel trigger controls. This button toggles between positive and negative slopes.

Trigger Level

The trigger level presently in use appears at two places on the screen. It appears as a small + on the screen at the trigger position. Its value in volts is the leftmost of the bottom readouts.

You can set the trigger level of the 222PS anywhere within the vertical range of the instrument. The signal used for triggering need not appear on the screen. If the trigger level is off the screen and the instrument is triggered, the + trigger level indicator is at the top or the bottom of the screen, indicating the direction of the trigger level.

To set the trigger level explicitly, follow these steps.

- ☐ **Step 1:** Ensure that the trigger mode is normal, auto baseline, or single sequence. (In auto level mode, the 222PS sets the trigger level automatically. Trigger modes are discussed on page 3-71.)
- ☐ **Step 2:** Turn the **TRIGGER LEVEL** knob located in the left side of the trigger control area. Turning the outer knob clockwise raises the trigger level; turning it counterclockwise lowers the trigger level.

Auto-Level

You can also set the trigger level so that the instrument finds the peak values of the trigger signal and sets the trigger level at the midpoint. This feature is called *auto-level*. It is useful for finding a trigger level quickly to trigger the display.

To do this on a one-time only basis, push the knob labeled **AUTOLVL:PUSH**. Pushing this knob sets the trigger level to a point halfway between the peak values of the signal. However, unless you are in auto-level trigger mode, you can readjust the trigger level to any other level.

You can also set the 222PS to perform a new auto level search each time the trigger is lost. To do so, see the section on trigger modes on page 3-71.

Trigger Position

The trigger position is indicated on the display by a + at the current trigger location.

When in store mode, you can set the trigger position to the beginning, middle, or end of the waveform. This allows you to see waveform data distributed around the trigger point in several ways, depending on the portion of the signal that interests you.

- The **POST** trigger position displays most of the samples after the trigger event. The trigger position is near the beginning of the trace.
- The **MID** trigger position displays the samples evenly divided before and after the trigger event. The trigger position is in the middle of the trace.
- The **PRE** trigger position displays most of the samples before the trigger event. The trigger position is near the end of the trace.

NOTE

In nonstore mode, the trigger is always the sixth sample. Therefore the trigger position is always near the beginning of the waveform; you cannot adjust it. If you change the trigger position when in nonstore mode, the change will take effect when you put the instrument in store mode.

To change the trigger position, follow these steps.

☐ **Step 1:** Put the instrument in store mode by pressing the **STORE** button on the top panel.

☐ **Step 2:** Press the **TRIG POS** button on the top panel. A menu appears on the display, as shown in Figure 3-38. The trigger position presently in effect appears boxed in the menu.

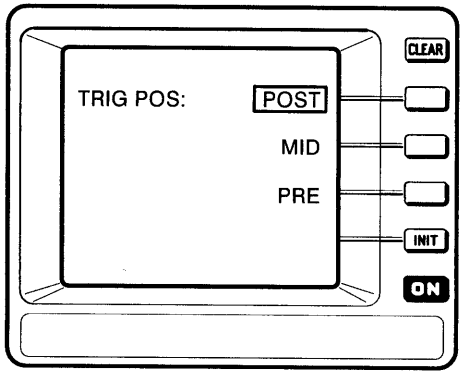

Figure 3-38: Trigger Position Menu

☐ **Step 3:** If you wish to use the boxed choice, press the **CLEAR** button. Otherwise, press the menu button next to the item you wish to select. The menu clears, and your choice takes effect.

You can also cycle through the choices by pressing **TRIG POS** repeatedly until the selection you want appears boxed. Then press **CLEAR**.

Trigger Modes

The 222PS has four trigger modes: normal, auto-level, auto baseline, and single-sequence.

Normal

When the instrument is in nonstore mode and normal trigger mode, it behaves in a manner similar to that of an analog oscilloscope. If a new trigger does not occur, the instrument holds the waveform until the end of the update period. Then the display is blanked until the next trigger occurs.

In store mode, the instrument stores the waveform on the display until a new trigger occurs.

Auto-Baseline

When in auto-baseline mode, the instrument acquires and displays whatever data it can capture, regardless of whether a trigger event occurs. This mode allows you to display information even when a signal is too small to trigger on.

If the instrument is using the scrolling time-base mode for slow time-base settings, it remains untriggered because scrolling accepts no triggers.

Auto-Level

In auto-level mode, the instrument sets the trigger level itself. It determines the high and low peak values of the signal, and sets the trigger level to the midpoint between them. If you adjust the trigger level setting directly while in this mode and triggering is lost, the trigger level quickly returns to the midpoint.

If no signal is applied to the trigger source, the auto-level feature causes the instrument to behave in the same manner as it does under auto-baseline mode: it forces a trigger event and displays the resulting data.

NOTE

If the instrument is using the auto-level trigger mode and you change the trigger level or the trigger is lost, the instrument can sometimes fail to reacquire the new trigger level. If this occurs, press the **AUTOLVL:PUSH** *knob.*

The instrument attempts to set the trigger level automatically when under three conditions:

- when you first enter auto-level trigger mode
- when you push the **AUTOLVL:PUSH** knob
- when a trigger event has not occurred within a certain time period after the previous display of the trace

The time the instrument waits after displaying the previous trace depends on the seconds-per-division setting. Table 3-3 provides these time periods.

Table 3-3: Auto-Level Trigger Interval Time Limits

Seconds per Division	Trigger Interval
5 ms or fewer	30 ms
10 ms to 50 ms	4 × seconds-per-division setting
100 ms or more	200 ms

NOTE

If the instrument is using the scrolling time-base mode, it remains untriggered because scrolling accepts no triggers.

Single-Sequence

In single-sequence mode, the instrument acquires one triggered signal. It then displays the signal and holds it until you press the **INIT** button to start the sequence all over again.

Changing a control that affects the signal acquisition also starts the sequence again.

Setting the Trigger Mode

To set the trigger mode, follow these steps.

☐ **Step 1:** Press the button labeled **MODE** to the right of the trigger control area on the front panel. A menu appears, as shown in Figure 3-39. The trigger mode presently in effect appears boxed in the menu.

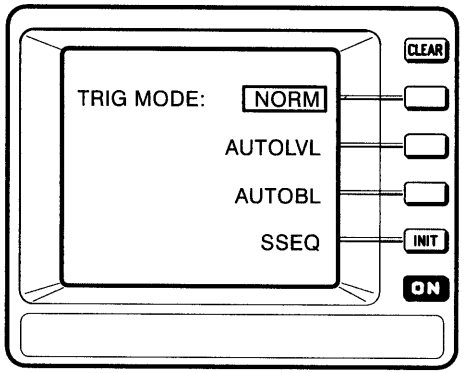

Figure 3-39: The Trigger Mode Menu

☐ **Step 2:** Press the menu button next to the menu item you wish to select. The menu clears. If the trigger mode you wish to use is already selected, press **CLEAR** to clear the menu.

You can also cycle through the menu choices by pressing **MODE** repeatedly until the trigger mode you wish is selected. Then press **CLEAR** to clear the menu.

Vertical Operation

This section discusses controlling the vertical aspects of your signal. The knobs you use to do this are at the top left of the front panel, as shown in Figure 3-40.

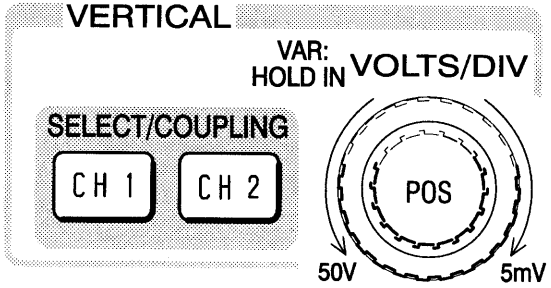

Figure 3-40: The Vertical Controls

These controls affect only the currently selected channel. The channel does not need to be displayed.

NOTE

Changes you make to a signal from a channel that is off take effect as soon as you turn the channel back on.

Vertical Positioning

To position the selected channel signal vertically, turn the inner knob labeled **POS**.

If the signal you are positioning is the trigger source, the trigger point indicator (a + on the display) follows the position of the signal. If you position the signal off the screen, the trigger point indicator remains at the top or the bottom of the screen to show the direction of the off-screen signal.

Volts per Division

The vertical axis of the 222PS display has eight divisions. The 222PS can display a signal with a range of 50 mV to 500 V per division. (If you are using 1X probes, the range is 5 mV to 50 V per division.) A waveform as large as 850 V peak-to-peak can fit entirely on the display. You can size a waveform as small as 40 mV peak-to-peak to take up the entire display as well.

The volts per division knob is the outer of the two vertical control knobs. It is labeled **VOLTS/DIV**.

NOTE

If the amplitude of your signal is less than 1/2 of a division, the instrument cannot trigger. Readjust the volts per division setting so that your signal amplitude is larger.

Variable Volts per Division

When you turn the variable volts per division control, the signal becomes *uncalibrated* along the vertical axis — voltage measurements are not necessarily accurate. This feature is useful for making such measurements as rise or fall times.

To change the size of a signal to an arbitrary number of divisions, follow these steps.

☐ **Step 1:** Press in the inner knob of the vertical controls, the one labeled **POS**.

☐ **Step 2:** Hold the knob in while turning it counterclockwise. A greater-than sign (>) appears in front of the volts-per-division readout for the selected channel. This symbol means the volts-per-division setting for that channel is now uncalibrated.

☐ **Step 3:** To return the signal to a calibrated volts-per-division readout, press the **POS** knob in again.

☐ **Step 4:** Hold the knob in while turning it clockwise slowly until you hear a beep. The uncalibrated symbol disappears from the readouts and you can now accurately determine the volts per division for the signal.

XY Mode

When the 222PS is in XY mode, it samples and digitizes the incoming signal just as it does when not in XY mode. Therefore, trigger level and seconds-per-division settings affect the XY display.

We recommend that before entering XY mode you set up your signals as you require. To avoid a loss of detail in the display, set up the instrument so that it is showing as few cycles as possible before putting it in XY mode.

Entering and Exiting XY Mode

To enter XY mode, follow these steps.

☐ **Step 1:** Press the **DISPL** button on the top panel. The screen appears as shown in Figure 3-41.

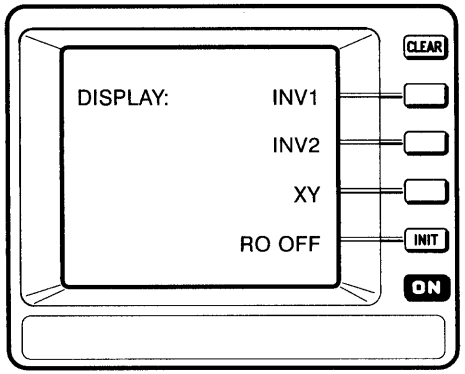

Figure 3-41: The Display Menu

☐ **Step 2:** Press the button next to the menu item **XY**. The instrument clears the menu and displays its signals in XY mode.

NOTE

Because XY mode depends on plotting one signal against another, both channels must be on. Therefore, if either channel was off before you entered XY mode, the instrument now turns it back on. And when you are in XY mode, neither channel can be turned off.

☐ **Step 3:** When you finish working in XY mode, invoke the display menu again by pressing the **DISPL** button on the top panel. The XY menu item appears boxed to indicate that XY mode is selected.

☐ **Step 4:** Press the button next to the menu item **XY** again to take the instrument out of XY mode. The 222PS clears the menu and displays the signals against a horizontal time base.

Positioning XY Waveforms

In XY mode, you can change both the horizontal and the vertical positions of a trace using only the vertical **POS** knob—the inner of the two vertical control knobs. To position an XY waveform, follow these steps.

☐ **Step 1:** Select channel 1.

☐ **Step 2:** Rotate the vertical **POS** knob to position the trace horizontally.

☐ **Step 3:** Select channel 2.

☐ **Step 4:** Rotate the vertical **POS** knob to position the trace vertically.

Appendices