Tektronix

222PS
PowerScout
Power Systems Oscilloscope
Operator Manual

070-8097-02

Please check for change information at the rear of this manual.

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Instrument Serial Numbers

Each instrument manufactured by Tektronix has a serial number on a panel insert or tag, or stamped on the chassis. The first letter in the serial number designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument. Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

B010000	Tektronix, Inc., Beaverton, Oregon, USA
E200000	Tektronix United Kingdom, Ltd., London
J300000	Sony/Tektronix, Japan
H700000	Tektronix Holland, NV, Heerenveen, The Netherlands

Instruments manufactured for Tektronix by external vendors outside the United States are assigned a two digit alpha code to identify the country of manufacture (e.g., JP for Japan, HK for Hong Kong, IL for Israel, etc.).

Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077

Printed in U.S.A.

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In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

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We hereby certify that the 222PS PowerScout POWER SYSTEMS OSCILLOSCOPE AND ALL INSTALLED OPTIONS

complies with the RF Interference Suppression requirements of Amtsbl.-Vfg 1046/1984.

The German Postal Service was notified that the equipment is being marketed.

The German Postal Service has the right to re-test the series and to verify that it complies.

TEKTRONIX

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in Übereinstimmung mit den Bestimmungen der Aamtsblatt-Verfugüng 1046/1984 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes angezeigt und die Berechtigung zur Überprufüng der Serie auf Einhalten der Bestimmungen eingeräumt.

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NOTICE to the user/operator:

The German Postal Service requires that Systems assembled by the operator/user of this instrument must also comply with Postal Regulation, Vfg. 1046/1984, Par. 2, Sect. 1.

HINWEIS für den Benutzer/Betreiber:

Die vom Betreiber zusammengestellte Anlage, innerhalb derer dies Gerät eingesetzt wird, muß ebenfalls den Voraussetzungen nach Par. 2, Ziff. 1 der Vfg. 1046/1984 genugen.

NOTICE to the user/operator:

The German Postal Service requires that this equipment, when used in a test setup, may only be operated if the requirements of Postal Regulation, Vfg. 1046/1984, Par. 2, Sect. 1.7.1 are complied with.

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Dies Gerät darf in Meßaufbauten nur betrieben werden, wenn die Voraussetzungen des Par. 2, Ziff. 1.7.1 der Vfg. 1046/1984 eingehalten werden.

Welcome

This manual contains the following sections:

- *Overview* describes the 222PS PowerScout and provides safety information.
- *At A Glance* describes the controls and connectors for the 222PS.
- *In Detail* provides further detail on some aspects of the 222PS, building on the information contained in *At A Glance*. The 15 topics of this chapter are in alphabetical order for your convenience:
  - Acquisition Modes
  - Auto Setup
  - Calibration
  - Capturing Random Events
  - Channels
  - The Display
  - Horizontal Operation
  - Maintenance and Repair
  - Power
  - Probes
  - Saving and Recalling Data
  - Store Mode
  - Triggering
  - Vertical Operation
  - XY Mode
- *Tutorial: Measuring Signals* provides step-by-step instructions to get you started making measurements quickly.

- *Remote Communication* provides information on RS-232 communication procedures between the 222PS and a PC.
- *Performance Verification* describes the procedures necessary to verify that the 222PS is performing according to specifications.
- *Specifications* provides complete specifications for the 222PS PowerScout.
- *Accessories* describes the standard and optional accessories available for the 222PS.
- *Glossary* defines various words used in the text.
- The *Index* helps you locate information quickly.

NOTE

If you have never used an oscilloscope before, please read the tutorial in Appendix A before using the 222PS.

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Overview

Overview

This section summarizes the product features and safety precautions of the 222PS PowerScout.

About the 222PS PowerScout

The Tektronix 222PS PowerScout is a portable digitizing oscilloscope. It has two **fully isolated, independently floatable** channels rated to 600 VAC_{RMS}. The 222PS/224 digitizing oscilloscopes are the only oscilloscopes in the world with this feature.

The 222PS also has these features.

- light weight with a battery power source for field operations
- automatic setup button
- automatic triggering modes
- averaging and enveloping acquisition modes
- remote operation capabilities via the RS-232 communications port
- internal memory for saving up to four waveforms and four instrument setups
- DC-to-10 MHz signal bandwidth
- 10 MS/s digitizing rate
- 1 MHz single pass storage bandwidth
- Motor trigger

If you need more information about your Tektronix 222PS PowerScout or other Tektronix products, contact the nearest Tektronix sales office or distributor, consult the Tektronix product catalog, or, in the U. S., call the Tektronix National Marketing Center toll-free at 1-800-426-2200.

Safety

You may be eager to begin using your Tektronix 222PS but please take a moment to review these safety precautions. We provide them for your protection and to prevent damage to the 222PS PowerScout. This safety information applies to all operators and service personnel.

WARNING

To avoid personal injury or damage to the 222PS, 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.

WARNING

To avoid injury, use caution when working on equipment with voltages above 42 V peak. Such voltages pose a shock hazard.

WARNING

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.

Symbols and Terms

These two terms appear in manuals:

- **CAUTION** statements identify conditions or practices that could result in damage to the equipment or other property.
- **WARNING** statements identify conditions or practices that could result in personal injury or loss of life.

These two terms appear on equipment:

- *CAUTION* indicates a personal injury hazard not immediately accessible as one reads the marking or a hazard to property including the equipment itself.
- *DANGER* indicates a personal injury hazard immediately accessible as one reads the marking.

This symbol appears in manuals:

Static-Sensitive Devices

These symbols appear on equipment:

DANGER
High Voltage

Protective
ground (earth)
terminal

ATTENTION
Refer to
manual

Specific Precautions

Observe all these precautions to ensure your personal safety and to prevent damage either to the 222PS or to equipment connected to it.

Power Source — The 222PS can use its self-contained sealed lead acid battery as a power source. It can also operate using power supplied to the external power input. Power supplied to this input must be 12 to 28 VDC or 16 to 20 VAC_{RMS}. Do not force either external power conductor negative by more than 0.5 V with respect to chassis ground. Both conductors of the external power input are fused internally. These fuses are not user accessible.

You can operate the instrument with external power operation from local 110 V or 240 V power supply using the appropriate external power AC adapter. Use only external power AC adapters specified for this instrument.

Grounding the PowerScout — The channel 1 and channel 2 measurement inputs of the 222PS are doubly insulated from each other and all other accessible portions of the instrument cabinet. It is not necessary to ground the instrument to avoid electric shock.

Fuse — The 222PS has no user-replaceable fuses.

Do Not Disassemble the Cabinet — To avoid personal injury, do not operate the instrument without a properly assembled cabinet. The cabinet of the instrument should be disassembled only by qualified service personnel.

Do Not Operate in Explosive Atmospheres — The 222PS provides no explosion protection from static discharges or arcing components. Do not operate the 222PS in an atmosphere of explosive gasses.

Electric Overload — Never apply a voltage to a probe or connector on the 222PS that is outside the range specified for that probe or connector.

At a Glance

At a Glance

This chapter describes the controls, connectors, and display readouts of the 222PS PowerScout. It is intended to help orient you and to provide basic information. For more detailed operating instructions for various features, see the appropriate section in the chapter entitled *In Detail.*

This section provides page references to the *In Detail* chapter for further information.

Front Panel Controls

The front panel for the 222PS PowerScout appears as shown in Figure 2-1.

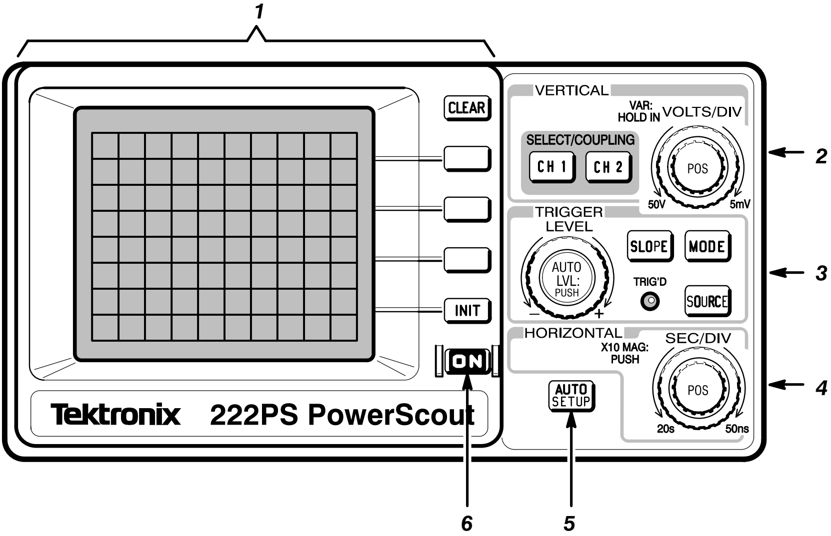

Figure 2-1: 222PS Front Panel

1. The display area includes the screen and associated buttons. The screen shows signal traces, readouts, and menu items. Buttons along the side of the screen allow you to manipulate menus. See page 2-6 for a more complete description of the display area.
2. The vertical controls allow you to manipulate the vertical aspects of your signal. See page 3-77 for a more complete description of the vertical controls.
3. The trigger controls allow you to manipulate the aspects of your signal having to do with triggering. See page 3-63 for a more complete description of the trigger controls.
4. The horizontal controls allow you to manipulate the horizontal aspects of your signal. See page 3-25 for more information on the horizontal controls.

5. **AUTO SETUP** allows you to set up the instrument with the push of a single button. Press this button for a quick, informative display of any signal between 20 Hz and 1 MHz. See page 3-5 for more information on the **AUTO SETUP** button.

6. The **ON** button toggles the instrument on or off. The instrument beeps when it is turned on.

Vertical Controls

Figure 2-2 shows the vertical controls that are located on the front panel.

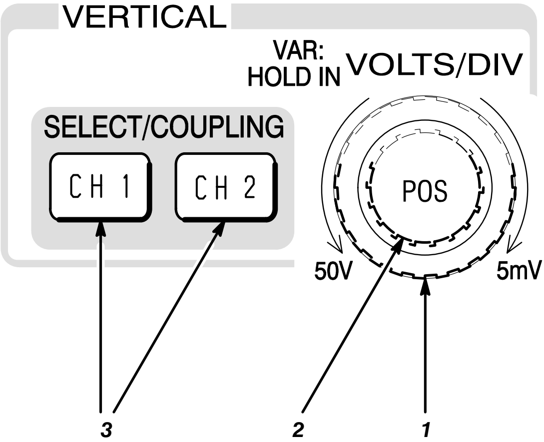

Figure 2-2: Vertical Controls

1. The outer knob sets the volts per division, which is the vertical scale of your display. Turn the knob clockwise to decrease the volts per division and counterclockwise to increase the volts per division. See page 3-78 for more information on setting the volts per division.

2. The inner knob sets the vertical position of the signal. Turn the knob clockwise to move the signal towards the top of the screen and counterclockwise to move the signal towards the bottom of the screen. For more information on setting the vertical position see page 3-77.

You can also use this knob to change the size of a signal to an arbitrary number of divisions. To do so, see page 3-78.

3. The 222PS can display signals acquired through either or both of its two channels. The channel selector buttons allow you to select the channel that is affected by changes to the controls. With these buttons you can also select channel coupling or turn a channel off so that the signal it is measuring is not displayed. For more information on channels, see page 3-17.

Trigger Controls

The trigger controls are on the front panel of the 222PS PowerScout. They appear as shown in Figure 2-3.

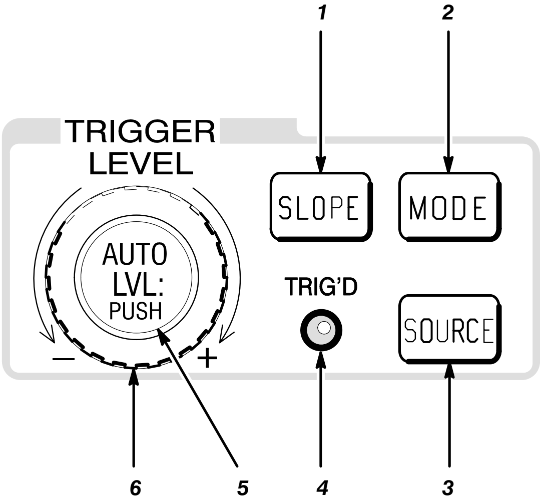

Figure 2-3: Trigger Controls

1. When you push the button labeled **SLOPE**, you toggle between a positive- and negative-trigger slope. For more details, see page 3-70.

2. When you push the button labeled **MODE**, you invoke a menu that allows you to specify the trigger mode. For a complete explanation of trigger modes, see page 3-72.

3. When you push the button labeled **SOURCE**, you invoke a menu that allows you to specify the trigger source. For a complete explanation of trigger sources, see page 3-64.

4. The light labeled **TRIG'D** turns on when the instrument is triggered. See page 3-63 for more details.

5. The inner button, labeled **AUTOLVL: PUSH**, sets the trigger level automatically. When you push it, it determines the peak values and sets the trigger level to the midpoint of the signal. For more information on this button, see page 3-71.

6. The outer knob sets the trigger level — the threshold voltage the signal must cross in order to trigger the instrument. Turn it clockwise to raise the trigger level; turn it counterclockwise to lower the trigger level. For more information on the trigger level see page 3-70.

Horizontal Controls

The horizontal controls are on the front panel of the 222PS PowerScout. They appear as shown in Figure 2-4.

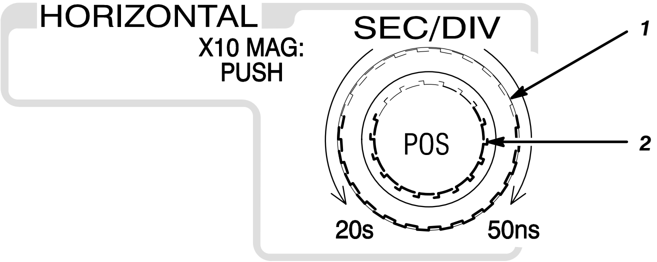

Figure 2-4: Horizontal Controls

1. The outer knob sets the seconds per division. This is the horizontal scale of your display. Turn the knob clockwise to decrease the seconds per division; turn it counterclockwise to increase the seconds per division. Setting the seconds per division is discussed in more detail on page 3-26.

2. The inner knob sets the horizontal position of the signal. Turn the knob clockwise to move the signal to the right. Turn it counter-clockwise to move the signal to the left. For more information on setting the horizontal position see page 3-25.

   You can also use this knob to magnify the signal by ten times. To do so, see page 3-29.

The Display

The 222PS display shows waveforms that represent electrical signals. However, it also shows two other kinds of information—readouts and menus.

Readouts

Readouts are numeric or symbolic information associated with a signal.

The 222PS displays readouts at three places on the screen: along the top, along the bottom, and slightly above the bottom.

Readouts along the top show information associated with the vertical controls. Readouts along the bottom show information associated with the trigger and horizontal controls. The readouts just above them show information associated with saved waveforms. Figures 2-5, 2-6, and 2-7 show these readouts.

Vertical Readouts — Figure 2-5 shows the vertical readouts along the top of the display. The readouts on the left refer to channel 1. The readouts on the right refer to channel 2.

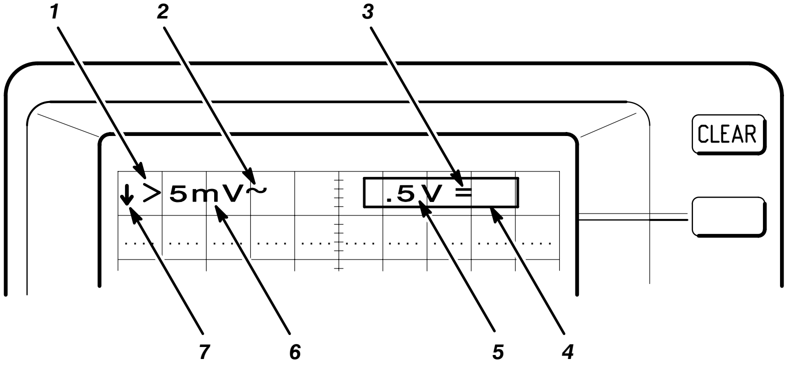

Figure 2-5: Vertical Readouts

1. The > indicates that the waveform is uncalibrated. For more information on uncalibrated waveforms, see page 3-78.
2. The ~ indicates AC coupling. For more information on coupling, see page 3-19.

   A ⏚ indicates ground coupling.
3. This is the channel 2 coupling. The = indicates DC coupling.
4. The box around the channel information indicates that this channel is selected.
5. This number is the volts per division for channel 2 — its vertical scaling. For more details on vertical scaling, see page 3-78.
6. This number is volts per division for channel 1.

NOTE

If either channel is off, the volts-per-division number is replaced by an OFF.

7. The downward-pointing arrow indicates that the channel is inverted. For more information on inverting a channel, see page 3-22.

Saved Waveform Readouts — Figure 2-6 shows the saved waveform readouts above the bottom of the display. The readouts refer to the last saved waveform displayed. For more information on saved waveforms, see page 3-51.

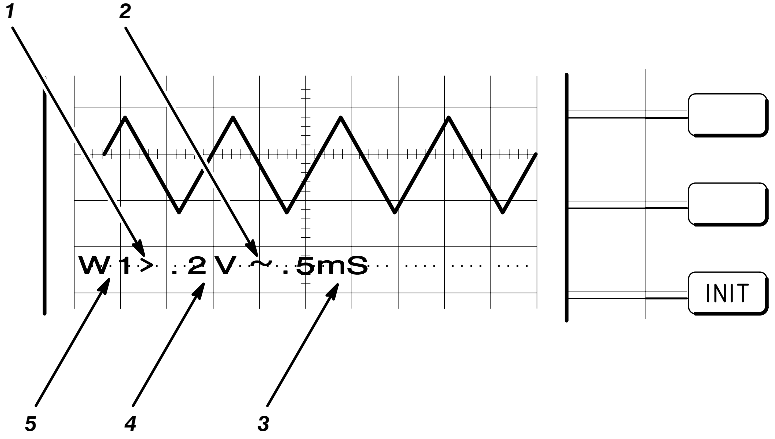

Figure 2-6: Saved Waveform Readouts

1. This indicates that the waveform is uncalibrated. For more information on uncalibrated waveforms see page 3-78.
2. This is the channel coupling for the saved waveform. For more information on coupling see page 3-19.
3. This is the seconds per division setting for the saved waveform.
4. This is the volts per division setting for the saved waveform.
5. This is the memory location to which the waveform was saved. In this case, the waveform is saved in memory location 1. See page 3-51.

Trigger and Horizontal Readouts — Figure 2-7 shows the horizontal and trigger readouts along the bottom of the display.

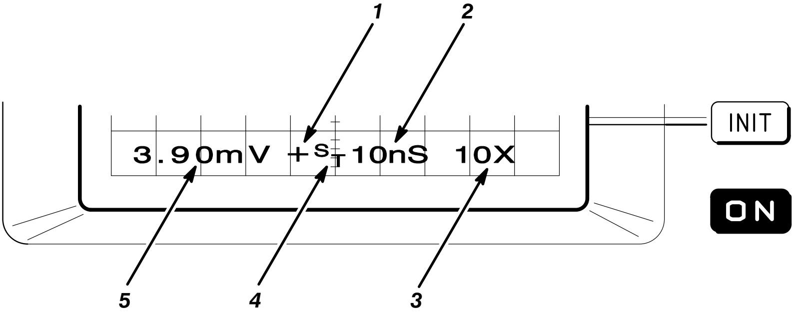

Figure 2-7: Trigger and Horizontal Readouts

1. The second from the left readout is the trigger slope. A + indicates that triggering occurs on a rising edge. A – indicates that triggering occurs on a falling edge. For more information on trigger slope, see page 3-70.
2. The second from the right readout is the seconds per division — the horizontal scale factor. For more information on horizontal scaling, see page 3-26.
3. At the right is the magnification indicator. For more details on the magnification feature, see page 3-29.
4. The middle readout indicates that the instrument is in store mode. For more information on store mode, see page 3-61.
5. At the left is the trigger level in volts. For more details on trigger level see page 3-70.

Menus and Menu Buttons

Menus are lists of choices that you can select in order to perform some action, such as placing the instrument in XY mode or turning off the time-out feature.

A number of buttons on the front and top panels of the 222PS invoke menus when pressed. When a menu is on the display, you can select one of its items to perform an action. Figure 2-8 illustrates the parts of a menu.

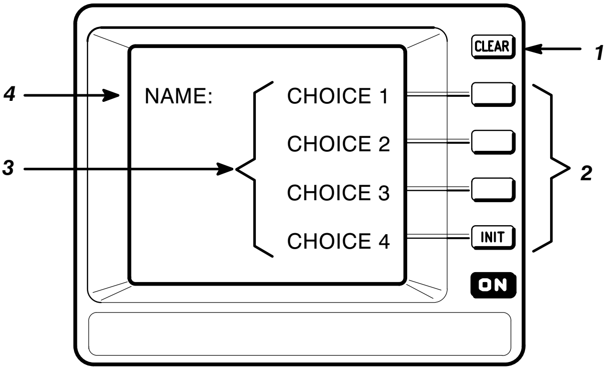

Figure 2-8: Parts of a Menu

1. The button labeled **CLEAR** erases the menu from the display.
2. The menu buttons are next to the screen, along its right edge. Pressing the button next to a menu item performs the action represented by that item.
3. The menu items appear along the right edge of the display. Up to four items can appear on a menu. Each represents a possible action you can perform.
4. The name of the menu appears at the top left of the display, followed by a colon.

Top Panel Controls

The top panel for the 222PS PowerScout appears as shown in Figure 2-9.

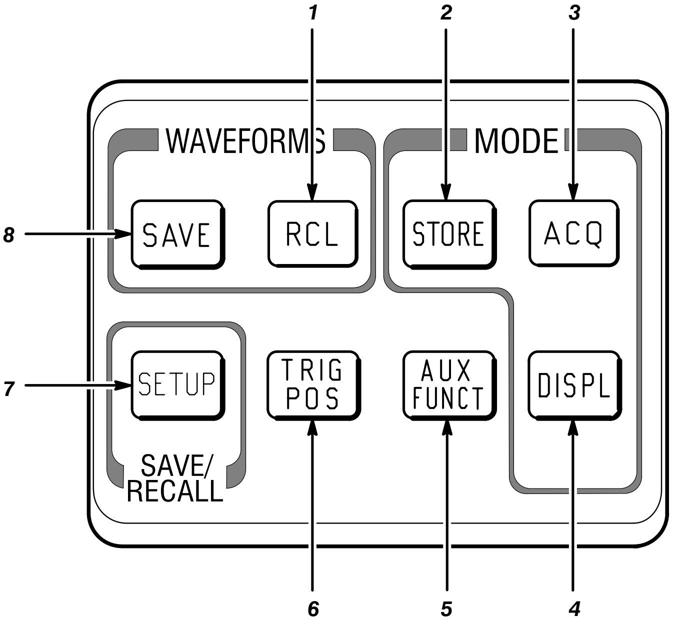

Figure 2-9: 222PS Top Panel

1. Pressing this button invokes a menu that allows you to recall saved waveforms. See page 3-53.
2. Pressing this button toggles the instrument in or out of store mode. For more information about store mode, see page 3-61.
3. Pressing this button invokes a menu that allows you to specify the acquisition mode of the instrument. For more information about acquisition modes, see page 3-1.

4. Pressing this button invokes a menu that allows you to specify whether to invert a channel, display signals in XY mode, or display signal readouts. For more information about inverting channels, see page 3-22. For more information about XY mode, see page 3-81. For more information about displaying or clearing signal readouts, see page 3-21.
5. Pressing this button invokes a menu that allows you to execute a variety of special functions. In some cases, you may execute items from two or three layers of menus.
   - You can check the display alignment and view the instrument identification and firmware number. See page 3-9.
   - You can start self-calibration routines for either channel or the external trigger input. See page 3-9.
   - You can enable or disable the time-out feature, set the baud rate, activate the modem, or select different probe types. For more information about the time-out feature, see page 3-37. For more information about setting the baud rate or activating the modem, see page A-11. For more information about configuring the 222PS for the correct probes, see page 3-45.
   - You can enable or disable MOTOR TRIG, which places a special filter in the trigger path to allow triggering on motor drive signals that are pulse-width modulated and on 50/60 Hz line signals. See page NO TAG.
6. Pressing this button invokes a menu that allows you to specify the trigger position. See page 3-71.
7. Pressing this button invokes a menu that allows you to save or recall front-panel setups. See page 3-55.
8. Pressing this button invokes a menu that allows you to save waveforms. See page 3-51.

Side Connectors

The right side of the 222PS PowerScout appears as shown in Figure 2-10.

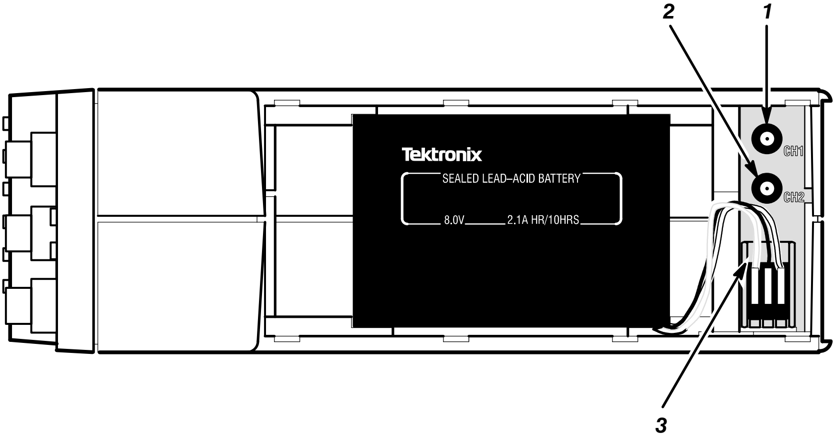

Figure 2-10: Side of 222PS, Storage Pouch Removed

1. This is the probe connector for channel 1.
2. This is the probe connector for channel 2.
3. This is the battery connection. See page 3-35 for more information on connecting the battery.

The 222PS comes with an attached storage pouch. Store the probes in the pouch when you are not using them. You do not need to disconnect the probes before you store them.

Rear Panel Controls and Connectors

The rear panel for the 222PS PowerScout appears as shown in Figure 2-11.

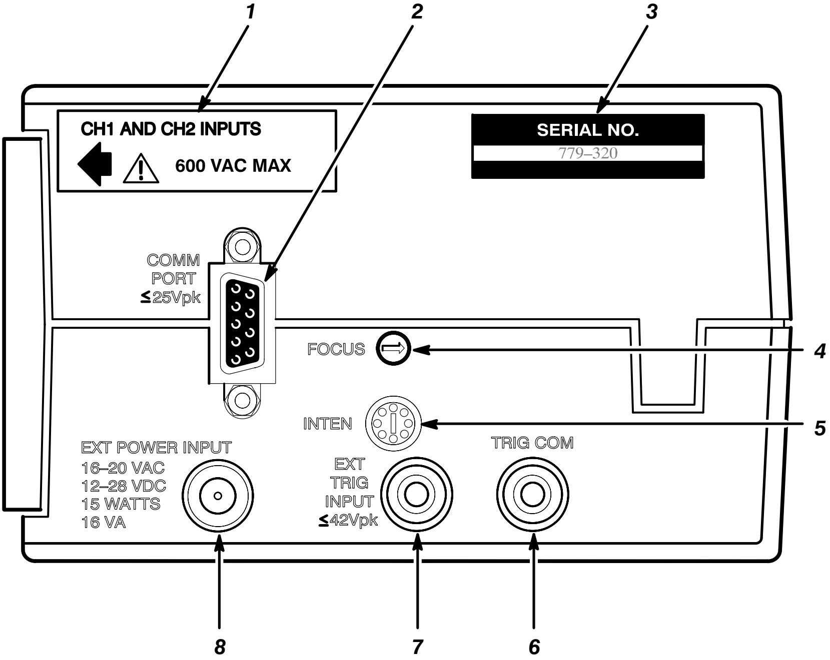

Figure 2-11: 222PS Rear Panel

1. This panel points to the probe inputs on the instrument's side and indicates the 222PS maximum input voltage rating.
2. This is the RS-232 connection port for remote communications. For more information on remote communications, see page A-9.
3. This is the instrument serial number. You will need it if you must ever arrange to ship the instrument back for maintenance. For more maintenance information, see page 3-31.
4. This knob focuses the 222PS screen. Insert a small screwdriver into the slot and turn it to adjust the focus.

5. This knob varies the brightness of the 222PS screen. See page 3-23 for more information on screen brightness.
6. This is the external trigger common reference connector. To use a grounded reference with your external trigger source, connect the reference signal here. See page 3-65.

WARNING

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

7. This is the external trigger input connector. To use an external signal as a trigger source, connect the external trigger signal here. For more information on external triggering, see page 3-65.

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.

8. This is the external power input. Connect the External Power AC Adapter to the input to run the instrument from line voltage. See page 3-41 for more information on external power.

The Tilt Stand

The 222PS PowerScout comes with a tilt stand so that you can view the front-panel and screen more easily. The tilt stand folds under the instrument when not in use. To use it, lift the instrument and pull the tilt stand forward until the instrument rests on it.

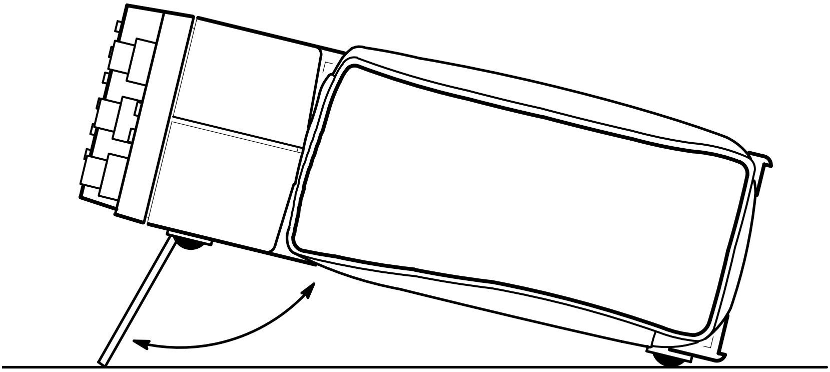

Figure 2-12: The 222PS With Tilt Stand

In Detail

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.

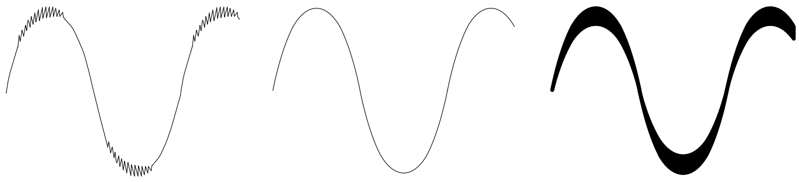

Figure 3-1: Normal, Average, and Envelope Signals

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.

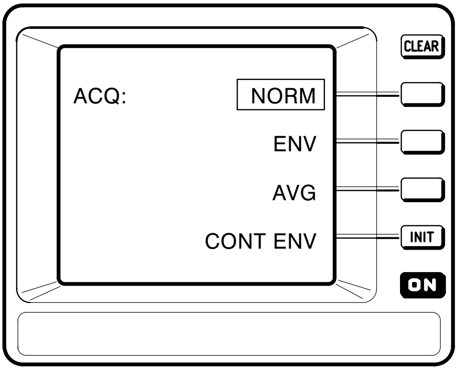

Figure 3-2: The Acquisition Menu

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 a vertical channel self-calibration routine to maintain best balance and accuracy with temperature variations.

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.

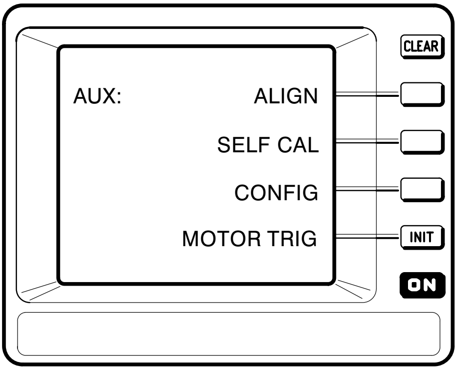

Figure 3-3: The Auxiliary Functions Menu

☐ **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.

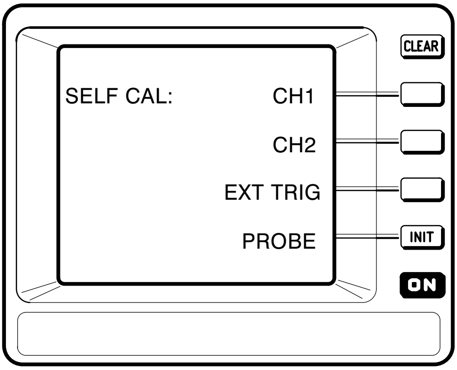

Figure 3-4: The Calibration Menu

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.

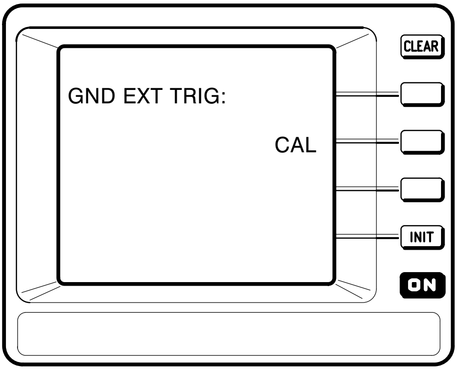

Figure 3-5: The Ground External Trigger Calibration Menu

☐ **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.

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 3-6 shows the 222PS displaying signals for two channels. Channel 1 is selected.

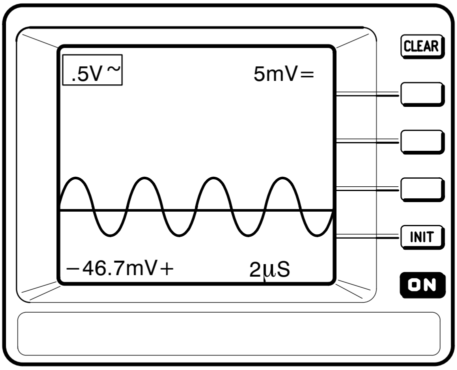

Figure 3-6: Channel One Selected

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.

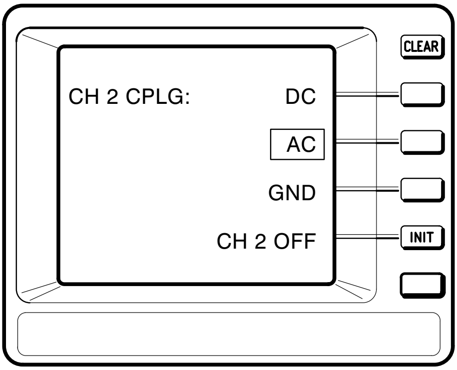

Figure 3-7: The Channel Menu

☐ **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 3-7.

☐ **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 3-8 shows the display menu.

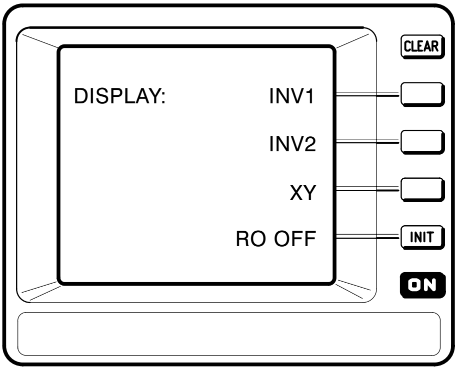

Figure 3-8: The Display Menu

☐ **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 3-9 shows an example of a normal and an inverted waveform.

Figure 3-9: 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 3-8.

☐ **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 3-10.

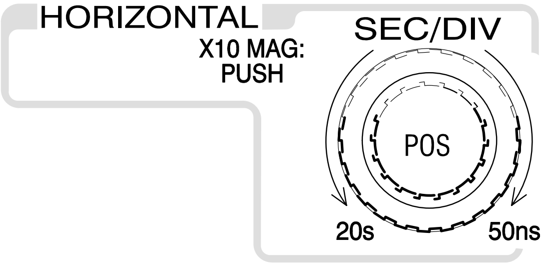

Figure 3-10: The Horizontal Controls

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 3-81.

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 3-11 illustrates an aliased waveform.

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

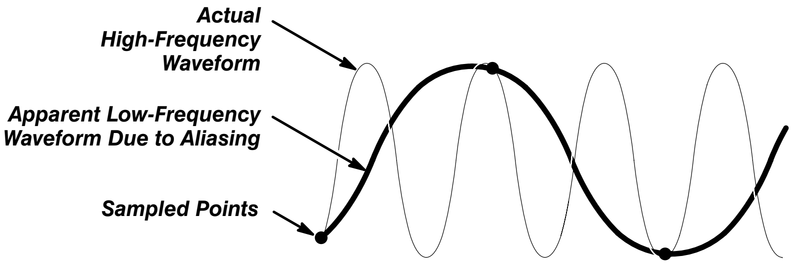

Figure 3-11: An Aliased Waveform

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
	Normal:	Any	Record
On	50 ms to 5 µs		
Off	20 ms to 5 µs		
	Slow:		
On	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 3-12.

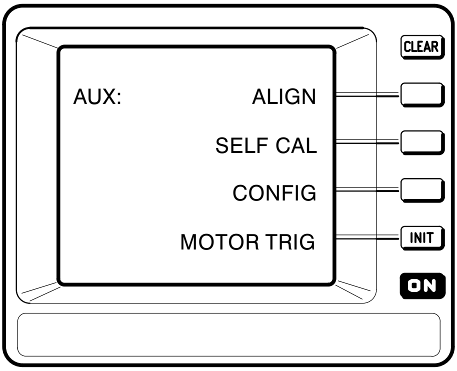

Figure 3-12: The Auxiliary Functions Menu

☐ **Step 2:** Press the menu button next to **ALIGN**. This calls up the XY Alignment Menu as shown in figure 3-13.

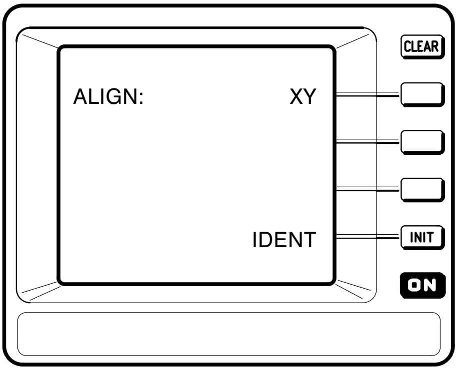

Figure 3-13: XY Alignment Menu

☐ **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 3-14. The version number you see may differ.

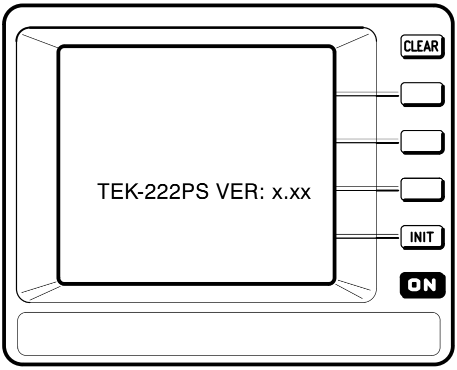

Figure 3-14: The Firmware Version

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 3-15.

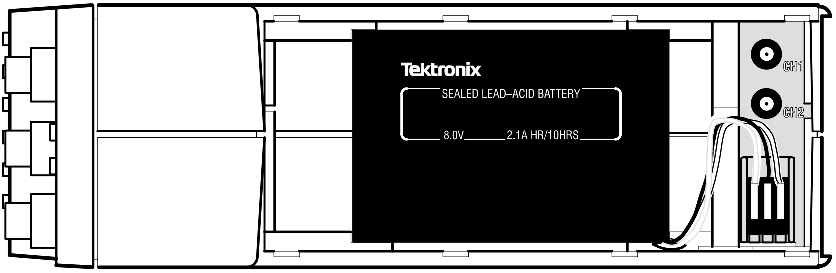

Figure 3-15: Side View Without Battery Cover

☐ **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

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

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 3-16 shows the display.

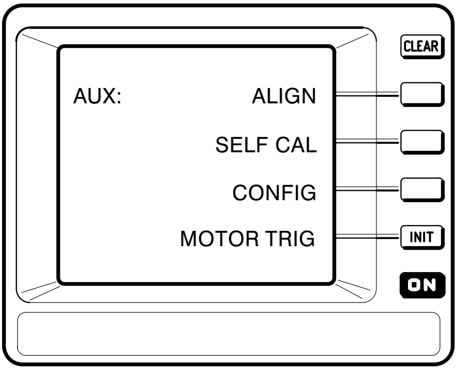

Figure 3-16: The Auxiliary Functions Menu

☐ **Step 2:** Press the menu button next to **CONFIG** to access the configuration menu. Figure 3-17 shows the configuration menu.

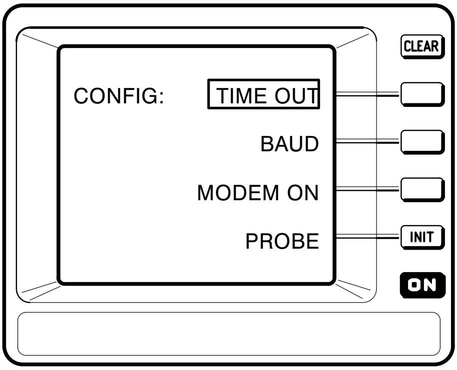

Figure 3-17: The Configuration Menu

☐ **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.

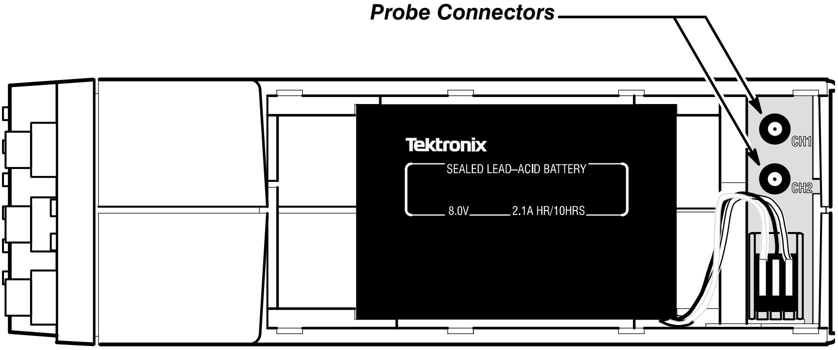

Figure 3-18: Side View Showing Probe Connectors (Pouch Removed)

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 3-19.

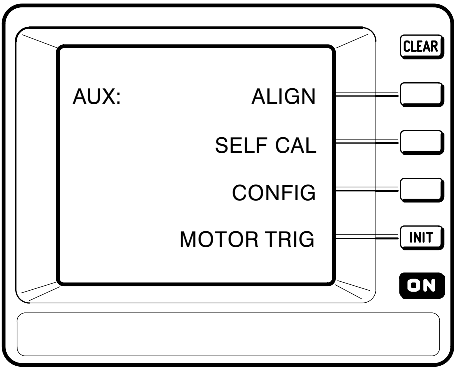

Figure 3-19: The Auxiliary Functions Menu

☐ **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 3-20.

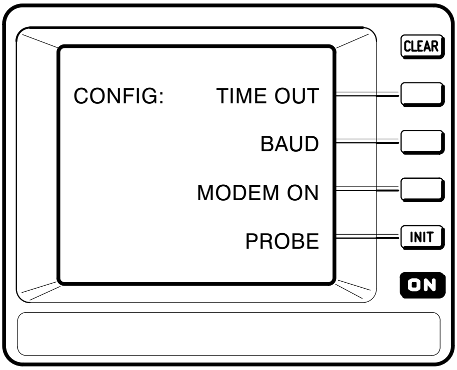

Figure 3-20: The Configuration Menu

☐ **Step 3:** Press the menu button next to the **PROBE** menu item to access the probe menu, as shown in Figure 3-21.

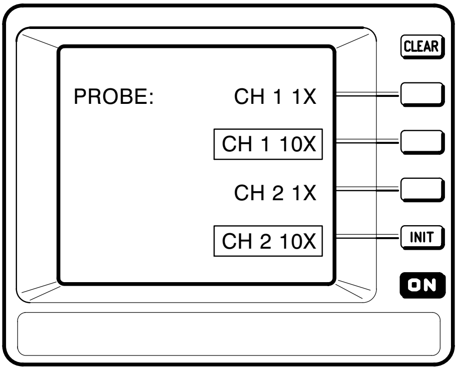

Figure 3-21: The Probe Menu

☐ **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 3-22):

- 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.

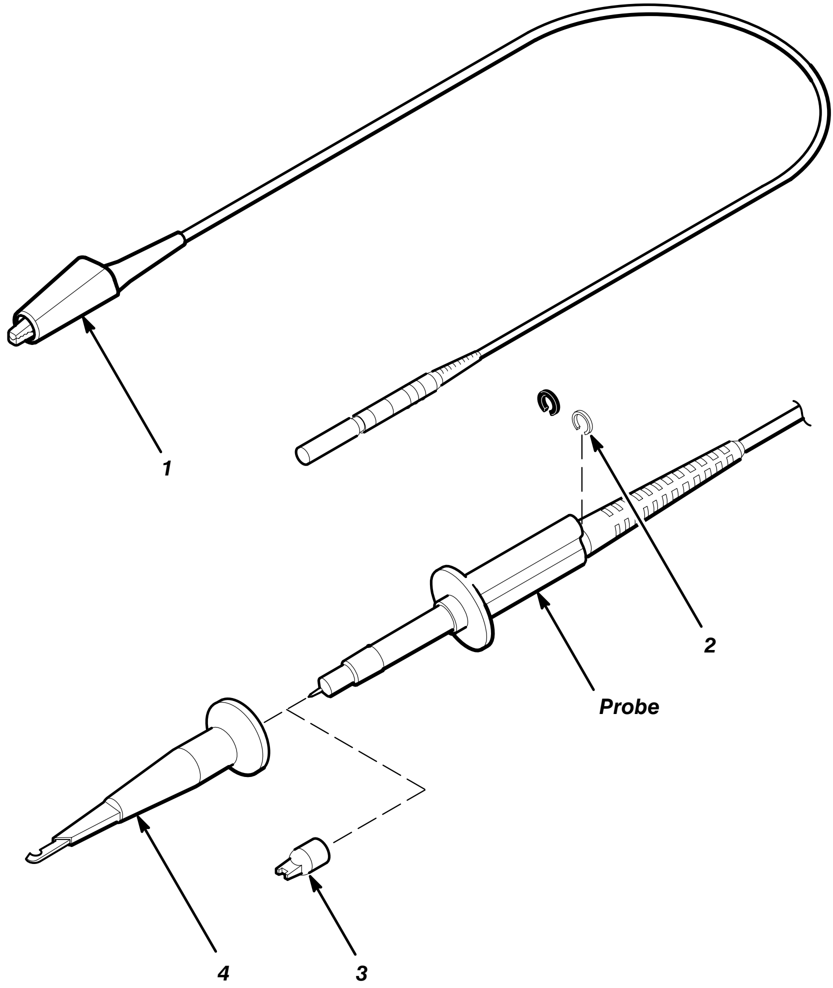

Figure 3-22: Probe and Accessories

1. You can use the detachable probe common lead shown in Figure 3-22 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 3-22 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 3-22 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 3-22 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 3-23.

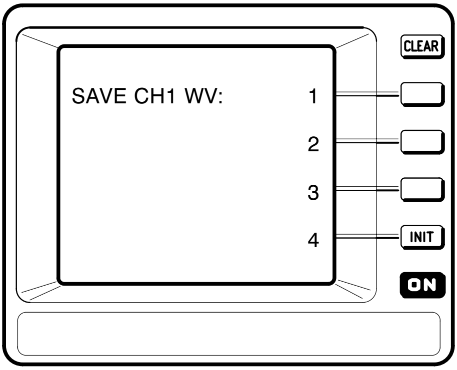

Figure 3-23: Saved Waveforms Menu

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 3-23 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 3-24.

In Figure 3-24, 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.

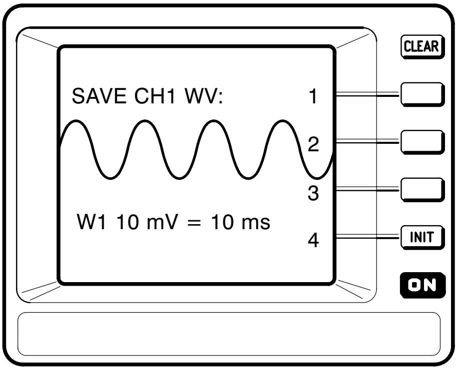

Figure 3-24: Saved Waveform Parameters

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 3-25.

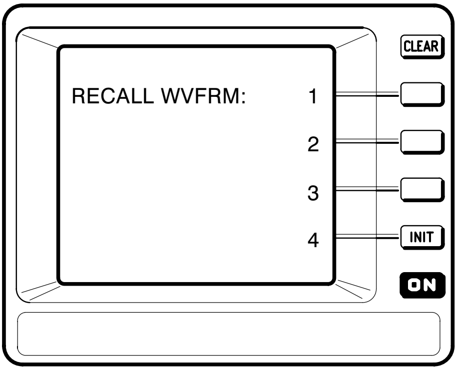

Figure 3-25: The Recall Waveforms Menu

☐ **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 3-26.

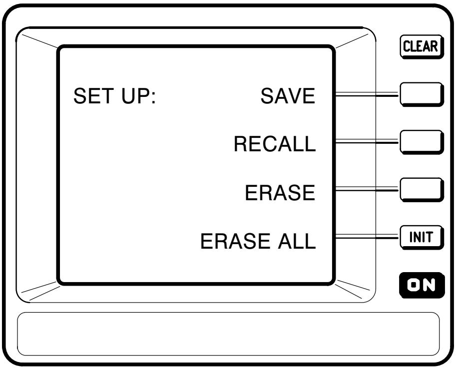

Figure 3-26: The Setup Menu

☐ **Step 3:** Press the button next to the menu item **SAVE**. A new menu appears, as shown in Figure 3-27.

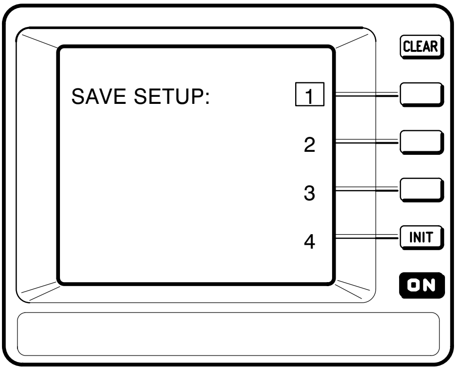

Figure 3-27: The Save Setup Menu

☐ **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 3-27, 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 3-26.

☐ **Step 2:** Press the button next to the menu item **RECALL**. A new menu appears, as shown in Figure 3-28.

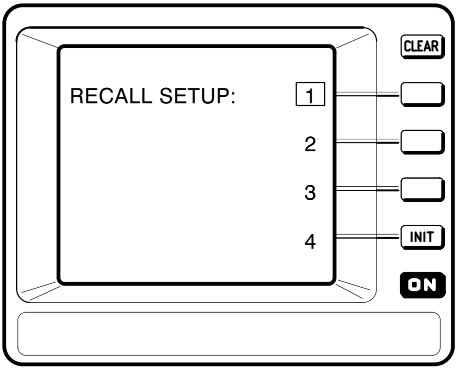

Figure 3-28: The Recall Setup Menu

☐ **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 3-26.

☐ **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 3-29.

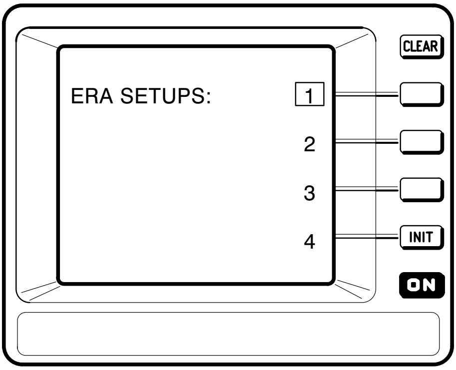

Figure 3-29: The Erase Setups Menu

☐ **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 3-30 shows a store mode readout.

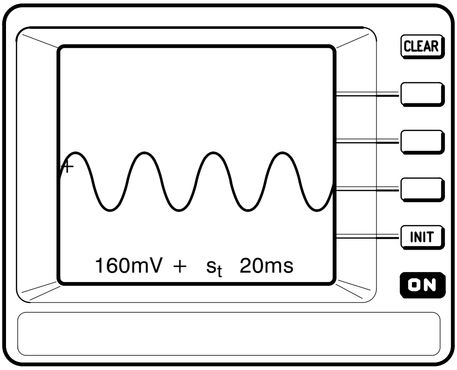

Figure 3-30: Horizontal Readouts in Store Mode

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 3-31.

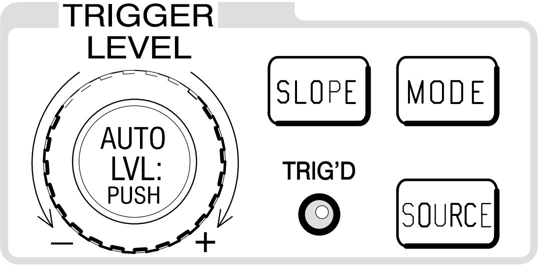

Figure 3-31: Trigger Controls

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 3-32.

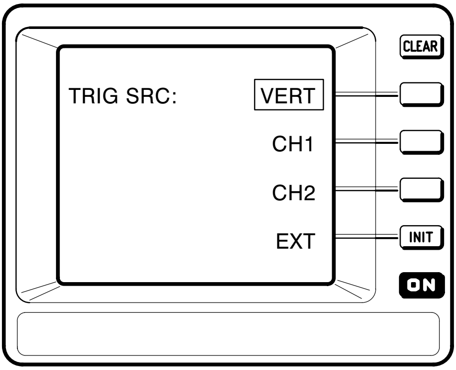

Figure 3-32: The Trigger Source Menu

- **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 3-33.

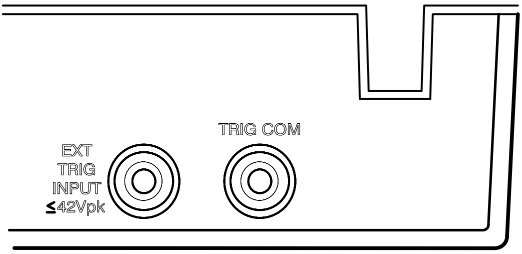

Figure 3-33: Rear Panel External Trigger Connectors

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 3-34). Set the trigger slope to – if the region separating the pulse groups is “high” (Figure 3-35).

☐ **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.

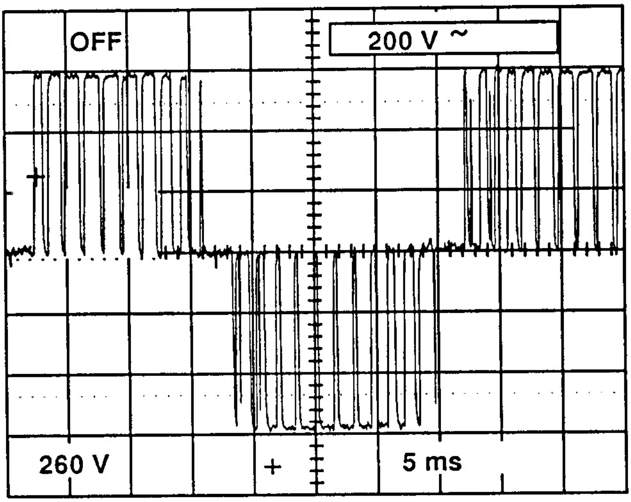

Figure 3-34: Motor Drive Signals Separated by a Low Region

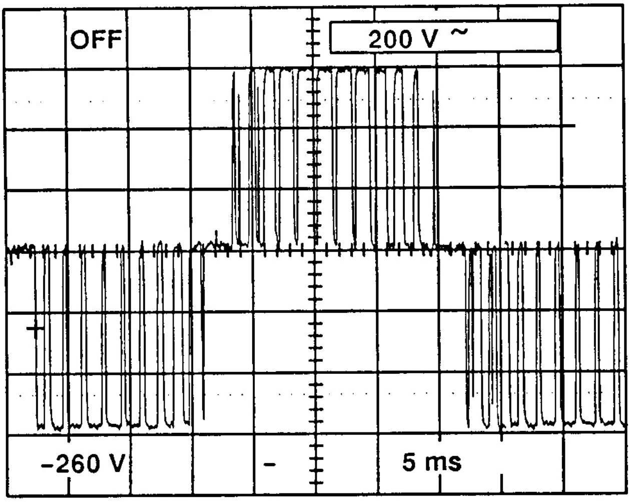

Figure 3-35: Motor Drive Signals Separated by a High Region

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 3-36. The trigger position presently in effect appears boxed in the menu.

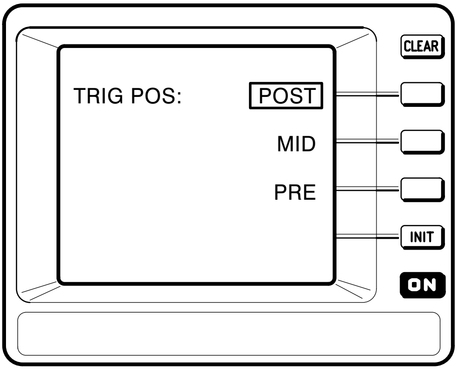

Figure 3-36: Trigger Position Menu

☐ **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 3-37. The trigger mode presently in effect appears boxed in the menu.

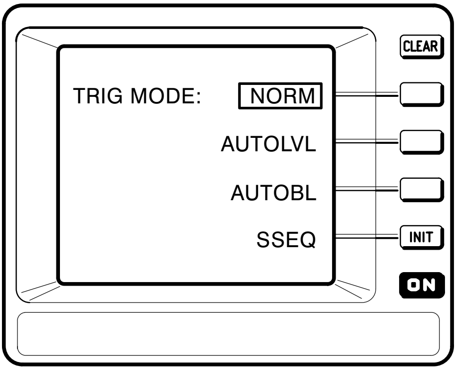

Figure 3-37: The Trigger Mode Menu

☐ **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 3-38.

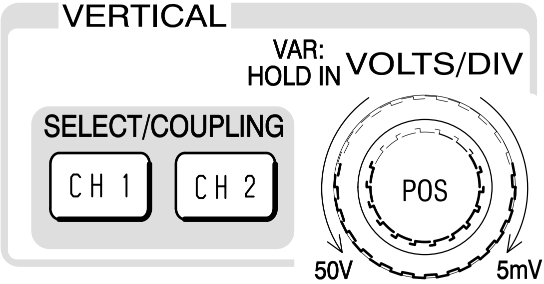

Figure 3-38: The Vertical Controls

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 3-39.

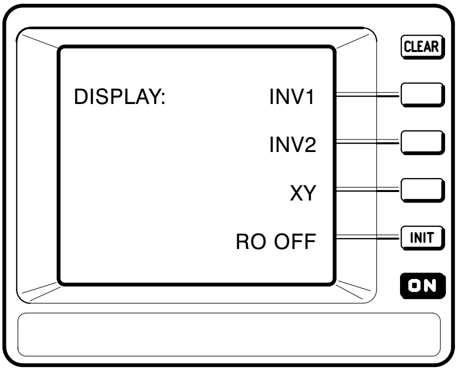

Figure 3-39: The Display Menu

☐ **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

Appendix A: Tutorial

This tutorial will get you started making basic signal measurements with the 222PS.

The Screen

Making accurate measurements with an oscilloscope means determining the voltage and timing of your signal from its size on the screen. Therefore, the screen of the 222PS is marked to help you determine exact signal measurements. The vertical axis of an oscilloscope represents voltage. Except in XY mode, the horizontal axis represents time. A waveform trace on the oscilloscope screen, therefore, represents the characteristics of an electrical signal as a function of voltage over time. The exact measurement of a particular trace, however, depends on the scale factor you assign to the vertical and horizontal axes. To determine the exact voltage and timing of a trace, you need to know these facts:

- how many volts each division represents
- how many seconds each division represents
- how many vertical divisions the trace occupies on the screen
- how many horizontal divisions the trace occupies on the screen

The 222PS provides a variety of aids to help you determine the exact size and location of your signal on the screen. You can read the volts-per-division and seconds-per-division scale factors directly from the on-screen readouts. The screen has several markings to help you determine the exact size of your trace.

Along the vertical axis, the screen has eight major divisions. Along the horizontal axis, it has ten major divisions. Major divisions form a grid that covers the entire screen. Each major division has five minor divisions. Minor divisions are marked along the center vertical and horizontal lines.

Two horizontal dotted lines mark the 10% and 90% points of a signal that takes up six vertical divisions. These lines can help you make rise- and fall-time measurements, as explained on page A-7.

Figure A-1 illustrates these markings.

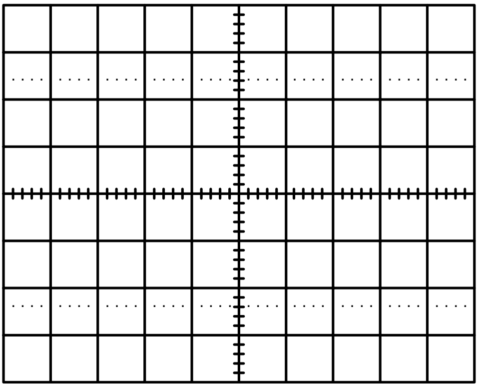

Figure A-1: The Screen Markings

The screen markings are internal, so that no matter what angle you view it from, your measurements are always accurate.

Measuring Voltage

The following two procedures will help you get started making peak-to-peak and ground-reference measurements.

NOTE

When you are measuring a stored waveform, use the vertical and horizontal scale factors that were in effect when you first saved the waveform. The scale factors in effect when you recall the waveform are unrelated to it.

Measuring Peak-to-Peak Voltages

To find the voltage of a waveform peak-to-peak, follow these steps.

☐ **Step 1:** Position the waveform so that either the lowest or the highest point (peak) is at the horizontal center of the screen. In Figure A-2, the high peak is at the center of the screen. Use the vertical center line to help you.

☐ **Step 2:** Count the vertical major and minor divisions occupied by the waveform from its high point (labeled ***A*** in Figure A-2) to its low point (labeled ***B*** in Figure A-2).

☐ **Step 3:** Multiply the number of divisions by the volts per division.

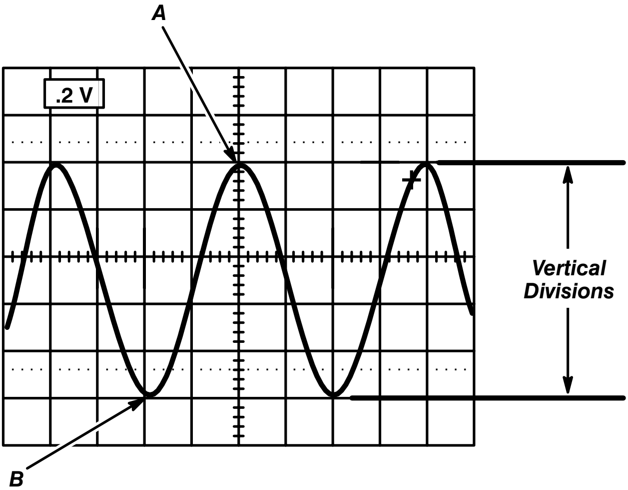

Figure A-2: Measuring Peak-to-Peak Voltages

For example, Figure A-2 shows a sine wave that is five major divisions high. As the readout at the top left indicates, the vertical scale factor is 0.2 volts per division. Therefore, the peak-to-peak voltage of the sine wave is 5 × 0.2, or 1 volt.

NOTE

The volts-per-division scale factor always refers to major divisions. A minor division is one-fifth of a major division.

Using a Ground Reference Point

To find the voltage of a waveform with respect to ground, you must first set a ground reference level. Then you can take the measurement.

To set the ground reference level, follow these steps.

☐ **Step 1:** Press the **MODE** button and select the AUTOBL trigger mode.

☐ **Step 2:** Select ground coupling for the channel you intend to use. Press the button labeled **CH1** (or **CH2**) located in the middle of the front panel, to the right of the display.

If that channel was selected, a menu appears on the display. If the channel was not selected, it now is. Press the button again to invoke the menu.

☐ **Step 3:** Press the menu button next to the item labeled **GND**. The menu disappears and a baseline trace appears on the screen.

☐ **Step 4:** Position the baseline trace to a reference horizontal line on the screen. If the signal is positive with respect to ground, the bottom line on the screen is a good reference to choose.

☐ **Step 5:** Change the channel coupling to DC.

NOTE

To avoid losing your ground reference, do not change the vertical position of the signal after you change to DC coupling.

You can now make your measurement.

☐ **Step 6:** Count the number of vertical divisions from the ground reference to the measurement point of the signal.

☐ **Step 7:** Multiply the number of divisions by the volts per division.

For example, Figure A-3 shows a ground reference at the bottom of the screen. The measurement point is the most negative voltage of the signal. There are 3.5 major divisions between them.

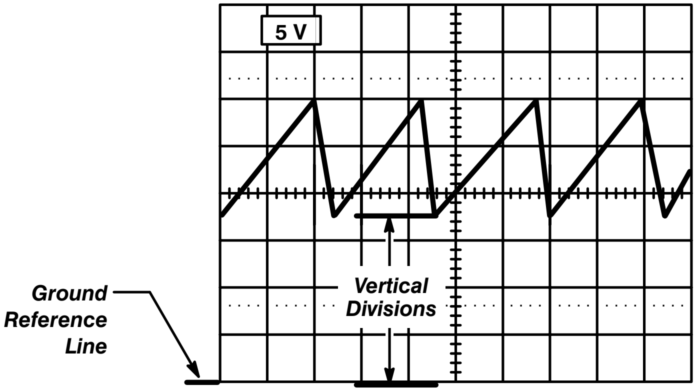

Figure A-3: Measuring With Respect to Ground

The vertical scale factor is 5 volts per division. Performing the multiplication of 5 × 3.5 = 17.5 tells us that the most negative voltage of the signal is 17.5 V above ground.

Measuring Time

The following two procedures will help you get started taking general timing and rise-time measurements.

NOTE

When you are measuring a stored waveform, use the vertical and horizontal scale factors that were in effect when you first saved the waveform. The scale factors in effect when you recall the waveform are unrelated to it.

To measure the time a signal represents, use the following procedure.

☐ **Step 1:** Position the waveform so that its center crosses the vertical center of the screen, as shown in Figure A-4. Use the horizontal center line to help you.

☐ **Step 2:** Count the horizontal major and minor divisions occupied by one complete period of the waveform — from the time it crosses the center line in the positive direction until it again crosses the center line in the positive direction.

☐ **Step 3:** Multiply the number of divisions by the seconds per division.

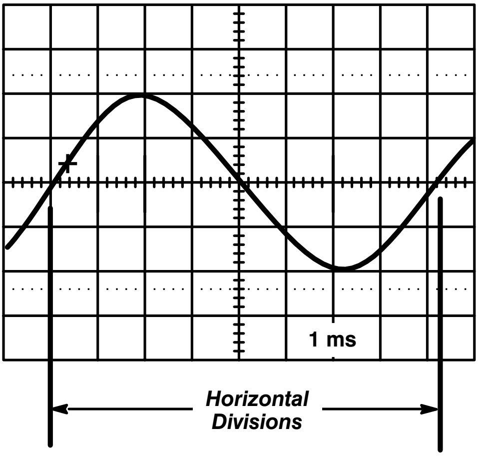

Figure A-4: Measuring Time

For example, one period of the sine wave in Figure A-4 occupies 8 major divisions and 1 minor division. Each minor division is one-fifth, or 0.2 of a major division. Therefore the waveform period is 8.2 major divisions. The horizontal scale factor, as indicated in the bottom right, is 1 ms per division. Therefore, one waveform period is 1 × 8.2 = 8.2 ms.

Measuring Rise- or Fall-time

To measure the rise- or fall-time of a signal, follow these steps.

☐ **Step 1:** Put the instrument in store mode. Press the button labeled **STORE** on the top panel of the instrument.

☐ **Step 2:** Set the trigger position for the display's midpoint. Press the button labeled **TRIG POS** and select the menu item **MID**.

☐ **Step 3:** Select a volts-per-division setting that produces a trace that occupies more than six vertical divisions.

☐ **Step 4:** Use the variable volts per division knob to adjust the trace so that it occupies exactly six vertical divisions.

☐ **Step 5:** Center the trace vertically, as shown in Figure A-5, so that the baseline is at the first vertical division and the peak is at the seventh vertical division.

☐ **Step 6:** Measure the horizontal distance from the place where the trace crosses the 10% dotted line to the place where it crosses the 90% dotted line.

☐ **Step 7:** Multiply that distance, in divisions, by the seconds per division scale factor.

For example, for the signal in Figure A-5, the horizontal distance between the 10% signal crossover point and the 90% crossover point is about nine-tenths of a division. Multiplying 0.9 by a horizontal scale factor of 50 ns gives us a rise time of 45 ns.

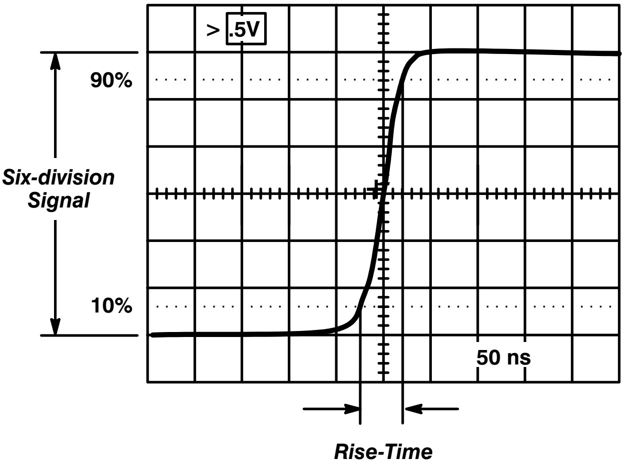

Figure A-5: Measuring Rise-Time

☐ **Step 8:** To change from rise-time to fall-time, press the **SLOPE** button in the trigger controls area of the front panel and repeat the procedure.

Appendix B: Remote Communication

This appendix provides detailed information on remote communication between a 222PS Digital Storage Oscilloscope and an IBM PC/XT®. It contains the following subsections:

- Introductory Information
- Setting the Baud Rate
- Command Formats
- Front Panel Encoding
- Error Codes
- Transfer Options
- Interface Specifications
- Optional Accessories

NOTE

With the exceptions of the "Introductory Information" and "Setting the Baud Rate" subsections, this appendix contains highly technical data and procedures. To use this data to its greatest potential, you must already have a strong background in modern telecommunications.

Introductory Information

You can connect the 222PS to a PC using the RS-232 communications port located on the rear panel, as shown in Figure A-6.

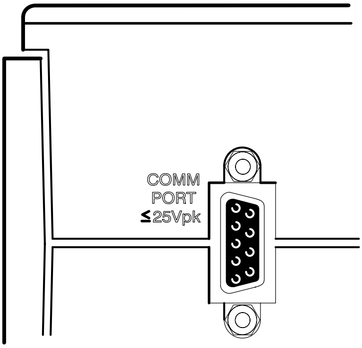

Figure A-6: RS-232 Communications Port

You can connect the 222PS to a PC directly, using the optional accessory cable. (If you connect the 222PS to a different model PC, you may need a different cable.) You can also connect the 222PS to a PC through modems that can communicate over a telephone line. Figure A-7 illustrates both these possible arrangements.

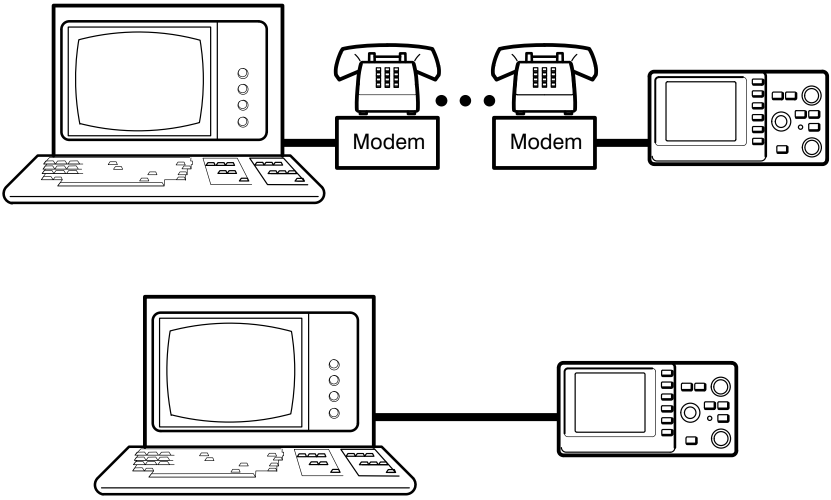

Figure A-7: Communication Between the 222PS and a PC

In either case, the PC must run appropriate terminal emulation and communications software, such as the CAT200 software package available from Tektronix or Procomm®, or a similar application.

If you are using the CAT200 software package from Tektronix and wish to use the same telephone connection for both voice and data communications, you can use the **MODEM ON** menu item on the configuration menu to start sending data. For more information, see the manual that comes with the CAT200 software.

Setting the Baud Rate

Before the 222PS can communicate through modems to a computer, you must set the *baud rate* — the rate at which the two machines send and receive data. The 222PS gives you the choice of four baud rates: 9600, 2400, 1200, or 300.

Determine the appropriate baud rate by checking the baud rate of your modems. Configure your communications software to the same rate.

To set the 222PS baud rate, follow these steps.

☐ **Step 1:** Press the button labeled **AUX FUNCT** on the top panel. This accesses the auxiliary functions menu, as shown in Figure A-8.

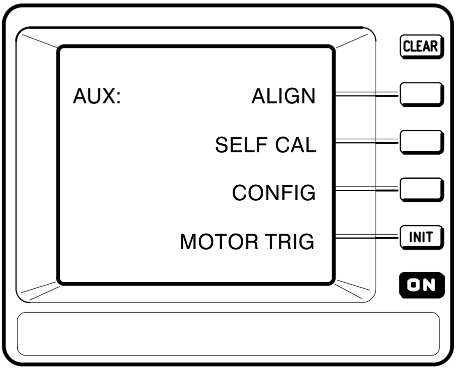

Figure A-8: The Auxiliary Functions Menu

☐ **Step 2:** Press the menu button next to the menu item **CONFIG** to access the configuration menu, as shown in Figure A-9.

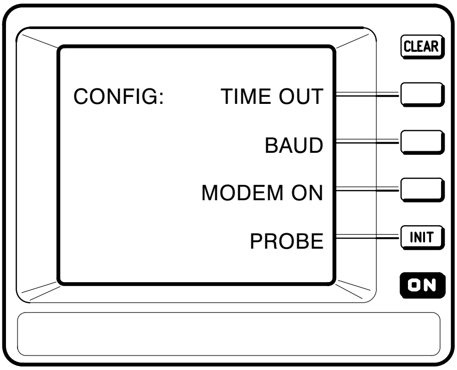

Figure A-9: The Configuration Menu

☐ **Step 3:** Press the menu button next to the menu item **BAUD**. This accesses the baud settings menu, as shown in Figure A-10. The selected baud rate appears boxed.

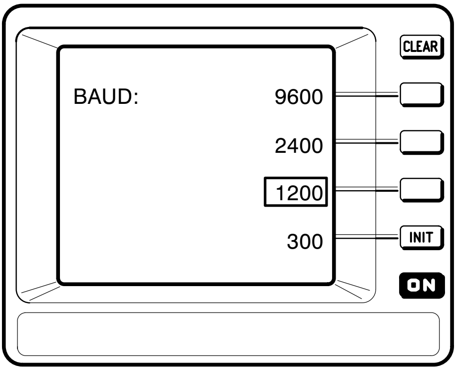

Figure A-10: The Baud Settings Menu

☐ **Step 4:** If the baud rate currently selected is the rate you require, press **CLEAR**. Otherwise, press the menu button next to the baud rate you require. Then press **CLEAR** to remove the menu from the display.

Command Formats

Commands, front panel setups, and waveforms sent over the RS-232 interface are composed of ASCII character strings. The ASCII characters represent hexadecimal numbers, with two characters per number. (See *Front Panel Encoding* for the meanings of the numbers.)

The general RS-232 command format is

cmd arg:data;

where

cmd is the command;

arg is an argument to the command; and

data is any additional data needed for the command.

There must be a single white space (either a space or a tab) between the command and argument. There must be no white space on either side of the colon delimiter between the argument and the data. The semicolon is the command terminator, but a carriage return also terminates the command. Semicolons are necessary only in multiple-command strings.

NOTE

The interface executes a command as soon as it receives the command terminator. If you place multiple commands on one line, the interface executes them in sequence. You can abort a command by sending an escape character.

Commands, Queries, and Responses

Figure A-11 shows the set of commands and queries sent to the instrument and the responses sent by the instrument. Explanation for each is given in the following text.

COMMANDS	QUERIES	RESPONSES
CURV	CURV?	CURV
BUT	ID?	ID
DAC	TRG?	TRG
FP	STA?	READY
	DAC?	DAC
	FP?	FP XXX;

Figure A-11: Commands, Queries, and Responses

Commands — The 222PS Digital Oscilloscope RS-232 interface supports these commands.

- **CURV <frame>: <wfrm data>;**
  This command loads waveform data into the specified 222PS reference memory (REF1–REF4). The waveform data must be sent as hex-encoded ASCII characters.

NOTE

Waveforms may be written back to channel 1 and channel 2, but the next acquisitions into those memories will overwrite any previously saved waveforms.

<frame> is one of the following strings:

CH 1	Channel 1 waveform
CH 2	Channel 2 waveform
REF1	Reference waveform 1
REF2	Reference waveform 2
REF3	Reference waveform 3
REF4	Reference waveform 4

<wfrm data> is composed of <fp data>,<modebyte>,<byte count>,<waveform data>, and <checksum>, which are defined as follows:

<fp data> is composed of ten ASCII characters that represent hexadecimal bytes of the front-panel settings for the waveform data. See *Front Panel Encoding* for the meaning of the characters.

<mode byte> is composed of two characters that indicate the mode the 222PS requires to display a waveform. Normally this byte will be 00. If the waveform is not completely filled (which can happen at very high sweep speeds), this byte will be 02. If it is an XY waveform, the byte will be 03.

<byte count> is composed of four ASCII characters representing the data byte count for the waveform data (in hexadecimal).

<waveform data> can be one of two ASCII character sequences, depending on which display mode the instrument is in. In YT mode, each data point is the hexadecimal value (represented by two ASCII characters) of the Y-coordinate. In XY mode, the X- and Y-coordinates are sent as two hexadecimal values (represented by four ASCII characters) with the X-coordinate value first, followed by the Y-coordinate value.

<checksum> is composed of two ASCII characters that represent the hexadecimal twos complement of the modulo 256 checksum of all data bytes, byte count bytes, and mode byte.

NOTE

Programmers: additional bytes may be added to the data string after the checksum byte. This space is reserved for future expansion.

- **BUT <button>;**
  This command simulates a button press, where <button> is composed of one or two ASCII characters that represent a button code. The button codes are shown in Table A-1.

Table A-1: BUT Button Codes

Code	Simulated Button Press
1	CLEAR
2	Menu Item 0
3	Menu Item 1

Table A-1: BUT Button Codes (Cont.)

Code	Simulated Button Press
4	Menu Item 2
5	Menu Item 3
6	OFF
9	Trigger SOURCE
A	Trigger MODE
B	Trigger SLOPE
C	CH 2 Select
D	Ch1 Select
E	AUTO SETUP
11	Front-Panel Setup Menu
12	Trigger Position Menu
13	Auxiliary Function Menu
14	Display Mode Menu
19	Save Waveform Menu
1A	Recall Waveform Menu
1B	STORE/NONSTORE
1C	Acquisition Mode Menu
20	X10 MAG
21	Variable Gain
22	AUTO LVL: PUSH

- **DAC <DAC code>: <DAC value>;**
  This command sets a DAC value. A DAC is a digital-to-analog converters for digitized potentiometer settings. The digital-to-analog converters determine the variable control settings for the POSITION controls (horizontal and vertical), the trigger LEVEL settings (CH1, CH2, and EXT), and the variable vertical gain (CH1 and CH2). See Table A-2 for the DAC code and DAC value data.

Table A-2: DAC Code and Value Data

DAC	DAC Code	Range	Scale	Reference	
Horiz POSITION	00	0−1FFC	±5 div	Full left	0
CH 1 Trigger LEVEL	01	0−1FFC	±30 div	Center	0FFF
CH 2 Trigger LEVEL	02	0−1FFC	±30 div	Center	0FFF
EXT Trigger LEVEL	03	0−1FFC	±2.33 V	Center	0FFF
CH 2 VAR Gain	04	0−03FF	−2.5:1 to 1:1	Cal'd	03FF
CH 1 VAR Gain	05	0−03FF	−2.5:1 to 1:1	Cal'd	03FF
CH 2 POSITION	06	0−1FFC	±12 div	Center	0FFF
CH 1 POSITION	07	0−1FFC	±12 div	Center	0FFF

- **FP <log fp>:<fp data>;**
  This command sends a front-panel setup to the <log fp> location.

  <log fp> is one of the following:

ACQ	Acquisition system
REF1	Reference waveform 1
REF2	Reference waveform 2
REF3	Reference waveform 3
REF4	Reference waveform 4
STR1	Front panel setup 1
STR2	Front panel setup 2
STR3	Front panel setup 3
STR4	Front panel setup 4

  <fp data> is composed of ten ASCII characters that represent the five, two-character hexadecimal bytes of a logical front-panel setup. See Tables A-3 through A-6 to encode and decode <fpdata>.

NOTE

REF1−REF4 front panel volts can be affected by the selected probe configuration in the 222PS instrument (see Front Panel Encoding section).

Queries — The 222PS Digital Storage Oscilloscope RS-232 interface supports the following queries:

- **CURV? <frame>;**
  This query requests waveform data. The instrument sends waveform data as hex-encoded ASCII characters. **<frame>** is one of six possible sources for curve data (CH1, CH2, REF1, REF2, REF3, or REF4).
- **ID?;**
  This query requests instrument identification and software version.
- **TRG?;**
  This query requests the trigger state.
- **STA?;**
  This query requests the communication task status.
- **DAC? <DAC code>**
  This query requests a DAC value. <DACcode> is one of eight DACs for digitized potentiometer settings. See Table A-2 for DAC identification.
- **FP? <log fp>**
  This query requests a front panel setup. See page A-17 for a listing of <logfp> values.

NOTE

*If you query an empty reference waveform location, you will receive a status error (STA 0005) in response. If you query an empty front-panel location, the response you receive will contain unreliable **<fp data>**. If you query an active channel before it acquires a waveform the response you receive will contain unreliable **<wfrm data>**.*

Responses — The following responses occur as a result of the associated query:

NOTE

If the query or command is terminated by a semicolon, responses will be terminated by a semicolon. If the query or command is terminated by a carriage return, the response will be terminated by a semicolon followed by a carriage return.

- **CURV <frame>:<wfrm data>**
  A frame is one of the six possible sources of waveform data in the instrument (CH1, CH2, REF1, REF2, REF3, or REF4) asked for in the CURV? query. The waveform data includes the front-panel setting and the waveform data point values as hex-encoded ASCII characters, as with the CURV command.
- **ID TEK-222PSVER:X.XX**
  This response is in reply to an ID? query. X.XX is the firmware version installed in the instrument.
- **TRG YES or NO**
  This response indicates if the TRIG'D LED is on (YES: triggered) or off (NO: not triggered) in response to the TRG? query.
- **READY**
  This is the reply to a STA? query when the instrument is ready to communicate. The the instrument sends the same response as the result of a carriage return. If the instrument is not ready, it delays reply until ready.
- **DAC <DAC code>:<DAC value>**
  In response to the DAC? query, the setting of the queried DAC is returned in the same form as the DAC command. See Table A-2 for DAC identification data.
- **FP <log fp>:<fp data>**
  This response is in the same form as the FP command. The byte decoding (by bit) for the front-panel settings is given in Tables A-3 through A-6; each table shows the decoding for one of the hexadecimal bytes.

NOTE

If you send <fp data> originally taken from a location where a setup had not yet been saved, the resulting instrument setup will be unreliable, possibly inducing a lock up condition.

NOTE

REF1 through REF4 front panel volts can be affected by probe configuration in the 222PS (see the Front Panel Encoding section).

Front-Panel Encoding

Tables A-3 through A-6 show how the ten ASCII characters of the logical front-panel hexadecimal bytes are encoded. The tables divide the coded number of the front panel setup into five bytes of two ASCII characters each.

Vertical Settings

From Table A-3 you can decode the ASCII characters for the channel 1 and channel 2 vertical settings. For example, in the setup data string **FP ACQ:24240C2112** the first four characters are 2424. Breaking these numbers into binary bits, a 2 equals 0010, and a 4 equals 0100. Looking at the bit information for the first character tells us that INVERT is OFF, VAR is disabled, and the input coupling is GND. For the second character, its bit values are given, but looking at the Hex Value column tells us that the VOLTS/DIV setting is 0.1 V per division. Exactly the same values are given for characters 3 and 4 as 1 and 2, respectively; therefore the channel 2 settings are the same as the channel 1 settings.

To change the VOLTS/DIV setting for channel 1 to 1 V, change the value of character 2 from 4 to 7 in the front panel setup string when it is sent back to the oscilloscope. The string sent back then is **FP ACQ:27240C2112**.

Table A-3: Channel Settings

CHAR 1			CHAR 2
BYTE 1			
7	6	5 4	3 2 1 0

HEX VALUE	BITS				VOLTS/ DIV
	3	2	1	0	
0	0	0	0	0	5 mV
1	0	0	0	1	10 mV
2	0	0	1	0	20 mV
3	0	0	1	1	50 mV
4	0	1	0	0	0.1 V
5	0	1	0	1	0.2 V
6	0	1	1	0	0.5 V
7	0	1	1	1	1 V
8	1	0	0	0	2 V
9	1	0	0	1	5 V
A	1	0	1	0	10 V
B	1	0	1	1	20 V
C	1	1	0	0	50 V
D*	1	1	0	1	100 V
E*	1	1	1	0	200 V

*Available for recalled waveforms only.

BITS		CLPG
5	4	
0	0	DC
0	1	AC
1	0	GND
1	1	CH OFF

BIT	VAR
6	
0	CAL’d
1	UNCAL’d

BIT	INVERT
7	
0	OFF
1	ON

SEC/DIV Setting

Characters 5 and 6 from the example string are 0 and C. In binary bits, these characters are 0000 and 1100 respectively. You can see from Table A-4 that the bits of character 5 define several settings of the front panel. The example bit values of 0000 decode to show that the READOUT OFF menu choice is OFF (not selected, so the readout is on), XY display mode is OFF, and X10 MAG is OFF.

The fourth bit of character 5 is assigned to the seconds-per-division settings along with all four bits of character 6. A bit value of 0 for this bit defines seconds-per-division settings of 5 ms and faster. A bit value of 1 defines seconds-per-division settings of 10 ms and slower. The four bits of character 6 are all used to define the seconds-per-division setting. In the example the seconds-per-division setting is below 10 ms (0 value of bit 4 of character 5), and the 1100 (hex C) value of character 6 gives a seconds-per-division setting of 0.5 ms per division.

To change the seconds-per-division setting to 0.1 ms, change character 6 from C to A. However to change to 20 ms, the value of character 5 will also have to change from 0 to 1 in the setup example string while character 6 changes to a 1.

Table A-4: Seconds-per-Division and Misc. Settings

<table>
<tr><th colspan="3">CHAR 5</th><th colspan="5">CHAR 6</th></tr>
<tr><th colspan="8">BYTE 3</th></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>

BIT 5	X10 MAG
0	OFF
1	ON

BIT 6	XY
0	OFF
1	ON

BIT 7	RO OFF
0	OFF
1	ON

BITS					SEC/DIV	HEX VALUE
4	3	2	1	0		
0	0	0	0	0	50 ns	0
0	0	0	0	1	0.1 µs	1
0	0	0	1	0	0.2 µs	2
0	0	0	1	1	0.5 µs	3
0	0	1	0	0	1 µs	4
0	0	1	0	1	2 µs	5
0	0	1	1	0	5 µs	6
0	0	1	1	1	10 µs	7
0	1	0	0	0	20 µs	8
0	1	0	0	1	50 µs	9
0	1	0	1	0	0.1 ms	A
0	1	0	1	1	0.2 ms	B
0	1	1	0	0	0.5 ms	C
0	1	1	0	1	1 ms	D
0	1	1	1	0	2 ms	E
1	1	1	1	1	5 ms	F
1	0	0	0	0	10 ms	0
1	0	0	0	1	20 ms	1
1	0	0	1	0	50 ms	2
1	0	0	1	1	0.1 s	3
1	0	1	0	0	0.2 s	4
1	0	1	0	1	0.5 s	5
1	0	1	1	0	1 s	6
1	0	1	1	1	2 s	7
1	1	0	0	0	5 s	8
1	1	0	0	1	10 s	9
1	1	0	1	0	20 s	A

Trigger Positions, Slope, Source, and Mode Settings

Characters 7 and 8 of the front-panel setup string define several of the trigger settings of the instrument. Two bit values of the characters are used to define the Trigger SOURCE setting (bit 4 of character 7 and bit 1 of character 8). Therefore, both characters must be set correctly to control the Trigger SOURCE setting. See Table A-5 for detailed information.

In our example front panel setup string, characters 7 and 8 are 2 and 1 respectively. The binary bits are 0010 and 0001 for these two characters. The first two bits of character 7 define the TRIG POS setting; the bit values of 0 0 in these positions decode to a TRIG POS of POST. The third bit is a 1 and decodes to a + SLOPE setting.

The last bit of character 7 and the first bit of character 8 are 0 and 0 respectively and decode to VERT Trigger SOURCE. The last three bits of character 8 are 001 and decode to AUTO LVL Trigger MODE.

Table A-5: Trigger Position, Slope, Source, and Mode Settings

CHAR 7				CHAR 8			
BYTE 4							
7	6	5	4	3	2	1	0

BITS			TRIG MODE
2	1	0	
0	0	0	NORM
0	0	1	AUTO LVL
0	1	0	AUTOBL
0	1	1	SSEQ

BITS		TRIG SRC
4	3	
0	0	VERT
0	1	CH 1
1	0	CH 2
1	1	EXT

BIT	TRIG SLOPE
5	
0	–
1	+

BITS		TRIG POS
7	6	
0	0	POST
0	1	MID
1	0	PRE

Acquisition Mode and Miscellaneous Settings

Characters 9 and 10 of the front panel-setup string define the remaining settings not defined by the other 8 characters. Table A-6 shows setup state controlled by each bit. The only two-bit setting is for Acquisition MODE.

The last two characters of our example setup string are 1 and 2. The bit values for these are 0001 and 0010, respectively. The decoding for the bit values of character 9 is then the following:

- TIME OUT is enabled
- CH2 is selected to respond to the controls settings
- It is not a recalled waveform
- It is a valid store

Character 10 (0010) decodes as follows:

- The Acquisition MODE (2 bits) is NORM
- It is in STORE mode
- AUTO TRIGGER is not enabled

Table A-6: Acquisition Mode and Misc. Settings

CHAR 9				CHAR 10			
BYTE 5							
7	6	5	4	3	2	1	0

BIT 0	AUTO TRIG ENABLED
0	NO
1	YES

BIT 1	STORE MODE
0	NONSTORE
1	STORE

BITS		ACQ MODE
3	2	
0	0	NORM
0	1	ENV
1	0	AVG
1	1	C ENV

BIT 4	VALID STORE
0	NO
1	YES

BIT 5	RCL'D WFM
0	NO
1	YES

BIT 6	CHAN SEL
0	CH2
1	CH1

BIT 7	TIME OUT
0	YES
1	NO

RS-232 Error Codes

When you connect the instrument to a terminal or PC, you can read RS-232 error codes. There are two types of error codes. Status messages result from a command error; diagnostic error codes result from errors that occur during normal operation or when running the calibration routine. If there are no errors, the instrument responds with "READY;" when it is ready to respond to commands.

Status Messages

Status messages are returned when an error is detected in a command.

STAtus 0001	Unrecognized command
STAtus 0002	Unrecognized character
STAtus 0003	Command is query only
STAtus 0004	Command has no query
STAtus 0005	Bad command argument
STAtus 0006	Bad data
STAtus 0007	Data is required
STAtus 0008	Argument is required
STAtus 0009	Communication task is busy
STAtus 000A	CURV command had bad checksum
STAtus 000B	Bad task name for message
STAtus FFFF	User pressed escape

Diagnostic Error Codes

If an error is detected in the oscilloscope during normal operation or calibration, an error message is output to an external terminal via the RS-232 serial port. These error codes are formatted as **ERROR wxyy zzzz** where wxyy and zzzz are 16-bit hexadecimal numbers representing the error message.

The code key is as follows:

w = the error type

0 = error during normal calibration
2 = EEPROM programming error
4 = EEPROM calibration constant area error
8 = Calibration error
F = Fatal system error

x = the channel affected by the error

1 = Channel 1
2 = Channel 2
0 = Channel not specified

yy = the error code. The value depends on the type of error (0, 2, 4, 8, or F) at the **w** position in the portion of the first code group (wxyy) as follows:

Error type 0:

Error code 09 = Trigger search error (auto level mode).

Error type 2:

Error code XX = The data that failed to program. The value of the second code group (zzzz) is the address that failed to program.

Error type 4:

Error code 01 = Bad EEPROM checksum detected.

Error code 02 = Calibration needed. The following zzzz codes indicate which calibration routine needs to be done:

0001 = Channel 1 offset/gain calibration
0002 = Channel 2 offset/gain calibration
0004 = Channel 1 offset DAC calibration
0008 = Channel 2 offset DAC calibration
0010 = Channel 1 trigger calibration
0020 = Channel 2 trigger calibration
0040 = External trigger calibration
0080 = Clock delay calibration

If the zzzz error code is FFFF, no calibration routines have been done since all the default values were loaded into the EEPROM (this error code is seen only at the first factory calibration).

Error type 8:

01 = Acquisition timeout error
02 = Mid position search error
03 = Mid position range error
04 = Offset search error
05 = Offset range error
06 = Offset gain error
07 = Gain range error
08 = Gain search error

09 = Trigger search error
10 = Trigger offset range error
11 = Trigger gain error
12 = Trigger hysteresis error
13 = External trigger offset range error
14 = External trigger hysteresis error
15 = Clock delay error
16 = Acquisition delay error

Error type F

00 = COP timeout error
01 = Illegal opcode execution
02 = Interrupt exception
03 = Task exception

NOTE

A COP timeout error most likely indicates that your communications software is not compatible with the 222PS.

zzzz = an additional 16-bit value the meaning of which depends on the first error word. The zzzz values are meaningful only when error type 2 and error type 4 codes are given.

Transfer Options

There are two ways to transfer data between the 222PS Digital Storage Oscilloscope and a PC: local transfer and transfer via modem.

Transfer to a Local PC

With a PC/XT as the host computer, the optional RS-232 interconnection cable provides the required match from the 25-pin connector on the PC to the 9-pin connector on the instrument. The optional cable is also compatible with a PC/AT that has a 25-pin communications port.

Transfer via Modem

Telephone lines may be used to control a remote instrument and to transfer waveforms between the instrument and a PC.

The software utility program you have will determine the operations you need for controlling the modem. If the software does not have a modem control routine, you must first use a terminal communications utility to make the modem connection. You must then exit that utility to permit the instrument control program to function. The CAT200 software provides for modem control. Once the software is installed on the PC and the actions needed at both ends of the link have been decided, the general procedure to capture a waveform follows:

☐ **Step 1:** At the remote site, the instrument operator must hook up the instrument to a modem and acquire the test waveforms to be transferred to the PC. In the operation described here, the modem connected to the instrument at the remote site must be set to auto answer mode (see your modem manual for operating instructions) and told to perform the following actions:

- Answer the phone after a predetermined number of rings
  Hayes: ATS0=2
- Not transfer status information
  Hayes: ATQ1
- Not echo commands back to the 220 series instrument
  Hayes: ATE0
- Enable the CONNECT 1200/2400 code
  Hayes: ATX1

For modems with nonvolatile memory, each Hayes command should be followed by &W to preserve this configuration even if the modem loses power.

☐ **Step 2:** Now the PC operator must call the remote site and establish the modem link. If the instrument control utility does not have modem access capabilities, the PC operator must first use a terminal communications utility (such as Kermit or Procomm) to establish the modem link. When the remote modem answers, the PC operator can exit the communications utility and start the instrument control utility (either by command or by exiting the terminal communications utility without hanging up the modem).

☐ **Step 3:** The PC operator is now in control of the instrument and may request waveforms from it. Waveforms may be transferred from the reference memories and from the two vertical channels. If the PC operator needs more waveforms, the instrument operator must move the probes to new test points or make other adjustments to gather new waveforms. The operator at the PC may store new waveforms into the reference memories or, if wanted, continually ask for new waveforms from channel 1 and channel 2 as they acquire new waveforms. The waveforms received can be filed in the PC for future study.

☐ **Step 4:** The instrument does not support user messages on-screen, so a second voice telephone connection between the two operators may be useful when a series of different waveforms needs to be transferred for use at the PC site. If the modems in use have the capability, VOICE/DATA switching solves the problem. The CAT200 software provides this utility. You may need to consult your modem/communications software manual for operating details.

RS-232 Interface Specifications

RS-232 Communication Parameters

Start bits: 1

Stop bits: 1

Data bits: 8

Parity: None

Flow Control: XON/XOFF

Signals: RX, TX, and SGND are functional. SGND is connected internally to EXT TRIG COMM. DSR and CTS are always high. DTR going active turns the scope on and RTS is ignored.

Baud Rates

300, 1200, 2400, 9600; 0.1% accuracy based on the microprocessor clock.

Levels

Compatible with RS-232-C.

Maximum Applied Voltage

25 V (DC + peak AC) to any pin.

Plotter/Printer Support

There is no plotter/printer support in the instrument.

Messages

User-message displays on the instrument CRT are not supported. The controlling PC cannot send messages to be displayed for the operator of the instrument.

Optional Accessories

CAT200

This is a Tektronix software product. It provides a virtual front panel (a graphical interface with mouse-input facilities) on the PC screen that allows you to fully control 222PS functions from the PC. Waveforms may be transferred either to or from a local instrument connected to the serial communications port of the PC or a remote instrument via a telephone modem. There are no capabilities for further processing of the captured waveform data or for automated control of the front panel under CAT200 programming.

NOTE

You must use CAT200 ***Version 1.2 or above*** *with the 222PS.*

RS-232 Interconnection Cables

The optional accessory RS-232 interconnection cable supports attachment of the instrument with its DE-9 connector to a PC/XT or compatible with a DB-25 connector (see Figure A-12). For connection to other types of equipment a user must provide the correct cabling (see Table A-7 for typical pin connections).

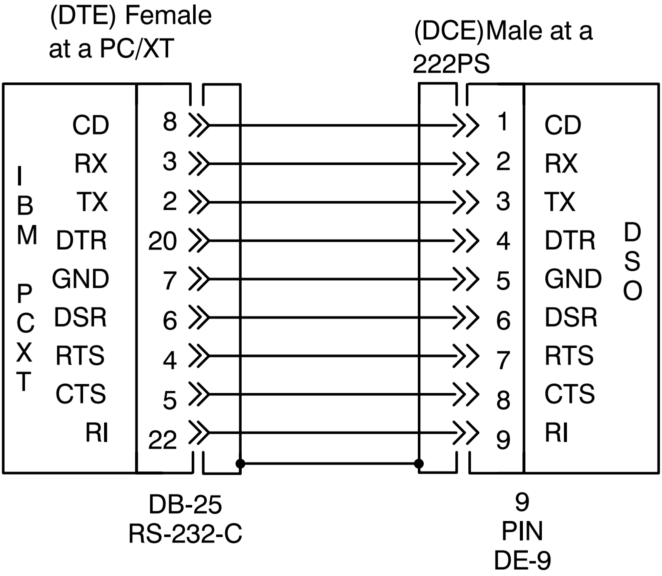

Figure A-12: RS-232 Interconnection Cable Pin Wiring

Table A-7: 222PS Interconnect Pin Assignments

(DCE) Male at the DSO		TO (DCE) Modem		TO (DTE) PC/XT		TO (DTE) PC/AT	
1*	CD	6	DSR	8	CD	1	CD
2	RX	2	TX	3	RX	2	RX
3	TX	3	RX	2	TX	3	TX
4	DTR	8	CD	20	DTR	4	DTR

Table A-7: 222PS Interconnect Pin Assignments (Cont.)

(DCE) Male at the DSO		TO (DCE) Modem		TO (DTE) PC/XT		TO (DTE) PC/AT	
5*	SGND	7	GND	7	GND	5	SGND
6	DSR	20	DTR	6	DSR	6	DSR
7*	RTS	5	CTS	4	RTS	7	RTS
8	CTS	4	RTS	5	CTS	8	CTS
9*	RI	22	RI	22	RI	9	RI

***Connection optional**

Appendix C: Quick Checks

This subsection contains quick-to-perform procedures that you can use to verify that the 222PS functions properly.

The *Self Cal Tests* procedure uses internal routines to confirm that both input channels can be calibrated and that the display is working properly. The only test equipment required is a patch cord.

The *Autoset Tests* procedure uses the automatic setup feature of the 222PS to verify the acquisition system, trigger circuits and waveform display capability. The standard-accessory probes, included with this oscilloscope, are the only equipment needed.

General Instructions

The *Self Cal Tests* and *Autoset Tests* procedures combine with the *Performance Tests* found later in this section to extensively test the 222PS.

You may not need to perform both the *Brief Procedures* and the *Performance Tests*, depending on what you want to accomplish:

- To rapidly confirm that this oscilloscope functions and was adjusted properly, just do the procedure under *Self Cal Tests*, which begins on page A-39.
- To further check functionality, first do the *Self Cal Tests* just mentioned, and then do the procedure under *Autoset Tests* that begins on page A-41.
- If more extensive confirmation of performance is desired, do the *Performance Tests*, beginning on page A-43, after doing the *Self Cal Tests* and *Autoset Tests*. The *Performance Tests* directly check warranted specifications, but they require more time and specific test equipment.

Conventions

Throughout these procedures the following conventions apply:

- Each test procedure uses the following general format:

  Title of Test

  Equipment Required

  Prerequisites

  Procedure

- Each procedure consists of many steps, substeps, and subparts as required to do the test. Steps, substeps, and subparts are sequenced as follows:

1. First Step
   a. First Substep
      - First Subpart
      - Second Subpart
   b. Second Substep
2. Second Step

- Where instructed to use a front-panel button or knob or verify a readout or status message, the name of the button or knob appears in boldface type: "Rotate the **VERT POS** knob to position the waveform at center screen."

STOP

The symbol above is accompanied by information you must read to do the procedure properly.

Initial Setup Procedure

This procedure connects the oscilloscope to external power and installs probes for the tests that follow.

Equipment Required (See Table A-8, page A-45)

P850 probe (standard accessory, Item 13)
External Power AC Adapter (standard accessory, Item 3)

Prerequisites

None

Procedure

1. Plug the External Power AC Adapter into the AC power source.
2. Plug in the cord from the adapter to the **EXT POWER INPUT** connector on the rear panel of the oscilloscope.
3. Open the zipper on the probe pouch and remove the probes. If disconnected, connect the probes through the oval opening at the rear of the pouch to the connectors on the oscilloscope.
4. Press the **ON** button of the oscilloscope to toggle it into the operating mode.

Self Cal Tests

This procedure uses internal routines to verify that this 222PS functions and can properly perform self-calibration of both input channels. This procedure also guarantees the highest accuracy state for the *Performance Tests* that follow.

Equipment Required (See Table A-8, page A-45)

Connector; female-to-dual-banana-plug (Item 7)
External Power AC Adapter (standard accessory, Item 3)

Prerequisites

Initial Setup Procedure

Procedure

1. Press the **AUX FUNCT** button to bring up the AUX menu.
2. Select SELF CAL from the menu.

NOTE

Disconnect both the Channel 1 and Channel 2 probes from any signal source before performing the self-calibration routines.

3. Select CH1 from the SELF CAL submenu to start the Channel 1 self-calibration routine. When the oscilloscope displays a PASS/FAIL message, the first routine is done.
4. Select CH2 from the SELF CAL submenu to start the Channel 2 self-calibration routine. When the oscilloscope displays a PASS/FAIL message, the second routine is done.
5. Select EXT TRIG to display the external trigger self-calibration menu.

NOTE

*For this self-calibration routine, the **EXT TRIG COMM** and **EXT TRIG INPUT** connectors must be connected together. Use a short jumper with banana plug connectors to make the connection.*

6. Select CAL to start the external trigger self-calibration routine after the **EXT TRIG COMM** and **EXT TRIG INPUT** connectors are joined. A PASS/FAIL message is displayed when the routine is done. Remove the jumper.
7. Press the **CLEAR** button at the completion of the self-calibration routines to return to normal oscilloscope operation. You are now ready to make the performance checks.

If a self-calibration step fails, the currently stored calibration constants are not changed. Run the failed routine again. Refer to the *Troubleshooting* in the *Maintenance* section of the 222PS service manual for an explanation of the error codes.

If the failure persists, further information about the nature of the failure may be found by connecting the RS-232 interface port to a terminal or host computer and rerunning the failed self-calibration routine. A coded error message is output when the error occurs.

Refer to the *Remote Communication* section of this manual for explanations of the error codes.

Autoset Tests

The autoset test procedure, while simple and easy to perform, will check 90% of the functionality of your 222PS Digital Storage Oscilloscope.

Equipment Required (See Table A-8)

P850 probe (standard accessory, Item 13)
External Power AC Adapter (standard accessory, Item 3)

Prerequisites

Initial Setup Procedure

Procedure

1. Remove the retractable hook tip from the channel 1 probe.
2. Display the channel 1 signal.
3. Hold the probe tip to the end of your finger. Make good contact, but do not puncture yourself.
4. With one of your *other* fingers, press the **AUTO SETUP** button.
5. When the auto-setup sequence is complete, channel 1 should show a 60 Hz noisy sine waveform.
6. Repeat this procedure for channel 2.

If the auto-setup routine displays a signal for both channels, it indicates that most of the instrument's major systems are operational and will perform correctly.

Appendix D: Performance Tests

This section contains a collection of procedures for checking that the 222PS Digital Storage Oscilloscope performs as warranted.

There are three primary performance verification sequences:

- Vertical Checks
- Horizontal Checks
- Trigger Checks

These performance check procedures verify the performance requirements of the instrument as listed in *Appendix D: Specification*. These checks may be used as an acceptance test or as a preliminary troubleshooting aid to help determine the need for repair or readjustment.

STOP

> *These procedures* extend *the confidence level provided by the basic procedures described in the previous section. Perform the basic procedures first, then continue to these if needed.*

Prerequisites

To ensure the validity of these performance check procedures, the testing environment must meet these qualifications:

- The cabinet must be in place.
- You must perform and pass the self-calibration routines and functional tests found on page A-39.

Related Information

Read *General Instructions* and *Conventions* that start on page A-37.

Equipment Required

Table A-8 lists all the test equipment required to do the performance check procedure. Test equipment specifications described are the minimum necessary to provide accurate results. For test equipment operation information, refer to the appropriate test equipment instruction manual.

When you use equipment other than that recommended, you may have to make some changes to the test setups. If the exact example equipment in Table A-8 is not available, use the Minimum Specification column to determine if any other available test equipment might be adequate to do the check.

Table A-8: Test Equipment

Item Number and Description	Minimum Requirements	Example	Purpose
1 Adapter	Connectors: BNC male-to-dual-banana-jack.	Tektronix part number 103-0035-00	Signal connection
2 Calibration Generator	Standard-amplitude signal levels (DC and square wave): 5 mV to 100 V. Accuracy: 5 mV to 100 V ±0.25%. High-amplitude signal levels: 1 V to 60 V. Repetition rate: 1 kHz. Fast-rise signal level: 1 V. Repetition rate: 1 MHz. Rise time: 1 ns or less. Flatness: ±0.5%	TEKTRONIX PG506A Calibration Generator	Gain and transient response checks
3 AC Power Source	External Power AC Adapter	Standard (U.S.) External Power AC Adapter, Tektronix part number 120-1807-00	Reliable power for oscilloscope and defeats auto-shutdown
4 Adjustment Tool	Small flat blade, narrow tip	General Tool 120-250	Adjust focus before measurements
5 Termination, 50 Ω	Impedance 50 Ω; connectors: female BNC input, male BNC output	Tektronix part number 011-0049-01	Impedance matching between generators and probes
6 Cable, 50 Ω Coaxial	50 Ω, 36 in, male-to-male BNC connectors	Tektronix part number 012-0482-00	Signal connection

Table A-8: Test Equipment (Cont.)

Item Number and Description	Minimum Requirements	Example	Purpose
7 Connector; dual-banana	BNC female-to-dual-banana plug	Tektronix part number 103-0090-00	Signal coupling to External Trigger and Common inputs
8 Connector, BNC-T	Male, BNC-to-dual-female BNC	Tektronix part number 103-0030-00	Checking Trigger Sensitivity
9 Generator, Leveled Sine Wave	50 kHz to 20 MHz; Variable amplitude from 5 mV to 5 V p-p into 50 Ω. Amplitude accuracy: constant within 1.5% of reference frequency to 20 MHz	TEKTRONIX SG 503 Leveled Sine Wave Generator	Checking Vertical Triggering and Bandwidth
10 Generator, Time Mark	Variable marker frequency from 0.55 ms to 5 ns; accuracy within 2 ppm	TEKTRONIX TG501A Time Mark Generator	Checking Sample-Rate and Delay-time Accuracy
11 Probe (2 required)	P850 10X	TEKTRONIX P850	Connect oscilloscope to signal source
12 Wire Leads	18 gauge bare wire; two 1-inch pieces	Tektronix part number 176-0120-00	Interconnect between the BNC-to-dual-banana jack and probe tip and ground

Preparation

The performance verification procedure is divided into subsections to let you check individual sections of the instrument when it is not necessary to do the complete performance check. An Equipment Required block at the beginning of each subsection lists the equipment from Table A-8 that is needed to do the checks in that subsection.

The initial control settings at the beginning of each subsection prepare the instrument for the first step of the subsection. Do each of the steps in a subsection completely and in order to ensure the correct control settings for the steps that follow. Let the test equipment warm-up for 20 minutes to obtain a valid performance check to the accuracies stated in *Appendix D: Specification*s.

Preliminaries

This preliminary procedure adjusts the display for greatest clarity prior to making measurements in the Performance Verification checks. You will make only externally available adjustments.

Equipment Required (See Table A-8)

External Power AC Adapter (Item 3)
Adjustment Tool (Item 4)

Prerequisites

Self Tests and Autoset Tests starting on page A-39.

Initial Control Settings

Power and Display

External Power	External Power AC Adapter connected
Power	**ON**

Front-Panel Controls

AUTO SETUP	Press for initial signal display

Procedure

1. Check/Adjust Intensity Control
    a. Adjust the **INTEN** control for a sharp display.
2. Adjust **FOCUS** Control
    a. Press the **AUX FUNCT** button on the top panel.
    b. Select the ALIGN menu choice, then the XY menu choice. These selections display a test pattern on the CRT.
    c. Adjust the **FOCUS** control for the best definition of the pattern.
    d. Press the **CLEAR** button to remove the display pattern and return to normal operation.

Vertical Checks

These procedures check characteristics for the signal acquisition and display systems that are listed as checked under *Warranted Characteristics* in *Appendix E: Specifications*. Set up the test equipment as shown in Figure A-13. The calibration generator and the leveled sine-wave generator will not be used at the same time but they should both remain powered up during the procedure to ensure stable operation.

Equipment Required (See Table A-8)

Leveled Sine Wave Generator (Item 9)
Calibration Generator (Item 2)
50 Ω BNC Termination (Item 5)
BNC-to-banana-jack Adapter (Item 1)
External Power AC Adapter (Item 3)
2 P850 Probes (Item 11)
Wire Leads (Item 12)

Prerequisites

Self Tests and Autoset Tests starting on page A-39

Preliminaries on page A-47

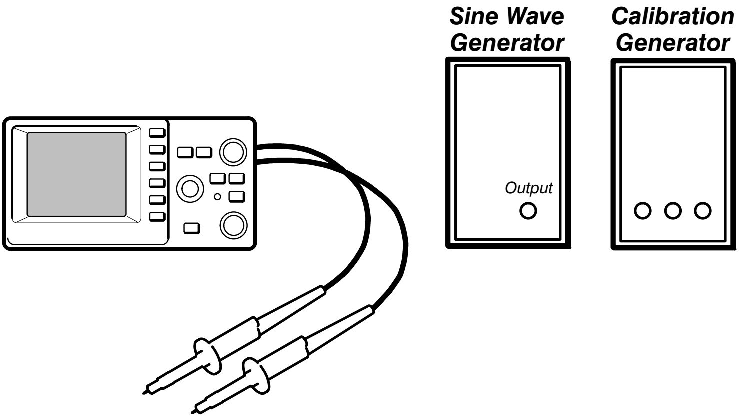

Figure A-13: Initial Setup for Vertical Checks

Initial Control Settings

Power and Display

External Power	External Power AC Adapter connected
Power	**ON**

Vertical Area

CH 2 **VOLTS/DIV**	50 mV
CH 2 Coupling	OFF
CH 2 Variable	CAL
CH 1 **VOLTS/DIV**	50 mV
CH 1 Coupling	GND
CH 1 Variable	CAL

Horizontal Area

SEC/DIV	1 ms
X10 MAG	OFF
POS	center the waveform

Trigger Area

Trigger **MODE** . . . . AUTOBL
Trigger **SOURCE** . . . . VERT
Trigger **SLOPE** . . . . +

Top Panel Controls

TRIG POS . . . . POST
STORE . . . . STORE

DISPL
INV1 . . . . OFF
INV2 . . . . OFF
XY . . . . OFF
RO OFF . . . . OFF (not selected)
ACQ . . . . NORM

Procedure

1. Check Input Current, DC Balance, and Invert Balance
   - a. Connect the channel 1 ground lead to the probe tip.
   - b. Press the **CLEAR** button to clear the display.
   - c. Vertically position the channel 1 trace to the center horizontal graticule line.
   - d. Set the channel 1 coupling to DC.
   - e. CHECK for 0.5 division or less shift from the center horizontal graticule line.
   - f. Set channel 1 coupling to GND.
   - g. Rotate the **VOLTS/DIV** control from 50 mV to 500 V.
   - h. CHECK for 0.2 division or less shift from the center horizontal graticule line.
   - i. Set the **VOLTS/DIV** control to 50 mV.
   - j. Select channel invert by pressing the **DISPL** button and selecting INV1.
   - k. CHECK for 0.4 division or less shift from the center horizontal graticule line.
   - l. Set channel 1 coupling to CH1 OFF.
   - m. Set channel 2 coupling to GND.
   - n. Turn off channel invert by pressing the **DISPL** button and selecting INV1.
   - o. Repeat steps a through n for channel 2.
2. Check Input Coupling (Set up the test equipment as shown in Figure A-14.)

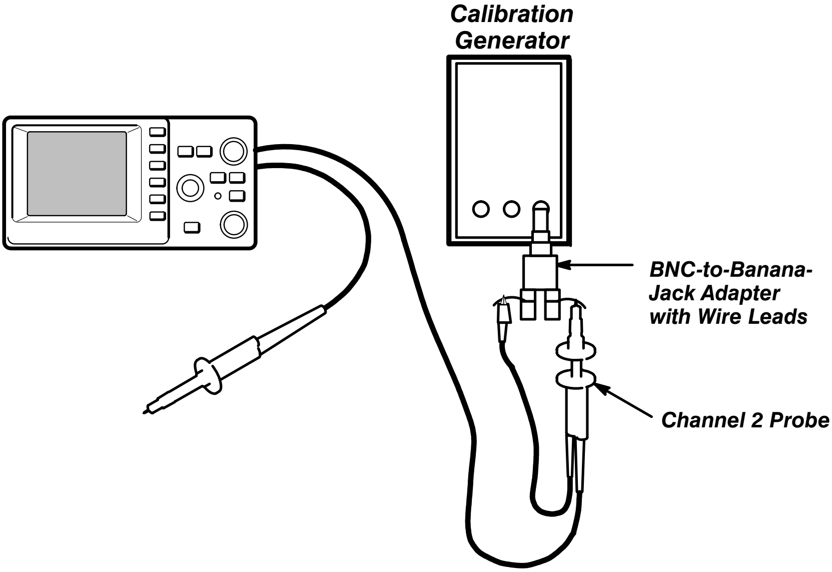

Figure A-14: Setup for Input Coupling Check

a.	Set:	CH 2 Coupling	DC
		SEC/**DIV**	0.5 ms
		Trigger **MODE**	AUTOLVL
		CH 2 **VOLTS**/**DIV**	0.5 V

b. Set the Calibration Generator to a standard-amplitude mode output signal of 2.0 V.

c. Vertically position the bottom of the signal to the center horizontal graticule line.

d. Set the channel 2 coupling to AC.

e. CHECK that the display moves to approximately vertical center screen.

f.	Set:	CH 2 Coupling	CH2 OFF
		CH 1 Coupling	DC
		CH 1 **VOLTS**/**DIV**	0.5 V

g. Disconnect the channel 2 probe from the test equipment and connect the channel 1 probe.

h. Repeat parts c, d, and e for channel 1.

3. Check the Volts-per-Division Accuracy

a. Set Calibration Generator for a standard-amplitude output signal of 0.2 V.

b. Set the channel 1 **VOLTS/DIV** control to 50 mV.
Set: CH 1 Coupling DC

c. Vertically center the display.

d. CHECK all positions of the volts per division settings for correct signal-to-graticule accuracy using the **VOLTS/DIV** control and Calibration Generator settings and amplitude limits given in Table A-9.

e. Return the Calibration Generator output to 0.2 V.

f. Set:

Set:	CH 1 Coupling	CH1 OFF
	CH 2 Coupling	DC
	CH 2 **VOLTS/DIV**	50 mV

g. Disconnect the channel 1 probe from the test equipment and connect the channel 2 probe.

h. Repeat part d and e for channel 2.

i. Disconnect the test equipment from the oscilloscope.

Table A-9: Volts-per-Division Accuracy Settings

Volts/Div	Calibration Generator	Amplitude Limits
5 mV[1]	20 mV	3.84 div – 4.16 div
10 mV[1]	50 mV	4.80 div – 5.20 div
20 mV[1]	0.1 V	4.80 div – 5.20 div
50 mV	0.2 V	3.84 div – 4.16 div
0.1 V	0.5 V	4.80 div – 5.20 div
0.2 V	1 V	4.80 div – 5.20 div
0.5 V	2 V	3.84 div – 4.16 div

[1] **These ranges are available only with a P400 X1 probe.**

Table A-9: Volts-per-Division Accuracy Settings (Cont.)

Volts/Div	Calibration Generator	Amplitude Limits
1 V	5 V	4.80 div – 5.20 div
2 V	10 V	4.80 div – 5.20 div
5 V	20 V	3.84 div – 4.16 div
10 V	50 V	4.80 div – 5.20 div
20 V	100 V	4.80 div – 5.20 div
50 V	100 V	1.92 div – 2.08 div
100 V	——	——[2]
200 V	——	——[2]
500 V	——	——[2]

[2] For P850 probe only; not practical to check due to calibration generator limitation. To check attenuator accuracy in these positions, check the 10 and 20 V per division settings.

4. Check Probe Compensation (Low Frequency Pulse Response)

   a. Set up the equipment as shown in Figure A-15.

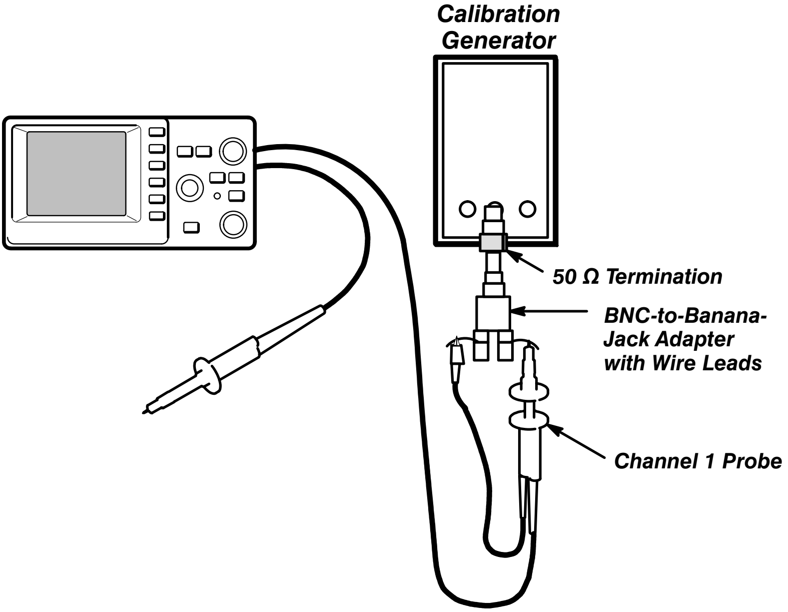

Figure A-15: Setup for Probe Compensation Check

b. Set:

Set:	CH 2 Coupling	OFF
	CH 1 Coupling	DC
	CH 1 **VOLTS/DIV**	50 mV
	SEC/DIV	0.2 ms
	TRIG POS	MID

c. Set the Calibration Generator output for a positive fast-rise signal with a 1 ms period.

d. Adjust the Calibration Generator pulse amplitude for a 5-division display.

e. Vertically position the top of the square wave on the second horizontal graticule line above the center.

f. Position the rising edge at the trigger position to the center vertical graticule line.

g. CHECK for 0.15 division or less of rolloff or overshoot at the front corner.

h.	Set:	CH 1 Coupling	CH1 OFF
		CH 2 Coupling	DC
		CH 2 **VOLTS**/**DIV**	50 mV

i. Disconnect the channel 1 probe from the BNC-to-banana-jack adapter and connect the channel 2 probe.

j. Repeat parts e – g for channel 2.

k. Disconnect the channel 2 probe from the test equipment.

5. Check Analog Bandwidth (Set up the test equipment as shown in Figure A-16.)

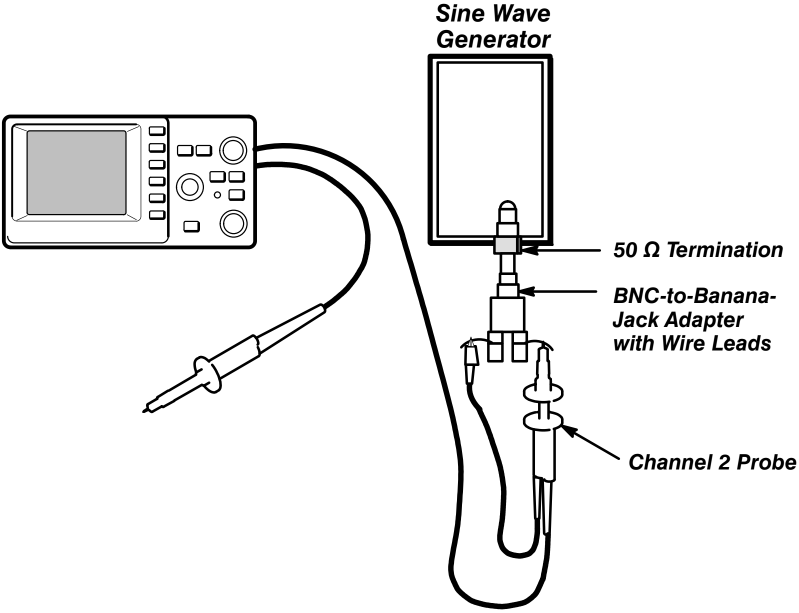

Figure A-16: Setup for Analog Bandwidth Check

a.	Set:	CH 2 **VOLTS**/**DIV**	0.5 V
		SEC/**DIV**	5 µs

b. Set the Leveled Sine Wave Generator for a display amplitude of 6 divisions at 50 kHz.

c. Set the **SEC/DIV** control to 50 ns.

d. Set the Leveled Sine Wave Generator output frequency to 10 MHz.

e. CHECK that the display amplitude is at least 4.2 divisions.

f. Return the Leveled Sine Wave Generator output frequency to 50 kHz.

g. Set:

CH 2 Coupling	CH2 OFF
CH 1 Coupling	DC
CH 1 **VOLTS/DIV**	0.5 V
SEC/DIV	5 µs

h. Disconnect the channel 2 probe from the test equipment and connect the channel 1 probe.

i. Vertically center the display.

j. Repeat parts b, c, d, and e for channel 1.

Horizontal Check

This horizontal check procedure verifies characteristics that relate to the time-base system and that are listed as checked under *Warranted Characteristics* in *Appendix D: Specification*. Set up the test equipment as shown in Figure A-17.

Equipment Required (See Table A-8)

Time-Mark Generator (Item 10)
50 Ω BNC Termination (Item 5)
BNC-to-banana-jack Adapter (Item 1)
External Power AC Adapter (Item 3)
2 P850 probes (Item 11)
Wire Leads (Item 12)

Prerequisites

Self Tests and Autoset Tests starting on page A-39

Preliminaries on page A-47

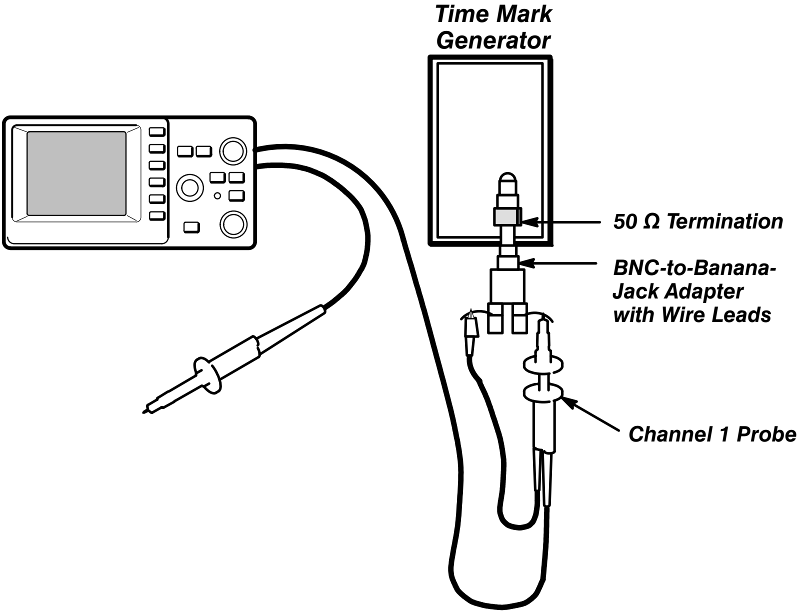

Figure A-17: Setup for Horizontal Test

Initial Control Settings

Power and Display

External Power	External Power AC Adapter connected
Power	**ON**

Vertical Area

CH 2 Coupling	CH2 OFF
CH 1 Coupling	DC
CH 1 **VOLTS/DIV**	0.1 V
CH 1 **VAR**	CAL

Horizontal Area

SEC/DIV	1 ms
X10 MAG	OFF

Trigger Area

Trigger **MODE** . . . . AUTOLVL
Trigger **SOURCE** . . . . VERT
Trigger **SLOPE** . . . . +

Top Panel Controls

TRIG POS . . . . POST
STORE . . . . STORE

DISPL
INV1 . . . . OFF
INV2 . . . . OFF
XY . . . . OFF
RO OFF . . . . OFF (not selected)

ACQ . . . . NORM

Procedure

1. Check X1 Seconds-per-Division Accuracy
   a. Press the **CLEAR** button to clear the display.
   b. Set the Time Mark Generator to output 1 ms time markers.
   c. Vertically position the baseline of the time-mark signal to the center horizontal graticule line.
   d. Horizontally position the left time marker with the first vertical graticule line.

e. CHECK the accuracy over the center 8 divisions. Accuracy should be ± 0.16 divisions (2%).

f. Disconnect the test equipment from the oscilloscope.

Trigger Checks

The Trigger Checks procedures verify those characteristics that relate to the trigger systems and that are listed as checked under *Warranted Characteristics* in *Appendix D: Specifications*. Set up the test equipment as shown in Figure A-18.

Equipment Required (See Table A-8)

Leveled Sine Wave Generator (Item 9)
BNC-to-dual-banana-plug Adapter (Item 7)
BNC-T connector (Item 8)
BNC-to-banana-jack Adapter (Item 1)
50 Ω BNC Termination (Item 5)
External Power AC Adapter (Item 3)
BNC Coaxial Cable (Item 6)
2 P850 Probes (Item 11)

Wire Leads (Item 12)

Prerequisites

Self Tests and Autoset Tests starting on page A-39

Preliminaries on page A-47

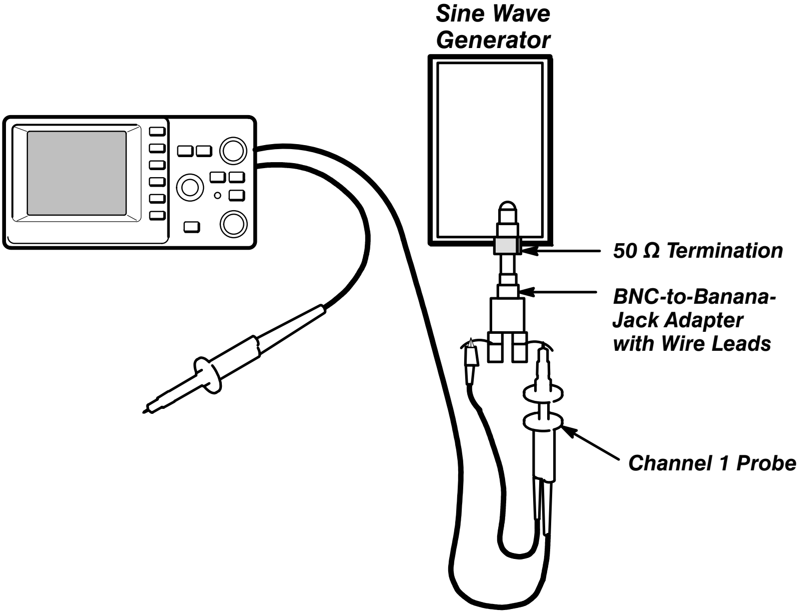

Figure A-18: Setup for Trigger Checks

Initial Control Settings

Power and Display

External Power . . . . External Power AC Adapter connected
Power . . . . **ON**

Vertical Area

CH 2 Coupling . . . . CH2 OFF
CH 2 **VAR** . . . . CAL

CH 1 Coupling . . . . DC
CH 1 **VOLTS**/**DIV** . . . . 50 mV
CH 1 **VAR** . . . . CAL

Horizontal Area

X10 MAG . . . . OFF
SEC/DIV . . . . 50 ns

Trigger Area

Trigger **MODE** . . . . AUTOLVL
Trigger **SLOPE** . . . . +
Trigger **SOURCE** . . . . VERT

Top Panel Controls

TRIG POS . . . . POST
STORE . . . . STORE

DISPL

INV1 . . . . OFF
INV2 . . . . OFF
XY . . . . OFF
RO OFF . . . . OFF (not selected)

ACQ . . . . NORM

Procedure

1. Check Trigger Sensitivity

   a. Set the Leveled Sine Wave Generator for a 5 division display amplitude at 10 MHz.

   b. Set the channel 1 **VOLTS/DIV** control to 0.5 V.

   c. Push **AUTOLVL** knob.

   d. CHECK for a stable display with the **TRIG'D** indicator on.

   e. Set the **SEC/DIV** control to 5 μs.

   f. Set channel 1 **VOLTS/DIV** control to 50 mV.

   g. Return the Leveled Sine Wave Generator to 50 kHz and adjust for a 5 division display amplitude.

   h. Set the **SEC/DIV** control to 0.2 μs.

i. Press **INIT** to restart the acquisition.

j. CHECK that the display fills completely in less than 10 s.

2. Check External Trigger Sensitivity (Set up the test equipment as shown in Figure A-19.)

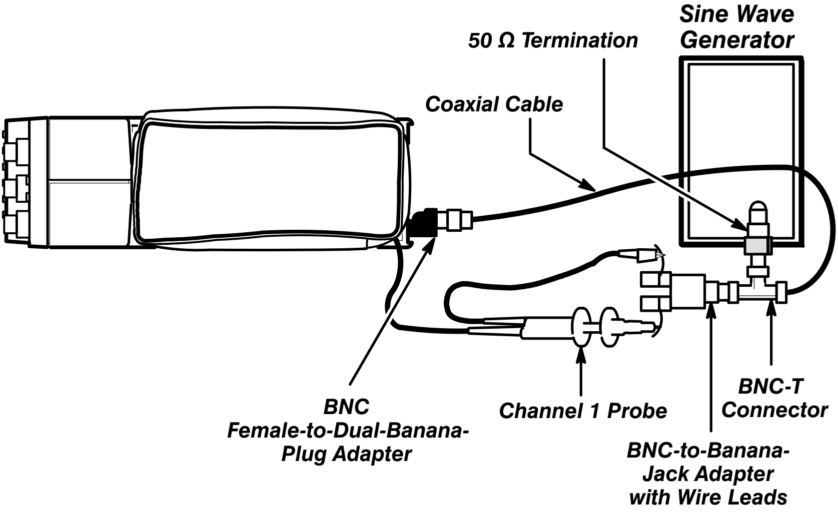

Figure A-19: Setup for External Trigger Sensitivity Check

a. Set:

CH 2 Coupling	GND
CH 1 Coupling	DC
CH 1 **VOLTS/DIV**	50 mV
Trigger **SOURCE**	EXT
STORE	OFF (not selected)
SEC/DIV	5 µs

b. Connect the Leveled Sine Wave Generator output via a 50 Ω termination, a BNC-T connector, and a BNC-to-banana-jack adapter to the channel 1 probe.

c. Connect the other side of the BNC-T connector via a 50 Ω coaxial cable and BNC-to-dual-banana-plug connector to the **EXT TRIG INPUT** and **EXT TRIG COMM** input jacks on the rear panel.

d. Vertically center the display.

e. Set the Leveled Sine Wave Generator to display 5 divisions of amplitude at 50 kHz.

f. CHECK for a triggered display (**TRIG'D** indicator light on).

g. Set the **SEC/DIV** control to 50 ns.

h. Set the Leveled Sine Wave Generator to display 5 divisions of amplitude at 10 MHz.

i. CHECK for a triggered display (**TRIG'D** indicator light on).

j. Disconnect the probe from the test equipment.

3. Check Motor Trigger

a. Set:

CH 1 **VOLTS/DIV**	0.1 V
SEC/DIV	1 ms
Trigger **MODE**	AUTO BL
Trigger **SOURCE**	VERT
TRIG POS	MID
MOTOR TRIG	ON

b. Connect the fast rise output of the Calibration Generator through the BNC-to-banana-plug adapter to the CH 1 probe tip and adjust the fast rise amplitude for 4 divisions.

c. Set the Calibration Generator frequency to 1 kHz.

d. Press the **AUTO:LVL PUSH** button to center the trigger level on the waveform.

e. Adjust the Calibration Generator frequency variable to the point where the trigger of the waveform is just able to be maintained.

f. Verify that the negative portion of the displayed square wave is between 2.0 and 3.0 ms.

g. Disconnect the test equipment from the instrument.

Appendix E: Specifications

This section contains a collection of tables that list the various traits that describe the 222PS PowerScout. This section is divided into three subsections, one for each of three classes of traits: *nominal traits, warranted characteristics,* and *typical characteristics.*

Nominal Traits

This subsection contains a collection of tables that list the various *nominal traits* that describe the 222PS PowerScout. Included are electrical and mechanical traits.

Nominal traits are described using simple statements of fact such as “Two full featured” for the trait “Input Channels, Number of,” rather than in terms of limits that are performance requirements.

Table A-10: Nominal Traits—Vertical System

Name	Description
Digitizers, Number of	Two, both identical
Digitized Bits, Number of	8 bits, 25 levels per division, 10.24 divisions of dynamic range
Input Channels, Number of	Two full-featured (CH 1 and CH 2)
Input Coupling	DC, AC, GND or OFF
Maximum Input Voltage, Probe Tip to Common	850 V (DC + peak AC) or 600 VAC rms[1]; Peak Surge Voltage: 6000 V for 250 µs or less (P850 only); derate with increased frequency according to Figure A-20

Table A-10: Nominal Traits—Vertical System (Cont.)

Name	Description
Maximum Input Voltage, Probe Common to Chassis	850 V (DC + peak AC) or 600 VAC rms[1]; Peak Surge Voltage: 6000 V for 250 µs or less (P850 only); derate with increased frequency according to Figure A-21
Maximum Input Voltage, Between Channels	1700 V (DC + peak AC) or 1200 VAC rms[1]
Pulse Width, Minimum Detectable	Envelope and Continuous Envelope Modes: 100 ns
Range, Sensitivity, CH 1 and CH 2	1X probe: 5 mV/div to 50 V/div in a 1-2-5 settings sequence10X probe: 50 mV/div to 500 V/div in a 1-2-5 settings sequence
Single Shot Storage, Useful Bandwidth[2]	Normal Acquisition Mode: $\frac{5}{SEC/DIV \;\; Setting}$ Hz or 1 MHz, whichever is less Envelope and Continuous Envelope Modes: 1 MHz

[1] **Performance requirement not checked in manual.**

[2] **Useful storage bandwidth is limited to the frequency where there are 10 Display Sample/Sine Wave Signal periods. At seconds-per-division settings faster than 5 µs/Div, Storage Bandwidths are limited to 1 MHz max sampling rate.**

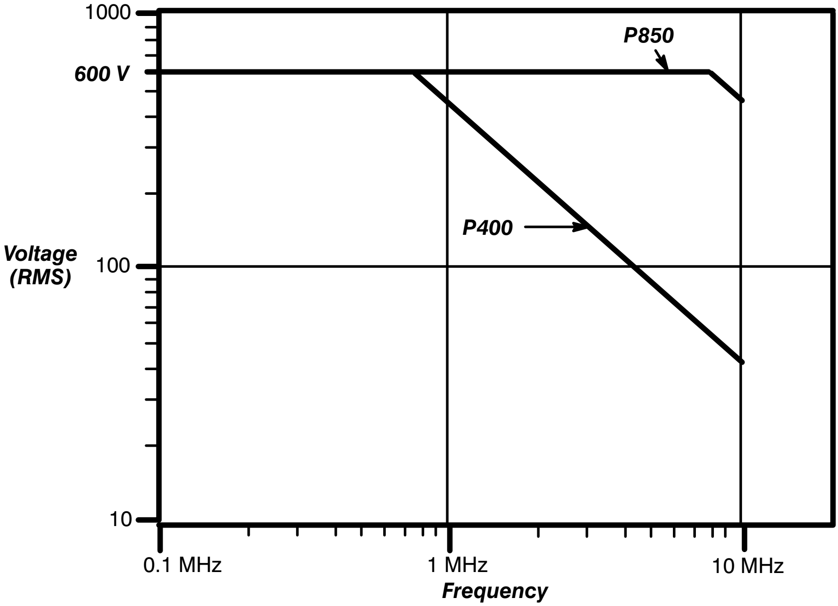

Figure A-20: Maximum Normal-Mode Voltage Versus Frequency Derating Curve

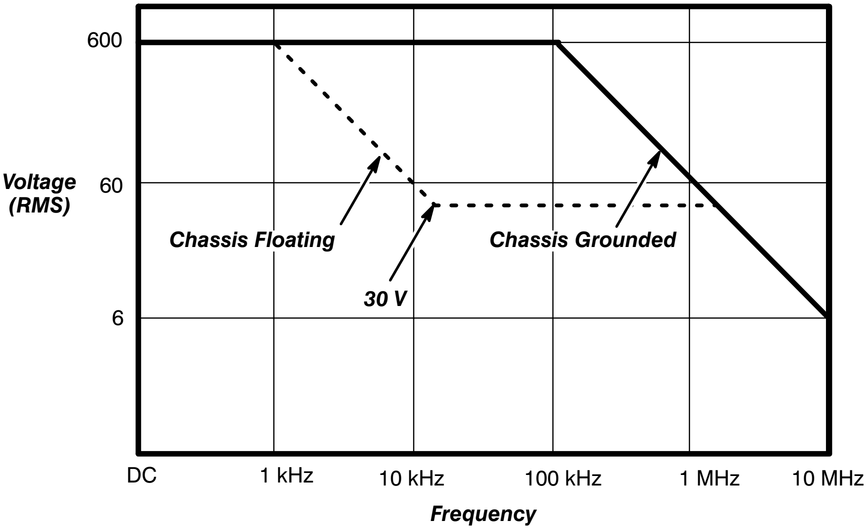

Figure A-21: Maximum Common-Mode Voltage Versus Frequency Derating Curve

Table A-11: Nominal Traits—Horizontal System

Name	Description		
Range, Sample-Rate	***Time/Div***	***Acquisition Mode***	***Sample-Rate Range***
	5 µs to 20 s/div	Normal	50/(sec/div) Samples/sec
	2 µs/div	Normal	5 MSamples/ sec
	50 ns to 1 µs/div	Normal	10 MSamples/ sec
	20 µs to 20 s/div	Envelope	10 MSamples/ sec
Range, Seconds/Division	50 ns/div to 20 s/div; the X10 MAG control extends the maximum sweep speed to 5 ns/div		
Record Length	512 points; 50 points per division		

Table A-12: Nominal Traits—Triggering System

Name	Description
External Trigger Maximum Input Voltage[1], Input to Common, Input to Earth Ground, Common to Earth Ground	42 V (DC + peak AC)

[1] The external trigger input is not intended for floating measurements beyond 42 V peak.

Table A-13: Nominal Traits—Display System

Name	Description
CRT Display Size	Display area of 6.4 cm (2.5 in) measured diagonally
Waveform Display Graticule	Single graticule: 8 divisions high by 10 divisions wide, where divisions are 0.5 cm by 0.5 cm (0.2 in by 0.2 in)
CRT Reflectivity	CRT filter shield has an anti-reflectance surface to aid viewing in high ambient light conditions

Table A-14: Nominal Traits—Power System

Name	Description
Internal Battery, Type	Sealed lead-acid
External Power, Input Voltage Range Pin to Pin	DC: 12 to 28 VDC AC: 16 to 20 V AC, 47 Hz to 400 Hz
External Power, Input Voltage Range Either Pin to EXT TRIG COM or RS-232 SGND (signal ground)	−0.5 to 28 V (DC + peak AC)

Table A-15: Nominal Traits—Communications Interface

Name	Description
COMM PORT Interface, Type	Complies with RS-232-C specification
COMM PORT Interface, Baud Rates	300, 1200, 2400, and 9600
COMM PORT Interface, Signals	RD, TD and SGND normally used (configured as a DCE device). When the instrument is off, a rising edge on DTR will turn instrument power on
Maximum Input Voltage, Any Pin	25 V (DC + peak AC)

Table A-16: Nominal Traits—Mechanical

Name	Description
Cooling Method	Conduction through cabinet walls; there are no cooling vents
Construction Material	Cabinet/chassis parts constructed of plastic with the internal surface coated with conductive paint for shielding; circuit boards constructed of glass-laminate with predominantly surface mount components
Finish Type	Tektronix Blue cabinet with black synthetic rubber hand grips and black vinyl probe pouch
Weight	Without accessories 2 kg (4.4 lbs) With accessories 2.72 kg (6.0 lbs)
Overall Dimensions	Height: 86.4 mm (3.4 in) Width: 159 mm (6.25 in), with handle. Length: 252 mm (9.9 in)
Probe Length, Detachable	2.0 m (78.7 in), P850

Warranted Characteristics

This subsection lists the various *warranted characteristics* that describe the 222PS PowerScout. Included are electrical and environmental characteristics.

Warranted characteristics are described in terms of quantifiable performance limits that are warranted.

NOTE

In these tables, those warranted characteristics that are checked in the procedure Performance Verification*, found in Appendix C, appear in* **boldface type** *under the column* **Name**.

As stated above, this subsection lists only warranted characteristics. A list of *typical characteristics* starts on page A-76.

Performance Conditions

The electrical characteristics found in these tables of warranted characteristics apply when the scope has been adjusted at an ambient temperature between +15° C and +35° C and is operating at an ambient temperature within ±5° C of the temperature at which self-calibration was performed (unless otherwise noted).

Table A-17: Warranted Characteristics—Vertical System

Name	Description
Accuracy, DC Gain (+15 to +35° C)	±4%, valid when self-cal performed within ±5° C of ambient temperature
Accuracy, DC Gain (Ambient Temperature −15 to +15° C and +35 to +55° C)	±5%, valid when self-cal performed within ±5° C of ambient temperature
Analog Bandwidth, Repetitive Signal[1]	$\frac{5}{\textit{SEC/DIV Setting}}$ Hz or 10 MHz whichever is less
Balance, DC	±0.2 divisions maximum trace shift between VOLTS/DIV settings, valid when self-cal performed within ±5° C of ambient temperature
Balance, Invert	±0.4 divisions maximum trace shift between inverted and non-inverted displays, valid when self cal performed within ±5° C of ambient temperature
Input Current	2.5 nA maximum (0.5 divisions or less when switching between DC and GND input coupling with VOLTS/DIV set at 50 mV/div)
Pulse Response Aberrations, Low Frequency	±3% maximum (0.15 divisions with a 5 division signal displayed)

Table A-17: Warranted Characteristics—Vertical System (Cont.)

Name	Description
Rise Time, Useful for Repetitive Signals	$\frac{(SEC/DIV\ \ Setting) * 1.6}{50}$ or 35 ns, whichever is greater

[1] Useful repetitive bandwidth is limited to the frequency at which 10 display samples are acquired for each sine wave period. For example at 10 μs per division the useful repetitive bandwidth is 500 kHz. At seconds-per-division settings faster than 0.5 μs/div, repetitive bandwidth is limited to 10 MHz by the input amplifier.

Table A-18: Warranted Characteristics—Horizontal System

Name	Description
Accuracy, Displayed (X1)	±2% with X1 magnification
Accuracy, Displayed (X10)	±5% with X10 magnification

Table A-19: Warranted Characteristics—Triggering System

Name	Description
Jitter, Trigger	2 µs/div to 50 ns/div: 1/50 division ±2 ns in X1 magnification 1/5 division ±2 ns in X10 magnification
Sensitivity, CH 1 and CH 2[1]	0.5 division p-p at 10 MHz
Sensitivity, External Trigger	250 mV p-p at 10 MHz

[1] The minimum sensitivity for obtaining a stable trigger. A stable trigger results in a uniform, regular display triggered on the selected slope. The trigger point must not switch between opposite slopes on the waveform and the display must not “roll” across the screen on successive acquisitions. The TRIG’D LED stays constantly lit when the seconds-per-division setting is 2 ms or faster but may flash when the setting is 10 ms or slower.

Table A-20: Warranted Characteristics—Environmental, Safety, and Reliability

Name	Description
Atmospherics	Temperature: −15 to +55° C, operating; −30 to +70° C, non-operating Relative humidity: 0 to 95% (−5%, +0%), operating to +55° C; non-operating to 60° C Altitude: Operating: to 4572 m (15,000 ft); Nonoperating: to 15240 m (50,000 ft); Maximum Operating Temperature decreases 1° C/300 m (1000 ft) above 15240 m (50,000 ft)
Dynamics	Vibration, Sinusoidal (Operating and Nonoperating): Meets or exceeds MIL-T-28800D, Class III Shock, 50 G, half-sine, 11 ms duration: Meets or exceeds MIL-T-28800D, Class III
Emissions, Electromagnetic	Meets or exceeds the requirements of the following standards: VDE 0871, Class B[1] FCC Rules and Regulations, Part 15, Subpart B, Class A
User-Misuse Simulation	Electrostatic Discharge Susceptibility: Conforms to IEC 801-2 Bench Use (Operating and Nonoperating): One 10.6 cm (4 in) or balance point drop per corner

[1] To ensure compliance use the specified shielded cable and connector housing for the RS-232 connections and detach the probes or store them in the probe pouch.

Typical Characteristics

This subsection contains tables that lists the various *typical characteristics* that describe the 222PS PowerScout.

Typical characteristics are described in terms of typical or average performance. Typical characteristics are not warranted.

This subsection lists only typical characteristics. A list of warranted characteristics starts on page A-72.

Table A-21: Typical Characteristics—Vertical System

Name	Description
Common Mode Rejection Ratio, DC – 100 kHz	60 dB minimum (P850 probe), 1000:1 80 dB minimum (P400 probe), 10,000:1
Input Capacitance, Common to Chassis	150 pF
Input Capacitance Probe Tip to Common	X1 probe (P400): 30 pF X10 probe (P850): 4.5 pF
Input Resistance, Probe Tip to Common	X1 probe: 1 MΩ X10 probe: 10 MΩ
Isolation, Common Mode, DC – 100 kHz	80 dB minimum
Isolation, Normal Mode, DC – 10 MHz	80 dB minimum, 10000:1 (P400)
Slew Rate, Maximum Common Mode	10,000 V/µs
Range, Position, CH 1 and CH 2	±12 divisions minimum
Range, Variable VOLTS/DIV	Increases deflection factor by ≥250%

Table A-22: Typical Characteristics—Horizontal System

Name	Description
Accuracy, Sample Rate	±0.01%
Position Control Range	Either end of waveform can be positioned past the center vertical graticule line
Display Sweep Length	10.24 divisions

Table A-23: Typical Characteristics—Triggering System

Name	Description
Input Capacitance, External Input	18 pF
Input Resistance, External Input	1 MΩ
Trigger Level Range, External Input	±2.0 V
Trigger Level Range, Internal	±20 divisions

Table A-24: Typical Characteristics—Power System

Name	Description
Battery, Charge Time	Three hours for full charge with instrument turned off
Battery, Excessive Discharge Protection	Instrument operation automatically interrupted when battery voltage drops to 7.32 VDC
Battery, Minimum Operating Time	Three hours at 25° C
Battery, Capacity Over Operating Temperature	−15° C: 80% 25° C: 100% 55° C: 110%

Table A-24: Typical Characteristics—Power System (Cont.)

Name	Description
Current, Demand	1 A Max (when charging battery)
Consumption, Maximum	15 watts or 16 VA (maximum power demand occurs when charging the battery)

Appendix F: Accessories

This appendix provides a list of standard and optional accessories for the 222PS, with Tektronix part numbers. To order an accessory, determine its part number and contact your local Tektronix field office or representative. In the United States, you can also call the Tektronix National Marketing Center toll-free at 1-800-426-2200.

For more information about Tektronix products and accessories, see the current Tektronix Product Catalog.

Standard Accessories

The following accessories come with the instrument.

Table A-25: Standard Accessories

Accessory	Part Number
222PS PowerScout Operator Manual	070-8097-XX
222PS, 222A, and 224 Reference	070-8965-XX
External power AC adapter (110 VAC)	120-1807-00
Instrument carrying case	016-1024-01
Cabinet feet accessory kit	020-1752-00
10X probe with accessories (two each)	P850
Industrial Lead Set (2)	012-1392-00

Optional Accessories

You can order the following accessories.

Table A-26: Optional Accessories

Accessory	Part Number
222PS PowerScout Service Manual	070-8098-XX
Spare battery	146-0075-00
Accessory pouch (for spare battery or external power AC adapter)	016-0993-01
RS-232 cable	174-1453-00
BNC-female-to-dual-banana-plug adapter	103-0090-00
BNC-male-to-dual-banana-jack adapter	103-0035-00
Version 2.1 utility software	063-1585-00
1X probe with accessories	P400
Automotive lead set	020-2080-00
Automotive self-study training package	650-3076-00
External trigger probe with accessories (requires BNC-female-to-dual-banana-plug adapter)	P6122
Virtual instrument software package	CAT200
Intelligent printer interface	WP200
1X BNC-to-Probe Adaptor	206-0451-00
External battery charger with field accessories: External battery charger External battery charger data sheet Accessory pouch Viewing hood Spare battery Cigarette lighter adapter power cable Accessory kit data sheet	BAT200

Instrument Options

You can order the following options for the 222PS PowerScout.

Table A-27: Instrument Options

Description	Part Number
Option 05 — instrument supplied with CAT200 Virtual Instrument Software	CAT200
Option 04 — instrument supplied with WP200 Intelligent Printer Interface	WP200

External Power AC Adapter Options

You can order the following options for the external power AC adapter.

Table A-28: External Power AC Adapter Options

Description	Part Number
Option 02 — instrument supplied without external power AC adapter	———————
Option A1 — European 220 V	120-1826-00
Option A2 — UK 240 V	120-1827-00

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AC Coupling

A means to block the DC component of an input signal and to display only its AC component.

Acquisition Mode

A manner of acquiring the signal and constructing a waveform. The 222PS has four acquisition modes: normal, averaging, envelope, and continuous envelope. (See those definitions.)

Acquisition Sample Interval

The time between each sample the instrument acquires from the input signal.

Aliasing

A condition in which a waveform appears to have a frequency much lower than is accurate, because it has not been sampled often enough.

Attenuation

The sensitivity of a probe.

Auto-Baseline Trigger Mode

A trigger mode in which the instrument acquires and displays whatever data it can capture, regardless of whether a trigger event has occurred. This allows you to display information even when a signal is too small to trigger on.

Auto-Level Trigger Mode

A trigger mode in which the instrument determines the peak values of the incoming signal and sets the trigger level to its midpoint. This allows you to display a waveform without setting the trigger level.

Auto Setup

A function that automatically sets front-panel controls in a manner that depends on the signals applied to channels 1 and 2, speeding the process of setting up the instrument.

Averaging Acquisition Mode
An acquisition mode in which the instrument displays a waveform that is the point-by-point average of the last four waveforms acquired.

Baud Rate
The rate at which two connected electronic devices exchange data.

Brightness
The intensity with which the phosphor glows on the screen.

Calibration
The adjustment of instrument performance to meet published specifications or to verify such performance, according to external reference standards.

Channel
One input path to the instrument. When you connect a probe or cable to the channel input connector, you can conduct a signal into that input path.

Channel Coupling
The means by which an input signal is passed into a measurement channel. A channel can be AC coupled, DC coupled, or ground coupled. (See those definitions.)

Continuous Envelope Acquisition Mode
An acquisition mode in which the instrument continues to accumulate and display the positive and negative peak values of the signal until you press the **INIT** button.

Cycle
A complete, single unit of a periodic waveform.

DC Coupling
A means to pass both AC and DC frequency components of the input signal for display.

Deflection
The amount of movement of an indicating device, such as a meter needle or oscilloscope trace, due to some change in voltage, current, or resistance.

Display Sample Interval
The time interval between two points of the waveform on the screen.

Envelope Acquisition Mode

An acquisition mode in which the instrument displays the positive and negative peak values of the signal. An enveloped waveform shows the maximum and minimum variations in the signal.

Equivalent-Time Time-Base Mode

The time-base mode required to display a signal when the time base is fast—2 μs to 50 ns. In equivalent-time time-base mode, the instrument cannot 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.

External Trigger Source

A trigger source derived from a nondisplayable signal acquired through the external trigger input connector on the rear panel of the 222PS.

Ground Coupling

A means to connect a channel input to a ground reference.

Horizontal Axis

Usually, the axis along which an oscilloscope measures the timing of a signal. The exception to this is XY mode. (See definition below.) The timing of a signal is usually measured in seconds-per-division, or fractions of a second-per-division.

Inverted Waveform

A waveform that is flipped along its horizontal axis, so that it appears upside-down.

Major Division

One mark dividing the screen either horizontally or vertically for measurement purposes. The 222PS has eight major vertical divisions and ten major horizontal divisions.

Memory

The ability of the instrument to store data such as waveforms, front-panel settings, and configurations.

Menu

A list of choices that you can select in order to perform some action, such as placing the instrument in a specific mode, or enabling or disabling a specific feature.

Menu Button

One of four buttons alongside the right edge of the screen that can be associated with a menu item. Pressing a menu button performs the action associated with the item next to it.

Menu Item

One of four action choices printed at the right edge of the screen, alongside the menu buttons. Pressing the button next to the menu item performs the action represented by that item.

Minor Division

Subdivisions of major divisions for more accurate measurement. Minor divisions are seen as marks along the horizontal and vertical center lines. The 222PS has five minor divisions in each major division in both directions.

Normal Acquisition Mode

The most commonly used acquisition mode, in which the instrument displays one sample point for each point it acquires.

Normal Trigger Mode

A trigger mode in which the instrument does not acquire or display a waveform until a trigger occurs. The trigger source, level, and slope must be set appropriately.

Peak-to-Peak voltage (Vp-p)

The voltage between the positive and negative peaks of a sine wave.

Peak Voltage (Vp)

The voltage between the mean or average value and the peak of the sine wave of an alternating voltage.

Probe

A device that allows you to transfer an electrical signal from an external circuit into the oscilloscope.

Readout

Information, appearing on the screen, that is associated with a signal trace. Readouts can be numeric values such as the volts-per-division or symbols such as the kind of channel coupling.

Record Time-Base Mode

The time-base mode used for most time bases. When a trigger occurs, a record of the waveform is acquired and displayed.

RS-232

A communication interface that can be used to control the instrument and capture data remotely from a computer.

Sample

One point of the waveform. Waveforms on the 222PS are made up of 512 samples.

Sample Interval

See *acquisition sample interval* or *display sample interval*.

Sampling Rate

The number of times per second that the instrument samples the signal it is receiving.

Scrolling Time-Base Mode

The time-base mode used for slow time bases (20 s to 0.1 s or 50 ms) when the instrument is using autolevel or autobaseline trigger mode. In scrolling time-base mode, no trigger is accepted. The first sample appears at the left edge of the display; the display fills from left to right. After the display fills, new samples appear at the right edge and the old samples shift left one point at a time to accommodate the new samples. The oldest sample, the one at the leftmost edge of the screen, is erased. This gives the effect of the waveform continuously scrolling across the screen from right to left.

Scroll-Scan Time-Base Mode

The time-base mode used for slow time bases (20 s to 0.1 s or 50 ms) when the instrument is using normal or single-sequence trigger mode. In scroll-scan time-base mode, the display begins to fill from left to right until the trigger position is reached. The trigger system cannot accept a trigger until these pretrigger samples have all been acquired. When the pretrigger portion of the display is filled, a trigger can occur. Until a trigger occurs, however, new samples are continually acquired; they are added to the right side of the pretrigger portion of the display and scroll off the display to the left. When a trigger occurs, the post-trigger portion of the display starts to fill from the left to the right. When the entire display is filled, it is erased, and signal acquisition begins again.

Seconds per Division

The number of seconds, or fractions of a second, represented by each major division on the horizontal axis.

Selected Channel
The channel affected by changes to the front-panel controls. The readout associated with a selected channel appears boxed on the 222PS display.

Self-Calibration
A procedure which fine-tunes a system for increased accuracy. The 222PS provides self-calibration routines for both channels, the external trigger source, and display alignment.

Setup
A specific configuration of front- and top-panel control settings.

Sine wave
The graphic plot of voltage against time of the normal AC waveform; the most common signal form.

Single-Sequence Trigger Mode
A trigger mode in which the instrument acquires one triggered signal, displays it, and then holds it until you press the **INIT** button to restart the sequence.

Single-Shot
Single-sequence.

Single-Sweep
Single-sequence.

Store Mode
A mode in which the instrument continues to display waveforms between trigger events. When not in store mode, waveforms are displayed until the next trigger event, or until the next display update—about 30 ms. If a trigger has not occurred by the next display update, the display is blanked.

Time Base
The number of seconds per division.

Time-Base Mode
The mode required to display a signal, given the time-base of the instrument, and occasionally also depending on other factors such as trigger mode, acquisition mode, and whether the instrument is in store mode. Possible time-base modes are *record*, *equivalent-time*, *scroll*, and *scroll-scan*. (See those definitions.)

Time-Out Feature
A feature that shuts off the instrument after two minutes without changes to the controls, when the instrument is running under battery power. This feature prevents the battery from being discharged when the instrument is left unattended.

Trigger
The event that tells the oscilloscope to start acquiring and displaying a waveform.

Trigger Coupling
See *Channel Coupling*.

Trigger Level
The voltage threshold that a signal must cross in order for the instrument to trigger.

Trigger Light
A light on the 222PS front panel, labeled **TRIG'D**, that indicates when the instrument has acquired a trigger.

Trigger Mode
The way in which the instrument acquires a trigger. The 222PS has four trigger modes: normal, auto level, auto baseline, and single-sequence. (See those definitions.)

Trigger Slope
The parameter that determines whether the oscilloscope triggers as the voltage of the displayed signal is rising or falling.

Trigger Source
The signal that provides the trigger event. The trigger source can be a signal acquired through either channel or an external trigger.

Trigger Position
The location of the trigger event relative to the waveform on the display. When the 222PS is in store mode, the trigger position can be at the beginning, in the middle, or at the end of the waveform. This allows you to view the waveform data distributed around the trigger point in three ways.

Uncalibrated Channel
A channel manipulated with the variable volts-per-division (**VAR VOLTS**/**DIV**) knob. This knob allows you to scale a waveform vertically so that it takes up an arbitrary number of vertical divisions. However, after this manipulation, the exact number of volts-per-division for that signal is unknown.

Vertical Axis

The axis along which an oscilloscope measures the voltage of a signal, in volts per division or fractions of a volt per division.

Volt (V)

The unit of potential difference. One volt is the amount of voltage needed to cause one ampere of current to pass through one Ohm of resistance.

Volts per Division

The number of volts (or fractions of a volt) represented by each major division on the vertical axis, except in XY mode, where both axes represent volts per division.

XY Mode

A mode in which both the horizontal and the vertical axes of the instrument represent volts per division. The signal acquired through channel 1 is displayed on the *x* (horizontal) axis, and the signal acquired through channel 2 is displayed on the *y* (vertical) axis.

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