User Manual

Tektronix

2212
Digital Storage & Analog Oscilloscope

070-8438-00

Please check for CHANGE INFORMATION at the rear of this manual.

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INSTRUMENT SERIAL NUMBERS

Each instrument has a serial number on a panel insert, 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:

B000000	Tektronix, Inc., Beaverton, Oregon, U.S.A.
J300000	Sony / Tektronix, Japan
H700000	Tektronix Holland, N.V., Heerenveen, The Netherlands
HK00000	Tektronix, Inc., Hong Kong

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., J3 for Japan, HK for Hong Kong, IL for Israel, etc.).

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

Printed and produced in The Netherlands.

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Tektronix warrants that this product will be free from defects in materials and workmanship for a period of three (3) years from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

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 the service. Customer shall be responsible for packaging and shipping of 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 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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Certificate of the Manufacturer/Importer

We hereby certify that the ______________________

2212 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

Bescheinigung des Herstellers/Importeurs

Hiermit wird bescheinigt, daß der/die/das ______________

2212 OSCILLOSCOPE AND ALL INSTALLED OPTIONS

in Übereinstimmung mit den Bestimmungen der Ambtsblatt-Verfügung 1046/1984 funkentstört ist.

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

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NOTICE to the user/operator:

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

HINWEIS für den Benutzer/Betreiber:

Das Gerät darf in Meßaufstellung 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 2212 Oscilloscope and provides Safety information and Start-up information.

- Tutorial: *Measuring Signals* provides information and instructions to get you started making non-storage measuremens and storage measurements.

- *Measurement Examples*

- *At A Glance* describes the locations and purposes of the various function blocks on the front panel and the rear panel of the instrument.

- *In Detail* provides further detail on aspects of the 2212, building on the infomation contained in *At A Glance*. The topics of this chapter are:
  - General
  - The Display
  - Vertical Operation
  - Horizontal Operation
  - Trigger
  - Cursors
  - Storage
  - Setup
  - Making Hardcopies
  - Power
  - Interfaces
  - CRT Readout Display
  - Probes
  - Maintenance and Repair

- Appendix A: *Options & Accessories* describe the Options for the 2212 and the standard and optional accessories available for the 2212.
- Appendix B: *Specifications* provides complete specifications for the 2212 Digital Storage & Analog Oscilloscope.
- Appendix C: *Performance Verification* describes the procedures to verify that the 2212 is performing according to specifications.
- *Appendix D: Default Control Settings* provides a table with the frontpanel control settings at power up.
- *Appendix E: Glossary and Index* . The *Glossary* provides descriptions of expressions used in this manual, and the *ndex* helps you locate information quickly.

Related Documentation

Other documentation for the 2212 oscilloscope include:

- The 2212 Service Manual (Tektronix Part Number 070-8439-00) that provides information to maintain and service the 2212.
- The 2212 Quick Reference Tektronix Part Number 070-8592-00), standard with the 2212, to give you a quick overview of how to operate the 2212.
- The Programmers Manual (Tektronix Part Number 070-8440-01) that provides programming information for 2212 oscilloscopes with Option 10 (GPIB) and Option 12 (RS-232-C).

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Product Description

The Tektronix 2212 oscilloscope is a combination digital storage/analog (non-storage), dual-channel oscilloscope, with a microprocessor-based operating system controling most instrument functions.

This portable oscilloscope provides a Parallel Printer Communication Interface to communicate with Centronics ® compatible printers/plotters in Storage mode. A General Purpose Interface Bus (GPIB) and an RS-232-C interface are optional.

Instrument features include:

- DC to 60 MHz Analog (non-storage) bandwidth
- DC to 10 MHz digital (storage) bandwidth
- Auto Set-up
- Horizontal alternate magnifier
- CRT readout
- Cursor measurement display.
- Parallel Printer Communication Interface (Centronics ® compatible).
- RS-232-C Communication Control (optional).
- IEEE 488.2-1987 (GPIB) Communication Interface (optional).

If you need more information about your 2212 Oscilloscope or other Tektronix products, please contact your 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

Before you begin using your Tektronix 2212, please take a moment to review these safety precautions. We provide them for your protection and to prevent damage to the 2212 Oscilloscope. The general safety information is for both operating and servicing personnel.

WARNING

To avoid personal injury or damage to the 2212, do not apply more than 400V peak between probe tip and earth ground, between probe tip and probe common, or between probe common and earth ground.

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 live.

These two terms appear on equipment:

- *CAUTION* indicates a personal- injury hazard not immedi ately accessible as one reads the markings, or a hazard to property including the instrument itself.
- *DANGER* indicates a personal-injury hazard immediately as one reads the markings.

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 to the 2212 or to the equipment connected to it.

Power Source – Use the proper power source. This product is intended to operate from a power source that does not apply more than 250 V rms between the supply conductor or between either supply conductor and ground. A protective ground connection, by way of the grounding conductor in the power cord, is essential for safe operation.

Grounding the Product – This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before making any connections to the product input or output terminals. A protective ground connection by way of the ground conductor in the power cord, is essential for safe operation.

Danger Arising from Loss of Ground – Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulated) can render an electrical shock.

Use the Proper Power Cord – Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

Use the Proper Fuse – To avoid fire hazard, use only a fuse of the correct type, voltage rating and current rating specified on the back of your instrument and in the *Options and Accessories* section.

Do Not Operate in an Explosive Atmosphere – To avoid explosion, do not operate this instrument in an explosive atmosphere.

Do Not Remove Covers or Panels – To avoid personal injury, do not remove the instrument covers or panels. Do not operate the instrument without covers and panels properly installed.

Consignes de Securité

Ce rappel des consignes générales de secureté s'addresse à la fois aux utilisateurs et au personnel de maintenenance. Avertissements et précautions à respecter sont annotés au long de ce manuel à chaque fois que l'utilisation du 571 l'exige. Il est à noter que ceux-qui peuvent ne pas figurer dans cette rubrique de rappel.

Symboles et Termes dans ce manuel

- Les paragrahpes intitulés CAUTION (ATTENTION) identificient les circonstaces ou opérations pouvant entraîner la détérioration de l'appareil ou de tout autre équipment.
- Les paragraphes intitulés WARNING (AVERTISSEMENT) indiquent les circonstances dangereuses pour l'utilisateur (danger de mort ou risque de blessure).
-  Static-Sensitive Devices (Composants sensible à statique)

Termes reperères gravés sur l'appareil

- *CAUTION* (ATTENTION) : ce mot identifie les zones de risque non immédiatement perceptibles ou un risque éventuel de détérioration de l'appareil.
- *DANGER* (DANGER) : ce mot indique les zones de risque immédiat pouvant entraîner blessures ou mort.

Symboles gravés sur l'appareil

DANGER
Haute tension

Borne de masse
de protection (terre)

ATTENTION
se reporter au
manuel

Source d'alimentation – L'appareil est conçu pour fonctionner à partir d'une source d'alimentation maximale de 250 V efficace entre les conducteurs d'alimentation ou entre chaque conducteur et la terre. Pour utiliser l'appareil en toute sécurité, une connexion àl a masse, realisée au moyen d'un conducteur prévu dans le cordon d'alimentation, est indispensable.

Mise à la masse de l'appareil – Une fois installé dans le châssis d'alimentation, l'appareil est relié à la masse à l'aide d'un conducteur du cordon d'alimentation. Pour eviter tout choc électrique, insérer la prise du cordon d'alimentation dans une prise de distribution correspondante, avant de connecter l'entrée ou les sorties de l'appareil. Pour utiliser l'appareil en tout sécurité, une connexion à la masse, réalisée au moyen d'un conducteur prévu dans le cordon d'alimentation, est indispensable.

Danger provoqué par la coupure de connection de masse – En cas de coupure de la connexion de masse, tous les élements conducteurs accessible (y compris boutons et commandes apparissant isolants) peuvent provoquer un choc électrique.

Utuliser le cordon d'alimentation approprié – N'utiliser que le cordon d'alimentation et la prise recommandés pour votre appareil. Utiliser un cordon d'alimentationen parfait état.

Seul, un personnel qualifié peut procéder à un changement de cordon et prises.

Utiliser le fusible approprié – Pour éviter tout risque d'accident (incendie...) n'utiliser que le fusible recommandée pour votre apppareil. Le fusible remplacement doit toujours correspondre au fusible remplacée: même type, même tension et même courant. Un remplacement de fusible ne doit être effetué que par personnel qualifié.

Ne pas utiliser l'appareil en atmosphères explosives – Pour éviter toute explosion, ne pas utiliser cet appareil dans un atmosphère de gaz explosifs.

Ne pas demonter les capots ou les panneaux – Pour éviter toute blessure, ne pas ôter les capots ou les panneaux. N'utiliser l'appareil que si ceux-ci ont été correctivement remis en place.

Preparation for Use

Before you use the 2212 Oscilloscope, refer to the Safety part of this chapter for power source, grounding, and other safety considerations pertaining to the use of the instrument.

Installation

- **Step 1**: Check that you have the proper electrical connections. The 2212 oscilloscope operates from a nominal ac-power line between 95 V and 128 V rms or 190V to 250 V rms, depending on the power range setting inside the instrument, as ordered with the 2212, with any frequency from 48 Hz to 440 Hz.
- **Step 2**: Connect the proper power cord from the rear-panel power connector to the power system.
- **Step 3**: Check the fuse (located on the rear panel), to be sure it is of the proper type and rating.
  Use the following procedure to check that the proper fuse is installed or to install a replacement fuse.

  Step 1. Unplug the power cord from the power-input source

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

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

  Step 4. Verify that the installed fuse is the same type and rating as that listed on the back of the instrument.

  Step 5. Put the fuse (or replacement fuse) back in the fuse holder cap.

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

CAUTION

This instrument can be damaged if the wrong line fuse is installed.

- **Step 4:** Be sure you have the appropriate operating environment. Specifications for temperature, relative humidity, altitude, vibrations and emissions are included in the *Specifications* chapter.

- **Step 5:** Leave space around the instrument for cooling. Maintain adequate airflow to prevent instrument damage from internally generated heat. Before turning on the power, verify that the spaces around the air-intake holes on the bottom, sides, top, and rear cabinet are free of any obstruction to airflow.

- **Step 6**: Turn on your oscilloscope by pressing in the POWER button. Observe that the POWER-ON indicator, located above the button, comes on. After a few seconds a trace appears on the CRT screen, and the instrument is ready to make measurements.

Initial Setup

This tutorial get you started making measurements both in Non-Store and in Store mode, using the capabilities of the 2212 oscilloscope. The following will be discussed in separate chapters:

- Initial Setup
- Making Non-Store (Analog) Displays with the 2212
- Making Store (Digital) Displays with the 2212

Initial Setup

The following procedure will allow you to set up and operate the instrument to obtain the most commonly used oscilloscope displays.

Step 1. Verify that the POWER switch is OFF (switch is in the OUT position).

Step 2. Plug the power cord into the ac power outlet.

Step 3. Press in the POWER switch (ON) and let the instrument warm up
(20 minutes is recommended for best accuracy).

Step 4. Press the AUTO Setup button to obtain a **Baseline Display** with the following front panel setup:

Display

INTENSITY	Desired brightness
FOCUS	Best trace definition
Readout	ON with desired brightness

Vertical (CH 1 and CH 2)

Vertical MODE	CH 1
POSITION	Midrange
VOLTS/DIV	10 mV
AC-GND-DC	DC
VARiable VOLTS/DIV	Calibrated
BW Limit	Off

Horizontal

SEC/DIV	0.2 ms
VARiable SEC/DIV	Calibrated
POSITION	Midrange
Magnifier	X1
ALTernate MAGNifier	Off

Trigger

HOLDOFF	MIN
SOURCE	CH 1
MODE	P-P AUTO
LEVEL	For a suitable display (with signal applied)
SLOPE	Positive going
COUPLING	DC

Cursor

Cursor ON/OFF	ON
Cursor Type	ΔV1
POSITION	Midrange

Storage

STORE ON/OFF	OFF

Probe Compensation
Low-Frequency Compensation

Misadjustment of probe compensation is a possible source of measurement error. The attenuator probes are equiped with compensation adjustments. For the best measurement accuracy, you check probe compensation before making measurements (see Figure 2-1).
Use the following procedure to check and compensate the probes.

Step 1. Switch the instrument on and obtain a baseline trace.

Step 2. Connect the two supplied 10X probes to the CH 1 OR X and CH 2 OR Y input connectors.

Step 3. Connect the probe tips to the PROBE ADJUST connector and the probe ground leads to scope ground.

Step 4. Press the AUTO SETUP button.

Step 5. Set:

Vertical MODE .... CH 1
CH 1 VOLTS/DIV .... 0.1 V
CH 2 VOLTS/DIV .... 0.1 V

Step 6. Vertically center the PROBE ADJUST square wave signal. If necessary, adjust the Trigger LEVEL control to obtain a stable display on the positive SLOPE.

Step 7. Check the square-wave display for overshoot and rolloff (see Figure 2-1). If necessary, use a small-bladed screwdriver or alignment tool to adjust the compensation on the probe for a square front corner on the square wave displayed.

Step 8. Select the CH 2 Vertical MODE to turn CH 2 on in the display.

Step 9. Repeat step 6 and 7 for the probe on the CH 2 input connector.

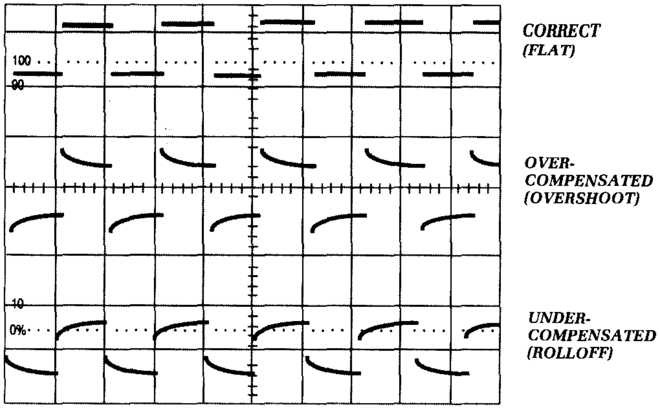


Figure 2-1: Probe Compensation

NOTE

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

Non-Store Displays

This chapter intends to help you make Non-Store (Analog) measurements, using the capabilities of the 2212 oscilloscope in the Non-Store mode. The following procedures explain how to set up and use the Non-Store (Analog) capabilities of the 2212:

- Normal Sweep Display.
- Magnified Sweep Display.
- Alternate Magnified Sweep Display.
- X-Y Display.
- Single Sweep Display.

Normal Sweep Display

With the 2212 in the normal (continuous) mode, you can use the following procedure to display the sweep:

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Using a 10X probe or a properly terminated coaxial cable, apply a signal to the CH1 OR X input connector. The signal source output impedance determines the termination impedance required when using a coaxial cable to interconnect test equipment.

NOTE

Instrument warm-up time required to meet all specification accuracies is 20 minutes.

Step 3. If the display is not visible with the INTENSITY control at midrange, you can :

- Press the BEAMFIND button and hold it in while adjusting the CH 1 VOLTS/DIV switch to reduce the vertical display size. Center the compressed display using the Vertical and Horizontal POSITION controls. Release the BEAM FIND button.
- Press the AUTO SETUP button, which automatically sets the vertical, horizontal, triggering and display to produce a usable, stable, triggered display.

Step 4. Set the CH1 VOLTS/DIV switch and adjust the Vertical and Horizontal POSITION controls to locate the display in the graticule area.

Step 5. Adjust the Trigger LEVEL control for a stable, triggered display.

Step 6. Set the SEC/DIV switch for the desired number of cycles of displayed signal. Then adjust the FOCUS control for the best defined display.

NOTE

Amplitude measurements are usually made with many complete cycles displayed. Period time, rise time and fall time measurements are made at the fastest sweep speed that allows only the area of measurement to be seen on screen.

Magnified Sweep Display

With the 2212 in the normal (continuous) mode, you can use the following procedure to display the signal in the X10 or X50 Horizontal Magnifier position:

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Set the SEC/DIV switch for a sweep speed that permits the area you want to magnify to be displayed.

Step 3. Adjust the Horizontal POSITION control for precise positioning of the area to be magnified to the center crt graticule division.
The actual magnified portion on either side of the center graticule line is equal to +/– 0.5 division in X10 Magnify and +/–0.1 division in the X50 Magnify. You may change the SEC/DIV switch setting as required.

Step 4. Set the Horizontal Magnify switch to the X10 or the X50 position.

Step 5. The magnified sweep rate is displayed in the crt readout.

Alternating Magnified Sweep Display

With the 2212 in the normal (continuous) mode, you can use the following procedure to display the unmagnified sweep and the magnified sweep on the crt sreen alternately.

Step 1. Preset the instrument as stated in Magnified Sweep Display.

Step 2. Toggle the the Alternate Magnify (ALT MAGN) switch to on (the ALT MAG LED lights).

Step 3. Adjust the CH1 POSTION control (and/or CH2 POSITION, if selected) and the Trace SEParation control as required to display the unmagnified and the magnified sweeps.

Step 4. The unmagnified sweep rate is displayed in the crt readout.

X-Y Display

You can use the following procedure to display signals with the 2212 osciloscope in the X-Y Non-Store mode:

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Rotate the INTENSITY control fully counterclockwise.

Step 3. Apply the vertical signal (Y-axis) to the CH 2 OR Y input connector. Apply the horizontal signal (X-axis) to the CH1 OR X input connector.

Step 4. Toggle the vertical MODE switch to X-Y.

Step 5. Increase the INTENSITY until the display is visible.

If the display is not visible with the INTENSITY control at midrange, press and hold in the BEAM FIND button while adjusting the CH 1 and CH 2 VOLTS/DIV switches until the display is reduced in size, both vertically and horizontally. With the BEAM FIND button still pressed in, center the compressed display with the POSITION controls (CH 2 POSITION control for vertical movement; Horizontal POSITION control for horizontal movement). Release the BEAM FIND button and adjust the FOCUS control for a well-defined display.

NOTE

The display obtained when sinusoidal signals are applied to the X- and Y-axis is called a Lissajous figure. This display is commonly used to compare the frequency and phase relationship of two input signals. The frequency relationship of the two input signals determines the pattern seen. The pattern will be stable only if a common divisor exists between the two frequencies.

Single Sweep Display

You can use the following procedure to display a single sweep in the SGL SWEEP trigger mode:

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Apply a test signal to the CH 1 OR X input to be used for setting the trigger LEVEL control.

For random signals, set the Trigger LEVEL control to trigger the sweep on a signal that is approximately the same amplitude as the random signal.

Step 3. Set the CH1 VOLTS/DIV switch and adjust the Vertical POSITION control to display the waveform correctly within the graticule area.
The Horizontal POSITION control should be adjusted to place the start of the sweep about one division from the left edge of the crt.

Step 4. Toggle the Trigger MODE to NORM and adjust the Trigger LEVEL control carefully until the display is stable.

Step 5. Toggle the Trigger MODE to SGL SWP and check that the sweep triggers when the RESET button is pressed.

If it does not trigger, readjust the Trigger LEVEL control slightly so that the sweep triggers each time the RESET button is pressed.

If no trigger signal is present, and the RESET button is pressed, the READY indicator LED should illuminate to indicate that the sweep generator circuit is set and ready to initiate a sweep when a trigger is received.

Step 6. When the single sweep has been triggered and the sweep is completed, the sweep logic circuit is locked out. Another sweep cannot be generated until the SGL SWP RESET button is pressed again to set the sweep to the READY state.

Step 7. Disconnect the test signal from the CH1 or X input, apply the random signal to the CH1 OR X input and press the RESET button to set the sweep to the READY state.

Step 8. When the random trigger pulse occurs, a sweep will be started and one single sweep will be displayed.

Step 9. When the single sweep has been triggered and completed, another sweep cannot be started until the RESET button is pressed again to rearm the sweep circuit.

Digital Storage Displays

This chapter intends to help you make Digital Storage measurements in Store mode.

- Store Mode Display
- HOLD Mode Display
- SAVE / RECALL Mode Display
- Single Sweep Mode Display
- X-Y Store Mode Display
- Aliases in Store Mode

Store Mode Display

You set the conditions under which a waveform is acquired for display with the front-panel control selections. Remember that:

- The display amplitude is controlled by the VOLTS/DIV switches.
- The storage time base is controlled by the SEC/DIV switch.

RECORD Mode – The SEC/DIV switch will acquire and display waveforms in RECORD mode from 50 ms/division to 20 μs/division. A full record of the acquired waveform is updated each time a trigger event is recognized.

ROLL Mode – The SEC/DIV switch will display and acquire waveforms in ROLL mode from 50 s/division to 0.1 s/division. Signals are continously acquired and displayed. Triggers are disabled in ROLL mode, except in SGL SWP.

In RECORD and ROLL digital store mode (no SGL SWEEP), you can use the following procedure to display your signal:

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Set the Store ON switch to the on state.

Step 3. Apply the signal to be displayed to the CH 1 OR X input connector.

Step 4. Set the PRETRIGger switch to either 25% or 75% as needed for your measurement. Adjust the Trigger LEVEL for a stable display.

Step 5. Store mode displays can be expanded horizontally with the Horizontal X1, X10, X50 magnify switch.

HOLD Mode Display

Prior to making measurements on the acquired waveform, you may toggle the HOLD ON/OFF switch to the ON position, holding the acquired waveform and providing a more stable display for measurement. You can use the following procedure to stop the acquisition using the HOLD mode:

Step 1. Acquire a waveform using the Store Mode Display procedure.

Step 2. Pressing the HOLD button while in RECORD mode, causes the current display to be stopped immediately, and the display is not updated.

Step 3. When you press the HOLD button again while in RECORD mode, you exit the HOLD mode and the acquisition is restarted.

Step 4. Pressing the HOLD button while in ROLL mode, causes the current acquisition to be stopped immediately.

Step 5. When you press the HOLD button again while in ROLL mode, you exit the HOLD mode and the acquisition continues where it was stopped.

Step 6. "HOLD" appears in the acquisition status field in the crt readout when the HOLD button is pressed.

SAVE / RECALL Reference Display

You can use the following procedure to save a displayed waveform in memory using the SAVE mode, and recall a stored waveform from that memory using the RECALL mode:

Step 1. Acquire the waveform to be used as a reference waveform by using the previous Store Mode Display procedure.

Step 2. Press the SAVE button to store the displayed waveform in the reference memory.

A new reference waveform is saved each time the SAVE button is pressed, and the existing reference waveform is replaced.

Step 3. When you press the RECALL switch you recall and display the stored reference waveform on the crt, together with the waveform already displayed.

The reference waveform remains stored in memory when you switch to Non-Store mode. You may recall it at any time the Store mode is active. The reference waveform is not saved when the oscilloscope is turned off.

Step 4. The Reference Position control (= TRace SEParation control) can be used to position the reference display vertically. It may be positioned below the level of the signal it was copied from.

The vertical POSITION controls do not affect the position of the reference display after it is saved, but they do set the base level of the reference at the time it is copied.

Step 5. The Reference display can be expanded horizontally along with the active acquisition display when the Horizontal X1, X10, X50 magnify switch is changed to the X10 or X50 position.

Single Sweep Display

The 2212 single sweep store mode may be operated in the RECORD mode or the ROLL mode. (RECORD mode from 50 ms/division to 20 μs/division, and ROLL mode from 50 s/division to 0.1 s/division.)

NOTE

With the 2212 in ROLL mode, triggers are disabled, but not in SGL SWEEP.

SGL Sweep Record Mode

With the 2212 is in the SGL Sweep Record mode, the last waveform acquired remains displayed. When you press the RESET button, you rearm the trigger circuit to accept a new trigger event. When that trigger event occurs, the full record is acquired and the display is updated.

When the 2212 is in the SGL Sweep Record mode, theVertical MODE in ALT and the Triggger SOURCE in VERT MODE, the triggered channel behaves as just described. The non-triggered channel is not updated. When you press the RESET button again, the second channel is updated.

For SGL Sweep Record mode, you can use the following procedure:

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Set the Store ON switch to the on state.

Step 3. Set the PRETRIGger switch to either 25% or 75% as needed for your measurement.

Step 4. Apply a test signal to the CH 1 OR X input for setting the trigger LEVEL control.

NOTE

For random signals, set the Trigger LEVEL control to trigger the sweep on a signal that is approximately the same amplitude as the random signal.

Step 5. Set the CH1 VOLTS/DIV switch and adjust the Vertical POSITION control to display the waveform correctly within the graticule area.

The Horizontal POSITION control should be adjusted to place the start of the display about one division from the left edge of the crt.

Step 6. Set the Trigger MODE to NORM and adjust the Trigger LEVEL control carefully until the display is stable.

Step 7. Toggle the Trigger MODE to SGL SWP and check that the display is updated when the RESET button is pressed.

If it does not trigger, readjust the Trigger LEVEL control slightly so that the display is updated each time the RESET button is pressed.

If no trigger signal is present, and the RESET button is pressed, the READY indicator LED should illuminate to indicate that the trigger circuit is set and ready to update the display when a trigger is received.

Step 8. When the acquisition system has been triggered and the display is updated, the sweep logic circuit is locked out. Another acquisition cannot be generated until the SGL SWP RESET button is pressed again to set the sweep to the READY state.

Step 9. Disconnect the test signal from the CH1 or X input and apply the random signal to the CH 1 OR X input and press the RESET button to set the acquisition system to the READY state.

Step 10. When the random trigger pulse occurs, the acquisition will be started, and one single acquisition will be displayed on the crt screen. Until the trigger event occurs, the READY light will be on to show that the oscilloscope is armed and ready to start the acquisition when the trigger occurs.

Step 11. When the single sweep has been triggered and completed, another acquisition cannot be started until the RESET button is pressed again to rearm the acquisition circuit.

SGL Sweep Roll Mode

In SGL Sweep Roll mode, the 2212 display continues to roll although the trigger circuit is not armed. Press the RESET button to arm the trigger circuit. The display continues to roll, until the pretrigger portion of the waveform RECORD is filled. The READY LED starts to light and the trigger point indicator (intensified dot) appears on the waveform. The storage acquisition system now is ready to accept a trigger event. When that trigger event occurs, filling the remaining portion of the RECORD begins and the display continues to roll. When the remaining portion of the RECORD is filled, the READY LED dims and the display will be updated.

The time needed to fill the pretrigger and posttrigger portions of the RECORD depends on :

- The sampling rate
- Seting of the PRE-TRIG 25%/75% switch.
  Until a trigger occurs, the pretrigger data is continually updated, but the RECORD display is not updated until a complete new waveform is acquired.

With the 2212 in SGL Sweep Roll mode, the Vertical MODE is set to ALT and Triggger SOURCE in VERT MODE, the triggered channel behaves as just described. The non-triggered channel is blanked. When you press the RESET button again, the second channel is updated. For SGL Sweep Roll mode, you can use the following procedure:

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Set the Store ON switch to the on state.

Step 3. Set the PRETRIGger switch to either 25% or 75% as needed for your measurement.

Step 4. Apply a test signal to the CH 1 OR X input to be used for setting the trigger LEVEL control.

For random signals, set the Trigger LEVEL control to trigger the sweep on a signal that is approximately the same amplitude as the random signal.

Step 5. Set the CH1 VOLTS/DIV switch and adjust the Vertical POSITION control to display the waveform correctly within the graticule area.

The Horizontal POSITION control should be adjusted so that the start of the display is about one division from the left edge of the crt.

Step 6. Set the Trigger MODE to NORM and adjust the Trigger LEVEL control carefully until the display is stable.

Step 7. Toggle the Trigger MODE to SGL SWP and check that the display is updated when the RESET button is pressed.

If it does not trigger, readjust the Trigger LEVEL control slightly so that the display is updated each time the RESET button is pressed.

If no trigger signal is present, and the RESET button is pressed, the READY indicator LED should illuminate to indicate that the trigger circuit is set and ready to update the display when a trigger is received.

Step 8. When the single sweep has been triggered and the display is updated, the sweep logic circuit is locked out. Another acquisition cannot be generated until the RESET button is pressed again to set the acquisition system to the READY state.

Step 9. Disconnect the test signal from the CH1 or X input, apply the random signal to the CH 1 OR X input and press the RESET button to set the acquisition system to the READY state.

Step 10. The trace starts rolling on from the right to the left of the screen. Until the trigger event occurs, the READY light will be on to show that the oscilloscope is armed and ready to start the acquisition when the trigger occurs.

When (after the pretrig time) the random trigger pulse occurs, the acquisition will be started, and one single acquisition will be displayed on the crt screen.

Step 11. When the single sweep has been triggered and completed, another acquisition cannot be started until the RESET button is pressed again to rearm the acquisition circuit.

X-Y Display (Storage Mode)

For X-Y displays in Store mode, you can use the following procedure:

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Rotate the INTENSITY control fully counterclockwise.

Step 3. Set the STORAGE ON/Off switch to ON.

Step 4. Using two coaxial cables or probes of equal delay, apply the vertical signal (Y-axis) to the CH 2 OR Y input connector and the horizontal signal (X-axis) to the CH1 OR X input connector.

Step 5. Toggle the vertical MODE switch to X-Y.

Step 6. With the SEC/DIV switch you set the sample rate for your signal. If the SEC/DIV is in one of the two EXT CLOCK positions, the sample rate is determined by the CLOCK frequency.

Step 7. Increase the INTENSITY until the display is visible.

If the display can not be made visible with the INTENSITY control at midrange, press and hold in the BEAM FIND button while adjusting the CH 1 and CH 2 VOLTS/DIV switches until the display is reduced in size, both vertically and horizontally. With the BEAM FIND button still pressed in, center the compressed display with the POSITION controls (CH 2 POSITION control for vertical movement. Horizontal POSITION control for horizontal movement). Release the BEAM FIND button and adjust the FOCUS control for a well-defined display.

NOTE

In X-Y Store Mode, ΔT/ 1/ΔT Cursors can be selected as well.

Observing Aliases in Store MODE

Aliasing

Aliasing occurs when the highest frequency component of the input signal is greater than half the current sample rate. The oscillocope cannot acquire the signal fast enough to construct an accurate waveform record. Figure 2-2 illustrates this by showing a slower aliased waveform on top of the actual input waveform.

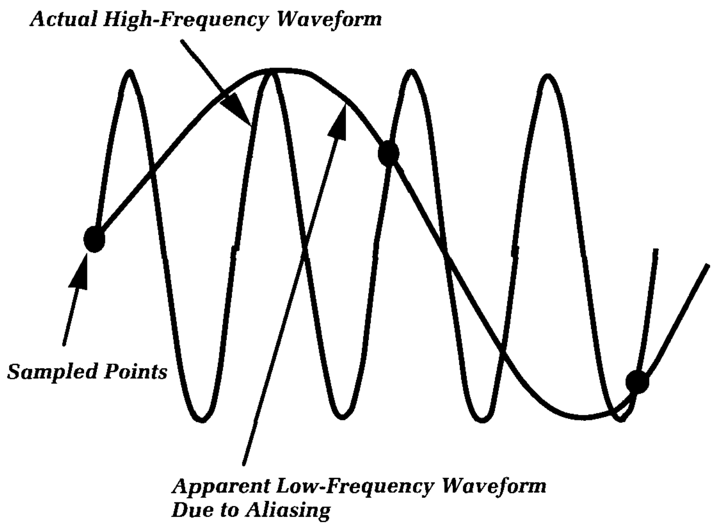


Figure 2-2: Aliasing

In digital sampling, a more accurate reproduction of a signal is possible when more samples of the signal are obtained. The instrument samples 4000 times across the 10 horizontal divisions of the graticule. This means that a sine wave spread across the full screen will be sampled 4000 times.

If the sine wave is only one graticule division in width, it will be sampled one-tenth as many times (400 samples). This number is still adequate for accurate reproduction of the stored waveform.

If the SEC/DIV switch is set so that the entire sine-wave period fills one-tenth of a graticule division, it will be sampled only 40 times during its acquisition. This means that only 40 samples of the waveform will be available to reproduce the waveform for display. In theory, if a sine wave is sampled at least two times during its period, it may be accurately reproduced. In practice, the sine wave can be reconstructed, using special filters, from slightly more than two samples.

At 20 μs per division, and a horizontal magnification of X10, a signal of 2 MHz will be sampled 10 times during the sinewave period. Consequently the waveform will be accurately reproduced within 95 % of its true amplitude. This is the accuracy required for useful storage bandwidth.

If the input frequency is increased beyond 8 MHz, the samples will soon become less than two times per period. This occurs at 10 MHz for a 20 MHz sample rate. Past this point, information sampled from two different sine-wave periods will be used to reconstruct the displayed waveform. This waveform will not be a correct reproduction of the input signal. At certain input frequencies, the data sampled will reproduce what appears to be a correct display, when in fact it is only related to the input signal by some multiple or part of a multiple of the input signal. This type of display is one type of "alias" (see Figure 2-2).

The sampling rate is controlled by the SEC/DIV switch, and it decreases when the SEC/DIV switch is set to slower settings. Whenever the SEC/DIV switch is set so that the input signal is sampled less than 10 times per period of the fastest frequency component, observable aliases will occur.

Anti-Aliasing

In the event that an alias is suspected, two things may be done to determine whether the display is of an alias.

- The first is to switch back to NON-Store mode to determine if the input signal is higher in frequency than the apparent signal being displayed. Ensure that this display is being triggered (TRIG'D LED on).

- The second possibility is to set the SEC/DIV switch to a faster sweep rate so that the number of samples per cycle of the input signal is increased. The maximum digital sweep speed available on the 2212 for Store mode is 20 μs per division.

Non-Storage Measurement Examples

The following measurement examples will enable you to perform basic measurements and to become familiar with the conventional oscilloscope capabilities of the 2212.

- AC Peak-to-Peak Voltage Measurement
- Voltage Ratio Measurement
- Algebraic Addition Measurement
- Common-Mode Rejection Measurement
- Rise-Time Measurement
- Frequency Measurement
- Time-Difference Measurement
- Time Ratio Measurement
- Phase-Difference Measurement
- Small-Angle Phase-Difference Measurement
- Percent Modulation Measurement
- TV-Line Signal Measurement
- TV-Field Signal Measurement

AC Peak-to-Peak Voltage Measurement

To make a peak-to-peak voltage measurement, see Figure 3–1, and use the following procedure:

NOTE
This procedure may also be used to make voltage measurements between any two points on a waveform.

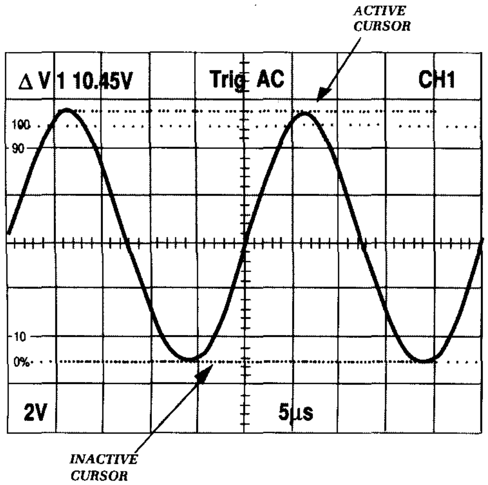


Figure 3-1: Peak-to-Peak Voltage Waveform Measurement

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Apply the AC signal to be measured to either vertical-channel input connector and set the Vertical MODE to display the channel used.

Step 3. Set the VOLTS/DIV switch to display about five divisions of the waveform. Make sure the VOLTS/DIV is in the calibrated position.

Step 4. Adjust the Trigger LEVEL control to obtain a stable display.

Step 5. Adjust the SEC/DIV switch to display several cycles of the waveform.

Step 6. Set the CURSOR ON/Off switch to ON.

Step 7. Toggle the ΔV1,ΔV2, ΔT,1/ΔT switch to ΔV1 or ΔV2 (depending on the vertical channel selected). Two horizontal cursors appear on the screen.

Step 8. With the TOGGLE CURSOR in Track mode, position the inactive cursor to the bottom of the waveform using the Cursor POSITION control. Set the TOGGLE CURSOR switch to the Delta cursor mode and position the active cursor to the top of the waveform, using the Cursor Position control.

Step 9. Read the voltage difference between the two cursors from the crt readout, or calculate the peak-to-peak voltage using the following formula:

$$\text{Volts (P-P)} = \begin{matrix}\text{Vertical}\\ \text{deflection}\\ \text{(Divisions)}\end{matrix} \times \begin{matrix}\text{VOLTS/DIV}\\ \text{switch}\\ \text{setting}\end{matrix} \times \begin{matrix}\text{Probe}\\ \text{attenuation}\\ \text{factor}\end{matrix}$$

Voltage Ratio Measurement

You can also use the Delta Volts (ΔV1 and ΔV2) function to measure and compute the RATIO, in terms of percent, between two different signal voltage levels (see Figure 3-2).

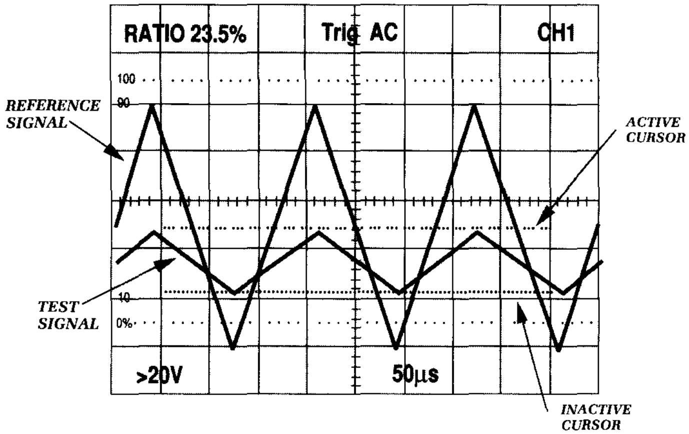


Figure 3-2: Voltage Ratios

To measure a voltage ratio in the situation of two separate signals, use the following procedure:

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Apply the signal to be referenced to, to either the CH1 OR X or CH 2 OR Y input connector and toggle the Vertical MODE switch to display the channel used.

Step 3. Set the appropriate VOLTS/DIV switch to display more than five divisions of the waveform.

Step 4. Adjust the Trigger LEVEL to obtain a stable display.

Step 5. Adjust the VARiable VOLTS/DIV control so that the reference waveform is exactly five divisions peak-to-peak.

Step 6. Set Cursors ON/OFF switch to ON.

Step 7. Toggle the ΔV1/ΔV2/ΔT/1/ΔT switch to the ΔV1 position. Observe that two horizontal cursors appear on the crt screen.

Step 8. Place one cursor at the top and one at the bottom of the reference waveform using the Cursor POSITION and the TOGGLE CURSOR control. The cursors must be exactly five divisions apart ("Ratio 100%" will appear in the crt readout).

Step 9. Remove the reference signal and apply the signal to be measured to the same input connector. DO NOT change the VOLTS/DIV or VARiable VOLTS/DIV setting.

Step 10. Align one cursor with the top of the waveform and the other cursor with the bottom of the waveform (see Figure 4-2).

Step 11. You can read the RATIO between the test signal and the reference signal on the crt readout.

Algebraic Addition Measurement

Toggle the Vertical MODE to ADD. The waveform displayed represents the algebraic sum of the signals applied to the CH1 OR X and CH2 OR Y input connectors (CH1 + CH2).

If the CH 2 INVert switch is in the INVert position, the resulting waveform is the difference of the two input signals (CH1– CH2). The total deflection factor in ADD mode is equal to the deflection factor indicated by either VOLTS/DIV switch when both VOLTS/DIV switches are set to the same setting.

In the ADD mode, you can also provide a dc offset for viewing an ac signal riding on top of a dc level.

The following general precautions should be observed when using the ADD mode:

1. Do not exceed the input voltage rating of the oscilloscope.
2. Do not apply signals that exceed the equivalent of about eight times the VOLTS/DIV switch setting, since large voltages may distort the display. For example, with a VOLTS/DIV switch setting of 0.5 V, the voltage applied to the input channel should not exceed 4 V.

Example:

Suppose the graticule center line as 0 V, and the CH 1 signal is at a two-division, positive dc level (see Figure3-3A).

a. Two divisions X VOLTS/DIV switch setting = DC-level value.

b. Apply a negative dc level to the CH 2 OR Y connector (or a positive level, using the CH 2 INVERT switch) of the value as determined in step a. (see Figure 3-3B).

c. Toggle the Vertical MODE switch to ADD and place the resulting display within the operating range of the Vertical POSITION controls (see Figure 3-3C).

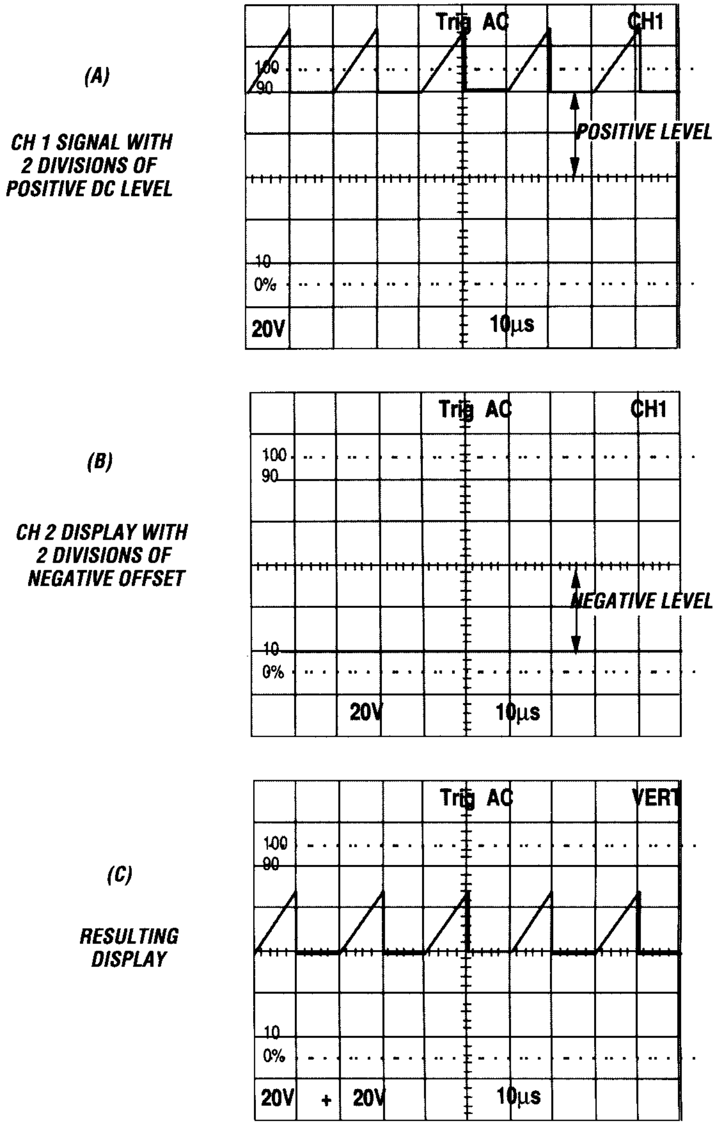


Figure 3-3: Algebraic Addition of a dc + ac Signal

Common-Mode Rejection Measurement

The ADD mode can also be used to display signals which contain undesirable frequency components. The undesirable components can be eliminated through common-mode rejection. Observe the precautions given under the preceding Algebraic Addition procedure.

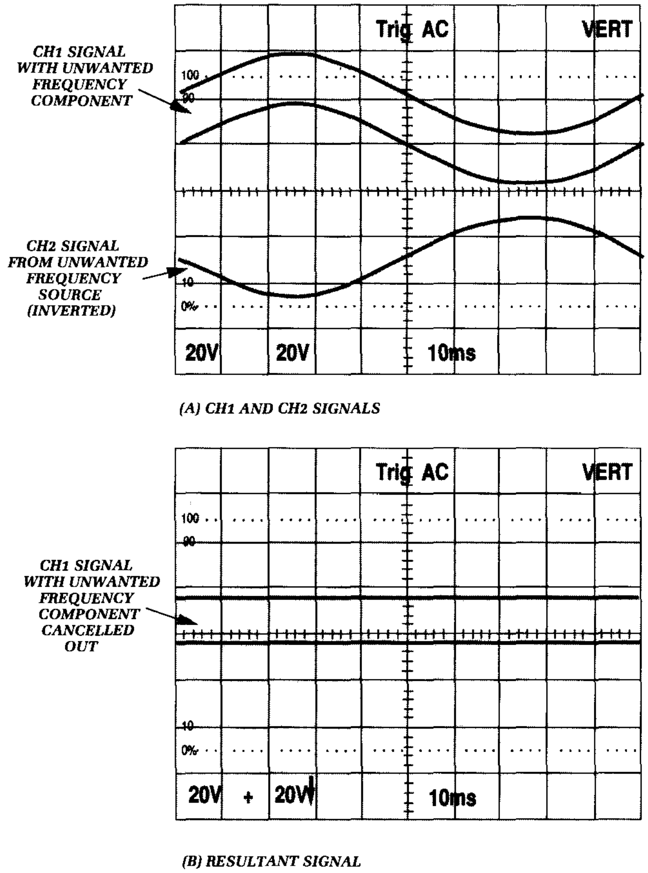


Figure 3-4: Common Mode Rejection Measurement

Example:

The signal applied to the CH1 OR X input connector contains unwanted frequency components (see Figure 3-4A). If you want to remove the undesired frequency components, you can use the following procedure:

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Apply the signal with the unwanted frequency components to the CH1 OR X input connector.

Step 3. Apply the unwanted signal to the CH 2 OR Y input.

Step 4. Toggle the Vertical MODE switch to ALT and set the CH 2 INVert switch to INVert.

Step 5. Adjust the CH 2 VOLTS/DIV switch and VARiable control to make the CH 2 display approximately the same amplitude as the undesired portion of the CH 1 display (see Figure 3-4A).

Step 6. Toggle the Vertical MODE switch to ADD and slightly readjust the CH 2 VARiable control for maximum cancellation of the undesired signal component (see Figure 3-4B).

Rise Time Measurement

A rise time measurement is the time duration measurement that is made between the 10% and 90% points on the leading edge of a waveform (see Figure 3-5). The fall time is measured between 90% and 10% points on the trailing edge of a waveform.

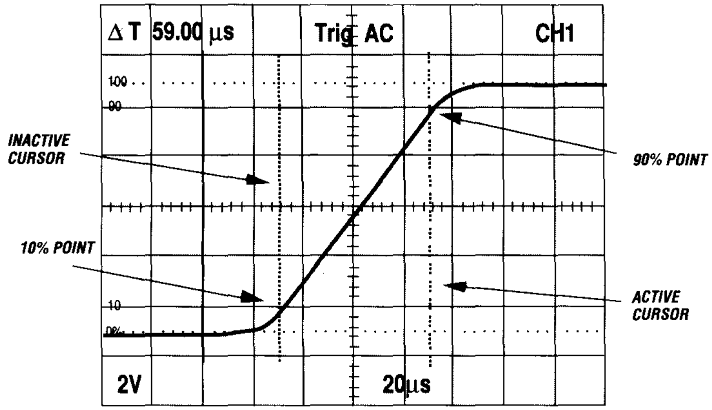


Figure 3-5: Rise Time Measurement

To measure the rise time of a waveform, you can use the following procedure:

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Apply a signal with an amplitude of exact five-divisions to either vertical channel input connector and set the Vertical MODE to display the channel used.

Step 3. Adjust the Trigger LEVEL control to obtain a stable display.

Step 4. Use the POSITION control to set the zero reference of the waveform to the 0 % graticule line and the top of the waveform to the 100 % graticule line.

NOTE
Make sure that the VOLTS/DIV control is in the calibrated position with signals that have a rise time of less than 0.5 μs.

Step 5. Set Cursors ON/Off switch to ON. Toggle the ΔV1/ΔV2/ΔT/1/ΔT switch to the ΔT position. Observe that two vertical cursors appear on the crt screen.

Step 6. Position the cursors to the 10% and 90% points of the waveform, using the Cursor POSITION control and the TOGGLE CURSOR switch.

Step 7. You can read the time difference (rise time) between the two cursors from the crt readout.

Frequency Measurement

The frequency of a recurrent signal can be measured using the following procedure (see Figure 3-6):

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

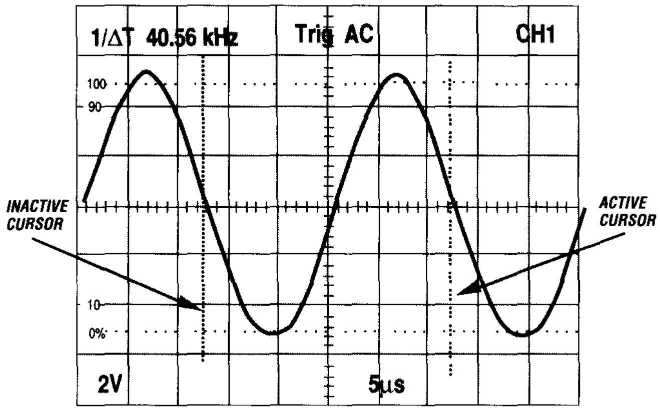


Figure 3-6: Frequency Measurement

Step 2. Apply the signal to either vertical channel input connector and toggle the Vertical MODE switch to display the channel used.

Step 3. Adjust the Trigger LEVEL control to obtain a stable display.

Step 4. Set the SEC/DIV control to display at least one complete period of the waveform. Make sure that the SEC/DIV control is in the calibrated position.

Step 5. Set the Cursors ON/Off switch to ON.

Step 6. Toggle the ΔV1/ΔV2/ΔT/1/ΔT switch to the 1/ΔT position. Observe that two vertical cursors appear on the crt.

Step 7. Position the cursors to the zero-crossing points of the waveform using the Cursor POSITION control and the TOGGLE CURSOR switch (see Figure 3-6).

Step 8. You can read the frequency of the waveform from the crt readout display.

Time Difference Measurement
Between Two Time-Related Pulses

The calibrated sweep speed and dual-trace features of the instrument allow measurement of the time difference between two separate events. To obtain a reliable measurement result, use either probes or cables with equal time delays. You can use the following procedure to measure time difference (see Figure 3-7):

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

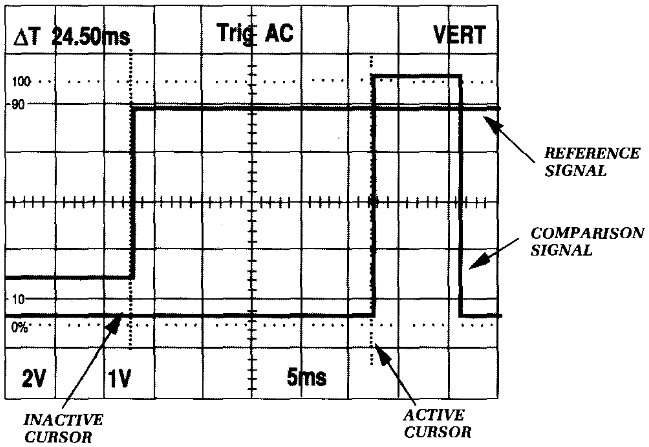


Figure 3-7: Time Difference Measurement between two Time-related Pulses

Step 2. Toggle the Trigger SOURCE switch to CH 1.

Step 3. Set both AC-GND-DC switches to the same position, depending on the type of input coupling desired (AC or DC).

Step 4. Connect the reference signal to the CH 1 OR X input and the comparison signal to the CH 2 OR Y input.

Step 5. Toggle the Vertical MODE switch to either ALT or CHOP mode, depending on the frequency of the input signals.

Step 6. Set both VOLTS/DIV switches for a 4- or 5-division display.

Step 7. Adjust the Trigger LEVEL control for a stable display.

Step 8. Set the SEC/DIV switch to a sweep speed which provides three or more divisions of horizontal separation between the reference points on the two displays. Center the displays vertically (see Figure 4-7).

Step 9. Set Cursors ON/Off switch to ON.

Step 10 Toggle the ΔV1/ΔV2/ΔT/1/ΔT switch to the ΔT position. Observe that two vertical cursors appear on the crt screen.

Step 11. Position the cursors to similar reference points (such as leading edges) on the two signal displays.

Step 12. You can read the time difference from the crt readout.

Time Ratio Measurement

The ΔT cursor function can also be used to measure and compute the RATIO, in terms of a percentage between two different time intervals. You can use the following procedure to measure a time ratio (see Figure 3-8):

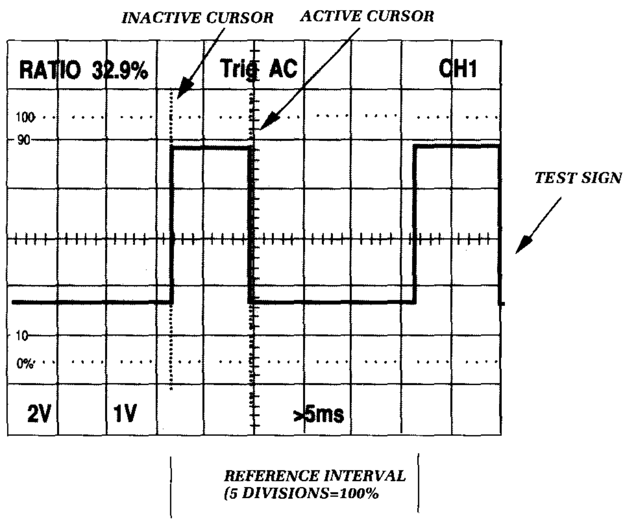


Figure 3-8: Time Ratio Measurement

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Apply the reference signal to either the CH 1 OR X or CH 2 OR Y input connector and toggle the Vertical MODE switch to display the channel used.

Step 3. Set the appropriate VOLTS/DIV switch for a convenient amplitude display of the waveform.

Step 4. Adjust the Trigger LEVEL control to obtain a stable display.

Step 5. Set the SEC/DIV and VARiable SEC/DIV controls to a reference interval of exactly five horizontal divisions.

Step 6. Set Cursors ON/Off switch to ON. Toggle the ΔV1/ΔV2/ΔT/1/ΔT switch to the ΔT position. Observe that two vertical cursors appear on the crt screen.

Step 7. If the test interval is part of a different signal, apply the test signal to the unused vertical input and select the Vertical Mode to display the channel used. Do not change the SEC/DIV or VARiable SEC/DIV setting.

Step 8. Position one cursor to the left edge of the test interval and the other cursor to the right edge, using the Cursor POSITION control and TOGGLE CURSOR switch (see Figure 3-8).

Step 9. You can read the RATIO percentage between the test interval and the reference interval from the crt readout.

Phase Difference Measurement

The 1/ΔT cursor function can also be used to measure and compute the phase difference between two signals. Phase comparison between two signals of the same frequency can be made using the dual-trace feature of the instrument. The phase-difference measurement can be made up to the frequency limit of the vertical system.

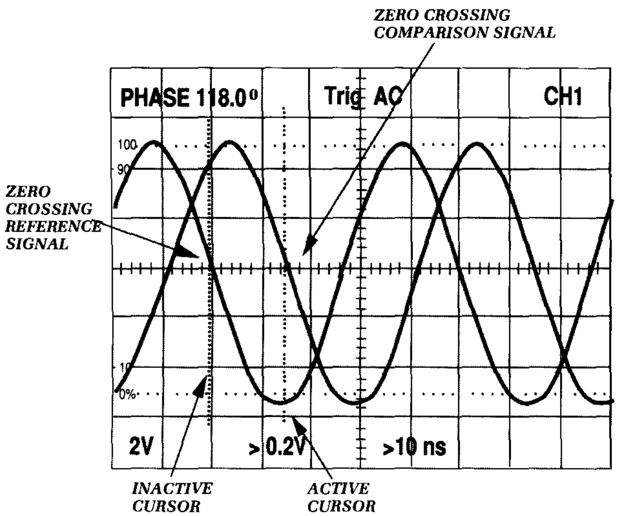


Figure 3-9: Phase Difference Measurement

To obtain a reliable measurement result, use either probes or coaxial cables with equal time delays. You can use the following procedure to make a phase comparison measurement (see Figure 3-9):

Step 1. Switch the 2212 on and obtain a baseline trace.

Step 2. Toggle the Trigger SOURCE switch to CH1.

Step 3. Set both AC-GND-DC switches to the same position, depending on the type of input coupling desired (AC or DC).

Step 4. Connect a known reference signal to the CH1 OR X input connector and the unknown signal to the CH2 OR Y input connector.

Step 5. Toggle the Vertical MODE switch to ALT or CHOP, depending on the frequency of the input signals. The reference signal should precede the comparison signal in time.

NOTE

If the two signals are of opposite polarity, you can set the CH2 INVert switch to invert the CH 2 display and make the phase measurement. Remember to add 180 degrees to the phase difference to get the total phase shift between the two signals.

Step 6. Adjust both VOLTS/DIV switches and both VARiable VOLTS/DIV controls so that the displays have the same amplitude.

Step 7. Adjust the Trigger LEVEL control for a stable display.

Step 8. Set the SEC/DIV and VARiable SEC/DIV controls for one period of the reference waveform to be exactly five divisions. Position the waveform to the zero-crossing point.

Step 9. With the SEC/DIV UNCALibrated, toggle the ΔV1/ΔV2/ΔT/1/ΔT switch to 1/ΔT. "PHASE" appears in the upper left corner of the crt screen.

Step 10. Set the cursors for one period of exactly five divisions (Phase 360 degrees) on the reference waveform. Readjust or position the reference waveform as necessary.

Step 11. Position the cursors to the zero-crossing points on the two waveforms (see Figure 3-9).

Step 12. Now , you can read the PHASE difference in degrees from the crt readout.

Small-Angle Phase Difference Measurement

If the phase difference between the two signals being measured is small, you can obtain an increased resolution for setting the cursors by using the X10 Horizontal Magnify feature. To make a small -angle phase difference comparison, use the following procedure (see Figure 3-10):

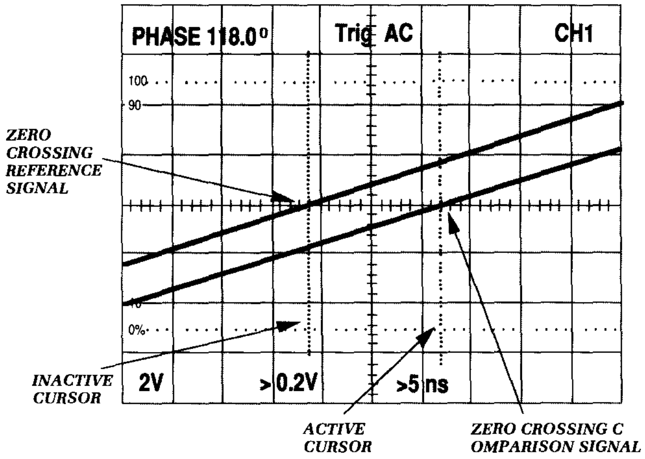


Figure 3-10: Small-angle Phase Difference Measurement

Step 1. Perform steps 1 through 6 of the preceding "Phase Difference Measurement" procedure to obtain a five-division display of one cycle of the reference and comparison signals.

Step 2. You can use the Horizontal POSITION control to move the zero-crossing points of the signals being measured to the center vertical graticule line.

Step 3. Select X10 Horizontal Magnify and use the Horizontal POSITION and the Cursor POSITION control to align the reference zero-crossing with one cursor.

Step 4. Align the other cursor with the second comparison zero-crossing (see Figure 3-10).

Step 5. You can read the magnified phase difference in degrees from the crt readout. Obtain the correct phase difference between the two signals by dividing the reading by 10.

Percent Modulation Measurement

To measure percent modulation with the 2212 oscilloscope, you can use the following procedure (see Figure 3-11):

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

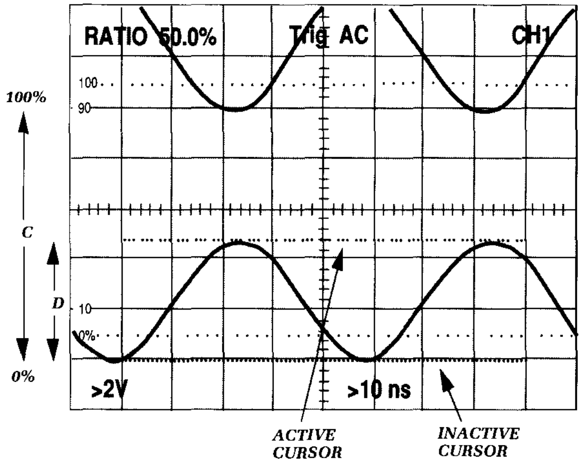


Figure 3-11: Percentage Modulation.

Step 2. Apply the signal to either vertical channel input connector and toggle the Vertical MODE switch to display the channel used.

Step 3. Adjust the Trigger LEVEL control to obtain a stable display.

Step 4. Using the VOLTS/DIV and Vertical POSITION controls, position the waveform such that dimension C (see Figure 3-11) is equal to 100%.

Step 5. Set the cursors ON/Off switch to ON.

Step 6. Toggle the ΔV1/ΔV2/ΔT/1/ΔT switch to the ΔV1 or ΔV2 position (depends on channel used). Observe that two horizontal cursors appear on the crt screen.

Step 7. Set the VOLTS/DIV in the UNCAL position. This will activate the RATIO measurement mode.

Step 8. Position the cursors, using the Cursor POSITION control, as shown by dimension D in Figure 3-11.

Step 9. The 2212 will display the percentage modulation in the top left-hand corner of the crt.

TV Line Signal Measurement

You can use the following procedure to measure a TV Line signal:

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Toggle the Trigger MODE switch to TV LINE.

Step 3. Apply the TV signal to either vertical channel input connector and toggle the Vertical MODE switch to display the channel used.

Step 4. Set the appropriate VOLTS/DIV switch to display 1.0 division or more of the composite video signal.

Step 5. Set the SEC/DIV switch to 10 μs.

Step 6. Set the Trigger SLOPE switch to either positive slope for positive-going TV signal sync pulses or negative slope for negative-going TV signal sync pulses.

NOTE

To examine a TV Line signal in more detail, toggle the Horizontal Magnify switch to X10.

TV Field Signal Measurement

The television triggering feature of the instrument can also be used to display TV Field signals.

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Toggle the Trigger MODE switch to TV FIELD and set the SEC/DIV switch to 2 ms.

Step 3. Connect the TV signal to either vertical-channel input connector to display a single TV field pulse, and toggle the Vertical MODE switch to display the channel used.

Step 4. Set the appropriate VOLTS/DIV switch to display 2.5 divisions or more of the composite video signal.

Step 5. Set the Trigger SLOPE switch to either positive slope for positive-going TV signal sync pulses or negative slope for negative-going TV signal sync pulses.

Step 6. If you want to change the TV field that is displayed, momentarily interrupt the trigger signal by toggling the AC-GND-DC switch to GND and then back to AC until the desired TV field is displayed.

NOTE

To examine a TV Field signal in more detail, toggle the Horizontal Magnify switch to X10.

Step 7. If you want to display either TV Field 1 or TV Field 2 individually, connect the TV signal to both the CH1 OR X and CH2 OR Y input connectors and select ALT Vertical Mode.

Step 8. Set the SEC/DIV switch to a faster sweep speed (so the display is less than one full field). This will synchronise the CH 1 display to one TV field pulse and the CH 2 display to the other TV field pulse.

Digital Storage Measurement Examples

The following measurement examples will enable you to perform basic measurements with digital-storage techniques.

– Waveform Comparison Measurement.

– Rise time Measurement.

The Non-Storage measurements, except the Time RATIO and the PHASE measurement (there is no Variable SEC/DIV function in Store Mode) may be performed in Store mode as well.
However, if you are not familiar with acquiring a signal in digital storage, you should review the previous information on digital storage displays in Section 2: *Digital Storage Displays.*

The 2212 can make accurate timing measurements when the ΔT Cursors are enabled in Store mode. In this mode the cursors are "attached" to the waveform (Waveform-Based Cursors). This feature can prove especially useful with signals which require a SEC/DIV setting of < 20 µs.

NOTE
When switching from NON-Store to Store the resolution of the ΔT readout display increases by one decimal place to reflect the greater accuracy of waveform-based cursor measurements.

NOTE
Prior to making measurements on the acquired waveform, toggle the HOLD ON/Off switch to the ON position, to hold the acquired waveform and provide a more stable display for measurement.

Waveform Comparison Measurement

You can easily and accurately make repeated comparisons of new acquired signals with a reference signal for amplitude, timing, or pulse-shaped analysis, using the SAVE/RECALL Reference function of the 2212. You can use the following procedure to make a waveform comparison measurement (See Figure 3-12):

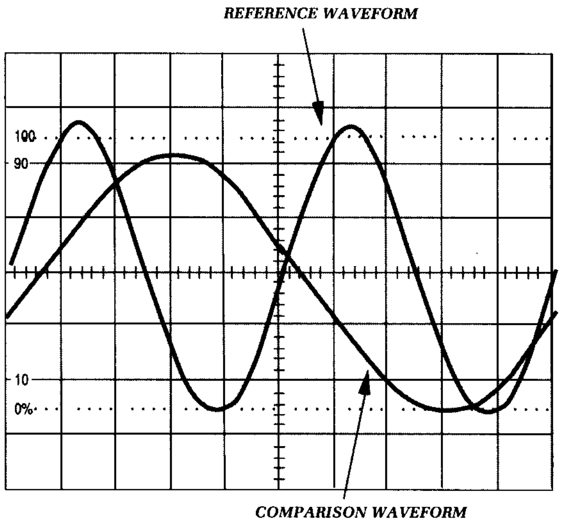


Figure 3-12: Waveform Comparison Measurement

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. After obtaining a display of the signal to be measured in Non-Store mode, toggle the STORAGE ON/Off switch to the ON position.

Step 3. Toggle the STORAGE ON/Off switch to the Store ON position.

Step 4. Select a VOLTS/DIV switch setting that gives the desired vertical deflection.

Step 5. Set the SEC/DIV switch to display the reference signal with the desired sweep rate (the fastest Store mode sweep rate of the 2212 is 20 µs per division).

Step 6. Push the SAVE button to store the reference waveform into the Reference memory.

NOTE

The VOLTS/DIV setting and the SEC/DIV setting of the reference waveform are not stored in the reference memory. The settings of the reference waveform and the newly acquired waveform must be identical to allow direct measurement from the graticule. Cursors may be used to determine voltage or time differences.

Step 7. Acquire the new waveform that is to be compared with the reference waveform.

Step 8. Push the RECALL ON/Off switch to display the stored reference waveform on the crt screen.

NOTE

A RECALLed reference waveform will remain displayed until the SAVE buton is pushed again. Then, a new reference waveform is stored in the reference memory. Switching the instrument to NON-Store removes the reference waveform and the acquired waveform from the display, but the stored reference waveform remains in the reference memory for use upon return to the Store mode.

Step 9. You can use the Reference Position control (=TRace SEParation control) to overlay the reference waveform on the newly acquired waveform for making the comparison (see Figure 3-12).

Rise Time Measurement in Store Mode

To measure the rise time of a waveform in Store mode, you can use the following procedure:

Step 1. Switch the 2212 on and obtain a baseline display in Non-Store mode.

Step 2. Apply the signal to the CH1 OR X or CH2 OR Y input connector and toggle the Vertical MODE switch to display the channel used.

Step 3. Adjust the Trigger LEVEL control to obtain a stable display.

Step 4. Set the SEC/DIV switch and alter the Vertical POSITION control so that the zero reference of the waveform touches the 0% graticule line and the top of the waveform the 100% graticule line.

NOTE

Make sure that the VOLTS/DIV switch is in the calibrated position with risetimes faster than 0.5 µs.

Step 5. Set Cursors ON/Off switch to ON.

Step 6. Toggle the ΔV1/ΔV2/ΔT/1/ΔT switch to the ΔT position. Observe that two vertical cursors appear on the crt.

Step 7. Press STORAGE ON/Off switch to Store ON. This will result in the cursors becoming "attached" to the waveform. Notice a highlighted dot at the crossings of the cursors and the waveform.

Step 8. Position the cursors to the 10% and 90% points of the waveform, using the Cursor POSITION and TOGGLE CURSOR controls and read the time difference between the two cursors from the crt readout.

Step 9. If the rise time is << 20 μs, position the cursors to the approximate positions required on the waveform, using the Cursor POSITION control.

Step 10. Toggle the X1,X10,X50 magnify switch to the X10 or X50 position. The cursors will be magnified with the waveform and may disappear off-screen.

Step 11. Use the Horizontal POSITION control to position the trace that one of the cursors appears on the screen.

Step 12. Use the Cursor POSITION control and the TOGGLE CURSOR switch to position the cursors to the 10% and 90% points of the expanded display.

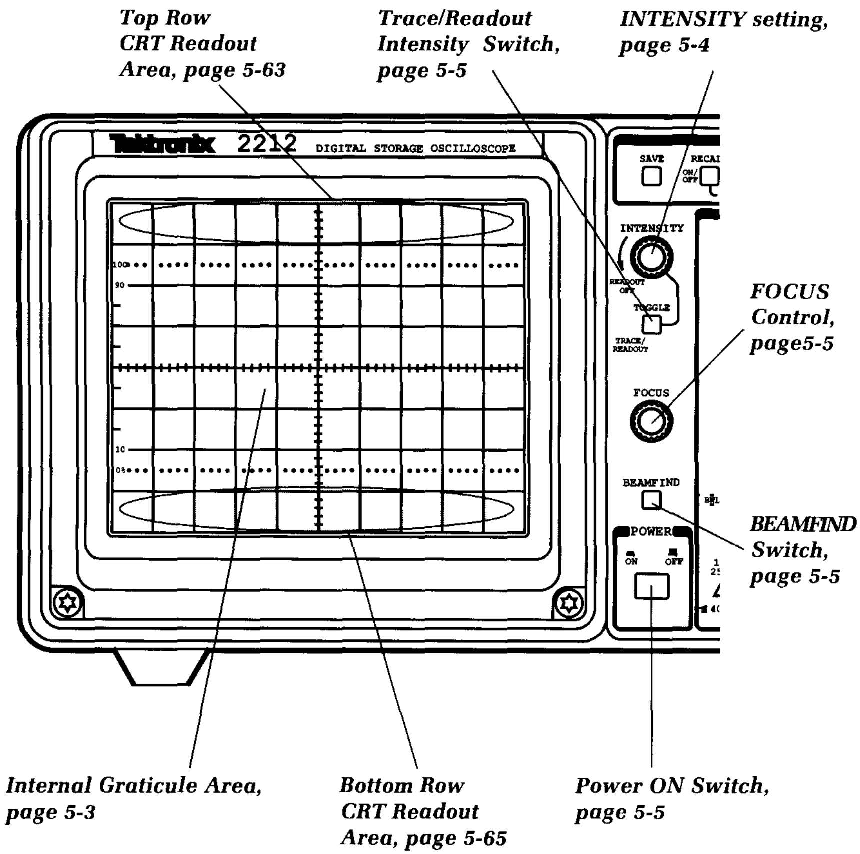
Step 13. You can read the time difference between the two cursors from the crt readout.

At a Glance

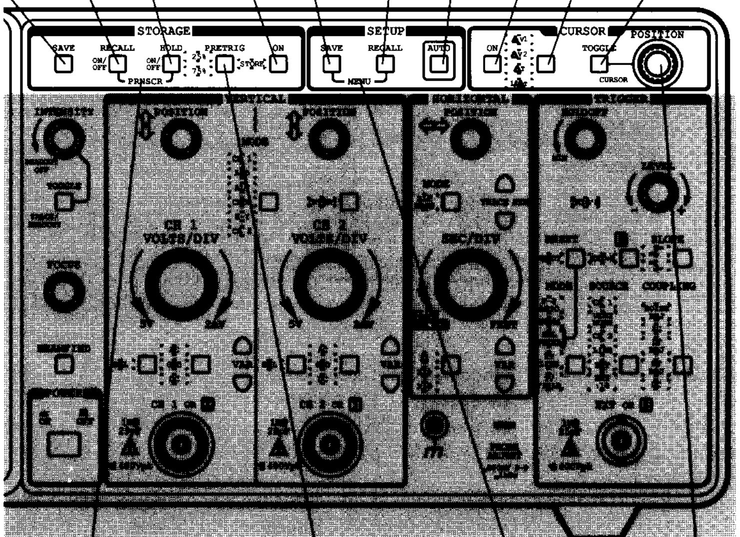
The *At a Glance* section contains maps of the front panel and rear panel. These maps should help you navigate the 2212 oscilloscope.

- The front panel map of the *Display* shows the parts, the locations and purposes of the knobs and buttons in the display section of the 2212 oscilloscope.
- The front panel map of the *Vertical* system shows the locations and purposes of the various knobs, buttons and connectors in the vertical section on the front panel of the 2212 oscilloscope.
- The front panel map of the *Storage* system, the *Setup* section and the *Cursor* section shows the locations and purposes of the various knobs and buttons in the vertical section on the front panel of the 2212 oscilloscope.
- The front panel map of the *Triggering* and*Horizontal* system shows the locations and purposes of the various knobs and buttons in the triggering and horizontal section on the front panel of the 2212 oscilloscope.
- The *Rear Panel* map shows the locations and purposes of the various parts on the rear panel of your 2212 oscilloscope.

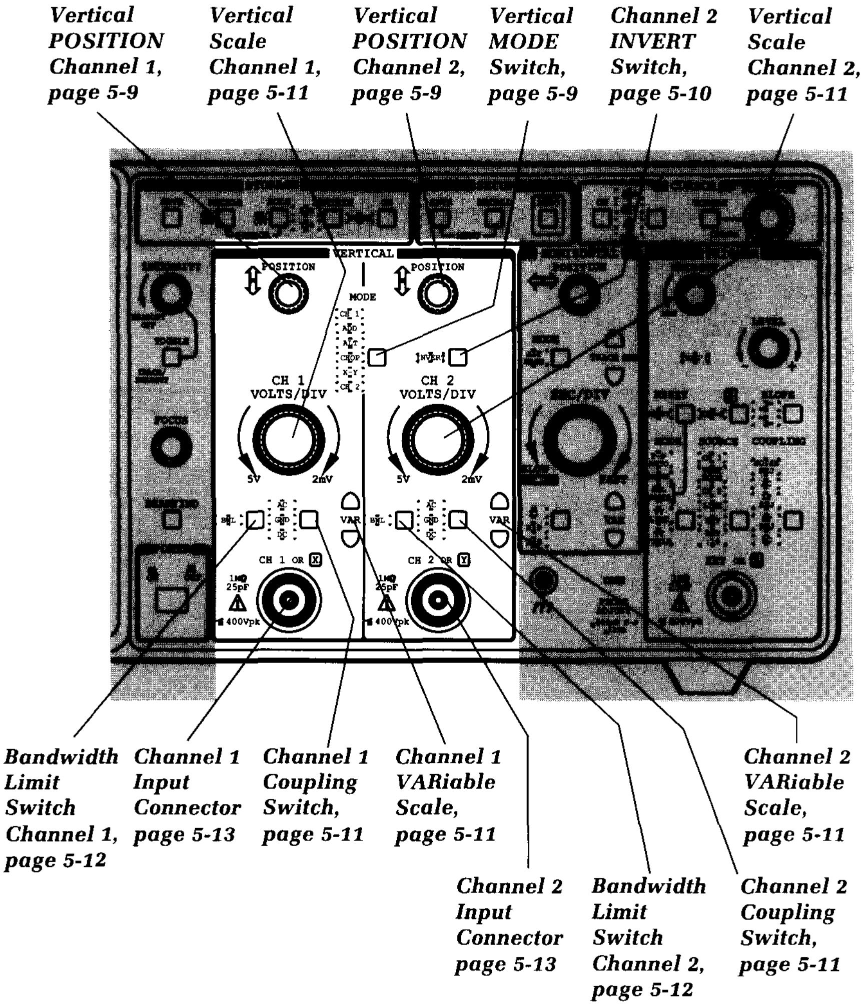
Display Map


Top Row
CRT Readout
Area, page 5-63
Trace/Readout
Intensity Switch,
page 5-5
INTENSITY setting,
page 5-4
FOCUS
Control,
page5-5
BEAMFIND
Switch,
page 5-5
Internal Graticule Area,
page 5-3
Bottom Row
CRT Readout
Area, page 5-65
Power ON Switch,
page 5-5
Tektronix 2212 DIGITAL STORAGE OSCILLOSCOPE
SAVE
INTENSITY
TOGGLE
TRACE/
READOUT
FOCUS
BEAMFIND
POWER
ON
OFF

Front Panel Map – Storage, Setup and Cursors Operation



Front Panel Map – Vertical System



Front Panel Map – Triggering and Horizontal System

HOLDOFF Control, page 5-23

Trigger Level Control, page 5-22

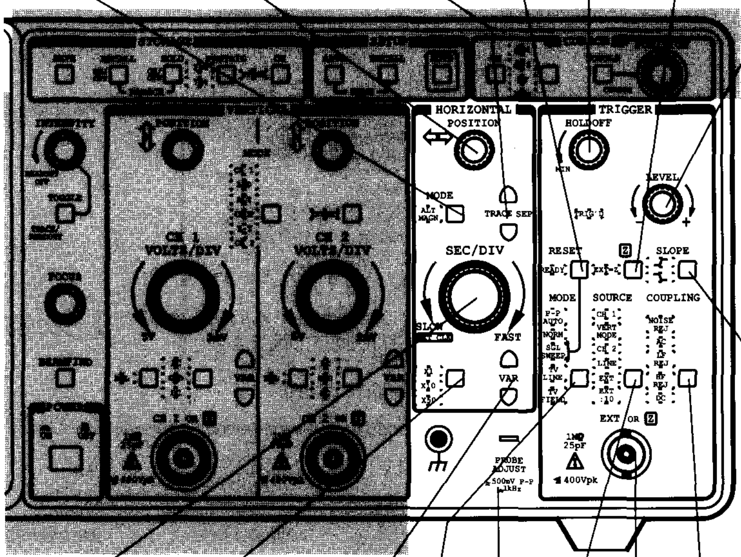
Alternate Magnifier Mode Switch, page 5-17

Horizontal POSITION Control, page 5-16

Trace Separation Control, page 5-17

Sweep RESET Switch, page 5-23

EXTernal=Z Axis Switch, page 5-26



Horizontal Scale, page 5-18

Horizontal Magnifier Switch, page 5-19

VARiable Horizontal Scale, page 5-19

Trigger MODE Switch, page 5-24

Trigger SOURCE Switch, page 5-25

Trigger COUPLING Switch, page 5-27

PROBE ADJUST Connector, page 5-20, 2-3

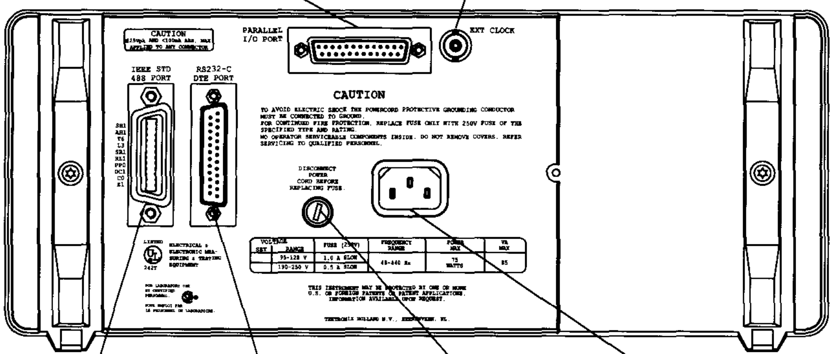
EXTernal Trigger Input and Z-Axis Input, page 5-26

Trigger SLOPE Switch, page 5-22

Rear Panel Map

Parallel I/O Port (Centronics ® Compatible), page 5-45, 5-58

EXTernal Clock Input, page 5-52



IEEE STD 488 PORT, page 5-55

RS-232-C DTE PORT, page 5-53

Fuse Holder, page 5-50

Power Cord Receptacle, page 5-50

General

The *In Detail* section contains a description of the functions and locations of the of the 2212 controls, connectors, and indicators of the front and rear panel. It is intended to provide you more detailed information about the locations and purposes of the various functions of the 2212 Digital Storage & Analog Oscilloscope.

NOTE

The 2212 push-button switches can make selections within a selection range. Pressing a push button switch once during a short period of time, results in stepping forwards to the next function in the selection range. Holding down the push button for a longer period of time results in stepping backwards to the previous function in the selection range.

The *In Detail* section is split up in subsections for the function blocks on the front panel and the functions on the rear panel. Also, a description of the CRT Readout, a Maintenance subsection and a subsection for Probes you can use with the 2212, is provided.

- The Display
- Vertical Operation
- Horizontal Operation
- Trigger
- Cursors
- Storage
- Set-up
- Making Hardcopies
- Power
- Interfaces
- CRT Readout
- Probes
- Maintenance and Repair

The Display

The 2212 display shows you signals, crt readouts, and/or a menu. This section explains the various parts and controls of the **Display** section of the front panel and how to adjust the **Trace Rotation**.

Display controls

See Figure 5-1 for location of items 1 through 7.

(1) **Internal Graticule**

The 8x10 cm crt graticule is internally marked on the faceplate of the crt to eliminates viewing errors between the trace and the graticule lines. On the center horizontal and vertical graticule line, each division is divided in five minor divisions to make accurate measurements.

The vertical deflection factors and horizontal timing are calibrated to the graticule for making accurate measurements directly from the crt.

Take voltage measurements by counting the vertical graticule divisions and partial divisions occupied by the portion of the display being measured and then multiplying by the VOLTS/DIV setting. Rise time amplitude and measurement points (0, 10, 90 and 100%) are indicated at the left side of the graticule.

Take time measurements using the graticule markings in a similar manner. Count the number of horizontal graticule divisions and partial divisions occupied by the portion of the waveform being measured and multiply by the SEC/DIV setting.

To improve the accuracy of the measurement, position the display to take advantage of the 0.2 division minor graticule markings on the center graticule lines. Also position one of the measurement points of the waveform as precisely as possible on one of the major graticule marks to be used as a measurement reference point.

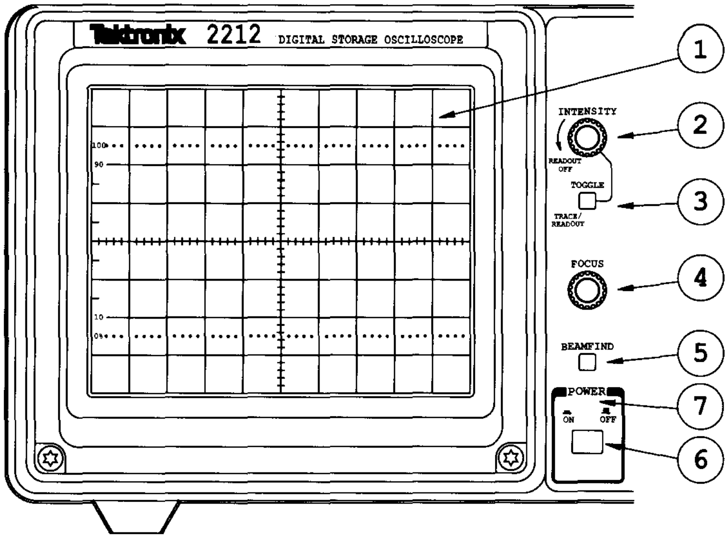


Figure 5-1: Power and Display Controls and Power-on Indicator

(2) INTENSITY Control

With the INTENSITY control you can adjust the brightness of:

- The trace intensity and the reference waveform intensity, if the TOGGLE TR/RO switch is toggled to the trace (TR) position.
- The crt readout intensity, the cursor display intensity and the intensity of messages, if the TOGGLE TR/RO switch is toggled to the readout (RO) position.

In the fully counter-clockwise position of the INTENSITY control, the crt-readout, and cursor-display are disabled.

3 TOGGLE TR/RO Switch

With the TOGGLE TR/RO switch you can select the Trace intensity control (TR) or the Readout intensity control (RO), including the cursors and reference waveform.

The crt readout display indicates how the instrument controls are set up, displays the cursor measurement value and displays the trigger level value. No physical markings are on the rotating switches and control knobs to indicate the control setting.

4 FOCUS Control

The FOCUS control adjusts the trace for optimum display definition. Once set, proper focusing is maintained over a wide range of display intensities.

5 BEAM FIND Switch

The BEAM FIND switch compresses the vertical and horizontal deflection to within the graticule area. The traces are intensified to aid the user in locating traces that are overscanned or deflected outside the crt viewing area.

6 POWER ON/OFF Switch

The POWER ON/OFF switch turns the instrument power on or off.

7 POWER On Indicator

The Power On indicator lights up when the power is turned on.

Trace Rotation Adjustment

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

If you have to readjust the Trace Rotation, use the following procedure:

Step 1. Press the AUTO SETUP button and obtain a baseline trace.

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

Step 3. If the baseline trace is not parallel to the center horizontal graticule line, the TRACE ROTATION potentiometer needs adjusting.

The Trace Rotation potentiometer is located inside the instrument and can be adjusted from the bottom side, as indicated on the cabinet. You should use a small-bladed insulated screwdriver or alignment tool to readjust the trace with the graticule line.

Vertical Operation

This section discusses controlling the vertical aspects of your signal. The knobs and switches to do this are situated in the **VERTICAL** section, enclosed within grey lines (see Figure: 5-2).

The vertical channels have calibrated deflection factors from 5 mV per division to 5 V per division at full bandwidth (60 MHz). The vertical deflection factor is extended to 2 mV/division at a reduced bandwidth of 10 MHz. Independent bandwidth limiting (10 MHz) for each channel is also possible with the BW Limit switches. You can limit one channel's bandwidth to 10 MHz without affecting the bandwidth of the other channel.

With the VARiable VOLTS/DIV gain control (VAR), you can increase the deflection factor to overlap the next VOLTS/DIV setting.

The 2212 Oscilloscope can be used in two different display modes:

- **Vertical Non-Store (Analog) display mode.**

  In the Non-Store (analog) display mode, you can select:

  CH 1, ADD, ALT, CHOP, X-Y and CH 2.

  In CH 1 or CH 2 mode, only the signal applied to the CH 1 OR X input connector or to the CH 2 OR Y input connector is displayed on the crt screen.

  In ALT mode, the display switches between CH 1 and CH 2 at the end of each sweep, showing the signals applied to each channel alternately.

  In CHOP mode, the display switches between CH 1 and CH 2 at ±500 kHz as the sweep is occurring to display both channels simultaneously on the crt.

  In the ADD mode, the signals applied to the CH 1 OR X input connector and the CH 2 OR Y input connector are algebraically added.

  In the X-Y mode, the signal connected to the CH 1 OR X connector is switched to the horizontal deflection and the signal connected to the CH 2 OR Y connector to the vertical deflection.

- **Vertical Store (Digital) display mode.**

  With the 2212 in the Store display mode, you can select:

  CH 1, ADD, ALT, CHOP, X-Y or CH 2.

  If the ADD, ALT or CHOP mode is selected in Store mode, the signals applied to the vertical input connectors are acquired simultaneously. However, if the vertical mode is in ALT and the trigger source is in VERT MODE, CH 1 and CH 2 will be digitized alternately.

  In the X–Y Store mode, the acquisition and the sampling rate are set by the SEC/DIV switch and/or the EXT CLOCK.

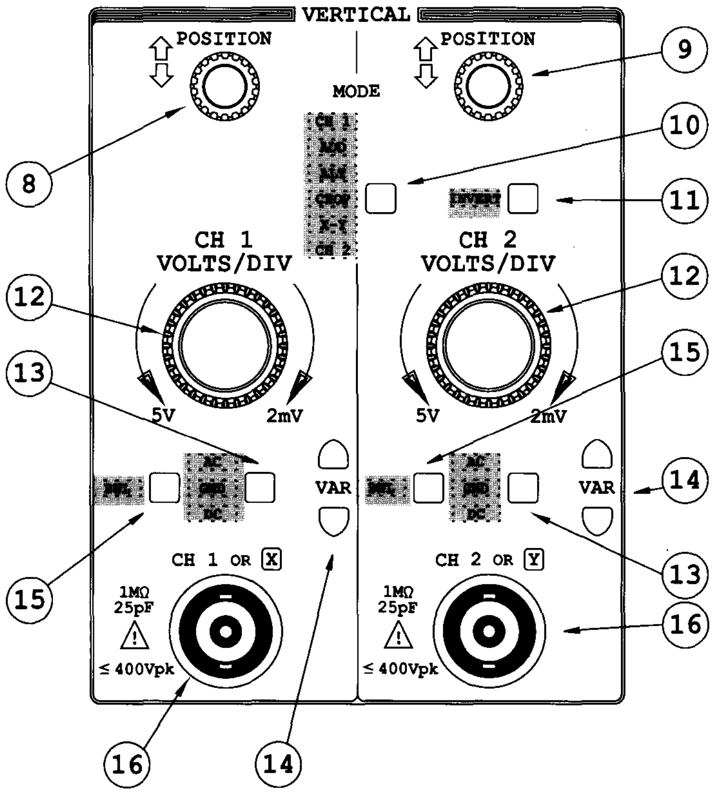


Figure 5-2: Vertical Controls and Connectors

Vertical Controls and Connectors

See Figure 5-2 for the location of items 8 through 16.

(8) Channel 1 Vertical POSITION Control

The CH 1 Vertical POSITION controls the vertical display position of the CH 1 signal on the crt screen. Coarse and fine control are combined in a one-knob operation. This control does not function in the X-Y mode.

(9) Channel 2 Vertical POSITION Control

The CH 2 Vertical POSITION controls the vertical display position of the CH 2 signal on the crt sreen. Coarse and fine control are combined in a one-knob operation. In X-Y mode this control vertically positions the display.

(10) Vertical MODE Switch

The Vertical MODE Switch selects the vertical mode for display in the Non-Store and Store mode by toggling the MODE switch to the desired selection.

CH 1 — In the CH 1 mode, only the CH 1 input signal is selected for display.

ADD — In the ADD mode, the sum of the CH 1 and CH 2 input signals is diplayed on the screen. An add symbol ("+") appears in the crt readout.

When CH 2 is inverted, while in ADDmode, the subtraction of the CH 1 and CH 2 inputs signals is displayed. An invert symbol ("↓") appears in the crt readout.

ALT — In the ALT mode the CH 1 and CH 2 input signals are alternately displayed. Switching between the channels occurs during retrace at the end of each sweep.

ALT vertical mode is most useful for viewing both channel input signals at sweep rates of 0.5 ms per division and faster.

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

In Store mode, both signals are acquired simultaneously. There is no functional difference between ALT and CHOP except when VERT MODE triggering source is selected.

X-Y — In the X-Y mode, the CH1 OR X input signal provides horizontal deflection and the CH 2 OR Y input signal provides vertical deflection on the crt screen. In the crt readout "X–Y" is displayed.

You can select the X-Y mode in the Non-Store as well as in the Store mode.

When using the cursors, ΔV1 becomes ΔVX and ΔV2 becomes ΔVY.

In X-Y Store mode, the full acquisition length is equal to the SEC/DIV switch setting times 10.24 (SEC/DIV X 10.24).

In X-Y Store mode, with the SEC/DIV switch in EXT CLK position, the full acquisition length is equal to 4096 divided by the Clock Frequency of the EXT CLK input signal (4096 : Clock Frequency).

CH 2 —In CH 2 mode, only the CH 2 input signal is selected for display.

(11) CH 2 INVERT Switch

The CH 2 INVERT switch inverts the CH 2 display when in the invert position. An invert symbol ("↓") is displayed in the crt readout when CH 2 is inverted.

With CH 2 inverted, the oscilloscope may be operated as a differential amplifier in the ADD mode.

(12) VOLTS/DIV Switches

With the VOLTS/DIV switches you select the vertical channel deflection factors. The selection is from 2 mV to 5 V per division in a 1-2-5 sequence.

The VOLTS/DIV crt readout depends on the VOLTS/DIV switch setting and the probe connected (with proper probe coding, see Table 5-1).

Table 5-1: Probe Coding

Probe Coding	Coding Resistance (usable)
1X	Infinite
10X	10 kΩ ±5%
100X	5.6 kΩ ±5%
IDENTIFY*	0 Ω

* The IDENTIFY coding will result in IDENT being displayed on the crt in stead of the corresponding VOLTS/DIV readout.

(13) AC-GND-DC Input Coupling Switches

With the AC-GND-DC Input Coupling switches you select the coupling of the input signal from the CH 1 and CH 2 vertical input connectors to the vertical amplifiers.

AC — In the AC position the input signal is capacitively coupled to the vertical deflection and signal acquisition systems. The dc component of the input signal is blocked. Selection of AC input coupling is indicated in the crt readout by a tilde symbol ("~") in the associated channel's VOLTS/DIV readout.

GND — In the GND position the input of the vertical deflection channel is grounded and provides a zero (ground) reference voltage display (and does not ground the input signal!).

DC — In the DC position, all frequency components of the input signal are coupled to the vertical deflection and signal acquisition systems.

14 VARiable VOLTS/DIV (VAR) Controls

The VARiable VOLTS/DIV (VAR) controls provide continuously variable deflection factors between the calibrated positions of the VOLTS/DIV controls.

Pushing the lower part of a VAR volts/division control switch sets the VOLTS/DIV to the UNCALibrated status and reduces the vertical sensitivity. The sensitivity reduction range is suficient to overlap the next VOLTS/DIV position. Pushing the upper part of a VAR volts/division control switch increases the vertical sensitivity up to the calibrated value of the VOLTS/DIV switch.

Pushing both the VAR switches simultaneously, will result in restoring the calibrated status.

The uncalibrated condition is indicated in the readout by a greater-than symbol (" > ") in front of the VOLTS/DIV readout concerned.

15 Band-Width Limit Switch

With theBandwidth Limit Switches you may select the bandwidth to be reduced to 10 MHz.

In the 2 mV/DIV position, the vertical bandwidth is reduced to approximately 10 MHz.

The bandwidth limit is indicated by "B_L" in the crt readout.

Selecting the Bandwidth Limit (BWL) in one channel may slightly detoriate the full bandwidth capability of the other unlimited channel.

16 CH1 OR X and CH 2 OR Y Input Connectors

The CH 1 OR X and CH 2 OR Y Input Connectors connect signals to the inputs of the deflection systems.

Coding-ring contacts on the CH 1 and CH 2 input connectors are used to automatically switch the scale factor in the crt readout when a probe with probe coding, as shown in Table 5-1, is attached to an input connector.

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

NOTE
We recommend that you use Tektronix Probes because the identity pin will allow the 2212 to automatically display a readout with corrected sensitivity.

Horizontal Operation

This section discusses controlling the horizontal aspects of your signal. The knobs and switches to do this are situated in the **HORIZONTAL** section of the front panel, which is enclosed within grey lines (see Figure 5-3).

The 2212 Oscilloscope can be used in two different horizontal display modes:

1. Horizontal Non-Store Display Mode

In Non-Store mode, the 2212 provides a calibrated sweep speed range from 0.5 s per division to 0.05 µs per division. You can use the variable timing control (VAR) to increase the non-store sweep time per division by a factor of up to 2.5 times the calibrated time per division, as selected with the SEC/DIV switch.

The X1, X10, X50 magnifier switch magnifies the horizontal display by 10 or 50 times around the center graticule line. This may extend the maximum sweep speed to 1 ns/div. The X50 magnification is not calibrated on the 4, 2 and 1 ns/div ranges.

You can use the Alternate Magnifier feature (ALT MAGN) to display the magnified and unmagnified sweep alternately on the crt screen in the Non-Store mode. You can reposition the unmagnified sweep vertically with the Trace Seperation control (TR SEP) in the ALT MAGN mode.

2. Horizontal Store Display Mode

In Store mode, the 2212 provides a calibrated sweep speed range from 50 s to 20 µs per division. The maximum sampling rate is 20 megasamples per second with a stored record length per waveform of 4096 points (4096) for single-and dual-channel acquisitions. All 4k points are visible on screen at one time.

One waveform set (CH 1 and CH 2), 4k record length each, may be stored in the reference memory as a reference waveform, giving a total 8k record length. Previous stored data in the reference memory is overwritten. A reference waveform may be recalled for display and comparison with the current acquisition waveform.

With the 2212 in X-Y mode, digital storage mode is also one of the features.

Horizontal Controls and Switches

See Figure: 5-3 for the location of items 17 through 24.

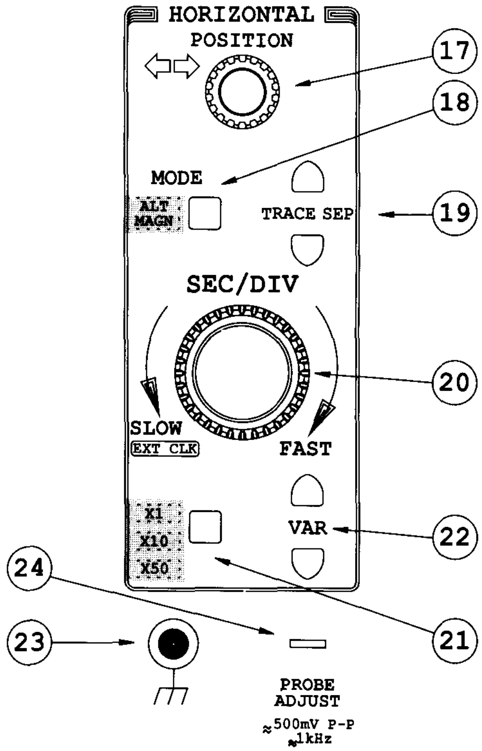


Figure 5-3: Horizontal Controls and Switches

(17) Horizontal POSITION Control

The Horizontal POSITION control positions the displayed waveform(s) horizontally over a one-sweep-length range (either X1, X10, or X50 magnified). The coarse and fine control are combined in a one knob operation.

In Non-Store mode, the Horizontal POSITION control does not move the cursor. In Store mode, with Δt cursors selected, the horizontal POSITION control moves the cursors also, as they are attached to the waveform(s). In X-Y mode, the Horizontal POSITION controls the X-axis position.

18 ALTernate MAGNifier (ALT MAGN) Switch

The Alternate Magnifier (ALT MAGN) switch selects the horizontal Alternate Magnify mode. Both the magnified and the unmagnified trace will be displayed on the crt screen alternately. The magnified trace is that part of the unmagnified trace around the center vertical graticule line. The magnification level can be set to either X10 or X50 with the X1, X10, X50 magnify switch.

If no magnification factor has been preselected in ALT MAGN mode, X10 magnification will be selected automatically. When ALT MAGN is deselected, the horizontal magnification will automatically revert to the setting selected prior to switching to ALT MAGN mode.

If vertical mode is in CHOP, pressing the ALT MAGN button will automatically change the vertical mode to ALT. Pressing the ALT MAGN button again will restore the CHOP mode.

If ALT MAG is on, X-Y mode is not selectable.

ALT MAGN is not selectable in X-Y mode.

19 TRACE SEParation (TRACE SEP) Control

The Trace Separation controls the position of a displayed waveform vertically, when:

- You select the Alternate Magnifier (ALT MAGN) mode. Pressing the Trace Separation control will move the magnified trace vertically according to the indicated direction of the button.
- You recall a Reference waveform (Press RECALL) in Store mode from the memory. The Reference waveform will be displayed, together with the acquired waveform. Pressing the Trace Separation control will move the Reference waveform vertically according to the indicated direction.

(20) SEC/DIV Switch

With the SEC/DIV switch you may select calibrated sweep rates in a 1-2-5 sequence in the Store and Non-Store mode. The resp. selection ranges are :

- 50 s per division to 20 µs per division in Store mode.
- 0.5 s per division to 0.05 µs per division in Non-Store mode.
- Two External Clock modes (EXT CLK) can be selected (in Store mode only) on the fully counterclockwise part of the SEC/DIV switch range, respectively:
  - ROLL mode (external clock frequencies of DC – 4kHz)
  - RECORD mode (external clock frequencies of DC –10 MHz)

In X-Y Store mode, the sampling rate can be established in two ways:

- The internal clock, set by the SEC/DIV switch
- An external clock signal applied to the EXT CLK input

In Store mode, the SEC/DIV switch setting determines the acquisition and display modes, also sets the sampling rate and establishes the time scale factor of the displayed waveforms. There are two storage modes with respect to the SEC/DIV switch setting (see also Table 5-2):

- RECORD mode — In RECORD mode, the acquired waveform updates a full record each time a trigger event is recognized.

  The storage mode is RECORD at sweep speeds of 20 µs to 50 ms per division.
- ROLL mode — In ROLL mode, the waveform is acquired and displayed continuously. Triggers are disabled except in SGL SWP (single sweep). The waveform display scrolls from right to left across thecrt screen with the latest samples appearing at the right edge of the crt.

  The storage mode changes automatically to ROLL at sweep speeds of 0.1 s per division to 50 s per division.

Table 5-2: Storage Modes

DISPLAY	MODE
50 ms - 20 μs	RECORD
50 s -100 ms	ROLL
EXT CLOCK: DC to10 MHz	RECORD
EXT CLOCK: DC to 4 KHz	ROLL

The SEC/DIV crt readout display reflects the current horizontal deflection factor selected. If you select magnification factors (X10, X50), these will be reflected in the readout.

21 X1, X10, X50 Magnify Switch

The X1, X10, X50 Magnify switch selects the amount of horizontal magnification (X1, X10, X50). The magnified trace is that part of the unmagnified trace registered around the centre vertical graticule line.

In Store mode, with Δt cursors selected, operation of the horizontal magnify switch will also magnify the distance between the cursors as they are attached to the waveform(s).

The X1, X10, X50 sweep magnification switch also functions on reference waveform displays and provides for a horizontal expansion of 10 and 50 times.

22 Variable SEC/DIV (VAR) control

The Variable SEC/DIV (VAR) control continuously varies the uncalibrated sweep time per division in the Non-Store position up to at least 2.5 times the calibrated time per division, set by the SEC/DIV switch.

The VAR SEC/DIV is not operational in Store mode.

Pushing the lower switch of the Variable seconds per division controls sets the SEC/DIV switch to the UNCAL position and increases the sweep time per division. Pushing the upper switch of the variable time per division controls reduces the sweep time perdivision until it has reached the calibrated position.

In the UNCAL position, a greater-than symbol (" > ") is displayed in the crt readout in front of the SEC/DIV readout, and the UNCAL LED lights.

Pushing both the VAR switches simultaneously, will result in restoring the calibrated status.

23 GND Connector

The GND connector provides an auxiliary ground connection directly to the instrument chassis via a banana-tip jack.

24 PROBE ADJUST Connector

The PROBE ADJUST connector provides an approximately 0.5 V square-wave voltage (at approximately 1 kHz) for use in compensating voltage probes and checking the vertical deflection system.

NOTE

The PROBE ADJUST output is not intended as a reference in checking either the vertical or the horizontal accuracy of the instrument.

Trigger

This section discusses the controls and connector which allow you to manipulate the triggering aspects of your signal.

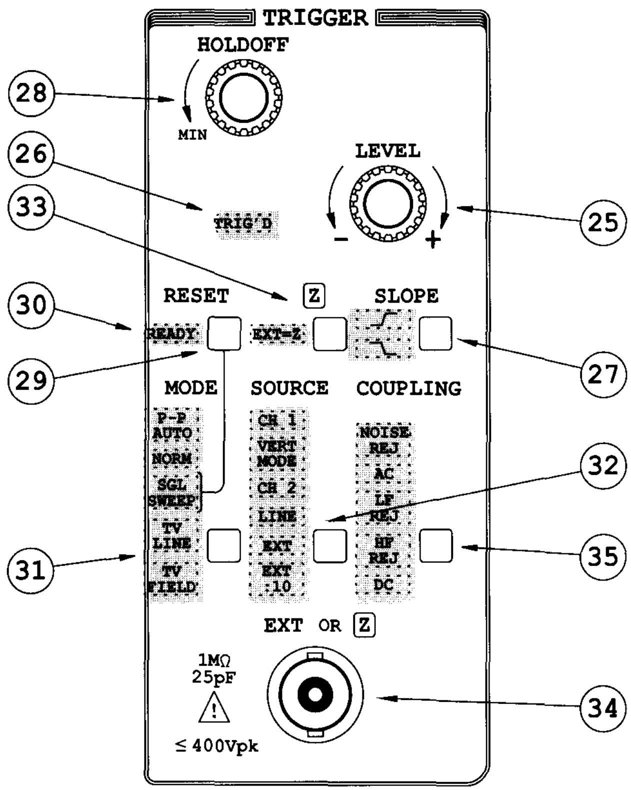


Figure 5-4: Trigger Controls and Connector.

Trigger Controls and Connector

See Figure 5-4 for the location of items 25 through 32.

25 Trigger LEVEL Control

The Trigger LEVEL control selects the amplitude point on the signal that produces triggering. The trigger level is displayed in the crt readout (the trigger display field) as a voltage readout, referenced to the input signal.

The readout display of the trigger is enabled if the trigger COUPLING is in DC and one of the following conditions exists:

- The trigger SOURCE is CH 1 and CH 1 is DC coupled and in calibrated position.
- The trigger SOURCE is CH 2 and CH 2 is DC coupled and in calibrated position.
- The trigger SOURCE is VERT and one of the following conditions is met:
  - Vertical MODE switch is in CH 1 and CH 1 is in DC and in calibrated position.
  - Vertical MODE switch is in CH 2 or X-Y and CH 2 is in DC and in calibrated position.
  - Vertical MODE switch is in ADD or ALT, DC coupled and the CH 1 and CH 2 deflection factors are the same.

26 TRIG'D Indicator

The TRIG'D LED indicator turns on when triggering occurs in the P-P AUTO, NORM, and TV FIELD trigger modes.

27 Trigger SLOPE Switch

With the trigger SLOPE switch you can select either the positive or negative slope of the trigger signal to start the sweep. The LED indicator for the selected SLOPE lights.

28 HOLDOFF Control

The HOLDOFF control adjusts the Holdoff time.

In Non-Store mode the holdoff time starts at the end of the sweep.

In Store mode the holdoff starts at the end of the acquisition cycle and ends when the waveform data has been transferred from the acquisition to the display memory and the pretrigger portion of the acquisition memory has been filled. After Store mode holdoff ends, the next acquisition can be triggered after the Non-Store Holdoff ends.

Store mode holdoff time can be much longer than the sweep time so that several Non-Store holdoffs may have occurred during Store holdoff time. This ensures that Store mode triggering is controllable by the HOLDOFF control and will be stable if the Non-Store display is stable.

29 RESET switch

Pressing the RESET button will arm the trigger circuit for one of two actions:

- A single sweep in Non-Store SGL SWP
- A single acquisition record in Store SGL SWP

The triggering requirements are the same as in NORM trigger mode.

After completion of a Non-Store sweep or a Store acquisition record, pressing the RESET button rearms the trigger circuitry to be ready for the next triggering event.

In Store mode, selecting SGL SWP mode and pressing the RESET button does not immediately turn on the READY LED, because of the pretrigger portion of the acquisition memory starts filling after the RESET button is pressed. The READY LED is turned on when the pretrigger memory is full. The storage acquisition system is then ready to accept a trigger event. At the end of the acquisition record the READY LED is turned off. This may be several seconds or minutes before the current acquisition is complete.

30 READY Indicator

The READY LED turns on when the trigger is in SGL SWEEP trigger mode, and the trigger circuit is armed by pressing RESET switch, awaiting a triggering event. As soon as the single sweep has been completed, the READY LED will be turned off.

31 Trigger MODE Switch

The trigger MODE switch of the 2212 selects the Non-Store sweep triggering modes (P-P AUTO, NORM, SGL SWEEP, TV LINE or TV FIELD). The Store mode triggering operation depends on the trigger mode selected and the position of the SEC/DIV switch (RECORD, ROLL). The LED indicator for the selected MODE lights.

- **P-P AUTO** — In Non-Store mode, P-P AUTO triggering occurs on a trigger signal that has adequate amplitude and a repetition rate of about 20 Hz or faster. In the absence of a proper trigger signal, an autotrigger is generated, and the sweep runs free. In Store mode, in the absence of a trigger signal, an auto trigger is also generated.

  The trigger point indicator (intensified dot) is visible on the generated trace at the position selected by the 25%/ 75% pretrigger button.

  For SEC/DIV settings of 50 s per division to 0.1 s per division, the P-P AUTO trigger mode is disabled and the display rolls. At faster SEC/DIV settings, to the maximum Store mode setting of 20 µs, triggered acquisitions occur under the same conditions as Non-Store mode P-P AUTO triggering.

- **NORM** — NORM mode triggering permits triggering at all sweep rates (an auto trigger is not generated in the absence of an adequate trigger repetition rate).

NOTE

NORM Trigger mode is especially useful for low-frequency and low-repetition-rate signals.

- **SGL SWEEP** — In SGL SWEEP trigger mode, the single sweep operation is selected. Pressing the RESET switch arms the trigger circuitry to accept a trigger event. When a trigger event is recognized, one single sweep is generated.

  NOTE:
  To avoid the possibility of losing parts of the signal display, it is advisable to switch the readout system off when doing single sweep measurements at SEC/ DIV settings faster than 0.2 ms in NON-STORE mode.

- **TV LINE** — TV LINE triggering permits stable triggering on a television line (horizontal sync) signal. The triggering LEVEL is automatically set. In absence of an adequate trigger signal, the sweep (or acquisition in Store mode) free-runs. When TV LINE is selected, "TVLine" is displayed in the crt trigger readout field.

- **TV FIELD** — TV FIELD triggering permits stable triggering on a television field (vertical sync) signal. In the absence of an adequate trigger signal, the sweep (or acquisition in Store mode) free-runs. The 2212 otherwise, behaves in TV FIELD mode as in the P-P AUTO trigger mode. When TV FIELD is selected, "TVFld" is displayed in the crt trigger readout field.

32 Trigger SOURCE Switch

The trigger SOURCE switch selects the signal SOURCE (CH 1, VERT MODE, CH 2, LINE, EXT, or EXT:10) of the trigger signal for the trigger circuit. The LED indicator for the selected SOURCE lights.

- **CH 1** —The Trigger signal is obtained from the CH 1 input channel. When CH 1 is selected, "CH1" is displayed in the crt readout.
- **VERT MODE** — In VERT MODE, trigger signals are obtained alternately from the CH 1 and CH 2 input channels when the vertical MODE is in ALTernate. When VERT MODE is selected, "VERT" is displayed in the crt readout.

  In CHOP mode, the trigger signal source is the CH 1 input signal.

  In Store display mode, with the vertical mode in X-Y, the trigger SOURCE is CH 2.

- **CH 2** — The trigger SOURCE signal is obtained from the CH 2 input channel. When CH 2 is selected, "CH2" is displayed in the crt readout.

  The CH 2 INVert switch also inverts the polarity of the internal CH 2 trigger signal when the CH 2 display is inverted.

- **LINE** — The trigger SOURCE signal is obtained from the attenuated ac power line signal and routed to the Trigger circuit. When LINE is selected, "LINE" is displayed in the crt readout.

- **EXT** — In the EXTernal trigger SOURCE position an external signal applied to the EXT INPUT OR Z input connector is routed to the trigger circuit. When EXT is selected, "EXT" is displayed in the crt readout.

- **EXT:10** — In the EXT:10 trigger SOURCE position an external signal applied to the EXT INPUT OR Z input connector is attenuated by a factor 10 before being applied to the Trigger circuit. When EXT/10 is selected, "EXT" is displayed in the crt readout.

33 EXT=Z Switch

By pressing the EXT=Z switch, the signal applied to the EXT OR Z input connector is routed to the Z-Axis circuit to obtain intensity modulation, and the LED indicator EXT=Z lights.

34 EXT INPUT OR Z Input Connector

The EXT INPUT OR Z input connects an external signal to the trigger circuit or to the Z-axis circuit.

If EXT trigger SOURCE and EXT=Z both are selected, the signal applied to the EXT INPUT OR Z connector is routed to both the trigger circuit and the Z-axis amplifier.

35 Trigger COUPLING Switch

With the COUPLING switch you select the method of coupling the trigger SOURCE signal to the trigger circuit (NOISE REJ, AC, LF REJ, HF REJ, or DC). The LED indicator for the selected COUPLING lights.

- **NOISE REJ** (Noise Reject) — In the NOISE REJ position all frequency components of the trigger input signal are coupled to the trigger circuitry, but increases the peak-to-peak signal amplitude that is required to produce a trigger event."Noise" is displayed in the crt trigger readout field.

NOTE

NOISE REJ trigger coupling is useful for improving stability when the trigger signal is accompanied by low-level noise.

- **AC** — In the AC position, the trigger input signal is capacitively coupled to the trigger circuit, and the dc component is blocked. "AC" is displayed in the crt trigger readout field.

NOTE

AC trigger coupling is useful for triggering on ac waveforms that have a large dc offset.

- **HF REJ** (High Frequency Reject)— In the HF REJ coupling position, the high-frequency components from the trigger input signal (above 30 kHz), are attenuated. "HFrej" is displayed in the crt trigger readout field.

NOTE

HF REJ trigger coupling is useful for providing a stable display of low-frequency components of complex waveforms and eliminates high-frequency interference from the trigger signal.

- **LF REJ** (Low Frequency Reject) — In the LF REJ coupling position, the low-frequency components from the trigger input signal (below 30 kHz), are attenuated. "LFrej" is displayed in the crt trigger readout field.

NOTE

LF REJ trigger coupling is useful for providing a stable display of high-frequency components of complex waveforms and eliminates low-frequency interference or power supply hum from the trigger signal.

- **DC** — In the DC trigger coupling position, all frequency components of the triggering signal are coupled to the trigger circuit (DC to full bandwidth).
  If the conditions, mentioned for the Trigger LEVEL readout are not met, "DC" is displayed in the crt trigger readout field.

NOTE

DC trigger coupling is useful for most signals, but it is especially useful for providing a stable display of low-frequency or low-repetition-rate signals.

Cursors

This section discusses the cursor control functions of your 2212 oscilloscope, which allow you to manipulate the aspects of your signal having to do with cursor measurements.

- Cursor Control
- $\Delta V1$, $\Delta V2$, ΔV, ΔVX, ΔVY and Ratio Cursor
- ΔT and Ratio
- $1/\Delta T$ and Phase

You can make Delta Volts (ΔV), Delta Time (ΔT), and One Over Delta Time ($1/\Delta T$ or frequency) measurements of the displays, using the CURSOR controls.

The crt readout of the 2212 reports the cursor type and the cursor delta (Δ) settings. The ΔV, ΔT or $1/\Delta T$ crt readouts indicate, respectively:

- The Voltage-difference (ΔV) between the cursors
- The Timing-difference (ΔT) between the cursors
- The Reciprocal Time-difference ($1/\Delta T$), (approximate frequency)

Cursor Control Functions

See Figure 5-5 for location of items 36 through 39.

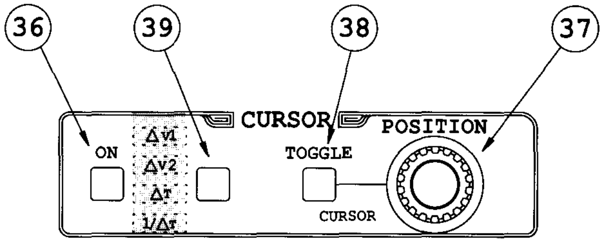


Figure 5-5: Cursor controls

36 Cursor ON Switch

Pressing the cursor ON switch activates the cursor measurement mode, and two cursor lines appear on the crt screen. For ΔV1 and ΔV2 the cursors are horizontal lines, and for ΔT and 1/ΔT, the cursors are vertical lines. Pressing this button again cancels the cursor measurement mode, extinguishing the cursors and the cursor measurement display.

When the cursor measurement mode is inactive, pressing the cursor ON button enables the cursor measurement mode to restore the previous cursors and the cursor measurement display.

37 Cursor POSITION Control

With the cursor POSITION, you control the positions of:

- The delta time (ΔT) cursor(s) (vertical dotted line) when either the Δt or 1/Δt measurement mode is active. Rotating the POSITION control clockwise (CW) moves the Δt cursor(s) to the right. Rotating the POSITION control counter clockwise moves the the Δt cursor(s) to the left.
- The delta voltage cursor(s) (horizontal dotted line), when the delta voltage measurement mode is active. Rotating the POSITION control clockwise (CW) moves the ΔV cursor(s) upwards. Rotating the POSITION control counter clockwise moves the ΔV cursor(s) downwards.

38 TOGGLE CURSOR Switch

With the TOGGLE CURSOR switch you can select the TRACK mode or the DELTA cursor mode.

- When in TRACK mode, both cursors are dashed lines. Rotating the cursor POSITION control causes both cursors to move equal amounts until the limit of either one is reached.
- When in DELTA cursor mode, the delta cursor (dashed line) is movable, using the cursor POSITION control, and the reference cursor (solid line) is fixed.

39 ΔV1 / ΔV2 / ΔT / 1/ΔT Cursor Measurement Mode Switch

With the ΔV1 / ΔV2 / ΔT / 1/ΔT cursor-measurement mode switch, you can select (See also Table 5-3 and Table 5-4):

- The delta volts (ΔV1, ΔV2, ΔV, ΔVX, ΔVY, and RATIO) measurement functions.
- The delta time measurement function (ΔT and RATIO).
- The frequency function (1/ΔTand RATIO).

ΔV1, ΔV2 , ΔV, ΔVX, ΔVY and RATIO Cursor Functions

ΔV1 Cursor Function

With the cursor mode switch in the ΔV1 mode, two horizontal cursors are displayed on the screen. The vertical mode switch is set to the CH1 position. ΔV1 is represented in the crt readout display by the distance between the two cursors and expressed in an equivalent voltage.

The VOLTS/DIV scaling for this measurement mode is defined by:

- The setting of the CH 1 VOLTS/DIV switch.
- The probe encoding (1X, 10X, 100X).

ΔV2 Cursor Function

With the cursor mode switch in the ΔV2 mode, two horizontal cursors are displayed on the screen. The vertical mode switch is set to the CH 2 position. ΔV2 is represented in the crt readout display by the distance between the two cursors and expressed in an equivalent voltage.

The VOLTS/DIV scaling for this measurement mode is defined by:

- The setting of the CH 2 VOLTS/DIV switch.
- The probe encoding (1X, 10X, 100X).

ΔV Cursor Function

The cursor type is displayed in the crt readout as ΔV when the vertical MODE switch is in **ADD** position and both vertical channels have the same deflection factor (VOLTS/DIV switch setting).

ΔV is represented in the crt readout display by the distance between the two cursors and expressed in an equivalent voltage.

RATIO (ΔV1, ΔV2, ΔV) Function

When the 2212 is switched to timebase (**Y–t**) mode, you can select the ΔV1 and ΔV2 cursors with the ΔV1/ΔV2 /ΔT/1/ΔT cursor mode switch.

The delta volts (ΔV1, ΔV2, ΔV) readout is displayed as a percentage "RATIO" (with a vertical signal of five screen divisions corresponding to a ratio of 100%), when:

- The VOLTS/DIV of a selected vertical channel is in the UNCAL position.
- ADD mode is selected and the CH 1 and CH 2 deflection factors are not the same (e.g. one vertical channel is in the UNCAL position, or the VOLTS/DIV settings are not the same).

The delta volts RATIO function is applicable to the ΔV1 as well as to the ΔV2 and to the ΔV function.

ΔVX Cursor Function

When the 2212 is switched to **X-Y** mode, you can select the ΔVX and ΔVY cursors with the ΔV1/ΔV2 /ΔT/1/ΔT cursor mode switch.

The ΔV1 cursors become the ΔVX cursors (vertical lines on the crt). The ΔVX cursors represent a crt readout display of a voltage measurement that depends upon:

- The distance between the position of the vertical cursors.
- The CH 2 VOLTS/DIV switch setting.
- The probe coding.

ΔVY Cursor Function

When the 2212 is in **X-Y** Mode, you can select the ΔVX and ΔVY cursors with the ΔV1/ΔV2 /ΔT/1/ΔT cursor mode switch.

The ΔV2 cursors become the ΔVY cursors (horizontal lines on the crt). The ΔVY cursors represent a crt readout display of a voltage measurement that depends upon:

- The distance between the position of the horizontal cursors.
- The CH 1 VOLTS/DIV switch setting.
- The probe coding.

RATIO (ΔVX, ΔVY) Function

With the 2212 in X-Y mode, the ΔVX and ΔVY measurements will be displayed as a "RATIO" if one of the VOLTS/DIV switches or both switches are in the UNCAL position. (With a signal of five screen divisions corresponding to a ratio of 100%).

Table 5-3: Voltage Cursor Function Readouts

CURSOR Funktion	Cursor Readout with VOLTS/DIV Calibrated	Cursor Readout with VOLTS/DIV UNCALibrated
ΔV1	ΔV1 V	RATIO ....%
ΔV2	ΔV2 V	RATIO ....%
ΔVX	ΔVX V	RATIO ....%
ΔVY	ΔVY V	RATIO ....%
ΔV	ΔV V	RATIO ....%

ΔT and RATIO Cursor Function

With the 2212 in the Y–t mode, and the cursor mode switch in the Δt position, two vertical cursors are displayed on the screen, and the crt readout displays:

- The time difference in seconds (if ΔT is selected).
- The RATIO, with five horizontal screen division corresponding to 100%(if the SEC/DIV is in UNCAL).

ΔT Function

With the cursor mode switch in the ΔT position, the time difference between the two vertical cursors is determined by:

- The distance between the two vertical cursors.
- The SEC/DIV scaling as defined by the SEC/DIV switch.
- The setting of the X1, X10, X50 horizontal magnify switch .

RATIO (ΔT) Function

With the SEC/DIV switch in the UNCAL position, in Non-Store mode, Δt is expressed as a "RATIO", with five horizontal screen divisions corresponding to a ratio of 100% (see Table 5-4).

1/ΔT and PHASE Cursor Function

With the 2212 in the Y–t mode, and the cursor mode switch in the reciprocal delta time function (1/Δt), two vertical cursors are displayed on the screen, and the crt readout displays:

- The reciprocal of the delta time difference (frequency) in Hz.
- The PHASE, with five horizontal screen divisions corresponding to a phase of 360 degrees.

1/ΔT Function

With the cursor mode switch in the 1/ΔT position, the 1/ΔT frequency is determined by :

- The distance between the two vertical cursors.
- The SEC/DIV scaling as defined by the SEC/DIV switch.
- The setting of the X1, X10, X50 magnify switch.

PHASE (1/ΔT) Function

With the SEC/DIV switch in the UNCAL position in the Non-Store mode, the 1/Δt cursor difference is expressed as "PHASE", in degrees(°), with five horizontal screen divisions corresponding to a phase of 360 degrees (see Table 5-4).

Table 5-4: Time / Frequency Cursor Function Readouts

CURSOR Function	Cursor Readout with SEC/DIV Calibrated	Cursor Readout with SEC/DIV UNCALibrated
ΔT	ΔT .... s	RATIO .... % **
1/ΔT	1/ΔT .... Hz	PHASE .... ° **

** In Non-Store mode or EXT CLK Store mode only.

Storage

This section discusses the storage control functions. The switches to activate the storage control functions are located in the **STORAGE** section on the front panel.

See Figure 5-6 for locations of items 40 through 45.

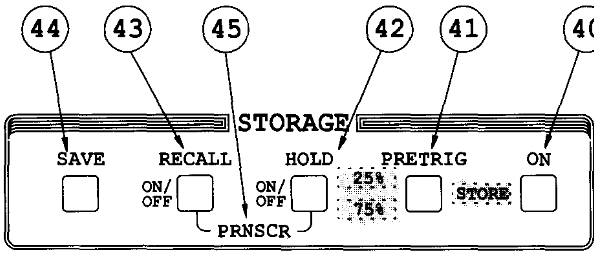


Figure 5-6: Storage Controls

Storage Controls

40 Store ON Switch

With the Store ON switch you select or de-select either the Non-Store or the Store mode of the 2212.

When Store mode is selected, the Store LED lights. When Non-Store mode is selected, the Store acquisition is turned off, and the last waveform acquired in Store mode remains in memory until the power is switched off.

41 PRETRIG Switch

The PRETRIG switch selects 25% pretrigger time or 75% pretrigger time in Store mode.

In RECORD mode or SGL SWEEP ROLL mode (see Table 5-2), the trigger position is shown in the display by an intensified dot.

42 HOLD ON/OFF Switch

In Store mode, you can stop the display from being updated by pressing the HOLD ON/OFF switch.

If the Store display mode is ROLL (see Table 5-2), the current acquisition is stopped immediately upon pressing the button. Pressing the button again causes the acquisition to continue where it was stopped.

If the Store display mode is RECORD (see Table 5-2), the current display is held immediately upon pressing the button. When the button is pressed again, the acquisition is restarted.

When you select HOLD, "HOLD" appears in the crt readout acquisition status field, and it replaces "ROLL" if the 2212 is in ROLL mode.

(43) RECALL Reference Switch

Pressing the RECALL switch button will cause the waveform stored in the reference memory to be displayed on the crt. Pushing the button while the reference display is on causes the reference display to be blanked.

Positioning of the reference waveform occurs with the TRace SEParation control (called the Reference Separation with respect to the reference waveform) independent of the CHl 1 and CH 2 POSITION controls. When the RECALL function is off (no reference waveform is displayed), the TR SEP (REF SEP) control is inoperative.

(44) SAVE Reference Switch

When you press the SAVE Reference Switch while the 2212 is in Store mode, the displayed waveform acquisition is written into the reference memory and any existing reference memory is overwritten by the displayed waveform acquisition . The stored waveform remains displayed on the crt. The reference waveform is retained when the instrument is switched between Store and Non-Store mode.

Only traces positioned entirely inside the screen area will be saved correctly when placed in the reference memory. Waveforms placed outside the screen area will be clipped at the point where they cross the top and bottom of the screen. This is most noticeable when a waveform which is partially off the bottom of the screen is saved in the reference memory. The reference waveform, displayed when repositioned with the TRace SEParation control, will be clipped at the point that the waveform originally crossed the bottom of the screen.

45 Print Screen (PRNSCR) Function

When you press the RECALL and HOLD button simultaneously, a data dump to a selected output device is started. (Only when the 2212 is in the Store mode).

NOTE

Neither the horizontal POSITION nor the horizontal magnify switch (X1, X10, X50) has any effect on the horizontal position of the plot. The hardcopy output represents the unmagnified (X1 horizontal magnification) screen and the plotted SEC/DIV scaling reflects the unmagnified horizontal deflection factor.

Holding the RECALL and HOLD switches simultaneously pushed-in for more than three seconds will result in aborting the print/plot process when a plot is in progress.

The trigger point on a plot or printout is indicated by an X.

The cursors and crt readout are plotted as displayed on the crt screen.

The MENU screen can not be plotted.

Setup

This section discusses the SETUP functions and the MENU function of your 2212 oscilloscope. The switch buttons to activate the SETUP functions are located in the **SETUP** section on the front panel.

The SETUP functions include:

- Automatically set the vertical, horizontal, triggering and display controls to produce a usable waveform on the crt screen by pressing the AUTO button.

- Save a current front panel Set-up

- Recall the last saved front panel Set-up

- Display the MENU.
  The MENU functions include the settings for the communication interface (Parallel Printer Interface).
  When your instrument has Option 12 (RS-232-C Interface) or Option 10 (GPIB Interface) included, you can also make the selections required in the menu.

SETUP Controls

The AUTO SETUP feature enables you to automatically setup the horizontal, the vertical, and trigger controls in order to produce a display that fits vertically and horizontally on the screen, with at least two periods of the probed signal displayed. A front panel setup can be saved in memory and recalled from that memory. The saved front panel setup is retained in memory even after the instrument is switched off. See *APPENDIX A* for the default control settings of each front panel control at power up.

See Figure 5-7 for locations of items 46 through 49.

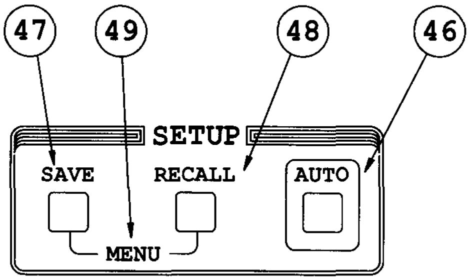


Figure 5-7: SETUP controls

(46) AUTO Setup Switch

The AUTO Setup switch selects the AUTO SETUP function. When you press the AUTO button, the vertical, horizontal, triggering and display controls to display an unknown waveform are automatically set. A stable, automatically triggered display of the probed waveform appears on-screen with an optimized front panel setup.

Auto Setup does not affect the STORAGE and CURSOR modes and controls.

47 SAVE Setup Switch

When you press the SAVE Setup switch, you save the front panel setup in the memory for later use. The last stored front panel set up is overwritten.

The saved front panel setup is retained in memory even after the instrument is switched off.

48 RECALL Setup Switch

Pressing the RECALL button recalls the last stored front panel setup from the memory.

49 MENU

When you press the RECALL switch and the SAVE switch simultaneously, the MENU function is displayed on the crt screen (See Figure 5-8 on page 5-45). Pressing the RECALL and SAVE button again, will result in leaving the MENU and return to signal display (indicated as "`exit <menu>`" on the menu).

Names of menu lines are in lower case, and parameters on the menu lines are in upper case. Menu lines outside the dotted lines are the fixed part of the menu and inside the dotted lines are the variable part.

Types

If you have a standard instrument, only the Parallel Printer (I/O Port) HARDCOPY menu (see Figure 5-8) is available. You can have a 2212 configuration with one of the next four different menus:

1. The HARDCOPY menu is standard for every 2212.
2. The OTHER menu is for future expansion.
3. The GPIB menu is added to a 2212 with a GPIB interface option (Option10).
4. The RS232 menu is added to a 2212 with an RS-232-C interface option (Option 12).

Type Identification (Line 1)

The top menu line of every MENU page shows the instrument type, the version of the main software (V1.3 in Figure 5-8 on page 5-45) and the version of the front panel software (number 2 in Figure 5-8 on page 5-45).

Menu Type (Line 2)

On the second line of the MENU you can select one of the menu pages that are available for your instrument configuration.

Parameter Selection

Parameters on a menu page can be selected by using the CURSOR POSITION control and the TOGGLE CURSOR switch, as described hereafter:

- The CURSOR POSITION control is used for selection of parameters on a horizontal menu line (indicated by " ← → `<cursor position>`"on the bottom line). The selected parameters are displayed underlined. When a parameter is changed, the underlining disappears and the new setting will be indicated by a "[" opening bracket in front and a "]" closing bracket behind the new setting. When you leave the menu, the new parameter setting will be stored in the non-volatile memory.
- The TOGGLE CURSOR switch is used for selecting a menu line (indicated by " ↓ `<cursor toggle>`"on the bottom menu line). The selected menu line is indicated by a ">" pointer in front of the menu line involved.

Parameter Positioning and Line Positioning (Line 9)

On menu line 9 is stated that you can select a parameter on a menu line with the CURSOR POSITION control, and a menu line with the TOGGLE CURSOR switch.

Exit <menu> and/or a-Z <trigger level> (Line 10)

On menu line 10 is stated that you can leave the MENU by pressing the SAVE +RECALL buttons simultaneously, in the Setup region of the front panel, and return to normal signal display. If "user text" is on, "a-Z <trigger level>" states that you can select characters with the Trigger LEVEL control on the front panel.

Making Hardcopies

All 2212 's have a HARDCOPY MENU installed (see Figure 5-8).

The Parallel Printer (Parallel I/O Port) Interface is designed for connecting to printers with a Centronics ® compatible interface, via the 25-pin D type female connector.

```
        Tektronix 2212 V2.2.20

     menu: HARDCOPY  GPIB  RS232
------------------------------------------
    port: CENTRONICS GPIB  RS232
    driver: HPGL EPS_FX  EPS_LQ  T →
    size: SMALL NORMAL  FULL_REC
    grat:   OFF CROSS  DIVS  FULL
    user text:OFF ON
 ⇒       "Tektronix 2212"
------------------------------------------
⇐ ⇒ <cursor position> ⇓ <cursor select>
    exit <menu>   a-Z<trigger level>
```

Figure 5-8: HARDCOPY Menu Settings

HARDCOPY Menu

To make a hardcopy of the record, the HARDCOPY menu must be set. Therefore, press Save + Recall in the Setup function block). In the HARDCOPY menu you can make the following selections (see also Figure 5-8):

- ## Output Port

The following ports can be selected in the menu:

- Centronics output
- RS232-C output (only with Option 12)
- GPIB output (only with Option 10)

NOTE
If the RS-232-C or GPIB output is selected, the programmable communication interface is switched off.

- ## Printer Drivers

The following printer drivers can be selected in the menu:

- EPS_FX
- EPS_LQ
- HPGL
- Deskjet
- Thinkjet
- Laserjet

NOTE
If HPGL is selected, the "size" line is changed to:
nr of pens: 1 <u>4</u>

The HP-GL (Hewlett-Packard Graphics Language) driver uses a small subset of the HP-GL command set.

The commands used are shown as follows:

Scale	SC < scale x, scale y >
Select Pen	SP < pen number >
Pen Up	PU
Pen Down	PD
Set Defaults	DF
Move Absolute	PA < absolute x,y location >
Set Character Size	SR < character width, character height >
Plot Text String	LB < text string > < ETX character >

Command arguments are shown in < > brackets.

The xy command arguments for the PA command are restricted to the scale x and scale y limits defined by the scale command.

- **Print Sizes**

  The following print sizes can be selected in the menu:

  - SMALL ; for printing two plots per page.
  - NORMAL; for printing one plot per page.
  - FULL RECORD; for printing the full size record, but 90 ° rotated.

NOTE
The FULL RECORD selection is only available in combination with the EPS_FX, EPS_LQ and Thinkjet drivers.

- **Number of Pens**

  For an HPGL driver, you can select:

  - One pen
  - Four pens

  The fixed pen allocations are as follows:

Graticule	Pen 1
Acquisition channel 1 data	Pen 2
Acquisition channel 2 data	Pen 3
Reference channel 1 data	Pen 4
Reference channel 2 data	Pen 1

- **Graticule**

  The following graticule settings can be selected in the menu:

  - OFF; no graticule will be printed.
  - CROSS; a cross with graticule minor division and division classification will be printed.
  - DIVS; graticule division lines will be printed.
  - FULL; graticule division lines and a graticule cross with graticule minor division and division classification will be printed.

- **User Text**

The "user text" feature enables you to create a textstring with a maximum of 20 characters, that will be printed/plotted with the waveform. The following user text settings can be selected in the menu:

- OFF; no text information will be printed and the user text is removed from the menu display.
- ON; text can be composed in the menu on the "textstring line" and printed on the hardcopy.

- **Textstring**

On the menu-line next to the "user text" line, you see the format of the textstring to be printed/plotted on the crt screen.
Characters are selected with the Trigger LEVEL control, and the position is set by the CURSOR POSITION control.

Power

This section discusses the ac power connections to your 2212.

– Fuse Holder

– Power Cord Receptacle.

The 2212 can be operated from a ac power source in the 95-128 VAC range, or in the 190-250 VAC range, as indicated on the **Rear Panel**.

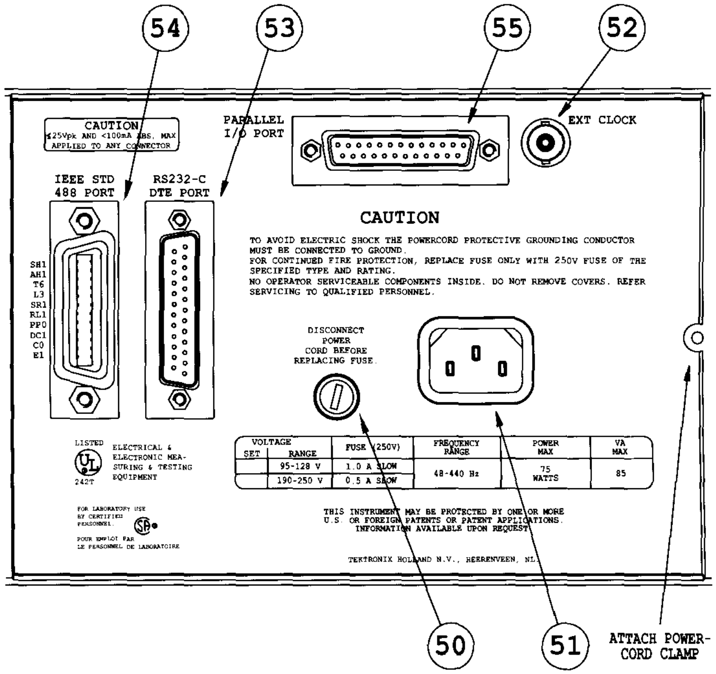


Figure 5-9 Rear Panel (Partial)

NOTE

If you want to change the ac power source rating, a qualified service technician must be consulted to change the fuse and the power setting inside the instrument.

See Figure 5-9 for locations of items 50 through 51.

50 Fuse Holder

The Fuse Holder contains the ac-power-source fuse. The rear panel nomenclature informs you about fuse rating (0.5 A Slow for 190-250VAC,1.0 A Slow for 95-128 VAC)and line voltage range (95-128 VAC or 190-250 VAC).

51 Power Cord Receptacle

The Detachable Power Cord Receptacle provides the connection point for the ac power source to the instrument.

For replacement of a power cord, see the *Accessories* (Appendix A) for a Tektronix Part Number.

Interfaces

This section discusses the Communications Interface connections, and the External Clock input function, located on the **Rear Panel**.

- The External Clock Input Function.
- The RS-232-C Communications Interface (Optional).
- The GPIB (IEEE STD 488.2 1987) Communications Interface (Optional).
- The Parallel Printer Interface (Centronics ® compatible).

The standard 2212 (without Options 10 and 12) is equipped with a parallel printer interface to be connected to printers/plotters which have a Centronics compatible interface.

See Figure 5-9 (Page 5-49) for locations of items 52 through 55.

52 External ClocK Input (EXT CLK)

The External ClocK (EXT CLK) input connector provides a TTL compatible input for external clock signals to the storage acquisition circuit of the 2212.

If you want to use the 2212 with an external clock signal(in Store mode), set the SEC/DIV switch to one of the two EXT CLK positions (as indicated in the crt readout):

- EXT CLK RECORD position for the RECORD mode.
- EXT CLK ROLL position for the ROLL mode.

Samples are clocked on the falling edges.
The maximum input frequency is 10 MHz in RECORD mode and 4 kHz in ROLL mode.

53 Serial Communications (RS-232-C) Interface Connector (Option 12)

The Serial Communications Interface provides an RS-232-C communications interface connection meeting the EIA RS-232-C standard for data terminal equipment. To operate the interface use the following procedure:

Step 1. Connect a RS-232-C cable to the 25-pin male Sub-D connector (see Table 5-5)on the 2212.

Step 2. Select settings of the serial interface (RS-232-C) in the MENU display (see Figure 5-8a).

With Option 12 installed, the instrument is fully remote programmable. Connections for signal ground and shield ground are also provided for grounding between the instrument and an external device.

Table 5-5 lists the function of each pin of the RS-232-C DTE port (male).

Table 5-5: RS-232-C DTE Connector

Pin	Signal Name	Function
1	CHAS GND	Chassis ground
2 [a]	TXD	Transmitted data
3 [a]	RXD	Received data
4	RTS	Request to send
5	CTS	Clear to send
6	DSR	Data set ready
7 [a]	SIG GND	Signal ground
8	RLSD	Received line signal detect
20	DTR	Data terminal ready

[a] **Only these lines are required for communication with software handshaking (X-ON, X-OFF)**

RS-232-C Menu

The RS-232-C menu is added to a 2212 with the RS-232-C interface option (Option12). Line 1 and Line 2 at the top and Line 9 and Line 10 at the bottom of the menu are the same as for the Hardcopy menu (see page 5-45).

```
(line 1)                 Tektronix 2212 V2.0.10

(line 2)   ⇒  menu:     HARDCOPY   GPIB      RS232
          - - - - - - - - - - - - - - - - - - - - - - -
(line 3)      programmable: OFF   ON
(line 4)      baud:19K2   9K6  4800 1200  300
(line 5)      handshake: XON/XOFF     HARDWARE
(line 6)      parity:     ODD   EVEN   NONE
(line 7)      stopbits:   1     2
          - - - - - - - - - - - - - - - - - - - - - - -
(line 9)      ⇐ ⇒ <cursor position> ⇓ <cursor toggle>
(line 10)     exit <menu>
```

Figure 5-8a: RS-232-C Menu Settings

The following parameters between the dotted lines (Lines 3....7) can be selected separately (see Figure 5-8a).

Line 3	Select the programmability of the interface
Line 4	Set the Baudrate
Line 5	Select the type of handshaking
Line 6	Set the parity
Line 7	Set the number of stopbits

For more information, see your Programmer Manual standard delivered with Option 12.

54 GPIB (IEEE STD 488.2 1987) – Interface Connector (Option 10)

With Option 10 installed, the instrument is fully remote programmable by a controller (PC). To operate the interface use the follwing procedure:

Step1.	Connect a GPIB cable to the 2212 IEEE STD 488 PORT.
Step2.	Select settings of the GPIB interface (IEEE 488.2) in the MENU display.

The GPIB Interface provides ANSI/IEEE STD 488.2 1987 compatible electrical and mechanical connection to the GPIB (General Purpose Interface Bus) and also complies to Tektronix Standard Codes and Formats 4-91.

The function of each pin of the connector is shown in Table 5–6 on page 5-56.

GPIB Menu

A GPIB menu is added to a 2212 with the GPIB interface option (Option10). Line 1 and Line 2 at the top and Line 9 and Line 10 at the bottom are the same as for the Hardcopy menu (see page 5-45).

The following parameters between the dotted lines can be selected seperately (see Figure 8b on page 5-57)).

Line 3	Select the programmability of the interface
Line 4	Set the primary GPIB address.
Line 5	Set warning 501 .

For more information, see your Programmer Manual standard with Option 10.

NOTE
Warning 501 is "Related Settings Changed"

Table 5-6: GPIB Connector

Pin	Line Name	Description
1	DI01	IEEE-488 Data I/O
2	DI02	IEEE-488 Data I/O
3	DI03	IEEE-488 Data I/O
4	DI04	IEEE-488 Data I/O
5	EOI	IEEE-488 END or Identify
6	DAV	IEEE-488 Handshake
7	NRFD	IEEE-488 Handshake
8	NDAC	IEEE-488 Handshake
9	IFC	IEEE-488 Input
10	SRQ	IEEE-488 Output
11	ATN	IEEE-488 Input
12	SHIELD	System Ground (Chassis)
13	DI05	IEEE-488 Data I/O
14	DI06	IEEE-488 Data I/O
15	DI07	IEEE-488 Data I/O
16	DI08	IEEE-488 Data I/O
17	REN	IEEE-488 Input
18	GND	Digital Ground (DAV)
19	GND	Digital Ground (NRDF)
20	GND	Digital Ground (NDAC)
21	GND	Digital Ground (IFC)
22	GND	Digital Ground (SRQ)
23	GND	Digital Ground (ATN)
24	GND	Digital Ground (LOGIC)

```
(Line 1)            Tektronix 2212 V2.0.10
         ------------------------------------------------
(Line 2)  ⇒   menu:  HARDCOPY  GPIB  RS232
(Line 3)      programmable:          OFF     ON
(Line 4)      primary address:         1
(Line 5)      warning 501:           OFF     ON
(Line 6)
(Line 7)
         ------------------------------------------------
(Line 8)
(Line 9)      ⇐ ⇒ <cursor position>  ⇓ <cursor toggle>
(Line 10)     exit  <menu>
```

Figure 5-8b: GPIB Menu Settings

55 Parallel Printer Interface Connector

The Parallel Printer Interface Connector provides an IBM ® PC compatible parallel printer interface for connecting printers and plotters with a Centronics ® compatible interface. To operate the interface use the following procedure:

Step 1.	Connect a 25-pin PC to Centronics cable (Tektronix Part Number 012-1214-00) to the 25-pin D-type female connector of the 2212.
Step 2.	Select settings of the Parallel Printer Interface in the MENU display (See also page 5-43 and 5-44).
Step 3.	Press the RECALL and the SAVE button simultaneously to initiates the interface and start a data dump of crt screen data to the printer/plotter connected to the 2212 oscilloscope. (See also the Print Screen Function on page 5-40.)

Table 5-7 lists the functions of each pin of the connector.

Table 5-7: Parallel Printer Interface Connector

Pin Number	At Standard TTL levels Signal Name
1	– Strobe
2	+ Data Bit 0
3	+ Data Bit 1
4	+ Data Bit 2
5	+ Data Bit 3
6	+ Data Bit 4
7	+ Data Bit 5
8	+ Data Bit 6
9	+ Data Bit 7
10	– Acknowledge
11	+ Busy
12	+ P. End (out of paper)
13	+ Select
14	– Auto Feed
15	– Error
16	– Initialize Printer
17	– Select Input
18 -25	Ground

CRT Readout

This section discusses the CRT Readout System which provides an alphanumeric display of information on the crt screen along with the waveform displays.

The readout is displayed in two rows of characters. One row is displayed within the top graticule division, and the other row within the bottom graticule division.

Messages and warnings may also be displayed on the crt.

On the row in the top graticule division, you will find the following readouts:

- Cursor Type
- Cursor Delta Value
- Trigger
- Trigger Value
- Trigger Source

On the row in the bottom graticule division, you will see:

- CH 1 Vertical Deflection
- ADD Sign
- CH 2 Vertical Deflection
- Horizontal Deflection
- Acquisition Mode
- Addressed Indication
- Remote Indication
- X-Y Store Mode

The locations and possible types of the information displayed are illustrated in Figure 5-10.

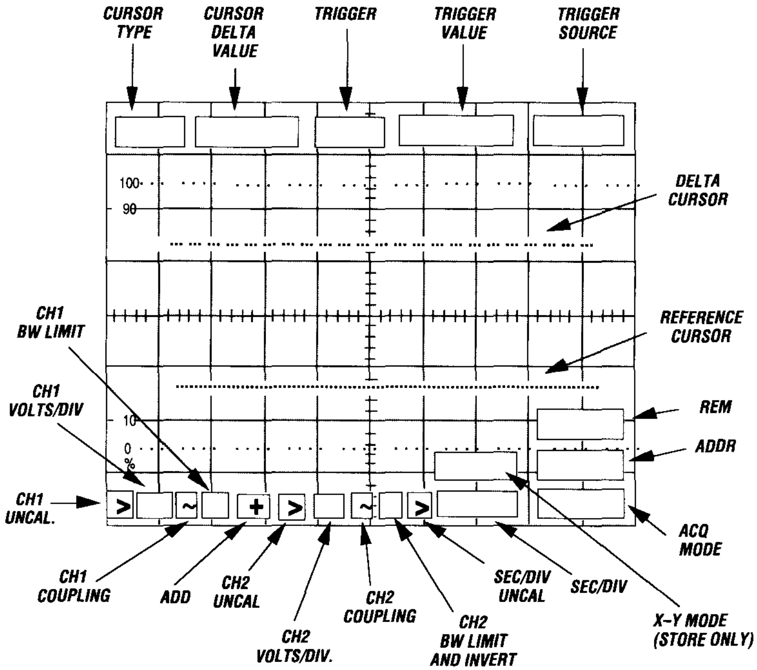


Figure 5-10: CRT Readout Display Fields

Top Row Readouts

Cursor Type

The Cursor Type indicates which Δ function has been selected.

Possible cursor types are:

- ΔV1, ΔV2, ΔV,
- ΔT,1/ΔT,
- Ratio, Phase,
- ΔVX and ΔVY.

The ΔT, 1/ΔT, ΔVX, and associated Phase and Ratio Cursors are displayed as vertical lines on the crt.

The ΔV1, ΔV2, ΔVY, ΔV and associated Ratio Cursors are displayed as horizontal lines on the crt as shown in Figure 5-10.

Cursor Delta Value

The Cursor Delta Value indicates the distance between the two cursors. The units in which the value is expressed, will depend upon the cursor type.

Possible units are:

- % (percent)
- ° (degrees)
- V (Volts)
- s (seconds), Hz (Herz)

Possible prefixes are :

- n (nano),
- μ (micro),
- m (milli),
- k (kilo),
- M (mega),
- G (giga)

Trigger

"Trig" indicates that the Trigger circuit is in operation.
In X-Y non-store mode, the trigger circuit doesn't influence the display, and therefore "Trig" is not displayed.

Trigger Value

The Trigger Value readout field indicates the value of the Trigger Level and the Trigger Coupling type. This field is disabled in X–Y mode.

Trigger Source

The Trigger Source readout field indicates the current trigger source.

Possible readouts are :

- CH1
- CH2
- VERT
- EXT
- LINE

Bottom Row Readouts

CH 1 Vertical Deflection

The CH 1 Vertical Deflection readout field indicates the current CH 1 VOLTS/DIV deflection setting.

Possible readouts are :

- 2, 5, 10, 20 and 50 mV
- 0.1, 0.2, 0.5, 1, 2, and 5V

A " > " sign appears in front of the value if the UNCAL LED lights.
A " ~ " sign appears after the value if the input is AC coupled.
" $\mathbf{B}_L$ " appears if the CH 1 bandwidth is limited.

ADD

If the instrument is set in the ADD Mode, a " **+** " sign appears in this readout field.

CH 2 Vertical Deflection

The CH 2 Vertical Deflection readout field indicates the current CH 2 VOLTS/DIV deflection setting.

Possible readouts are :

- 2, 5, 10, 20 and 50 mV
- 0.1, 0.2, 0.5, 1, 2, and 5V

A " > " sign appears in front of the value if the UNCAL LED lights.
A " ~ " sign appears after the value if the input is AC coupled.
" $\mathbf{B}_L$ " appears if the CH 2 bandwidth is limited.
A down arrow (" ↓ ") is displayed if CH 2 is inverted.

Horizontal Deflection

The Horizontal Deflection readout field indicates

- The current value of the SEC/DIV setting.
- In X-Y mode "**X-Y**" is displayed.

Possible readouts are :

- 1, 2, 4, 5, 10, 20, 40, and 50 ns
- 0.1, 0.2, 0.4, 0.5, 1, 2, 4, 5, 10, 20, 40, and 50 μs
- 0.1, 0.2, 0.4, 0.5, 1, 2, 4, 5, 10, 20, 40, and 50 ms
- 0.1, 0.2, 0.4, 0.5, 1, 2, 4, 5, 10, 20, 40, and 50 s

A " > " sign appears in front of the value if the UNCAL LED lights. A "≈" sign appears in front of the SEC/DIV setting if in the 1, 2, and 4 ns/div positions, to indicate the settings are approximate.

Acquisition Mode

The Acquisition Mode readout field indicates whether the instrument is in " **HOLD** " or " **ROLL** " store mode. This field is only active in the STORE mode.

ADDR

The ADDR readout field is used only by instruments with an optional interface option (Option 10 and/or 12), indicating that the instrument is ADDRessed to Talk or Listen.

REM

The REM readout field is used only by instruments with an interface option (Option 10 and/or 12), indicating that the instrument is in the REMote state.

X-Y MODE

The X-Y Mode readout field is only active if the instrument is in the X-Y Store mode.

Probes

This section intends to help you select the right probe for your application (see Table 5-8), how to connect a probe, and how to adjust the low-frequency compensation of a probe.

- Passive Voltage Probes
- Active Voltage Probes
- Current Probes
- Differential Probes
- Probe Connection

The 2212 standard instrument comes with two x10 probes (Tektronix type P6109) which are useful for a wide variety of tasks. For different measurement situations, you need different probes.

Additional probes are optional as listed in *Accesssories* (Appendix A). You may also use Table 5-8 to select a probe for your application.

NOTE

For more information on Tektronix Probes, etc., see the Tektronix Product Catalog or contact your Tektronix field representitive.

Passive Voltage Probes

Passive probes measure voltage. They employ passive circuit components such as resistors, capacitors and inductors. The common classes of passive voltage probes are:

- General purpose (High input resistance) probes
- High voltage probes

General Purpose (High Input Resistance) Probes

These are considered "typical" oscilloscope probes. Two passive probes are included with the 2212. The high input resistance of passive probes (typical 10 MΩ) provides negligible DC loading. Their capacitive loading however, can distort timing and phase measurements. High input resistance passive probes are preferred for measurements involving:

- Device characterization (above 15 V, thermal drift applications)
- Maximum sensitivity using 1X high impedance passive probes
- Between 15 and 500V
- Qualitative or go/no-go measurements

High Voltage Probes

High voltage probes have attenuation factors in the 100X to 1000X range. The considerations which apply to other passive probes apply equally well to the high voltage probes, with a few exceptions. The voltage range on high voltage probes varies from 1kV to 20 kV (DC + peak AC), resulting in probe head mechanical designs which are larger than their passive probe counterparts. High voltage probes have the added advantage of lower input capacitance, although this is offset by the reduced sensitivity.

The 2212 works with the P6009 and the P6015 high voltage probes for 1MΩ inputs. The P6009 works with a maximum input voltage of 1.5 kV DC + peak AC and the P6015 maximum input voltage is 20 kV + peak AC continuous (or 40 kV peak for less than 100 ms)

Active Voltage Probes

Active voltage probes employ active circuit elements such as transistors in the probe body and compensation box to acquire and process signals from the circuit under test. All active probes require a source of power for their operation. Power is obtained from an external power supply or from the scope itself.

Active probes offer low input capacitance (2 pF typically) while maintaining the higher input resistance of passive probes (10 MΩ typically). Active probes are useful for making accurate timing and phase measurements, without degradation of amplitude accuracy. Active probes have a dynamic range of typically ±10 to ± 15 V.

Some active probes are also referred to as "FET" probes. The 2212 works with the P6202A FET probe and the 1101A probe power supply for the P6202A.

Current Probes

Current sensing probes use transformers or a combination of transformers and Hall effect devices to convert flux fields to voltage signals.

Current probes enable you to directly observe and measure current waveforms, which may be very different from voltage signals.

Two types of current probes are available: one that measures AC current only, and AC/DC probes, which utilize the Hall effect to accurately measure the AC or DC components of a DC or mixed AC/DC signal. AC-only current probes use a transformer to convert current flux into a voltage signal to the oscilloscope, and have a frequency response from a few hundred Hertz up to 1 GHz. AC/DC current probes include Hall effect semiconductor devices and provide a frequency response from DC to 50 MHz.

Use a current probe by clipping its jaws around the wire carrying the current that you want to measure. Because current probes are non-invasive, with loading typically in the mΩ to low Ω range, they are especially useful where low loading of the circuit is important. Current probes can also make differential measurements by measuring the results of two opposing currents in the jaws of the probe.

The 2212 oscilloscope can work with a variety of Tektronix current probes including:

- The A6302/A6303, with an AM503 current probe amplifier in a TM502A power module, which provides you the capability to measure both AC and DC currents with one probe.
- The P6021 AC current probe, with an 134 current probe amplifier amplifier, which provides you the capability to measure AC currents.
- The P6022, with a small package that makes it well-suited to measure current in compact semiconductor circuits.
- The CT-1 and CT-2, which are designed for more permanent in-circuit installation.

Differential Probes

Differential Probes determine the voltage drop between two points in a circuit under test. Differential probes enable you to simultaneously measure two points and to display the difference of the two voltages on your 2212.

Differential signal processing takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. Differential probe-tip signal processing minimzes the measurement errors caused by differences in probes, cable lengths, and input attenuators.

The common mode rejection ratio is a measure of how effectively the probe cancels signals which are common to both inputs while the common mode range indicates the maximum amplitude the common signal can reach before the probe circuitry is saturated.

The 2212 works with the P6046 Differential Probe. This is a 100 MHz differential amplifier in probe form which connects one oscilloscope input channel.

Table 5-8: Summary of Tektronix Measurement Probes for the 2212 Oscilloscope

Probe Type	Description/ Attenuation	Loading (R_{in}, C_{in})	Bandwidth at –3 dB
P6101A Opt 01	1X Passive Probe	1 MΩ / 32 pF	DC to 34 MHz
P6109 Opt 01	10X Passive Probe	10 MΩ / 11.8 pF	DC to 150 MHz
P6121	10X Passive Probe Tip/Head Style : Sub miniature	10 MΩ / 11 pF	DC to 100 MHz
P6062B	1X / 10X Passive Switchable Probe	10 MΩ / 14 pF	DC to 100 MHz
P6009	100X High Voltage Passive Probe (1.5 kV max.)	10 MΩ / 2.5 pF	DC to 120 MHz
P6015	1000X High Voltage Passive Probe (20 kV max.)	100 MΩ / 3.0 pF	DC to 75 MHz
P6046	1X/10X Differential Probe		Dc to 100 MHz
P6008	Environmentalized 10X Probe (–50 to +150 °C)	10 MΩ / 7.5 pF	DC to 100 MHz
P6202A	Active FET 10X Probe	10 MΩ / 2.0 pF	DC to 500 MHz
1101A	Accessory Power Supply for P6202A.		
P6408	Word Recognizer/ Trigger Probe		
A6302	Current Probe (max. 20 A DC)		DC to 50 MHz
A6303	Current Probe (max. 100 A DC)		DC to 15 MHz
AM503	Current Probe Amplifier for P6302 / P6303		

Probe Connection

Generally, the probes supplied with the instrument provide the most convenient way of connecting a signal to the vertical inputs of the oscilloscope.

The standard accessory probe is a compensated 10X voltage divider. It is a resistive voltage divider for low frequencies and a capacitive voltage divider for high-frequency signal components. The VOLTS/DIV scale factors, displayed on the crt readout, reflect the probe attenuation factor when a Tektronix coded probe is used.

The probe and probe lead are shielded to prevent pickup of stray electromagnetic interference, and the 10X attenuation factor of the probe offers a high input impedance that minimizes loading in the circuitry under test.

The way you attach your probe to a signal source can affect the results you get. Two important factors that can affect your signal are:

- Ground lead inductance (introduced by the probe).
- Misadjustment of the probe compensation.

Ground Lead Inductance

The probe's ground lead provides the best grounding method for signal interconnection and ensures the maximum amount of signal shielding in the probe cable. You can make reliable signal measurements when the 2212 and the Unit Under Test are connected by a common reference (ground lead) in addition to the signal lead or probe. A separate ground lead can also be connected from the unit under test to the oscilloscope ground receptacle located on the front panel.

To get the best waveform fidility, keep the probe ground and signal leads as short as possible. Inductance introduced by either a long signal lead or ground lead forms a series-resonant circuit. This circuit will affect the system bandwidth and it will cause ringing if driven by a signal containing frequency components at or near the circuit's resonant frequency. Oscillations (ringing) can then appear on the oscilloscope waveform display, distorting the true signal waveshape.

Misadjustment of Probes

Misadjustment of the probe compensation is a common source of measurement error. Probes should be compensated whenever the probe is moved from one oscilloscope to another or between channels on the same oscilloscope.

Maintenance and Repair

The 2212 is covered by a standard Tektronix three-year warranty. If the 2212 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 within the United States, call the following toll-free customer service number between 8.00 AM and 4.30 PM Pacific Time:

1-800-937-6007

Outside the U.S., call your local Tektronix Sales Office or Service Center. They are fully equipped to service your instrument.

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. The firware identification number can be found in the MENU (see Section 3, chapter *SETUP*).

If your instrument must be returned for servicing, package it as described below.

Repackaging for Shipment

We recommend that you save the original carton and packing material, in case you must return your instrument for repair or service. If the original packaging is unfit for use or is not available, then repackage the instrument in the following manner:

Step 1. Use a corrugated cardboard shipping carton having inside dimensions at least 15 cm (6 in) taller, wider and deeper than the instrument. The carton must be constructed of cardboard with a test strength of at least 375 pounds.

Step 2. If the instrument is being shipped to a Tektronix Service Center for repair or calibration, attach a tag to the instrument showing:

- The owner of the instrument and address.
- The name and phone number of a person to be contacted if additional information is needed.
- Instrument type and serial number.
- The reason for returning the instrument.
- A complete description of the service required.

Step 3. Wrap the instrument with polyethylene sheeting or equivalent material to protect the outside finish of the instrument.

Step 4. Cushion the instrument in the shipping carton by tightly packing dunnage or urethane foam on all sides between the carton and the instrument. Allow for 7.5 cm (3 in) of padding on all sides (including top and bottom).

Step 5. Seal the carton with strapping tape or with an industrial stapler.

Step 6. Mark the address of the Tektronix Service Center and your return address on the carton in one or more prominent locations.

Options & Accessories

This section presents you a general description of the 2212 options and accessories.

- Standard Accessories
- Options
- Optional Accessories

Also included is a complete list (with Tektronix part numbers) of standard accessories included with each 2212 and a list of optional accessories.

You can obtain additional information about instrument options, option availability, and other accessories by consulting the current Tektronix Product Catalog, or by contacting your local Tektronix Field Office or representative.

Standard Accessories

The following standard accessories are provided with each 2212 (see Table A-1):

Table A-1: Standard Accessories

Qty	Description	Tektronix Part Number
2	10x Passive Probe	P6109B
1	Power Cord and Fuse	As Ordered
1	Loop Clamp	343-0003-00
1	Flat Washer	210-0803-00
1	Self-Tapping Screw	213-0882-00
1	User Manual	070-8438-00
1	Quick Reference	070-xxxx-xx

Options

Options A1 – A5 International Power Cords

Instruments are shipped with a detachable power-cord configuration ordered by the customer. Table A-2 identifies the Tektronix part numbers for the available power cords and fuses.

Warranty -Plus Service Options

The following options add to the services available with the standard warranty.

- **Option M2**: When Option M2 is ordered, Tektronix provides five years of warranty/remedial service.
- **Option M8**: When Option M8 is ordered, Tektronix provides four calibrations and four performance verifications, one for each in the second through the fifth years of service.

Table A-2: Power Cord Options

Option	Description	Tektronix Part Number
Standard		
(North American)	120 V, 60 Hz, 74 in.	161-0230-01
Fuse	1.0 A, 250 V, Slow	159-0019-00
Option A1		
(Universal Euro)	220 V, 50 Hz, 2.5 m	161-0104-06
Fuse	0.5 A, 250 V, Slow	159-0032-00
Option A2		
(United Kingdom)	240 V, 50 Hz, 2.5 m	161-0104-07
Fuse	0.5 A, 250 V, Slow	159-0032-00
Option A3		
(Australian)	240 V, 50 Hz, 2.5 m	161-0104-05
Fuse	0.5 A, 250 V, Slow	159-0032-00
Option A4		
(North American)	220 V, 50 Hz, 2.5 m	161-0104-08
Fuse	0.5 A, 250 V, Slow	159-0032-00
Option A5		
(Switzerland)	220 V, 50 Hz, 2.5 m	161-0167-00
Fuse	0.5 A, 250 V, Slow	159-0032-00

Option 3R Rackmounted Instrument

When ordered with Option 3R, the oscilloscope is shipped in a configuration that permits easy installation into a 19-inch-wide, electronic-equipment rack. All hardware is supplied for mounting the instrument into the rack.

Complete rack-mounting instructions are provided in a separate document (Tektronix part nummer 070-8650-00). These instructions also contain the procedures for converting a standard instrument into the Option 3R configuration by using the separately ordered rack-mounting conversion kit.

Option 10 (GPIB)

Option 10 provides a GPIB (General Purpose Interface Bus) communication interface. The interface implemented conforms to the specifications contained in *IEEE Standard Digital Interface for Programmable Instrumentation (ANSI/IEEE Std 488.2-1987).* It also complies with a Tektronix Standard relating to GPIB Codes, Formats, Conventions and Features 4-91. Operating information for the Option 10 GPIB interface is given in the *2212 Programmer Manual,* delivered with Option 10.
GPIB connector pin-outs are described in Section 5 *(Interfaces).* The GPIB option can be set in the MENU (see Section 5 *(Interfaces*).

Option 12 (RS-232-C)

Option 12 provides an RS-232-C serial communications interface. The interface implemented conforms to RS-232-C specifications. The option provides DTE capability to hook up a printer, plotter, personal computer, or modem that may be encountered. Operating information for the Option 12 RS-232-C interface is given in the *2212 Programmer Manual,* delivered with Option 12.
The RS-232-C interconnection plug is described in Section 3 *(Interfaces).* The RS-232-C parameters can be set in the MENU(see Section 5 *(Interfaces).*

Option 02	A Front Panel Cover and Accessories Pouch is provided.
Option 05	Video Option aids in examining composite video signals. All basic functions remain the same, but the menu is changed and a TV page is added. Features of this option include a sync separator, back-porch clamp circuitry, and TV coupling modes.
Option 1K	A Tektronix K212 Portable Instrument Cart is provided.
Option 1M	This option provides in store mode selectable record lengths up to 131072 data points (128K) per acquisition on both channels.
Option 1T	A Carrying Case is provided.
Option 23	Two P6129B 1x /10x Readout Passive Voltage Probes are provided.

Optional Accessories

The following optional accessories are recommended for use with the 2212.

Instrument Enhancements	Tek Part Number
Front-panel Protective Cover	200-3397-00
Accessory Pouch	016-0677-02
Front-panel Protective Cover and Accessory Pouch	020-1514-00
Carrying Case	016-0792-01
CRT Light Filter, Clear	337-2775-01
Portable Instrument Cart	K212
25-Pin PC to Centronics Cable	012-1214-00
GPIB Cable (1 meter)	012-0991-01
GPIB Cable (2 meter)	012-0991-00
RS-232-C Cable	012-1423-00
Gender Changer (for use with 012-1423-00)	131-4923-00
Service Manual	070-8439-00
Programmer Manual	070-8440-01

Viewing Hoods

Collapsible	016-0592-00
Polarized	016-0180-00
Binocular	016-0566-00

Fuses

Fuse, 1.0 A, 250 V, 3AG, Slow	159-0019-00
Fuse, 0.5 A, 250 V, 3AG, Slow	159-0032-00

Voltage Probes

Differential 1X/10X Probe	P6046
Active Probe, 10X FET	P6202A
Active Probe Power Supply (for P6202A)	1101A
1X Probe	P6101B

1X Probe	P6101B
10X Probe (1.5 m)	P6109 Opt 01
10X Probe	P6109B
10X Environmental	P6008
1X-10X Selectable	P6129B
100X High Voltage	P6009
1000X High Voltage	P6015
Ground Isolation Monitor	A6901
Isolator (for multiple independently referenced differential measurements)	A6902B

Current Probes

Low-Current (0.5 A) Probe	P6021
Low-Current (0.2 A) Probe	P6022
Current-Probe Amplifier (for P6021/P6022)	134
High-Current Probe (20 A)	A6302
High-Current Probe (100 A)	A6303
Current Probe Amplifier (for A6202/A6203)	AM503
A TM500/TM5000 Power Module for AM503	TM50xx

Oscilloscope Cameras

Low Cost Camera (with portables hood)	C-9 Option 20
Low Cost Camera with Flash Unit	C-9 Option 1F
Low Cost Camera with Autofilm Motorized Back	C-9 Option 1A
High-Performance Camera	C30BP Option 01

Printers / Plotters

Printer	HC200
Plotter	HC100 Opt. 02

General Product Description

This subsection begins with a general description of the traits of the 2212 oscilloscope. Three subsections follow, one for each of the three classes of characteristics: *nominal traits, warranted characteristics,* and *typical characteristics.*

User Interface

This oscilloscope uses the front-panel buttons and knobs to control its many functions. The front-panel controls are grouped according to function: vertical, horizontal, trigger, cursor, setup, and storage. The controls just to the right of the crt screen are called the display group. Within each group, the functions are set directly by their own front-panel knob.

When Option 10 (GPIB) and/or Option 12 (RS-232-C) are included most functions of the oscilloscope can be operated externally by a controller (PC).

Indicators

Several on-screen readouts help you keep track of the settings for various functions, such as vertical and horizontal scale and trigger level. There are also crt readouts to display the results of measurements, using cursors.

Signal Acquisition System

In (Digital) Storage mode, the signal acquisition system provides two vertical channels with calibrated vertical scale factors from 20 mV thru 50 V with a 10X probe (P6109), and 2 mV thru 5 V per division with a 1X probe P6101A (optional). Both channels can be acquired simultaneously. The vertical channels have a bandwidth of ± 10 MHz in Store mode.

Each of the two channels can be displayed, scaled and vertically positioned and have their vertical coupling specified.
Channel 2 can also be inverted.

Besides the two channels, up to two stored waveforms are available for display.

With the VARiable VOLTS/DIV gain control (VAR) you can increase the deflection factor to overlap the next VOLTS/DIV setting.

You can select the following display modes:

CH 1, ADD, ALT, CHOP, X-Y or CH 2.

- In CH 1 or CH 2 mode, only the signal applied to the CH 1 OR X input connector or to the CH 2 OR Y input connector is displayed on the crt screen.
- In ALTernate mode, the display switches between CH 1 and CH 2 at the end of each sweep, showing the signals applied to each channel alternately.
- In CHOPped mode, the display switches between CH 1 and CH 2 at a rate of ±500 kHz as the sweep is occurring to display both channels simultaneously on the crt.
- In ADDed mode, the signals applied to the CH 1 OR X input connector and the CH 2 OR Y input connector are algebraically added.
- In the X–Y Store mode, the acquisition and the sampling rate are set by the SEC/DIV switch and/or the EXT CLOCK.
  The signal connected to the CH 1 OR X connector is switched to the horizontal deflection and the signal connected to the CH 2 OR Y connector to the vertical deflection.

If the ADD, ALT or CHOP mode is selected in Store mode, the signals applied to the vertical input connectors are acquired similtaneously. However, if the vertical mode is in ALT and the trigger source is in VERT MODE, CH 1 and CH 2 will be digitized alternately.

Vertical Non-Storage
Deflection System

In Non-Storage (Analog) mode, the vertical deflection system provides two vertical channels with calibrated vertical scale factors from 20 mV to 50 V with a 10X probe (P6109), and 2 mV to 5 V per division with a 1X probe P6101A (optional). Both channels can be displayed simultaneously.

Each of the two channels can be displayed, scaled and vertically positioned, and have their vertical coupling specified.
Channel 2 can also be inverted.

The vertical channels have a bandwidth of 60 MHz in the 5 mV/DIV thru 5 V/DIV position. In the 2 mV/DIV position the bandwidth is reduced to approximately 10 MHz.

Independent bandwidth limiting (to ±10 MHz) for each channel is also possible with the BW Limit switched on. You can limit one channel's bandwidth to ±10 MHz without affecting the bandwidth of the other channel.

With the VARiable VOLTS/DIV gain control (VAR), you can increase the deflection factor to overlap the next VOLTS/DIV setting.

You can select the following display modes:

CH 1, ADD, ALT, CHOP, X-Y and CH 2.

- In CH 1 or CH 2 mode, only the signal applied to the CH 1 OR X input connector or to the CH 2 OR Y input connector is displayed on the crt screen.
- In ALTernate mode, the display switches between CH 1 and CH 2 at the end of each sweep, showing the signals applied to each channel alternately.
- In CHOPped mode, the display switches between CH 1 and CH 2 at a rate of ±500 kHz as the sweep is occurring to display both channels simultaneously on the crt.
- In the ADDed mode, the signals applied to the CH 1 OR X input connector and the CH 2 OR Y input connector are algebraically added.
- In X-Y mode, the signal connected to the CH 1 OR X connector is switched to the horizontal deflection and the signal connected to the CH 2 OR Y connector to the vertical deflection.

Horizontal Display System

There are two horizontal display systems :

- Horizontal Non-Storage Display System
- Horizontal Storage Display System

You can horizontally position the waveform with the horizontal POSITION knob.

The X1, X10, X50 magnifier switch magnifies the horizontal display 10 or 50 times around the center vertical graticule line.

Horizontal Non-Storage Display System

In Non-Store mode, the 2212 provides a calibrated sweep speed range from 0.5 s per division to 0.05 μs per division. You can use the variable timing control (VAR) to increase the non-store sweep time per division by a factor of up to 2.5 times the calibrated time per division, as selected with the SEC/DIV switch.

You can use the Alternate Magnifier feature (ALT MAGN) to display the magnified and unmagnified sweep alternately on the crt screen in Non-Store mode. You can reposition the unmagnified sweep vertically with the Trace Separation control (TR SEP) in the ALT MAGN mode.

Horizontal Storage Display System

In Store mode, the 2212 provides a calibrated sweep speed range from 50 s to 20 μs per division. The SEC/DIV switch setting determines the acquisition and display modes, sets the sampling rate and establishes the time scale factor of the displayed waveform.

The maximum sampling rate is 20 megasamples per second (20 Ms/s) with a stored record length per waveform of 4096 points for single-channel and dual-channel acquisitions. All 4k points are visible on screen at one time.

One waveform set (CH 1 and CH 2), 4k record length each, can be stored in the reference memory as a refernce waveform, giving a total 8k record length. Previous stored data in the reference memory is overwritten. A reference waveform may be recalled for display and comparison with the current acquisition waveform.

The storage system has two acquisition modes, selected by the SEC/DIV switch setting:

- **RECORD** mode. The SEC/DIV must be set to 0.2 SEC/DIV or faster. A full record is acquired before the acquired data is displayed on the crt screen. All triggering modes are selectable.

- **ROLL** mode. The SEC/DIV must be set to 0.1 SEC/DIV or slower. Every new acquired data point is displayed immediately to the right side of the crt screen and the complete display is shifted one position to the left. Triggering is disabled, except in SGL SWEEP (single sweep) mode. "ROLL" is displayed in the crt readout.

With the 2212 in X-Y Store mode, the SEC/DIV and /or the EXT CLOCK INPUT determine the sample rate. The External Clock Input (EXT CLK)provides input for external clock signals to the storage circuit when the SEC/DIV switch is in one of the two EXT CLK positions (RECORD or ROLL).

Triggering System

The triggering system provides triggering from the channel 1 and/or channel 2 signals or from the external trigger input (EXT INPUT OR Z). Types of trigger signals recognized include:

- **Internal** : This type of triggering is fully configurable for LEVEL, SOURCE, MODE, COUPLING, and SLOPE.

- **External** : This triggering source is configurable for SLOPE, LEVEL, MODE, and COUPLING like the internal sources.

You can choose the pre-trigger point within the acquired waveform record by selecting the amount of pre-trigger (25% or 75%)with the PRETRIG switch.

The hold-off time can be adjusted with the trigger HOLD OFF control.

The EXT OR Z input, at the bottom of the TRIGGER section, can be used to apply either an external trigger signal to the trigger circuit or an external Z-axis (display intensity) control signal to the Z-axis circuit.

Setup

The setup function allows you to automatically setup the instrument with the push of a single button (AUTO).
The SET UP feature is intended to automatically set the vertical, horizontal, triggering and display controls, to display an unknown waveform on the crt screen with an optimized front panel set-up.

With the SAVE and RECALL function, you can respectively save the current front panel set-up in the memory, or recall the last stored front panel set-up from that memory.

With the SAVE and RECALL button pressed simultaneously, the MENU screen is called.

Cursor

Once you have set up to make your measurements, the cursor feature can help you make those measurements quickly.

Two types of cursor are provided for making measurements on the displayed waveforms:

- They appear as horizontal dotted lines on the screen with delta-voltage measurements.
- They appear as vertical dotted lines with delta-time and frequency measurements.

The cursor controls allow you to make delta-voltage (ΔV), delta-time (ΔT), and frequency ($1/\Delta T$) measurements using the cursors on the display.

You can select two cursor modes:

- **TRACK** mode. Both cursors are dashed. Rotating the cursor POSITION causes both cursors to move.
- **DELTA** mode. The delta cusor is dashed, and the reference cursor is dotted. Rotating the cursor POSITION causes the delta cursor to move and the reference cursor is fixed.

Storage and I/O

In STORE mode, signals supplied to the vertical inputs are acquired by the digital storage circuit and displayed on the crt screen.

You may store an acquired and displayed waveform in the reference memory pushing the SAVE button, and recall it pressing the RECALL button.

The HOLD switch is a function that stops the acquisition when pressed.

Another standard feature of the 2212 is the Print Screen (PRNSCR). function. This feature allows you to output waveforms and other on-screen information to a Centronics ® compatible printer/plotter, providing hardcopies without requiring you to put the oscilloscope in a system controller environment. The hardcopies obtained are based on what is displayed at the time PRNSCR is invoked.

A menu to setup the communication interface can be selected by pressing SAVE and RECALL simultaneously. The parameters for the menu can be selected with the TOGGLE CURSOR switch and the cursor POSITION control.

The 2212 oscilloscope with Option 10 (GPIB) an/or Option 12 (RS-232-C) is fully controllable and capable of sending and receiving waveforms over the GPIB interface (IEEE 488.2 1987 standard). This optional feature makes the 2212 ideal for making automated measurements in a production or research environment that calls for repetitive data taking

Display

The display functions of the 2212 include the crt screen and the display controls located just to the right of the crt screen.

The screen display shows you signal traces, the crt readouts associated with them, and menu items.

The 2212 displays crt readouts along the top row and the bottom row of the screen

The INTENSITY control is used to adjust brightness of the trace or the readout intensity.

The FOCUS control is used to adjust for a well defined display.

Pushing the BEAMFIND switch helps you find off-screen signals quickly.

NOTE
The display controls affect the display only.

Nominal Traits

This subsection contains a collection of tables that list the various *nominal traits* that describe the 2212 Analog & Digital Storage Oscilloscope. 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 of", rather than in terms of limits that are performance requirements.

Table B-1: Nominal Traits – Vertical System

Name	Description
Analog Input Channels, number of	Two, full-featured (CH 1 and CH 2)
Digitizers, Number of	Two, both identical
Digitized bits, Number of	8-bits, 25 levels per division,10.24 divisions of dynamic range
Input Coupling	DC, AC, or GND
Maximum Input Voltage, Probe Tip to Common	400 V (DC + peak AC) or 800 V AC p-p at 10 kHz or less; derate with increased frequency according to Figure B-1
Range, Sensitivity, CH 1 and CH 2	2 mV to 5 V in a 1-2-5 settings sequence
Analog Banbdwidth(–3 dB)	60 MHz at 5 mV/DIV thru 5 V/DIV and 10 MHz at 2 mV/DIV
Useful Storage Performance[1]	$\frac{20}{\text{SEC/DIV Setting}}$ or 10 MHz, whichever is less

[1] **Useful Storage performance is defined as the frequency where there are 2 samples per sinewave signal period at the maximum sampling rate. At SEC/DIV setting at 20 μs/division the bandwidth is limited to 10 MHz.**

Table B-2: Nominal Traits– Horizontal System

Name	Description
Non-Store Range, Seconds/Division	0.5 s to 50 ns per division in a 1-2-5 settings sequence
Magnification Factor	X10 and X50 the SEC/DIV setting
Store Range, Seconds/ Division	50 s to 20 μs per division
Record Length	4096 data points; 400 points per division across the graticule area
Digital Sample Rate	$\frac{400}{\text{SEC/DIV setting}}$ Samples per second

Table B-3: Nominal Traits –Triggering System

Name	Description
Trigger Source	CH 1, CH 2, Vert. Mode, Line, External, and External/10
Trigger Mode	P-P Auto, Normal, Single Sweep, TV Line, and TV field
Trigger Coupling	Noise Rejection, Low Frequency Rejection, High Frequency Rejection, AC, and DC
External Trigger Maximum Input Voltage	400 V (DC + Peak AC) or 800 V p-p AC at 10 kHz or less (see Figure B-1)

Table B-4: Nominal Traits – Display System

Name	Description
Waveform Display Graticule	Single graticule:Display area of 8 divisions high by 10 divisions wide,where divisions are 1x1 cm

Table B-5: Nominal Traits – Interfaces, Output Ports, and Power Fuse

Name	Description
Interface, Parallel	IBM ® PC compatible Parallel Printer/Plotter Interface for Centronics ® compatible printers/ plotters
Interface, Serial (RS-232-C) (Optional)	Conforms to EIA Standard RS-232-C
Interface, GPIB (Optional)	GPIB Interface complies with IEEE 488.2 1987
Fuse Rating	Either of two fuses may be used: 0.5 A 250 V, slow blow for 190-250 VAC, or 1.0 A, 250 V, slow blow for 95 - 128 VAC

Table B-6: Nominal Traits – Mechanical

Name	Description
Cooling Method	Forced-air ciculation with no air filter
Construction Material	Aluminum chassis. Plastic-laminate front and rear panel
Finish	Tek blue structure paint on aluminum cabinet
Weight with power cord	± 9.5 kg
Domestic Shipping Weight	± 12 kg
Overall Dimensions	Height ± 138 mm Width ± 380 mm (with carrying handle) Width ± 327 mm (without carrying handle) Depth ± 445 mm Depth ± 515 mm (with handle extended)

Warranted Characteristics

This subsection list the various *warranted characteristics* that describe the 2212 Analog & Digital Storage Oscilloscope. Included are electrical and environmental characteristics.

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

NOTE

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

In the *Name* column a distinction is made between operational modes:

- With comment Store means the characteristic is valid only if the instrument is in Store mode.
- With comment Non-Store means the characteristic is valid only if the instrument is in Non-Store mode.
- No comment means the characteristic is valid with the instrument in Store mode as well as in Non-Store mode.

Environmental characteristics are given in Table 6-15. This instrument meets the requirements of MIL-T-28800D for Type lll, Class 5 equipment, except where noted otherwise.

Performance Conditions

The following electrical characteristics (Table 6-7 thru Table B-15) are valid when the instrument has been adjusted at an ambient temperature between +20 °C and +30 °C, has had a warm-up period of at least 20 minutes, and is operating at an ambient temperature between 0 °C and +40 °C (unless otherwise stated).

Table B-7: Warranted Characteristics – Vertical System

Name	Description	
DC Accuracy	±3%	
CH Input Impedance	1 MΩ ± 2% parallel with 20 pF + 2.0 pF/–4 pF	
Trace Shift with VOLTS/ DIV Switch Rotation	**VARiable Setting**	**Trace Shift**
	VARiable Control Off	1.0 division or less
	VARiable control set to minimum sensitivity	1 division or less
	CH 2 Switched to CH 2 INVert	1.5 division or less
Cross Talk (Channel Isolation)	≥ 100:1 at 10 MHz for any two channels having equal Volts/Division and Coupling settings.	
Bandwidth (Non-Store) (-3 dB)	**VOLTS/DIV Setting**	**Bandwidth**
	5 mV/DIV to 5 V /DIV	DC to at least 60 MHz (5 °C to +35 °C ambient)
		DC to at least 48 MHz (0 °C to +40 °C ambient)
	2 mV/DIV	DC to at least 10 MHz (0 °C to +40 °C ambient)
AC Coupled Lower Cutoff Frequency	10 Hz or less at –3 dB	

Table B-8: Warranted Characteristics – Horizontal System

Name	Description	
Timebase Accuracy [a] (Non-Store)	**Magnifier Setting**	**Measurement Accuracy**
	X1 (+15 °C to +35 °C)	±3%
	X10 Magn (+15 °C to +35 °C)	±4%
	X50 Magn (+15 °C to +35 °C)	±5%[c]
	X1 (+0 °C to +40 °C)	±4%
	X10 Magn (+0 °C to +40 °C)	±5%
	X50 Magn (+0 °C to +40 °C)	±8% [c]
Sweep Linearity [a] (Non-Store)	**Magnifier Setting** (+15 °C to +35 °C)	**Measurement Accuracy**
	X1	5%
	X10	8%
	X50	9%
Displayed Trace Length (Non-Store)	≥10 Divisions.	
Storage SweepResolution	400 Dots per Division	
Differential Accuracy [b]	Graticule indication of time cursor difference is within ±2% of readout value	
EXT CLK Maximum Input Voltage	(DC + peak AC) 25 V or 25 V p-p AC at 100 kHz or less (See Figure B-1)	
Input Impedance	1 MΩ ± 10 % parallel 25 pF ± 2.5 pF	

[a] **Sweep accuracy and Sweep Linearity applies over the center eight divisions. Exclude the first 50 ns of the sweep for X10 magnified sweeps and the first 100 ns for X50 magnified sweep. Exclude beyond the 10th division of the unmagnified sweep.**

[b] **Measured over center eight divisions.**

[c] **Max. 10 nsec/Div**

Table B-9: Warranted Characteristics – Triggering System

Name	Description	
Sensitivity [a], with Coupling DC	**Source**	**Sensitivity**
	Internal	0.35 division from DC to 5 MHz, increasing to 1.2 division at 60 MHz
	External [b]	40 mV p-p from DC to 5 MHz, increasing to 150 mV p-p at 60 MHz
Sensitivity [a], with Coupling AC	**Source**	**Sensitivity**
	Internal	0.35 division from 50 Hz to 5 MHz, increasing to 1.2 division at 60 MHz
	External [b]	40 mV p-p from 50 Hz to 5 MHz, increasing to 150 mV p-p at 60 MHz
Sensitivity [a], with Coupling NOISE REJ	**Source**	**Sensitivity**
	Internal	1.4 division from DC to 5 MHz, increasing to 2.2 division at 60 MHz
	External [b]	160 mV p-p from DC to 5 MHz, increasing to 600 mV p-p at 60 MHz

[a] Trigger sensitivity is defined as the minimum peak-to-peak sine-wave signal amplitude required to show the test signal with horizontal jitter of less than 3% of one period (p-p viewed over two seconds),with trigger LEVEL control set at about midrange level, but not at control extremes.

[b] External trigger signal from a 50 Ω source driving a 50 Ω coaxial cable terminated in 50 Ω at the input connector.

Table B-9: Warranted Characteristics – Triggering System (cont.)

Name	Description	
Sensitivity [a], with Coupling LF REJ	**Source**	**Sensitivity**
	Internal	0.35 division from 50 kHz to 5 MHz, increasing to 1.2 division at 60 MHz
	External [b]	40 mV p-p from 50 kHz to 5 MHz, increasing to 150 mV p-p at 60 MHz
Sensitivity [a], with Coupling HF REJ	**Source**	**Sensitivity**
	Internal	0.35 division from DC to 20 kHz
	External [b]	40 mV p-p from DC to 20 kHz
Sensitivity [a], with TV Trigger Mode	**Source**	**Sensitivity**
	TV Line Internal	1.0 division
	TV Field Internal	1.0 division of Composite Sync
EXT Trigger Input	**Measurement**	**Limit**
	Maximum Input Voltage	400 V (DC + peak AC) or 800 V AC p-p at 10 kHz or less (See Figure B-2)
	Input Impedance	1 MΩ ±10% parallel to 20 pF ±2.5 pF

[a] **Trigger sensitivity is defined as the minimum peak-to-peak sine-wave signal amplitude required to show the test signal with horizontal jitter of less than 3% of one period (p-p viewed over two seconds),with trigger LEVEL control set at about midrange level, but not at control extremes.**

[b] **External trigger signal from a 50 Ω source driving a 50 Ω coaxial cable terminated in 50 Ω at the input connector.**

Table B-9: Warranted Characteristics – Triggering System (cont.)

Name	Description	
Trigger LEVEL Control Range (P-P AUTO, NORM,and SGL SWP Mode)	**Measurement**	**Range**
	INT	May be set to any voltage level of the waveform that can be displayed
	EXT, DC	At least ±1.2 V, 2.4 V p-p
	EXT:10, DC	At least ±12 V, 24 V p-p
Trigger COUPLING (–3 dB points)	**Measurement**	**Accuracy**
	NOISE REJection	DC to Full Bandwidth
	AC Coupled Lower –3 dB point	10 Hz or less (Internal Source) 20 Hz or less (External Source)
	LF REJ Lower –3 dB point	30 kHz ± 25%
	HF REJ Upper –3 dB Point	30 kHz ± 25%
	DC Coupled	DC to Full Bandwidth

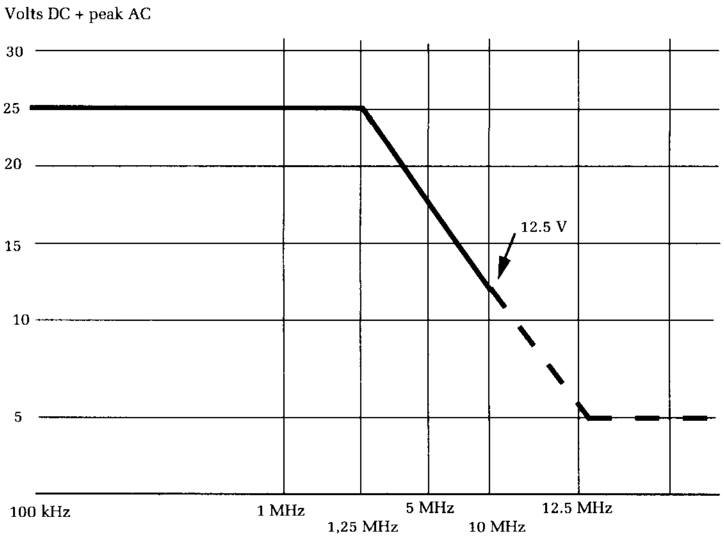


Figure B-1: Maximum Input Voltage Versus Frequency Derating Curve for the EXT CLK Connector

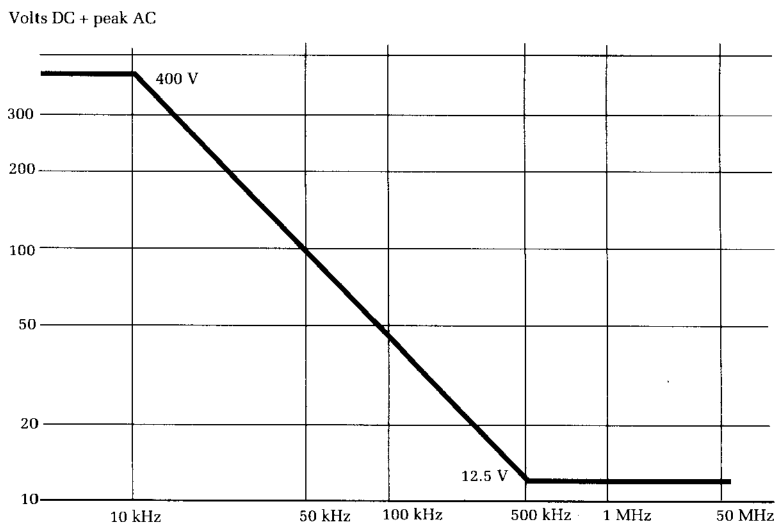


Figure B-2: Maximum Voltage Versus Frequency Derating Curve for the CH1 OR X, CH 2 OR Y, and EXT OR Z Connectors

Table B-10: Warranted Characteristics – Digital Storage System

Name	Description
Position Registration	Switching from Non-Store to Store the trace shift must be within ±0.5 division at graticule center, with VOLTS/DIV switch settings from 2 mV/DIV to 5 V/DIV
Differential Accuracy [a]	Graticule indication of time cursor difference is within ±2% of readout value

[a] Measured over center eight divisions

Table B-11: Warranted Characteristics – Readout Display System

Name	Description	
Trigger Level Readout Accuracy [a]	Within ± (0.3 division + 5% of reading)	
Voltage Difference Readout Accuracy [b]	± (3% of reading + 2% of one vertical Readout division + high frequency display errors) of the ΔV Readout value	
Time Difference Readout Accuracy Non-Store Mode [c] (15 °C to 35 °C)	**Magnifier Setting**	**Accuracy**
	X1	± 4%of reading + (2% of one horizontal division)
	X10 Magn	± 5% of reading + (2% of one horizontal division)
	X50 Magn	± 6% of reading + (2% of one horizontal division)
Time Difference Readout Accuracy Non-Store Mode [c] (0 °C to 40 °C)	**Magnifier Setting**	**Accuracy**
	X1	± 5% of reading + (2% of one horizontal division)
	X10 Magn	± 6% of reading + (2% of one horizontal division)
	X50 Magn	± 9% of reading + (2% of one horizontal division)
Time Difference Readout Accuracy Store Mode [c] from 0 °C to 40 °C	± 0.1% of reading + (2% of one horizontal division)	

Table B-11: Warranted Characteristics – Readout Display System (cont.)

Name	Description	
Cursor Resolution Voltage Difference Accuracy	100 steps per division	
Cursor Resolution Time Difference Accuracy	**Display**	**Resolution**
	Non-Store	100 steps per division
	Store X1	400 steps per division
	Store X10 Magn	40 steps per division
	Store X50 Magn	8 steps per division

[a] **With less than 8 division vertical input signal, and Trigger Mode NORM, Source CH 1 or CH 2, Coupling DC, Vert. Channels DC)**

[b] **Measured over the center six divisions.**

[c] **Measured over the center eight divisions.**

Table B-12: Warranted Characteristics – X-Y Display System

Name	Description	
X-Y Accuracy (Non-Store)	**Measurement**	**Accuracy**
	X-Axis Deflection Factor [a]	Within ±5%
	Y-Axis Deflection Factors [a]	Same accuracy as vertical deflection system
X-Y Bandwidth (Non-Store)	**Measurement**	**Bandwidth**
	Bandwidth X-Axis [b] (-3 dB)	DC to at least 2MHz
	Bandwidth Y-Axis [b] (-3 dB)	Same as vertical deflection system
X-Y Accuracy (Store)		
X-Axis and Y-Axis	Same accuracy as digital storage vertical deflection system	
Phase Difference between X-Axis and Y-Axis Amplifiers (Non-Store) [c]	Maximum ± 3 deg from dc to 150 kHz	

[a] **Measured with a dc-coupled, five-division reference signal**

[b] **Measured with a five-division reference signal**

[c] **Vertical Input Coupling set to DC**

Table B-13: Warranted Characteristics – Probe Adjust Output

Name	Description	
PROBE ADJUST Accuracy	**Measurement**	**Accuracy**
	Output Voltage	0.5 V ± 5%
	Repetition Rate	1 kHz ± 20%

Table B-14: Warranted Characteristics – Power Requirements

Name	Description	
Line Voltage Ranges	95 VAC to 128 VAC or 190-250 VAC (depending on Line Voltage Setting) [a]	
Line Frequency Range	48 Hz to 440 Hz	
Max. Power Consumption	85 Watts (95 VA)	
Line Fuse	**Line Voltage Range**	**Fuse**
	95-128 VAC Range	1 A , slow blow , 230 V
	190-250 VAC Range	0.5 A , slow blow , 230 V

[a] To change the Line Voltage Range inside the instrument, a qualified technician must be consulted to change the fuse and the power setting.

Table B-15: Warranted Characteristics – Environmental, Safety and Reliability

Name	Description	
Environmental Requirements	The instrument will meet the following MIL-T-28800D requirements for Type III, Class 5, Style D equipment, except where noted otherwise	
Temperature	**Measurement Type**	**Range**
	Operating [a]	0 °C to +40 °C (+32 to +104 deg F)
	Non-operating [a]	−55 °C to +75 °C (−67 to +167 deg F).
Altitude	**Measurement Type**	**Range**
	Operating (15,000 feet) [b]	To 4,570 metres
	Non-operating (50,000 feet) [b]	To 15,240 metres
Humidity	**Measurement Type**	**Range**
	Operating and non-operating [c] relative humidity.	95%, −5% to +0%
	Operating [c] for all modes of operation.	+30 °C to +40 °C
	Non-operating [c]	+30 °C to +60 °C
EMC (Electromagnetic Compatibility)	Meets radiated and conducted emission requirements per VDE 0871, Class B. Plus FCC section 15, subpart J, class A. [d] Also meets IEC 801, EN50082-1, EN50081-1. In case of ESD and EFT tests, a temporarily degradation of the performance may occur. No change of actual operating state or stored data occurs.	

Table B-15: Warranted Characteristics – Environmental, Safety and Reliability (cont.)

Name	Description
Electrostatic Discharge	Conforms to Tektronix Standard 062-2862-00. (Withstands discharge of up to 20 kV) [e]
Vibration (Operating)	Meets requirements of MIL-T-28800D, para 4.5.5.3.1. [f]
Shock (Non-operating)	Meets requirements of MIL-T-28800D, para 4.5.5.4.1, except limited to 30 g. [g]
Bench Handling Test	Meets requirements of MIL-T-28800D, para 4.5.5.4.3. [h]

[a] Tested to MIL-T-28800D, para 4.5.5.1.3 and 4.5.5.1.4, except that in par 4.5.5.1.3, steps 4 and 5 (10 °C operating test) are performed before step 2 (–55 °C non-operating test).
Equipment shall remain off upon return to room ambient temperature during step 6. Excessive condensation shall be removed before operating during step 7.

[b] Maximum operating temperature decreases 1 °C per 1000 feet above 5,000 feet.

[c] 5 cycles (120 hours) referenced toMIL-T 28800D para 4.5.5.1.2.2 for type III, Class 5 instruments.

[d] To meet EMI regulations and specifications, use the specified shielded cable and metal connector housing with the housing grounded to the cable shield on the Parallel Printer/Plotter connector.

[e] Test performed with probe containing 500 pF capacitor with 1 kΩ resistance charged to the test voltage.

[f] 15 minutes along each of three major axes at a total displacement of 0.015 inch p-p (2.4 g at 55 Hz) with frequency varied from 10 Hz to 55 Hz to 10 Hz in one minutes sweeps. Hold for 10 minutes at 55 Hz in each of the three major axes. All major resonances must be above 55 Hz.

[g] 30 g, half-sine, 11 ms duration, three shocks per axis each direction, for a total of 18 shocks.

[h] Edge lifted four inches and allowed to free fall onto a solid wooden bench surface.

Typical Characteristics

This subsection contains tables that list the various *typical characteristics* that describe the 2212 Analog & Digital Storage Oscilloscope.

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

This subsection contains only typical characteristics.

In the *Name* column a distinction is made between operational modes:

- With comment Store means the characteristic is valid only if the instrument is in Storage mode.
- With comment Non-Store means the characteristic is valid only if the instrument is in Non-Storage mode.
- No comment means the characteristic is valid with the instrument in Store mode as well as in Non-Store mode.

Table B-16: Typical Characteristics – Vertical System

Name	Description	
Range of VAR control	Range is sufficient to overlap the next VOLT/DIV step in the range	
Chopped Switching Rate	500 kHz ± 30%	
Position Control Range	± 10.5 Divisions from graticule center	
CMRR Non-Store (Common Mode Rejection Ratio)	≥ 10: 1 at 20 MHz [a]	
CMRR (Store)	**VOLTS/DIV Setting**	**Ratio** [a]
	5 mV/DIV to 5V/DIV	10:1 at 10 MHz
	2 mV/DIV	10:1 at 1 MHz
Step Response (Non-Store) [b]	**VOLTS/DIV Setting**	**Rise Time**
	5 mV/DIV to 5 V /DIV	5.8 ns or less. (5 °C to +35 °C)
	5 mV/DIV to 5 V /DIV	7.0 ns or less. (0 °C to +40 °C)
Aberrations (Non-Store)	**VOLTS/DIV Setting**	**Abberations** [c]
	5 mV/DIV	6% or less
	10 mV/DIV to 0. 2 V/DIV	4% or less
	0.5 V /DIV	6% or less
	1 V/DIV to 5 V /DIV	12% or less

Table B-16: Typical Characteristics – Vertical System (cont.)

Name	Description	
Step Response (Store) [d]	**Measurement Type**	**Risetime**
	Rise Time	35 ns
Aberrations (Store)	**VOLTS/DIV Setting**	**Abberrations** [c]
	5 mV/DIV	6% or less
	10 mV/DIV to 0. 2 V/DIV	4% or less
	0.5 V/DIV	6% or less
	1 V/DIV to 5 V per division	12% or less
Bandwidth Limit (Non-Store) (5 mV/Div to 5 V/Div)	Independant switchable for each Channel –3dB at ≥10 MHz and ≤15 MHz Mutial (from CH1 to CH2) detoriation of bandwidth is <20%	
Bandwidth (Store)	**VOLTS/DIV Setting**	**Bandwidth**
	2 mV/DIV to 5 V /DIV	DC to 10 MHz ± 10%
Useful Storage Performance [e] EXT CLK (External Clock)	$\frac{\text{EXT}}{2}$ Hz	
Vertical Storage Resolution	8–bit (1part in 256)[f]	

a Checked at 5 mV/DIV for common mode signals of six divisions or less with the VAR and POSITION control adjusted for the best CMRR at 50 kHz.

b Risetime is calculated from this formula: Rise Time = $\frac{0.35}{\text{Bandwidth } (-3 \text{ dB})}$ s

c Measured with a five-division reference signal, centred vertically, from a 50 Ω source driving a 50 Ω coaxial cable terminated in 50 Ω at the input connector with the VAR in calibrated position.

d Useful storage Risetime = $\frac{\text{SEC/DIV x } 1.6}{400}$ s

e Useful storage performance is defined as the frequency where there are 2 samples per sine wave signal period at the maximum sampling rate. This yields a maximum amplitude uncertainty of 5% (Maximum sampling rate is 20 MHz).

f Display waveforms are calibrated for 25 points per division.

Table B-17: Typical Characteristics – Horizontal System

Name	Description		
TRace SEPeration Control Range.	0 to –4 divisions		
Range of SEC/DIV VARiable Control	At least 2.5 : 1		
Horizontal POSITION Control Range	Start of the trace can be positioned beyond the right of the center vertical graticule line, and the start of the 10-th division beyond the left of the center vertical graticule line.		
Displayed Trace Length	Greater than 10 divisions.		
EXT CLK Input Frequency	**Mode**	**Frequency**	
	RECORD	DC to 10 MHz	
	ROLL	DC to 4 kHz	
EXT CLK Digital Sample Rate	Equal to the input frequency		
EXT CLK Pulse Width	**Mode**	**Low (min.)**	**High (min.)**
	RECORD	50 ns	50 ns
	ROLL	50 µs	125 ns
EXT CLK Logic Thresholds	**Low**	**High**	
	0.7 V	2.1 V	

Table B-18: Typical Characteristics – Triggering System

Name	Description
P-P AUTO Lowest Usable Frequency	20 Hz
Acqusition Window Trigger Point Selection (Store)	25% or 75% (as selected) of the waveform displayed is prior to the trigger event.

Table B-19: Typical Characteristics – Z–Axis System

Name	Description	
Sensitivity	5-V causes noticeable modulation [a]	
Usable Frequency Range	DC to 5 MHz	
EXT Input OR Z Input	**Measurement Type**	**Limit**
	Maximum Input Voltage	400 V (DC + peak AC) or 800 V AC p-p at 10 kHz or less (See Figure 6.1)
	Input Impedance	1 MΩ ±10% parallel to 20 pF ±2.5 pF

[a] Positive going input decreases the intensity

Performance Tests

This subsection contains a collection of procedures for checking that the 2212 Analog & Digital Storage Oscilloscope performs as warranted.

The performance checks described are:

- Vertical Checks
- Horizontal Checks
- Triggering Checks
- Probe Adjust check
- X-Y Display Checks

These performance check procedures are used to verify the instrument's performance requirements statements listed in Section 6, subsection *Warranted Characteristics*. The performance checks may also be used as an acceptance test or as a preliminary troubleshooting aid to help determine the need for repair or readjustment.

Conventions

Throughout the test procedures the following conventions apply:

- Each test procedure uses the following general format:

  Title of Test

  Equipment Required

  Initial Control Settings

  Procedure Steps

- 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 Vertical **POSITION** knob to ...", etc.

Initial Setup Procedure

This procedure sets the front-panel controls for the tests that follow.

Procedure

1. Plug the female connector of the power cord in the power cord receptacle of the 2212 and the male connector to the AC power source.

2. Connect the test equipment, as indicated in the Equipment Required list, to the 2212 oscilloscope.

2. Press the **POWER** button to on.

3. Set the front-panel controls as indicated in the Initial Control Settings list.

Test Equipment Required

The test equipment listed in Table C-1 is a complete list of the equipment required to accomplish the Performance Checks in this section. Test equipment specifications described are the minimum necessary to provide accurate results.

Detailed operating instructions of the test equipment is not given in this procedure. If more operating information is required, refer to the appropriate test equipment instruction manual.

When you use equipment other than that recommended, you may have to change the control settings of the test setup. If the exact example equipment in Table C-1 is not available,use the minimum specification column to determine if any other available test equipment might suffice to perform the check or adjustment.

Table C-1: Test Equipment Required

Item and Description	Minimum Specification	Use	Example of Test Equipment
1. Calibration Generator	Standard-amplitude signal levels: 5 mV to 50 V. Accuracy: ±0.3 %. – High-amplitude signal levels: 1 V to 60 V. Repetition rate: 1 kHz. – Fast rise signal level: 1 V. Repetition rate: 1 MHz. Risetime: 1 ns or less. Flatness: ±0.5%.	Signal source for gain and transient response checks and adjustments.	Tektronix PG 506A Calibration Generator. [a]
2. Leveled Sine-Wave amplitude Generator	Frequency: 250 kHz to above 60 MHz. Output:: variable from 10 mV to 5V p-p. Output impedance: 50 Ω. Reference frequency: 50 kHz. Amplitude accuracy: constant within 3% of reference frequency as output frequency changes.	Vertical, horizontal, and triggering checks and adjustments. Display adjustments and Z-Axis check.	Tektronix SG503 Leveled Sine-Wave Generator. [a]
3. Time-Mark Generator	Marker outputs: 10 ns to 0.5 s. Marker accuracy: ±0.1 %. Trigger output: 1 ms to 0.1 μs, time-coincident with markers.	Horizontal checks and adjustments. Display adjustment	Tektronix TG501 Time-Mark Generator [a]

Table C-1 (cont.)
Test Equipment Required

Item and Description	Minimum Specification	Use	Example of Test Equipment
4. Low-Frequency Sine-Wave Generator	Range 10 Hz to 500 kHz.Output amplitude: 300 mV. Output impedance: 600 Ω. Reference frequency: constant within 0.3 dB of reference frequency as output frequency changes.	Low-Frequency trigger checks	Tektronix SG502 Oscillator.[a]
5. Pulse Generator	Repetition rate: 1 kHz. Output amplitude: 5 V.	Signal source for Storage and external clock checks.	Tektronix PG501 Pulse Generator.[a]
6. TV Signal Generator	Provide Composite TV Video and Line Sync Signals	Check TV Trigger circuit Test Signal Generator.	Tektronix TSG-100
7. Coaxial Cable (2x)	Impedance: 50 Ω. Length: 42 in. Connectors: BNC.	Signal interconnection.	Tektronix Part Number 012-0057-01.
8. Dual Input Coupler	Connectors: BNC. Female-to-dual-BNC male.	Signal interconnection.	Tektronix Part Number 067-0525-02.
9. Precision Coaxial Cable	Impedance: 50 Ω. Length: 42 in. Connectors: BNC.	Vertical Bandwidth	Tektronix Part Number 012-0482-00.
10. T-Connector	Connector: BNC.	Signal interconnection.	Tektronix Part Number 103-0030-00.
11. Termination	Impedance: 50 Ω. Connectors: BNC.	Signal Termination.	Tektronix Part Number 011-0049-01.

Table C-1 (cont.)
Test Equipment Required

Item and Description	Minimum Specification	Use	Example of Test Equipment
12.Termination	Impedance: 600 Ω. Connectors: BNC.	Signal Termination.	Tektronix Part Number 011-0092-00.
13. 10X Attenuator	Ratio: 10X. Impedance: 50 Ω. Connectors: BNC	Vertical compensation and triggering checks.	Tektronix Part Number 011-0059-02.
14. Adapter male-to-tip plug	Connectors: BNC .	Signal interconnection.	Tektronix Part Number 175-1178-00.
15. Interface Cable		Signal interconnection.	Tektronix Part Number 012-1214-00.
16. Centronics Compatible Printer/Plotter		Parallel Interface Check	

[a] **Requires a TM 500-Series Power Module.**

Preparation

The Performance Verification Procedure is divided in subsections to let you check individual sections of the instrument, when it is not necessary to do a complete performance check.

It is not necessary to remove the instrument cover to accomplish any subsection in the Performance Verification Procedure, since all checks are made using operator-accessable front-and-rear-panel controls and connectors.

The most accurate display adjustments are made with a stable, well-focused, low-intensity display. Unless otherwise noted, adjust the INTENSITY, FOCUS and Trigger LEVEL controls as needed to view the display.

An Equipment-Required block at the beginning of each subsection lists only the test equipment necessary to do the checks in that sub-section.

Also at the beginning of each subsection is a list of all the front-panel control settings required to prepare the instrument for performing the first step of the subsection. Do each of the steps within a particular subsection completely, to ensure the correct control settings for steps that follow.

Limits and Tolerances

The limits and tolerances given in this procedure are valid for an instrument that is operating in an ambient temperature between +20 °C and +30 °C. The instrument also must have had at least a 20-minute warm-up period. All tolerances specified are for the instrument only and do not include test-equipment error.

Index to Performance Tests

Vertical Checks

Horizontal Checks

Triggering Checks

Probe Adjust Check

X-Y Display Checks

Vertical Checks

These procedures check those characteristics for the vertical display system that are listed under *Warranted Characteristics* in *Appendix B: Specifications*. You should set up the test equipment as shown at the start of the procedure list. Changes to the test setup will be indicated in the procedures, if necessary.

Equipment Required (see Table B1) :

Calibration Generator (Item 1)
Leveled Sine-Wave Generator (Item 2)
50 Ω BNC Coaxial Cable (Item 7)
Dual Input Coupler (Item 8)
50 Ω BNC Termination (Item 11)
10X BNC Attenuator (Item 13)
BNC Male-to-Tip Plug (Item 14)

Initial Control Settings

Vertical (CH 1 and CH 2)

POSITION .... Midrange (CH1 and CH2)
MODE .... CH 1
VOLTS/DIV .... 2 mV (CH1 and CH2)
VARiable .... Off (CH1 and CH2)
AC-GND-DC .... DC (CH1 and CH2)

Horizontal

POSITION .... Midrange
MODE ALT MAGN .... Off
SEC/DIV .... 0.5 ms
VARiable .... Off
X1, X10, X50 Magnifier X1

Trigger

HOLDOFF .... MIN
LEVEL .... Midrange
SLOPE .... Positive Going
MODE .... P-P AUTO
SOURCE .... VERTical MODE
COUPLING .... DC

Procedure Steps

Step 1. Check Deflection Accuracy

a. Connect a 10 mV standard-amplitude signal from the calibration generator via a 50 Ω BNC coaxial cable to the
CH 1 OR X input connector.

b. CHECK – Deflection accuracy is within the limits given in
Table C-2 for each CH 1 VOLTS/DIV switch setting and corresponding standard-amplitude signal.

Step 2. Check Trace Shift

a. Set CH 1 **VOLTS/DIV** switch to 2 mV/division.

b. Rotate the **VOLTS/DIV** switch through the range.

c. CHECK – The trace shift should be ≤ 1.0 division.

d. Set the **VAR** to the minumum sensitivity, and rotate the **VOLTS/DIV** switch through the range.

e. CHECK – The trace shift should be ≤ 1.0 division.

f. Move the cable from the **CH 1 OR X** input connector to the **CH 2 OR Y** input connector. Toggle the **MODE** switch to CH 2.

g. Repeat part b through f using the CH 2 controls.

h. Push the CH 2 **INV**ert switch to the INV position.

j. CHECK – The trace shift should be ≤ 1.5 division.

Table C-2
Deflection Accuracy Limits

VOLTS/DIV switch setting	STANDARD amplitude signal	ACCURACY limits (divisions)
2 mV	10 m V	4.85 to 5.15
5 mV	2 0 mV	3.88 to 4.12
10 mV	50 mV	4.85 to 5.15
20 mV	0.1 V	4.85 to 5.15
50 mV	0.2 V	3.88 to 4.12
0.1 V	0.5 V	4.85 to 5.15
0.2 V	1 V	4.85 to 5.15
0.5 V	2 V	3.88 to 4.12
1V	5 V	4.85 to 5.15
2 V	10 V	4.85 to 5.15
5 V	20 V	3.88 to 4.12

Step 3. Check Non-Store (Analog) Bandwidth

a. SET:
VOLTS/DIV (CH 1 and CH 2) 5 mV
Vertical MODE CH 1
SEC/DIV 10 µs

b. Connect the leveled sine-wave generator output via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination to the
CH 1 OR X input connector.

c. Set the generator to produce a 50 kHz, six-division display.

d. Increase the signal frequency until a 4.2 division display is obtained.

e. Check that the frequency is greater than 60 MHz.

f. Repeat parts b through e for all **VOLTS/DIV** settings from 10 mV through 1 V.

NOTE

For the 1 V /DIV settings, use a five division signal frequency reference; use 3.5 divisions peak to peak as the –3 dB reference point of the bandwidth.

g. Toggle the vertical **MODE** switch to CH 2. Connect the leveled sine-wave generator output via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination to the **CH 2 OR Y** input connector.

h. Repeat part b through e for CH 2 using the CH 2 controls.

i. Set:
VOLTS/DIV CH 1 .... 2 mV
Vertical MODE .... CH 1
SEC/DIV .... 10 μs

j. Set the leveled sinewave generator to produce a 50 kHz, six division display.

k. Increase the signal frequency until a 4.2 division display is obtained.

l. Check that the frequency is ≥10 MHz.

m. Repeat part i through l for CH 2 using the CH 2 controls.

n. Disconnect test equipment from the instrument.

Horizontal Checks

These procedures check those characteristics for the horizontal display system that are listed under *Warranted Characteristics* in *Appendix B: Specifications*. You should set up the test equipment as shown at the start of the procedure list. Changes to the test set-up will be indicated in the procedures, if necessary.

Equipment Required (See Table C-1)

Calibration Generator (Item 1)
Leveled Sine-Wave Generator (Item 2)
Time-Mark Generator (Item 3)
50 Ω Coaxial Cable (Item 7)
50 Ω BNC Termination (Item 11)

Initial Control Settings

Vertical (CH 1 and CH 2)

POSITION .... Midrange
MODE .... CH 1
VOLTS/DIV .... 0.5 V
VARiable .... Off
AC-GND-DC .... DC

Horizontal

POSITION .... Midrange
MODE ALT MAGN .... Off
SEC/DIV .... 0.05 μs
VARiable .... Off
X1, X10, X50 Magnifier X1

Trigger

HOLDOFF .... MIN
LEVEL .... Midrange
SLOPE .... Positive Going
MODE .... P-P AUTO
SOURCE .... VERTical MODE
COUPLING .... AC

Procedure Steps

Step 1. Check Non Store Timing Accuracy

a. Connect 50 ns time markers from the time-mark generator via a 50 Ω BNC coaxial cable and a 50 Ω termination to the **CH 1 OR X** input connector.

b. Adjust the Trigger **LEVEL** control for a stable, triggered display.

c. Use the Horizontal **POSITION** control to align the second time marker with the second vertical graticule line.

d. CHECK – Timing accuracy is within 3 % (0.24 division at the tenth vertical graticule line), and the linearity is within 5% (0.10 division over any two of the center eight divisions).

NOTE

For checking the timing accuracy of the SEC/DIV switch setting from 50 ms to 0.5 s, watch the time marker tips only at the second and tenth vertical graticule lines while adjusting the Horizontal POSITION control to line up the time markers.

e. Repeat parts b through d for the remaining **SEC/DIV** and time mark generator setting combinations as shown in Table C-3.

NOTE

In X50 magnification in all "2" decade switch settings, the associated time marker settings give only five markers per ten divisions instead of ten with the "1" and "5" decade switch settings. When checking the "2" ranges, position the time markers on the second and ninth vertical graticule lines.

f. SET:
SEC/DIV .... 0.1 µs
Horizontal Magnify X10

g. Select 10 ns time markers from the time-marker generator.

h. Use the Horizontal **POSITION** control to align the first time marker that is 50 ns beyond the start of the sweep with the second vertical graticule line.

i. CHECK – Timing accuracy is within 4 % (0.32 division at the tenth vertical graticule line), and the linearity is within 7% (0.14 division over any two of the center eight divisions). Exclude any portion of the sweep past the 50th magnified division.

j. Repeat parts h and i for the remaining **SEC/DIV** and time mark generator setting combinations as shown in Table C-3.

k. SET:
SEC/DIV .... 0.5 µs
Horizontal Magnify X50

l. Select 10 ns time markers from the time-marker generator.

m. Use the Horizontal **POSITION** control to align the first time marker that is 100 ns beyond the start of the sweep with the second vertical graticule line.

n. CHECK – Timing accuracy is within 5 % (0.40 division at the tenth vertical graticule line), and the linearity is within 9% (0.18 division over any two of the center eight divisions). Exclude any portion of the sweep past the 100th magnified division.

o. Repeat parts m and n for the remaining **SEC/DIV** and time mark generator setting combinations as shown in Table C-3.

Table C-3
Settings for Timing Accuracy Checks

SEC/DIV Switch Setting	Time-Mark Generator Setting		
	X1 (Normal)	X10 Magnify	X50 Magnify
0.05 µs	50 ns	5 ns	≈1 ns
0.1 µs	0.1 µs	10 ns	≈2 ns
0.2 µs	0.2 µs	20 ns	≈4 ns
0.5 µs	0.5 µs	50 ns	10 ns
1 µs	1 µs	0.1 µs	20 ns
2 µs	2 µs	0.2 µs	0.04µs
5 µs	5 µs	0.5 µs	0.1 µs
10 µs	10 µs	1 µs	0.2 µs
20 µs	20 µs	2 µs	0.4 µs
50 µs	50 µs	5 µs	1 µs
0.1 ms	0.1 ms	10 µs	2 µs
0.2 ms	0.2 ms	20 µs	4 µs
0.5 ms	0.5 ms	50 µs	10 µs
1 ms	1 ms	0.1 ms	20 µs
2 ms	2 ms	0.2 ms	0.04ms
5 ms	5 ms	0.5 ms	0.1 ms
10 ms	10 ms	1 ms	0.2 ms
20 ms	20 ms	2 ms	0.4 ms
50 ms	50 ms	5 ms	1 ms
0.1 s	0.1 s	10 ms	2 ms
0.2 s	0.2 s	20 ms	4 ms
0.5 s	0.5 s	50 ms	10 ms

Step 2. Check Sweep Length

a. SET:
SEC/DIV 0.1 ms
Horizontal Magnify X1

b. Select 0.1 ms time markers from the time-mark generator.

c. Position the start of the sweep at the first vertical graticule line using the Horizontal POSITION control.

d. CHECK – That the sweep length is $\geq$ 10 divisions.

Triggering Checks

The Triggering Checks procedures check those characteristics that relate to the trigger system and that are listed under *Warranted Characteristics* in *Appendix B: Specifications.* You should set up the test equipment as shown at the start of the procedure list. Changes to the test set-up will be indicated in the procedures, if necessary.

Equipment Required (See Table C-1)

Calibration Generator (Item 1)
Leveled Sine-Wave Generator (Item 2)
Low-Frequency Sine-Wave Generator (Item 4)
TV Signal Generator (Item 6)
Dual-Input Coupler (Item 8)
50 Ω Coaxial Cable (Item 7)
50 Ω BNC Termination (Item 11)
600 Ω BNC Termination (Item 12)

Initial Control Settings

Vertical

POSITION .... Midrange
MODE .... CH 1
CH 1 VOLTS/DIV .... 0.1 V
CH 2 VOLTS/DIV .... 1 V
VARiable .... Off
AC-GND-DC (CH 1 and CH 2) ...... DC

Horizontal

POSITION .... Midrange
MODE ALT MAGN .... Off
SEC/DIV .... 0.2 μs
VARiable .... Off
X1, X10, X50 Magnifier X1

Trigger

HOLDOFF .... MIN
LEVEL .... Midrange
SLOPE .... Positive Going
MODE .... P-P AUTO
SOURCE .... VERTical MODE
COUPLING .... DC

Procedure Steps

Step 1. Check 500 Hz Trigger Sensitivity

a. Connect the low-frequency sine-wave generator output via a 50 Ω BNC coaxial cable and a 50 Ω termination to the **CH 1 OR X** input connector.

b. Set the low-frequency sine-wave generator to produce a 3.5-division display at an output frequency of 500 Hz.

c. Set the CH 1 **VOLTS/DIV** switch to 1 V/DIV.

d. CHECK – That a stable display can be obtained by adjusting the Trigger **LEVEL** control for each switch combination given in Table C-4 with **DC**, **HF REJ**, and **AC** Trigger **COUPLING**; and that the display will not trigger with **NOISE REJ** or **LF REJ** Trigger COUPLING. Ensure that the TRIG'D light comes on when triggered.

e. Disconnect the test equipment from the instrument and set the CH 1 **VOLTS/DIV** switch to .1 V.

Table C-4
Switch Combinations for Triggering Checks

Trigger MODE	Trigger SLOPE
P-P AUTO	Positive Slope
P-P AUTO	Negative Slope
NORM	Positive Slope
NORM	Negative Slope

Step 2. Check 500 kHz Trigger Sensitivity

a. Connect the leveled sine-wave generator output via a 50 Ω BNC coaxial cable and a 50 Ω termination to the **CH 1 OR X** input connector. Set the **SEC/DIV** to 2 μs.

b. Set the leveled sine-wave generator to produce a 3.5-division display at an output frequency of 500 kHz.

c. Set the CH 1 **VOLTS/DIV** switch to 1 V.

d. CHECK – That a stable display can be obtained by adjusting the Trigger **LEVEL** control for each switch combination given in Table C-4 with **DC**, **LF REJ** and **AC** Trigger **COUPLING**; and that the display will not trigger with **NOISE REJ** or **HF REJ** Trigger **COUPLING**. Ensure that the TRIG'D light comes on when triggered.

Step 3. Check 5 MHz Trigger Sensitivity

a. Connect the leveled sine-wave generator output via a 50 Ω BNC coaxial cable and a 50 Ω termination to the **CH 1 OR X** input connector. Set the **SEC/DIV** to 0.2 μs.

b. Set the leveled sine-wave generator to produce a 3.5-division display at an output frequency of 5 MHz at **0.1 V/DIV**.

c. Set the CH 1 **VOLTS/DIV** switch to 1 V.

d. CHECK – That a stable display can be obtained by adjusting the Trigger **LEVEL** control for each switch combination given in Table C-4 with **DC**, **LF REJ** and **AC** Trigger **COUPLING**; and that the display will not trigger with **NOISE REJ** or **HF REJ** Trigger **COUPLING**. Ensure that the TRIG'D light comes on when triggered.

Step 4. Check 60 MHz Trigger Sensitivity

a. Set the leveled sine-wave generator to produce a 1.2 division display at an output frequency of 60 MHz.

b. CHECK – That a stable display can be obtained by adjusting the Trigger **LEVEL** control for each switch combination given in Table C-4 with **DC**, **LF REJ**, and **AC** Trigger **COUPLING**; and that the display will not trigger with **NOISE REJ** or **HF REJ** Trigger **COUPLING**. Ensure that the TRIG'D light comes on when triggered.

c. Disconnect the test equipment from the instrument.

Step 5. Check External Trigger Range

a. SET:
VOLTS/DIV (CH 1) ....0.5 V
SEC/DIV ....20 μs
Trigger COUPLING ....AC
Trigger SLOPE ....Positive Going

b. Connect the leveled sine-wave generator output via a 50 Ω BNC coaxial cable, a 50 Ω termination and a dual-input coupler, to the **CH 1 OR X** and the **EXT INPUT OR Z** input connectors.

c. Set the leveled sine-wave generator to produce a five-division display at an output frequency of 50 kHz.

d. Position the waveform equally around the center horizontal graticule line.

e. SET:
Trigger MODE ....NORM
Trigger SOURCE ....EXT

f. CHECK – That the display is not triggered at either extreme of rotation of the Trigger **LEVEL** control.

g. Toggle the Trigger **COUPLING** switch to **DC**.

h. Repeat part f.

i. Toggle the Trigger **SOURCE** switch to **EXT : 10**.

j. CHECK – That the display can be triggered at about the midrange of the Trigger **LEVEL** control.

k. Push the Trigger **SLOPE** switch to the negative going slope and repeat part j.

l. Disconnect the test equipment from the instrument.

Step 6. TV Field Trigger Sensitivity

a. SET:
Vertical MODE .... CH 2
VOLTS/DIV (CH 2) .... 1 V
SEC/DIV .... 0.2 ms
Trigger SLOPE .... Negative Going
Trigger MODE .... TV FIELD

b. Connect the TV signal generator video output to the **CH 2 OR Y** input connector via a 50 Ω BNC coaxial cable.

c. Press the lower part of the **VAR**iable VOLTS/DIV control for a one-division composite sync signal display.

d. CHECK – That a stable display is obtained.

e. SET:
CH 2 INVert .... INV
Trigger SLOPE .... Positive Going

f. CHECK – That a stable display is obtained.

Step 7. Check Trigger Readout

a. SET:
Vertical MODE .... CH 1
VOLTS/DIV (CH 1) .... 0.1 V
AC-GND-DC (CH 1) .... DC
SEC/DIV .... 20 μs
Trigger MODE .... P-P AUTO
Trigger SOURCE .... CH 1
Trigger COUPLING .... DC
Readout (RO) .... On

b. Connect the leveled sine-wave generator output via a 50 Ω BNC coaxial cable and a 50 Ω termination to the **CH 1 OR X** input connector.

c. Set the leveled sine-wave generator to produce a eight-division display at an output frequency of 50 kHz.

d. Position the waveform displayed equally around the center horizontal graticule line. Toggle the Trigger **MODE** switch to NORM.

e. Adjust the Vertical **POSITION** control so that the sweep starts equally around the center horizontal graticule line when switching between the positive and the negative going slope.

f. Press the Trigger **SLOPE** switch to the positive going slope.

g. Adjust the Trigger **LEVEL** control so that the start of the sweep is aligned with the center horizontal graticule line.

h. CHECK – That the trigger readout is 0.00 V ±0.03 V.

i. Adjust the Trigger **LEVEL** control so that the sweep starts one division above the center horizontal graticule line.

j. CHECK – That the trigger readout is 0.10 V ±0.03 V.

k. Adjust the Trigger **LEVEL** control so that the sweep starts two divisions above the center horizontal graticule line and check that the trigger readout is 0.20 V ±0.03 V. For three divisions it is 0.30 V ± 0.03 V.

l. Adjust the Trigger **LEVEL** control so that the sweep starts one division below the center horizontal graticule line and check that the trigger readout is – 0.10 V ±0.03 V. For two divisions it is – 0.20 V± 0.03 V and for three divisions – 0.30 V ± 0.03 V.

m. Disconnect the test equipment from the instrument.

Step 8. LINE Trigger Function Check

a. SET:
CH 2 VOLTS/DIV .... 0.1 V (without 10X probe attached)
CH 2 AC-GND-DC .... DC
SEC/DIV .... 5 ms
Trigger MODE .... P-P AUTO
Trigger SOURCE .... LINE
Trigger COUPLING .... DC
X1, X10, X50 Magnify X1
ALT MAGN switch .... Off

b. Connect a 10X probe to the **CH 2 OR Y** input connector.

c. Attach a length of wire of two inches long to the probe tip. Hold the wire near the middle portion of the instrument power cord.

d. CHECK – That the display can be triggered on positive-going and negative-going slopes.

e. Disconnect the test set up from the instrument.

Probe Adjust Check

The Probe Adjust procedure checks those characteristics that are listed under *Warranted Characteristics* in *Appendix B: Specifications*. You should set up the test equipment as shown at the start of the procedure list. Changes to the test set-up will be indicated in the procedures, if necessary.

Equipment Required (See Table C-1)

10X Probe (Provided with the instrument)

Initial Control Settings

Vertical

POSITION .... Midrange
MODE .... CH 1
CH 1 VOLTS/DIV .... 1 V
VARiable .... Off
AC-GND-DC (CH 1 and CH 2) .... DC

Horizontal

POSITION .... Midrange
MODE ALT MAGN .... Off
SEC/DIV .... 20 µs
VARiable .... Off
X1, X10, X50 Magnifier X1

Trigger

HOLDOFF .... MIN
LEVEL .... Midrange
SLOPE .... Positive Going
MODE .... P-P AUTO
COUPLING .... DC

Procedure Steps

Step 1. Check Probe Adjust Operation

a. SET:
VOLTS/DIV (CH 1) 10 mV
SEC/DIV 0.5 ms
Trigger SOURCECH 1

b. Connect the 10X probe to the **CH 1 OR X** input connector and clip the probe tip to the **PROBE ADJUST** connector on the front panel.

c. If necessary, adjust the probe compensation for a flat-topped squarewave display (See also Figure 2-1 on page 2-4).

d. CHECK – That the display amplitude is between 4.75 to 5.25 divisions.

X-Y Display Checks

The X-Y Display Check procedures check those characteristics that relate to the X-Y Display system and that are listed under *Warranted Characteristics* in *Appendix B: Specifications*. You should set up the test equipment as shown at the start of the procedure list. Changes to the test set-up will be indicated in the procedures, if necessary.

Equipment Required (See Table C-1)

Calibration Generator (Item 1)
Leveled Sine-Wave Generator (Item 2)
50 Ω BNC Coaxial Cable (Item 7)
50 Ω BNC Termination (Item 11)

Initial Control Settings

Vertical

POSITION (CH 1 and CH 2) .... Midrange
MODE .... X-Y
CH 1 VOLTS/DIV .... 10 mV
CH 2 VOLTS/DIV .... 1 V
VARiable .... Off
AC-GND-DC (CH 1 and CH 2) ...... DC

Horizontal

POSITION .... Midrange
MODE ALT MAGN .... Off
SEC/DIV .... 0.5 ms
VARiable .... Off
X1, X10, X50 Magnifier X1

Trigger

HOLDOFF .... MIN
LEVEL .... Midrange
SLOPE .... Positive Going
MODE .... P-P AUTO
SOURCE .... VERTical MODE
COUPLING .... DC

Storage

STORE ON .... Off
PRETRIG 75%
HOLD .... Off

Procedure Steps

Step 1. Check X-Axis Gain

a. SET:
VOLTS/DIV (CH 1 and CH 2) 10 mV
Vertical MODE X-Y

b. Connect a 50 mV standard amplitude signal from the calibration generator via a 50 Ω BNC coaxial cable to the **CH 1 OR X** input connector.

c. CHECK – That the display is between 4.85 and 5.15 divisions.

d. Disconnect the test equipment from the instrument.

Step 2. Check X-Axis Bandwidth

a. SET:
VOLTS/DIV (CH 1 and CH 2) 50 mV

b. Connect the leveled sine-wave generator output via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination to the **CH 1 OR X** input connector.

c. Set the generator to produce an eight-division horizontal display at an output frequency of 50 kHz.

d. Increase the generator output frequency until the X-Axis (horizontal) deflection amplitude is 5.7 divisions.

e. CHECK – That the generators frequency is 2 MHz or more.

Default Control Settings

This section presents you the default front-panel control settings per function block of the 2212 oscilloscope at power up (see Table D-1).

Table D-1
Default Control Settings at Power-Up

Function Block	Front Panel Control	Setup Setting
CRT		
	Intensity Trace	33% of range
	Intensity Readout	Midrange
	BEAMFIND	Off
VERTICAL		
	MODE	CH 1 (CH 2 Off)
	CH 2 INVert	Off
	CH 1/CH 2 Coupling	DC
	CH 1 POSITION	Ground level at graticule line center screen
	CH 2 POSITION	Ground level at 2nd graticule line below center screen
	CH 1/CH 2 VOLTS/DIV	2 V (Multiply scale factor by 10 when 10X probe attached)
	CH 1/CH 2 Bandwidth Limit	Off
HORIZONTAL		
	Position	Midrange
	MODE ALT MAGNifier	Off
	TRace SEParation	Off
	SEC/DIV	.2 ms
	X1, X10, X50 Magnifier	X1
	VARiable SEC/DIV	Off

Table D-1 (cont.)

Default Control Settings at Power-Up

Function Block	Front Panel Control	Setup Setting
TRIGGER		
	HOLDOFF	as set
	LEVEL	Midrange
	RESET	Off
	EXT=Z	Off
	SLOPE	Positive going
	MODE	P-P AUTO
	SOURCE	VERT
	COUPLING	DC
CURSOR		
	ON/Off	Off
	ΔV1, ΔV2, ΔT, 1/ΔT Switch	ΔV1
	TOGGLE CURSOR Mode	Delta Mode
AUTO SETUP		
	AUTO	Off
	RECALL	Off
	SAVE	Off
	MENU	Off
STORAGE		
	ON/Off	Off
	PRETRIG	25%
	HOLD	Off
	RECALL	Off
	SAVE	Off
	PRNSCR	Off

Glossary

AC Coupling
A type of signal transmission that blocks the signal's DC component but uses the signal's dynamic (AC) component. Useful for observing an AC signal that is normally riding on a DC signal.

Accuracy
The closeness of the indicated value to the true value.

Acquisition
The process of sampling signals from input channels, digitizing the samples, processing the resulting samples into data points, and assembling the data points into a waveform record. The waveform record is stored in memory.

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

Active cursor
The cursor that moves when you turn the Cursor POSITION knob.

Aliasing
A false representation of the signal's waveform due to insufficient sampling of high frequencies or fast transitions. That is, a condition that occurs when a digitizing oscilloscope digitizes at an effective sampling rate that is too slow to reproduce the input signal. The waveform displayed on the oscilloscope may have a lower frequency than the actual input signal. Can cause excessive measurement and other errors.

Amplitude
The High waveform value less the Low waveform value.

Attenuation

The degree of reduction in amplitude as a signal passes through an attenuating device such as a probe or attenuator. That is, the ratio of the input measure to the output measure. For example, a 10X probe will attenuate, or reduce, the input signal's voltage by a factor of 10.

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.

Automatic trigger mode

A trigger mode that causes the system to automatically acquire if triggerable events are not detected within a specified time period. Useful for displaying a waveform even though the oscilloscope has not been triggered.

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.

Bandwidth

The highest frequency signal the oscilloscope can acquire with no more than 3 dB (X .707) attenuation of the original (reference) signal.

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 the 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.)

Cursors
Dotted markers that you use to make measurements between two waveform locations. You can use them for visual comparison. The oscilloscope displays a readout of the distance between the cursors.

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.

External Trigger Source
A trigger source derived from a non-displayed external signal through the external trigger input connector (EXT INPUT OR Z).

Fall time
Measurement of the time it takes for a pulse's trailing edge to fall from a High Ref. value (typically 90%) to a Low Ref. value (typically 10%) of its amplitude.

Frequency

Timing measurement. The reciprocal of the period. Measured in Hertz (Hz) where 1 Hz = 1 cycle per second.

GPIB (General Purpose Interface Bus)

An interconnection bus and protocol that allows you to connect multiple instruments in a network under the control of a controller. Also known as IEEE 488 bus. Transfers data with eight parallel data lines, five control lines, and three handshake lines.

Graticule

A grid on the display screen that serves as horizontal and vertical scales. You can use it to visually measure waveform parameters.

Ground (GND) coupling

Coupling option that disconnects the input signal from the vertical system.

Hardcopy

A copy, in a format useable by a printer or plotter, of the display.

Holdoff, trigger

The time after a trigger signal that must elapse before the trigger circuit will accept another trigger signal.

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-period.

Inverted Waveform

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

Intensity

Displays brightness.

Knob
A rotary control.

Major Division
One mark dividing the screen either horizontally or vertically for measurement purposes. The 2212 has eight major vertical divisions and ten major horizontal divisions.

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

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

Minor Division
Subdivision of major divisions for more accurate measurement. Minor divisions are seen as marks along the horizontal and vertical center lines. The 2212 has five minor divisions in each major division in both directions.

Normal Acquisition Mode
The 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.

Oscilloscope
An instrument for making a graph of two factors. These are typically voltage versus time.

Peak-to-Peak
Amplitude (voltage) measurement. The absolute difference between the maximum and minimum amplitude.

Period
Timing measurement. Time it takes for one complete signal cycle. The reciprocal or frequency. Measured in seconds.

Post-trigger
The part of the waveform record data that occurs after the trigger event.

Pre-trigger
The part of the waveform record data that occurs before the trigger event.

Probe
An oscilloscope input device.

Probe compensation
Adjustment that improves a probe's frequency response.

Real-time sampling
Sampling where the digitizing oscilloscope operates fast enough to completely fill a waveform record from a single trigger event.

Record Length
The number of samples in a waveform.

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.

Reference memory
Memory in an oscilloscope used to store waveforms or settings. You can use the waveform data for later processing. Non-volatile reference memory, as in your digitizing oscilloscope, saves data even after the oscilloscope's external power is turned off.

Rise time
The time it takes for a pulse's leading edge to rise from a Low Ref. value (typically 10%) to a High Ref. value (typically 90%) of its amplitude.

RMS
Amplitude (voltage) measurement. The true Root Mean Square voltage.

Roll Time-Base Mode
The digital time-base mode used for slow bases (50 s to 0.1 s). In Roll 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 lift one point at a time to accommodate the new samples. The oldest sample, the one at the left edge of the screen, is erased. This gives the effect of the waveform continuously scrolling across the screen from right to left.

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.

Sample Interval
The time interval between successive samples in a time base.

Sampling
The process of converting a portion of the input signal to digital form for display and processing. Two general methods of sampling are: real-time sampling and equivalent-time-sampling.

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.

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.

Setup
A specific configuration of front-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 RESET button to restart the sequence.

Single-shot
Single-sequence.

Single-sweep
Single-sequence.

Store Mode
A mode in which the instrument is set to the digital storage mode.

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, and whether the instrument is in store mode. Possible time-base modes are Record and Roll.

Toggle Button
A button that when pressed to let you select between two or more states.

Trigger
The event that tells the oscilloscope to start acquiring and displaying a waveform in store mode, or to start the time base to display a waveform in non-store mode.

Trigger Coupling
See Channel Coupling.

Trigger Level
The level the trigger signal must cross to generate a trigger.

Trigger Light
A light on the 2212 front panel, labelled TRIG'D, that indicates when the instrument has acquired a trigger.

Trigger Mode
The way in which the instrument acquires a trigger.

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.

Uncalibrated Channel
A channel manipulated with the variable volts-per-division (VAR switch) control. This control 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 factions 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.

Waveform

The shape of form (visible representation) of a signal.

XY Format

A display of two signals plotted against each other. That is, both the horizontal and vertical position of the displayed points reflect signal data.

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.

Y-t Format

A display where the vertical position of the displayed data points reflects signal level and the horizontal position reflects time.

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MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with the latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on the following pages.

A single change may effect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.