User Manual

Tektronix

2216
Four Channel Digital Storage & Analog Oscilloscope

070-8903-00

First Printing Febr.1994
Revised 3/14 1994

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.

WARRANTY

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) 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.

This warranty shall not apply to any defect, failure or damage caused by improper use or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THIS PRODUCT IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX AND ITS VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX AND ITS VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

Tektronix

EC Declaration of Conformity

We

Tektronix Holland N.V.
Marktweg 73A
8444 AB Heerenveen
The Netherlands

declare under sole responsibility that the

2216 Four Channel Digitizing Oscilloscope

meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the official Journal of the European Communities:

EN 50081-1 - Emissions:

EN 55011	Radiated
EN 60555-2	Conducted

EN 50082-1 - Immunity:

IEC 801-2	Electrostatic Discharge
IEC 801-3	RF Radiated
IEC 801-4	Fast Transients
IEC 801-5	Surge (Draft)

Welcome

This is the User Manual of the **2216 Digital Storage & Analog Oscilloscope**. (see Figure i)

At the start of this manual you find the *Contents*, a *Product Overview*, *Safety* information, and *Start Up* information.

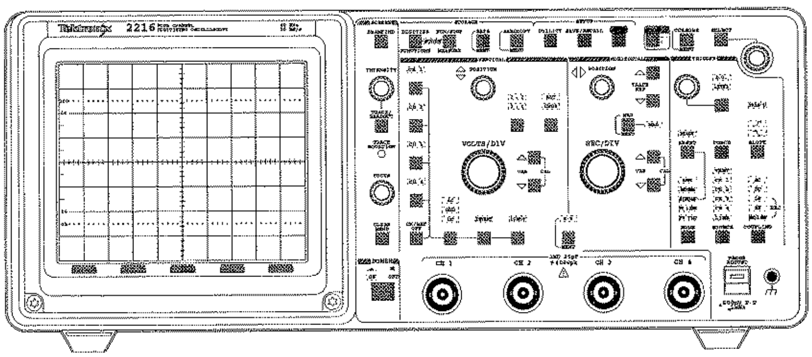


Figure i: 2216 Digital Storage & Analog Oscilloscope

The following sections are included:

- ❒ ***Tutorial*** section: The first chapter of this section gives you an overall *Product Description* of the 2216 oscilloscope operation. The next three chapters provide information and instructions to get you started making non-storage and storage measurements. In the last five chapters of this section, the special features of the 2216 will be discussed, like using Automated Measurements, References, Cursors, Custom Units, and Making Hardcopies.

- ❒ The ***At A Glance*** section describes the locations and purposes of the various functions on the front panel and the rear panel of the instrument and the menu system.

- The ***In Detail*** section provides further detailed information about the functions and locations of the 2216 controls, connectors, indicators and menus on the front and rear panel.
  Also included in this section are chapters about the CRT Readout system, Probes, and Maintenance.
- The ***Appendices*** section provides information about:

  A: Options & Accessories
  B: Specifications
  C: Performance Verification
  D: Algorithms
  E: CRT Readout
  G: Glossary
  I: Index
  M: Maintenance
  P: Probes

Related Documentation

Other documentation for the 2216 oscilloscope includes:

- 2216 Programmers Manual (Part Number 070-8905-00), providing programming information for 2216 oscilloscopes with Option 10 (GPIB) and Option 12 (RS-232-C).
- 2216 SCPI Programmers Manual (Part Number 070-8906-00) for 2216 oscilloscopes with Option 10 (GPIB) and Option 12 (RS-232-C).
- 2216 Service Manual (Part Number 070-8902-00) that provides information how to maintain and service the 2216.
- 2216 Reference (Part Number 070-8904-00), supplied with each 2216, to give you a quick overview of how to operate the 2216.

Contents

Tutorial

At A Glance

In Detail

Appendices

List of Illustrations

Product Overview

Your Tektronix 2216 oscilloscope is a combination digital storage & analog (non-storage), four-channel oscilloscope with a Parallel Printer Communication Interface (Centronics ® compatible). The 2216 addresses the needs of applications with the following features:

- **Digital Storage & Analog Oscilloscope**
- **Four full-featured channels**
- **16384-point record length per channel (131072-point optional)**
- **Auto Set-up**
- **CRT readout as well as front panel LED indicators**
- **Cursor measurement**
- **Advanced Measurement Functions**
- **DC to 60 MHz Analog (non-storage) bandwidth**
- **20 Megasamples/second maximum digitizing rate**
- **Menu operation blended with the traditional horizontal, vertical, and triggering knobs**
- **Parallel Printer Interface (Centronics® compatible)**
- **Full GPIB software programmability (optional)**
- **Full RS-232-C Communication Control (optional)**

Safety

Please take a moment to review these safety precautions. We provide them for your protection and to prevent damage to the 2216 Oscilloscope. This safety information applies to all operators and service personnel.

WARNING

To avoid personal injury or damage to the 2216, 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 immediately 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 2216 or to the equipment connected to it.

Power Source

This product is intended to operate from a power source that will not apply more than 250 V rms between the supply conductors or between either supply conductor and ground. A protective ground connection, through the grounding conductor in the power cord, is essential for safe system operation.

Grounding the Product

This product is grounded through the grounding conductor of the power cord. To avoid electric shock, plug the power cord into a properly wired receptacle where earth ground has been verified by a qualified service person. Do this before making connections to the input or output terminals of the product.

Without the protective ground connection, all parts of the product are potential shock hazards. This includes knobs and controls that may appear to be insulators.

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 the 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

This product provides no explosion protection from static discharges or arcing components. Do not operate this product in an atmosphere of explosive gasses.

Do Not Remove Covers or Panels

To avoid personal injury, do not operate the instrument without covers and panels.

Electric Overload

Never apply to a connector on this product a voltage that is outside the range for that connector.

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 2216 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) manuel	ATTENTION se reporter au

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.

Start Up

Before you use the 2216 Oscilloscope, refer to the Safety part of this chapter for power source, grounding, and other safety considerations.

Installation Procedure

Step 1. Be sure you have the appropriate operating environment. Specifications for temperature, relative humidity, altitude, vibrations and emissions are included in the Appendix: *Specifications* at the rear of this manual.

Step 2. Leave space for cooling. Do this by verifying that the air intake and exhaust holes on the sides of the cabinet are free of any airflow obstructions. Leave at least 5 cm (2 inches) free on each side.

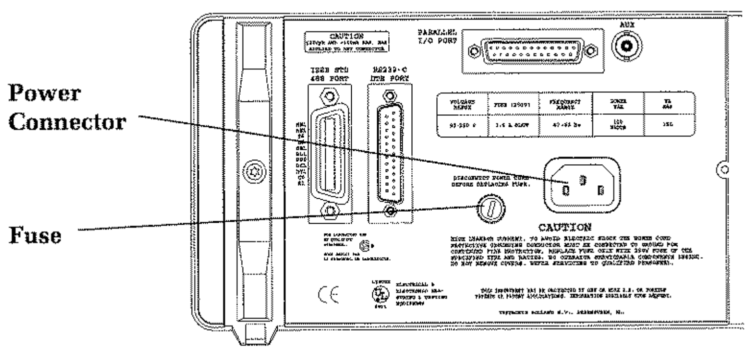


Figure ii: Rear Panel Controls Used at Start Up

NOTE
To avoid electrical shock, be sure that the power cord is disconnected from the instrument before checking the fuse.

The 2216 oscilloscope operates from a nominal ac-power line between 90 V and 250 V rms with a fuse of 1.6 A slow, with any frequency from 47 Hz to 63 Hz.

Step 3. Check the fuse, located on the rear panel (see Figure ii) to be sure it is of the proper type and rating.

CAUTION

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

Step 4. Connect the proper power cord from the rear-panel power connector to the power system (see Figure ii).

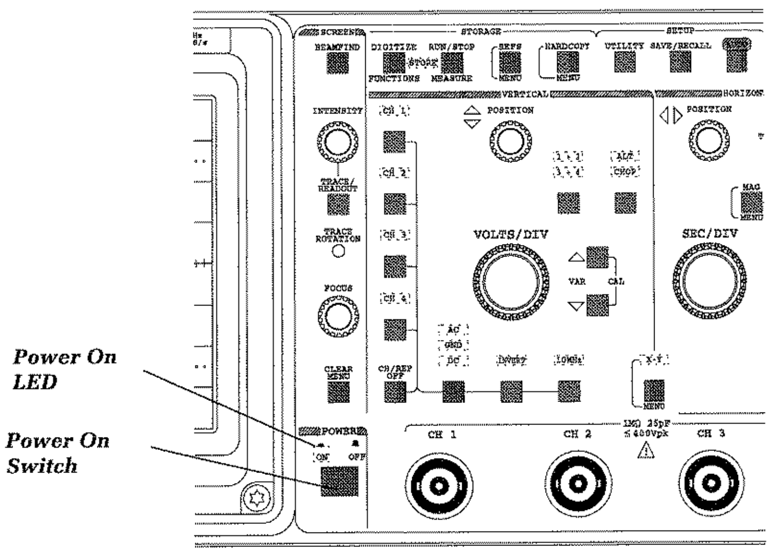


Figure iii: Partial 2216 Front Panel Controls Used at Start-up

Step 5. Press the POWER button. Observe that the POWER-ON indicator, located above the button, comes on (see Figure iii). After a few seconds a trace appears on the CRT screen, and the instrument is ready to make measurements.

Step 6. Press the Setup AUTO switch to obtain an optimized display that fits on the screen.

Tutorial Overview

This tutorial will try to help you making measurements with the 2216.

After a chapter with a description of the 2216, a number of chapters are presented in a sequence to perform all kinds of measurements, both in non-store and in store mode.

Besides the regular measurements, special topics to maximize the use of the 2216 are discussed in separate chapters.

The *Tutorial* section is split up in the following separate chapters:

Product Description

This 2216 *Product Description* intends to help you understand the operation of the instrument by describing the functions and controls of the instrument.

General

The 2216 is a digital storage (store) and analog (non-store), portable, four-channel oscilloscope with a DC to 60 MHz analog bandwidth, and a DC to 10 MHz digital bandwidth (20 MS/s).

The 2216 is menu operated blended with the traditional horizontal, vertical, and triggering knobs.

The 16KB record length in the standard 2216 can be extended to 128KB with Option 1M implemented.

The 2216 can be made a programmable oscilloscope with Option 10 (GPIB) and/or Option 12 (RS232) implemented.

The following topics will be discussed:

- Display System
- Vertical System
- Horizontal System
- Triggering System
- Storage System Features
- Setup Controls
- Cursor Feature
- CRT Readout
- Hardcopy Interface
- Options
- Standard Accessories
- Certification

See for detailed information *Section 3: In Detail* .

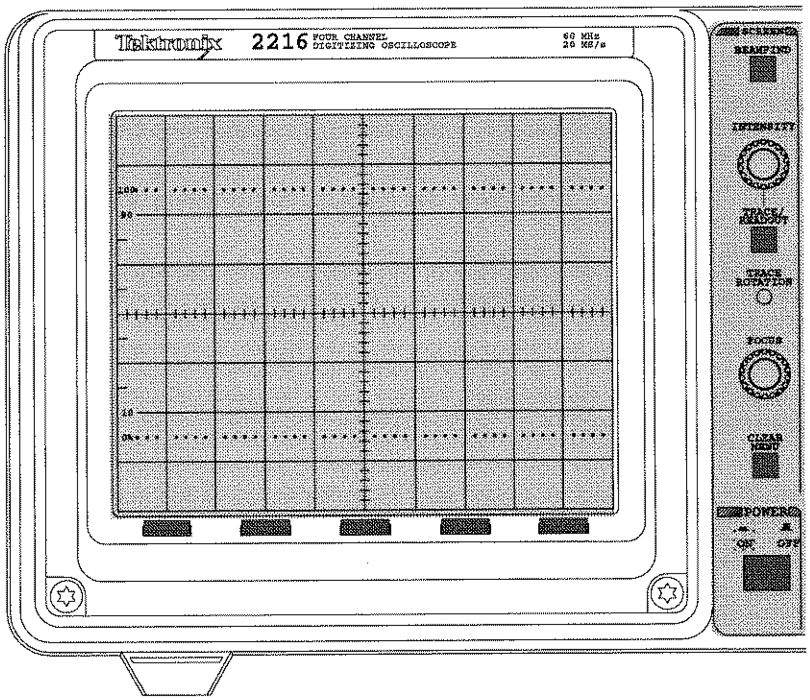


Figure 1-1: 2216 Power and Screen Section

Display System

The 2216 display shows signals, crt readouts, measurement results, and menus. In the SCREEN section of the front panel the display controls are situated (see Figure 1-1).

The **POWER** switch turns the power ON or OFF. At power-on, the 'ON' led lights.

The **INTENSITY** control adjusts the brightness of the trace or the readout.

With the **TRACE/READOUT** toggle switch you can select to adjust the trace intensity or the readout intensity.

Pressing the **BEAMFIND** switch compresses the CRT viewing area such that a signal will be located inside the crt area. Adjusting the vertical POSITION and the horizontal POSITION control will situate the signal on the screen.

The **FOCUS** control adjusts the trace for optimum display definition.

To remove a menu from the display, you simply press the **CLEAR MENU** switch.

The five bezel buttons can be used to make selections in a menu or to select a sub-menu.

Vertical System

The 2216 oscilloscope has four fully featured vertical channels (see Figure 1-2) with calibrated deflection factors (**VOLTS/DIV**) from 1 mV to 10 V per division. All vertical channels can be selected separately with the **CH1, 2, 3, 4** channel switches. One vertical channel at a time can be made the active channel and can be operated by the following controls:

- The **CH/REF OFF** switch turns off the active channel or the active reference.
- The vertical **POSITION** control positions the display of the active channel.
- The **INVERT** switch inverts the signal of the active channel.
- The **AC-GND-DC** switch selects the input coupling mode of the active channel.
- The **10 MHz** bandwidth limit switch; The bandwidth of the active channel will be limited to ±10 MHz.
  At 1 mV/DIV and 2 mV/DIV the analog bandwidth is always approximately 10 MHz. Full bandwidth (60 MHz) is available from 5 mV to 10 V/DIV.
- The **VAR** gain switches. The VARiable VOLTS/DIV gain control increases or decreases the deflection factor to provide overlapping VOLTS/DIV settings.

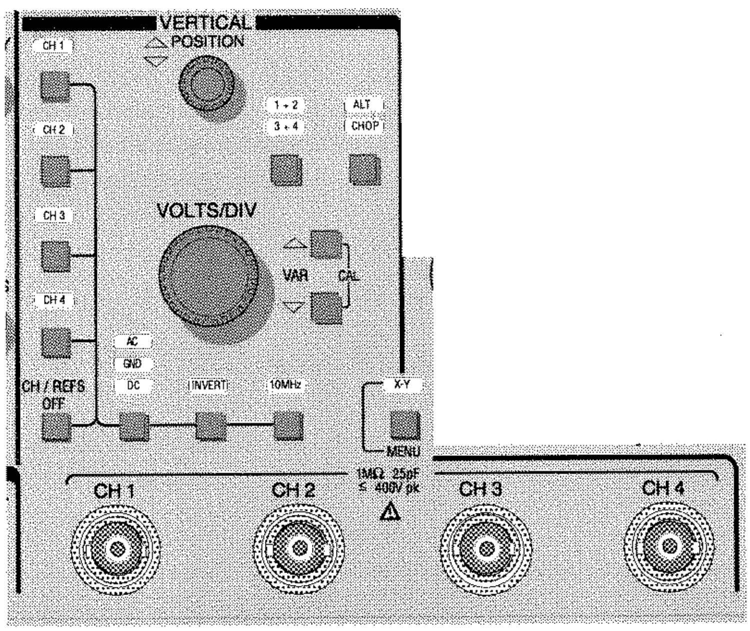


Figure 1-2: 2216 Vertical System Section

The following vertical **Display modes** can be selected:

- CH 1
- CH 2
- CH 3
- CH 4
- X-Y
- CH 1+2
- CH 3+4
- ALT
- CHOP

Using CH 1+2 and CH 3+4 simultaneously, turns the 2216 into a dual channel differential oscilloscope.

X-Y-Mode
In non-store mode, CH 1 or CH1+2 can be operated as the X-axis and CH 2, CH 3, CH 4, and CH3+4 as the Y-axis (see also page 1-33). In store mode, the X-axis and the Y-axis signals can be selected in the XY Menu (see also page 1-34).

Horizontal System

The horizontal system of the 2216 (see Figure 1-3) operates either in the analog way (non-store mode) or as a digital acquisition system (store mode). Horizontal scaling is expressed in seconds per division.

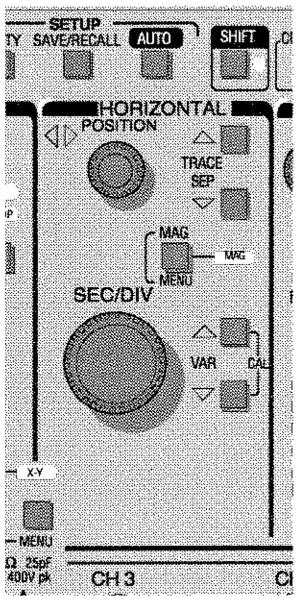


Figure 1-3: 2216 Horizontal Systen

Non-Store Mode

In non-store mode (STORE led off), the calibrated horizontal sweep speeds (**SEC/DIV**) range from 0.5 s to 0.05 μs per division.

The **VAR**iable SEC/DIV control may be used to increase the analog sweep time per division by a factor up to 2.5 times of the calibrated time per division as set by the SEC/DIV switch.

Store Mode

In store mode (STORE led On), the calibrated horizontal sweep speeds (SEC/DIV) range from 50 s to 20 µs per division.

At sweep speeds of 20 µs per division to 50 ms per division the display mode is RECORD for recordlengths of 4K and up. At sweep speeds of 0.1 s per division to 50 s per division the display mode changes to ROLL/ SCAN.

At a recordlength of 512 points, the display mode changes from RECORD to ROLL/SCAN at 50 ms/division.

The maximum sampling rate is 20 Mega-samples per second.

Magnification

By pressing the **MAG / MENU** button, the horizontal magnifier is switched on. Pressing the MAG/MENU button again switches the magnifier off.

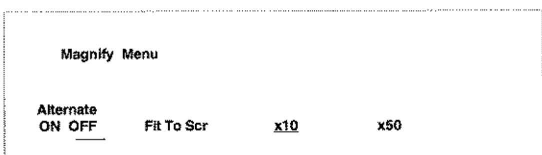


Figure 1-4: 2216 Magnify Menu

Pressing successively the SHIFT button and the MAG / MENU button shows the **Magnify Menu** (see Figure 1-4). Selections from the menu can be made with the bezel buttons, as indicated in the readout:

- Selecting **Alternate ON** will alternately display an unmagnified sweep and a sweep with the selected magnification factor.
- Selecting the **x10** and **x50** magnifies the display by times 10 or times 50. The magnifier feature extends the maximum calibrated sweep speed to 5 ns/division.
- Selecting **FIT TO SCREEN** selects a magnification factor such that a full record is displayed on the crt screen (in store mode), regardless of the selected record-length.

Trace separation controls (**TRACE SEP**) are used to vertically reposition the sweep with the fastest SEC/DIV setting in the alternate magnifier mode.

Triggering System

The triggering system of the 2216 is fully operated by front panel controls in non-store mode (see Figure 1-5), except if the AUX input is selected for TRIGGER in the Setup Configuration Menu. In store mode, the additional pre-trigger selection is defined in the 'Trigger Position Menu' (sub-menu of the 'Functions Menu').

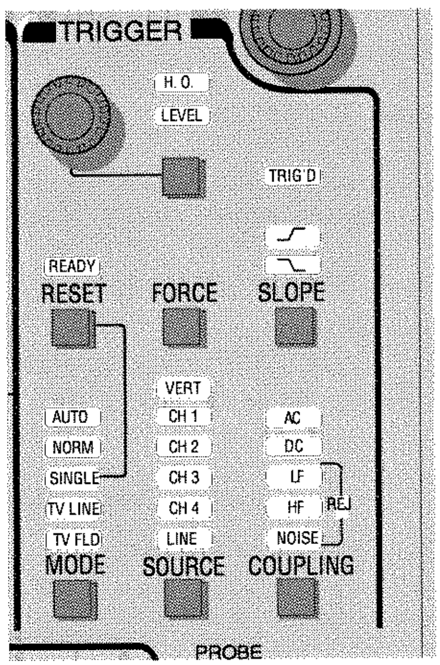


Figure 1-5: 2216 Triggering System Section

In the TRIGGER section of the 2216, the following trigger settings can be established:

- Trigger **SOURCE**, which determines the signal-source the trigger signal is derived from. You can select the following signal-sources:
  - A signal from one of the input channels (**CH 1, 2, 3, 4**)
  - A signal alternately obtained from CH 1, 2, 3, 4, CH 1+2 or CH 3+4 (**VERT**) when the vertical mode is set to alternate (ALT).

    In vertical chopped mode (CHOP), the channel which is displayed on the screen with the lowest number is used as the trigger source.
  - The AC **LINE** voltage, which is an attenuated ac power line signal.
- Trigger **MODE** determines how the oscilloscope behaves in the absence of a trigger:
  - **AUTO** triggering. In the absence of a trigger signal an auto trigger is generated and the sweep free-runs. With sweep triggers of 20 Hz and more, the sweep behaves as normally triggered.
  - **NORM**al triggering. In the absence of a trigger signal no auto trigger is generated and the sweep can only be started with a trigger from the trigger circuit.
  - Single sweep (**SINGLE**) triggering. One single sweep is started by a trigger pulse which is generated after the **RESET** button is pressed and a trigger signal from the trigger SOURCE is obtained.
  - **TV LINE** triggering. Permits triggering on a TV LINE. In absence of a trigger signal the sweep runs-free.
  - **TV Field** triggering. Permits triggering on a TV Field. In absence of a trigger signal the sweep runs-free.
- Trigger **COUPLING** selects the method of coupling to the trigger circuit. The following coupling methods can be used:
  - **AC** coupling. The trigger source signal is capacitively coupled to the trigger circuit, and the dc component is blocked.

  - **DC** coupling. The trigger source signal is dc-coupled to the trigger circuit.
  - Low Frequent Rejection coupling (**LF REJ**). Low frequency signals (below 30 kHz) from the trigger source are attenuated before being sent to the trigger circuit.
  - High Frequent Rejection coupling (**HF REJ**). High frequency signals (over 30 kHz) from the trigger source are attenuated before being send to the trigger circuit.
  - Noise Reject coupling (**NOISE**). Noise on trigger signals is rejected by increasing the peak-to-peak signal amplitude required to produce two succesive trigger events.

- The trigger **SLOPE** determines whether the oscilloscope finds the trigger point on the rising or the falling edge of the signal.

- The triggering **LEVEL/HOLDOFF** control determines where on the edge of the signal the trigger point occurs, when the H.O./ LEVEL switch is in the LEVEL position.

- Pressing the **FORCE** trigger button, a sweep starts immediately, regardless of any other trigger condition.

- In single sweep operation (**SINGLE**) the trigger circuit is reset to accept a trigger event by pressing the **RESET** button. After receiving a trigger pulse, the timebase (or acquisition) starts one single sweep.

- Holdoff can be adjusted by pressing the **H.O./LEVEL** button to the **H.O.** position. The holdoff is a variable time period after every sweep during which triggering is disabled. By rotating the trigger Level/Holdoff control, the holdoff time is adjusted.

NOTE

External Trigger Source can be selected in the Setup Utility Configuration Menu (a sub-menu of the Setup Utility Menu). With external triggering, trigger coupling, trigger level and trigger slope are fixed.

Storage System Features

The 2216 **STORAGE** section of the 2216 (see Figure 1-6) offers storage features to optimize a storage measurement. The features are defined in menus and sub-menus. The following storage menus are available:

- Storage Functions Menu
- Measurements Menu
- References Menu
- Hardcopy Menu

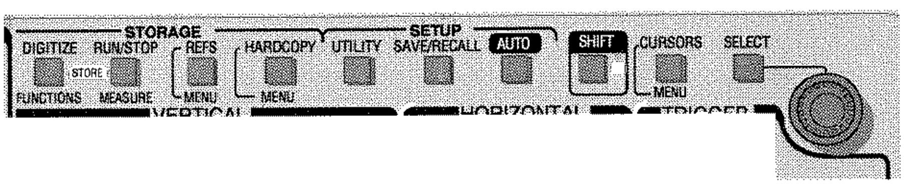


Figure 1-6: 2216 Storage and Setup Section

Storage function-buttons and menu-buttons are located in the STORAGE section of the front panel. Storage menus can be displayed by first pressing the SHIFT button and successively the required menu button.

• Digitize Function & Storage Functions Menu

The 2216 can be operated as an analog or a digitizing oscilloscope. Pressing the **DIGITIZE/FUNCTIONS** button toggles the 2216 between the analog and storage mode.In store mode the STORE LED lights, and analog data is converted into digital form by the acquisition system.

Pressing the SHIFT button and the DIGITIZE/FUNCTIONS button successively, the storage **Functions Menu** (see Figure 1-7) is displayed.

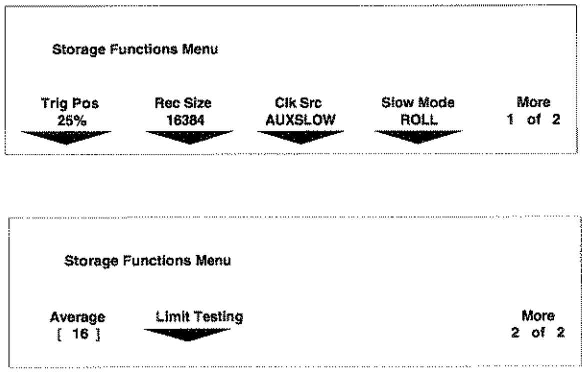


Figure 1-7: 2216 Functions Menu

Several functions in the Functions Menu (see Figure 1-6) can be defined in sub-menus and selections, such as:

- The **Trigger Position Menu**, to set the amount of pre-trigger data in the record.
- The **Record Size Menu**, to select the record length of the acquisition. The recordlength can be set to 512B, 4KB, 8 KB or 16 KB.

  NOTE

  In a 2216 with the long-record option implemented (Option 1M) the record length selection list is extended to 32 KB, 64 KB and 128 KB .
- The acquisition **Clock Source** Menu, to select the internal clock (INTERN) or the external clock (AUX IN RECORD or AUX IN SLOW).
- The Storage Function **Slow Display Mode Menu**, to select a ROLL or SCAN display mode at slow acquisition rates.
- In **Average** acquisition mode setting, the 2216 calculates an averaged waveform. Waveforms are the result from each new acquisition and the previously averaged waveform. The selected value, defined by the GPK control, determines the averaging ratio between the new and old data.
- The **Limit Testing Menu**, to activate limit testing, select the test limits and the resulting functionality.

• Run/Stop Acquisition & Measurements Menu

An acquisition of a waveform can be stopped when necessary. Pressing the **RUN/STOP / MEASURE** button stops the acquisition. Pressing the button again causes the acquisition to continue.

Automated measurements on starage waveforms can be performed by the 2216, as defined in the **Measurement Menu** and sub-menus (see Figure 1-8).
Pressing the SHIFT button and the RUN/STOP/MEASURE button successively shows the Measurement Menu (see also: *Using Automated Measurements* , on page 1-43)

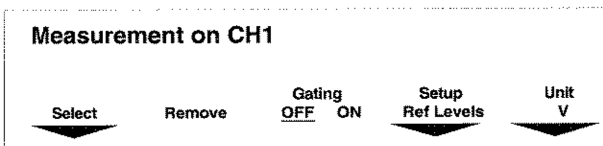


Figure 1-8: 2216 Measurements Menu

The following items and sub-menus can be selected:

- Pressing the 'Select bezel button, the **Select Measurement Menu** will be selected. The following measurements can be selected:
  - Minimum Value
  - Maximum Value
  - Peak to Peak
  - Period
  - Frequency
  - + Duty Cycle
  - – Duty Cycle
  - Power
  - Mean
  - Cycle Mean
  - RMS
  - Cycle RMS
  - Area
  - Cycle Area
  - Cycle Power
- Pressing the **Remove** bezel button removes the measurement.
- The **Gating** bezel button selects whether measurements are performed using the complete record (gating OFF), or a pre-selected part of the record (gating ON).
- Selecting Setup Ref Levels shows the **Set Measurement Reference Level Menu**. The 'mid ref level' can be selected as a percentage or as a voltage.
- Selecting Unit shows the **Measurement Unit Menu**. The 'unit' can be selected as a voltage or as a custom unit.

- **References & References Menu**

The 2216 can store the active waveforms as a reference in memory and can also display references from that memory to be compared with the currently acquired waveform(s). References can be removed from the screen by pressing the CH/REF OFF button.

Pressing the **REFS/MENU** button causes a reference to become the active waveform and shows the **Reference Readout** . In this readout, a maximum of four reference waveforms at a time can be selected, recalled and displayed on the screen for comparison with the currently acquired waveform(s).

Pressing the SHIFT button and the REFS/MENU button successively, the **Refs Menu** is shown (see Figure 1-9).

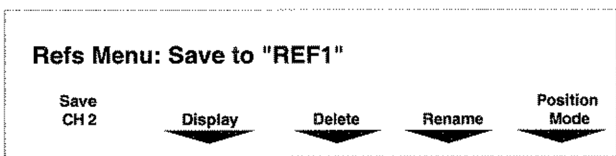


Figure 1-9: 2216 References Menu

The following items and sub-menus can be selected:

- Pressing the **Save** bezel button in the Refs Menu causes the active waveform to be saved in the reference memory.
  A maximum of 64 KB reference memory is available, which can be used for storing a maximum of 16 waveforms.
- Pressing the **Display** bezel button, the **Reference Display Menu** is shown. References can be selected.
- Pressing the **Delete** button the causes the **Delete References Menu** to be selected. In the Delete Reference Menu, a reference waveform can be deleted from memory.
- Pressing the **Rename** button the **Rename Reference Menu** is selected. In the Rename Reference Menu, a selected reference waveform can be renamed via the REFS Edit Name sub-menu.
- Pressing the Position Mode button, the **REFS Position Mode Menu** is selected. Horizontal positioning of the references is defined in this menu.

• Hardcopy & Hardcopy Menu

The 2216 can initiate a plotter or printer which is connected to the Parallel Printer/Plotter Interface connector to plot or print an acquired record or a selected part of a record.

The GPIB Interface connector or the Serial Communication Interface (RS232) connector can also be used as the hardcopy output, if the 2216 has Option 10 (GPIB) and/or Option 12 (RS232) implemented. The Hardcopy settings are defined in the Hardcopy Menu and sub-menus.

Pressing the **HARDCOPY/MENU** button initiates a printer/plotter, connected to the 2216, to print or plot a hardcopy as defined in the Hardcopy Menu. During hardcopy, a 'PRN' message is shown in the readout. Pressing the HARDCOPY/MENU switch again stops the print action.

Pressing the SHIFT and the HARDCOPY/MENU button successively, the **Hardcopy Menu** is shown (see Figure 1-10).

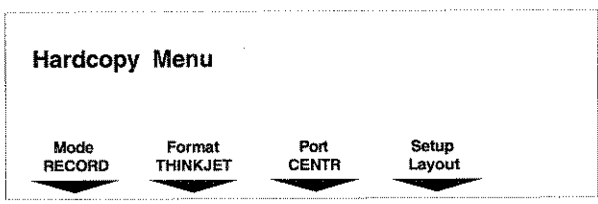


Figure 1-10: 2216 Hardcopy Menu

In the Hardcopy Menu the following sub-menus can be selected:

- Pressing the **Mode** button selects the Hardcopy Mode Menu.
  Pressing the 'Mode' bezel button again, the Hardcopy Print Mode Menu is displayed. In the Hardcopy Print Mode Menu, the RECORD print mode, the CHART print mode or the STATUS print mode can be selected.
  - The hardcopy **RECORD Mode Menu.** In the hardcopy Mode Menu RECORD position, the part of the record to be recorded, must be selected:
    - SCREEN COPY
    - FULL RECORD
    - BETWEEN CURSORS

- Hardcopy **Chart Mode Menu**. In this mode, a continuous printout is generated of basically infinite length, enabling recording of very slow phenomena. The printing speed (Time/Div) is selected with the GPK control.

- Hardcopy **Status Mode Menu**. If this mode is selected, pressing the HARDCOPY/MENU button, a hardcopy will be made of all 2216 settings.

– Pressing the **Format** button, the Hardcopy Format Menu is selected. In the hardcopy Format Menu, the following formats can be selected:

- HPGL	- THINKJET
- EPSON FX	- DESKJET
- EPSON LQ	- LASERJET

– Pressing the **Port** button, the Hardcopy Port Menu is selected. In the Hardcopy Port Menu, a sub-menu to setup the RS232 parameters or a hardcopy output port is selected:

- CENTRONICS
- GPIB (Option 10 only)
- RS232 (Option 12 only)
- Hardcopy **Setup RS232 Menu**

In the Hardcopy **Setup RS232 Menu**, the RS232 interface parameters are set that are used when making a hardcopy via the RS232 port.

– Pressing the **Setup Layout** button, the Hardcopy Setup Layout Menu is selected. In the Hardcopy Setup Layout Menu, layout parameters and, by selecting 'user note', the Edit Note menu can be selected:

- the size (non HPGL only)
- number of pens (HPGL only)
- graticule
- time visibility
- date visibility
- user note text
- user note visibility

Setup Controls

In the Setup section of the front panel, the following features and menus are situated to configure the 2216 (see also Figure 1-11):

- ❐ Setup AUTO feature
- ❐ Utility Menu
- ❐ Save/Recall Menu

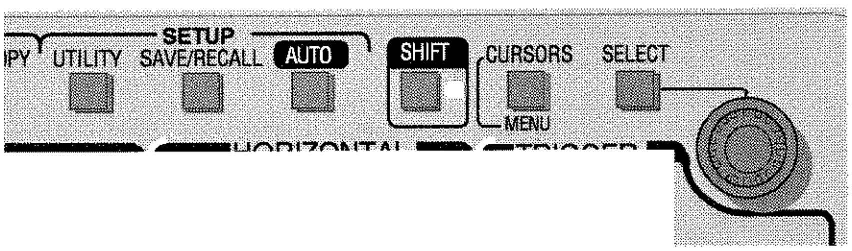


Figure 1-11: 2216 Setup and Cursor Section

• Setup AUTO Feature

The 2216 has a Setup AUTO feature implemented to get a display of an unknown signal by pressing just one front panel button.

Pressing the Setup **AUTO** button, the 2216 Setup AUTO feature sets automatically the following front panel functions to display an unknown waveform:

- Vertical scaling
- Horizontal scaling
- Triggering
- Display controls

A stable, automatically triggered display of the waveforms appears on-screen with an usable front panel setup.

• Setup Save/Recall Menu

With the Setup Save/Recall menu, a 2216 can store instrument setups in memory. Instrument setups can also be recalled from that memory and displayed on the screen.

Pressing the **SAVE/RECALL** button shows the Setup Save/Recall Menu on the screen (see Figure 1-12).

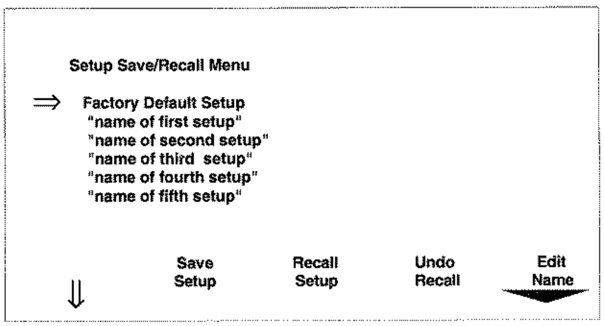


Figure 1-12: 2216 Setup Save/Recall Menu

In the Setup Save/Recall Menu, the Factory Default Setup can be selected for recall. Five 'User Settable Setups' can be selected for save, recall, and editing of the label. If the 2216 is switched off, the settings of the momentary instrument setup are saved and will be used at start up.

• Setup Utility Menu

Pressing the Setup **UTILITY** button shows the Utility Menu on the screen (see Figure 1-13). In the UTILITY menu, the following sub-menus can be selected:

– Pressing the Setup **Config** button shows the Setup Configuration Menu. In the Configuration Menu, the following settings of the 2216 are defined:

  - Function of the AUX INPUT (rear panel).
  - Type of Single Sweep Readout setting
  - Record-view readout visibility
  - Appearance of the readout
  - Date
  - Time

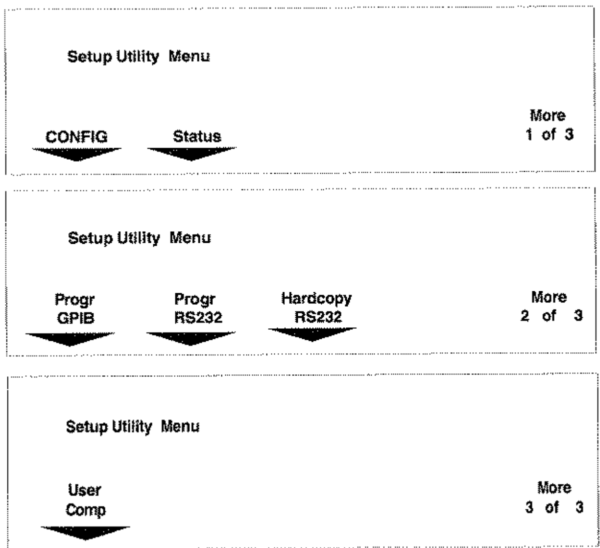


Figure 1-13: 2216 Setup Utility Menu

- Press the **'Status'** bezel button to show the **Status Display**. The display shows the instrument configuration .
- Press the **'Progr GPIB'** button on menu page 2 to show the **Programmable GPIB Menu**. In the Programmable GPIB Menu the settings of the (optional) GPIB communication interface are defined, if GPIB is used to remotely control the instrument.
- Press the **'Progr RS232'** button on menu page 2 to show the **Programmable RS232 Menu**. In the Programmable RS232 Menu the settings of the (optional) RS232 communication interface are defined, if RS232 is used to remotely control the instrument.
- Press the **'Hardcopy RS232'** button on menu page 2 to show the **Hardcopy RS232 Menu**. In the Hardcopy RS232 Menu the settings of the (optional) RS232 communication interface are defined, if RS232 is used to make a hardcopy.
- Press the **'User Comp'** button on menu page 3 to show the **User Compensation Menu**. Drift of some DC settings can be compensated.

Cursor Feature

General

The 2216 can make more accurate voltage, time, frequency or 'custom unit' measurements on waveforms by using the cursors.

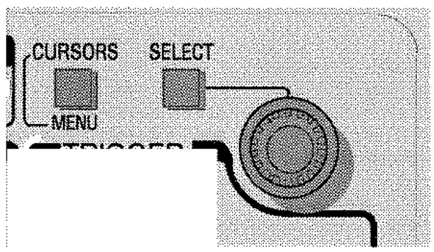


Figure 1-14: 2216 Cursors Section

Pressing the **CURSORS/ MENU** switch will activate the cursor function as selected in the Cursors Menu. Pressing the CURSORS/MENU button again will switch off the cursor function.

Cursors should be positioned on the required measurement points in a waveform. The crt readouts indicate that the distance between the cursors is expressed as:

- a voltage difference (ΔV)
- a RATIO, expressed in % of a previously set distance between the cursors (100%)
- a timing difference (ΔT)
- a reciprocal time-difference (approximate frequency) (1/ΔT)
- a PHASE , expressed in ^{0}'s of a previously set distance between the cursors (360 ^{0})
- a difference in "Custom Units" (ΔV)

Cursor Position

The cursor position is controlled by the general purpose knob **(GPK)** (see Figure 1-14).

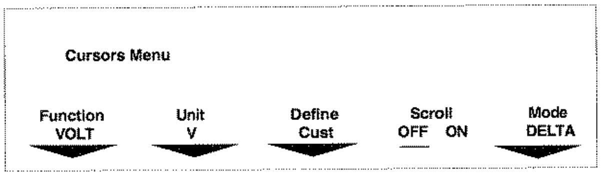


Figure 1-15: 2216 Cursors Menu

SELECT Switch

Pressing the **SELECT** button, the other cursor is selected if the 'DELTA' or 'TRACK' cursor function is selected.

Cursors Menu

Pressing the SHIFT and the CURSORS/MENU switch successively, the Cursors Menu is displayed (see Figure 1-15).

– Pressing the **Function** button will select the Cursor Function Menu. In the Cursor Function Menu, you can select:
  - VOLTS cursors, which are horizontal lines in Y-t mode.
  - TIME cursors, which results in vertical lines in Y-t mode, and squares in X-Y mode.
  - PAIRED cursors.
    Press 'PAIRED' if you want to observe the readout of the TIME cursors and the readout of the Voltage difference between the crossing points of the TIME cursors and the active signal.
– Pressing the **Unit** button will select the Cursor Unit Menu. This menu is dependent on the selected Cursor Function. There are three different Cursor Unit Menus:
  - Cursor Voltage Unit Menu
  - Cursor Time Unit Menu
  - Cursor Unit Menu if PAIRED is selected in the Cursor Function Menu.
– Pressing the **Define Cust** button will select the Cursor Custom Unit Menu. For more information on Custom Units, see chapter: *Using Custom Units*, page 1-61.

- Pressing the **Scroll** button will select scrolling ON or OFF. If 'Scroll' is ON, and the selected TIME cursor is moved off the screen, the horizontal position is automatically changed to keep the cursor on the screen.

- Pressing the **Mode** button will select the Cursor Mode Menu. In the Cursor Mode Menu, you can select:

  - **DELTA** cursor mode. In DELTA mode, one cursor is fixed and one cursor can be positioned with the GPK control.
  - **TRACK** cursor mode. In TRACK mode, both cursors can be positioned simultaneously with the GPK control.
  - **SINGLE** cursor mode. In SINGLE mode, one cursor is available. The cursor can be positioned with the GPK control. The distance between the trigger point and the cursor is measured (TIME Cursor Function), or the distance between ground level and the cursor (VOLTAGE Cursor Function).

NOTE

To ensure maximum accuracy for the VOLTAGE Cursor Function, the User Cal in the Setup Utility Menu should be performed.

CRT Readout

The CRT readout of the 2216 is intended to be of help to the user to provide extra information. The settings reported to the user in the crt readout display are:

- CH1, CH2, CH3 and CH4 VOLTS/DIV settings
- SEC/DIV setting
- Voltage or Time cursor data
- Trigger Level
- AC and GND position of AC-GND-DC switch
- The display mode (ROLL, SCAN)
- The acquisition status (STOP)
- Measurement results

Hardcopy Interface

The 2216 oscilloscope has a parallel printer/plotter interface connector (Centronics© compatible) on the rear panel. The interface is provided to make hardcopies via a printer /plotter with a Centronics compatible interface.

Options

The following options will become available for the 2216:

- GPIB (IEEE 488.2) communication interface (2216 Option 10).
- RS-232-C communication interface control (2216 Option 12).
- Long record-length of 128 KB per channel, user programmable. (2216 Option 1M)

Standard Accessories

The following accessories will be shipped with each 2216:

- Two Tektronix P6109B probes (10x attenuator).
- 2216 User Manual
- 2216 Quick Reference
- Power cord (as ordered)

Certification

The 2216 is certified for:

- UL 1244
- CSA-C22.2 No. 231
- Comply with IEC 1010-1

The 2216 is CE marked.

Initial Setup

Initial Setup

The following procedure will help 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 on the rear panel.

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

NOTE
At power-up, the instrument will return to the status before power-down.

Step 4. Connect the probe(s) or signal cable(s) with the signal(s) to be measured to the vertical input connector(s).

Step 5. Use the CH 1, CH 2, CH 3, and CH 4 select buttons to display the channel of interest.

Step 6. Press the Setup AUTO button to obtain a usable display.

Step 7. Adjust the front panel controls to obtain the desired display.

Probe Compensation

Misadjustment of probe compensation is a possible source of measurement error. The attenuator probes are equipped with compensation adjustments. For the best measurement accuracy, check the probe compensation before making measurements (see Figure 1-16). Use the following procedure to check and compensate the probes.

Step 1. Switch the instrument on.

Step 2. Connect the four supplied 10x probes to the **CH 1, CH 2, CH 3, and CH 4** input connectors.

Step 3. Connect the probe tip of CH 1 to the **PROBE ADJUST** connector and the probe ground lead to scope ground.

Step 4. Press the Setup **AUTO** button.

Step 5 Check the square-wave display for overshoot and rolloff (see Figure 1-16). 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 6. Remove the probe tip from the **PROBE ADJUST** connector.

Step 7. Connect the probe tip of CH 2 to the **PROBE ADJUST** connector and the probe ground lead to scope ground.

Step 8. Repeat step 4 through 6.

Step 9. Connect the probe tip of CH 3 to the **PROBE ADJUST** connector and the probe ground lead to scope ground.

Step 10. Repeat step 4 through 6.

Step 11. Connect the probe tip of CH 4 to the **PROBE ADJUST** connector and the probe ground lead to scope ground.

Step 12. Repeat step 4 through 6.

Step 13. Mark all four probes per vertical channel.

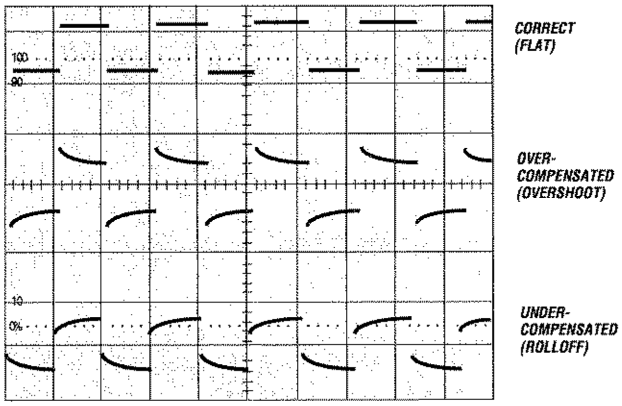


Figure 1-16: Probe Compensation

NOTE

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

Making Measurements

This chapter intends to help you make measurements with the 2216 oscilloscope in Non-Store mode as well in Store mode. The following topics will be discussed:

Using Unmagnified Sweep Displays

The 2216 can be operated as a an analog (Non-Store) oscilloscope or as a digitizing (Store) oscilloscope. Both types of displaying a waveform on the 2216 will be discussed.

Non-Store Display

Use the following procedure in non-store mode to display an unmagnified sweep (see Figure 1-17):

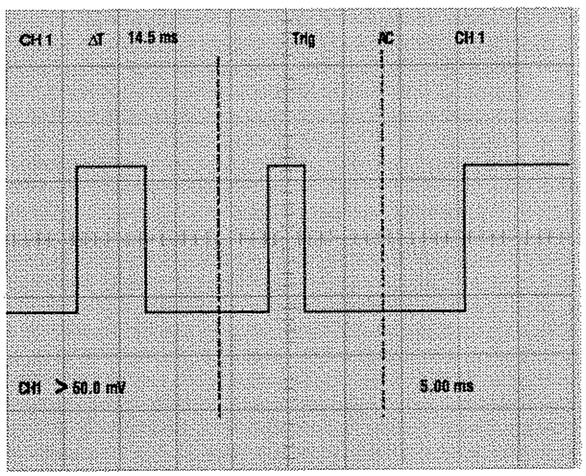


Figure 1-17: Example of a Waveform Display

Step 1. Switch the 2216 on, press '**CH 1**' button to on, and obtain a display on CH 1.

NOTE

You may use 'CH 2', 'CH 3' or 'CH 4' or a combination of channels as well.

Step 2. Using a 10x probe or a properly terminated coaxial cable, apply a signal to the CH1 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 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 Setup **AUTO** button, which automatically sets the vertical, horizontal, triggering and display to produce a usable, stable triggered display.

Step 4. Adjust the **VOLTS/DIV** switch position 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 the displayed signal. Then adjust the FOCUS control for the best defined display.

Store Mode Displays

The conditions under which a waveform is acquired in store mode for display are set with the usual front-panel control selections and the settings in the storage menus.

The difference with the non-store settings is mainly that the DIGITIZE function must be activated.
There are two modes in which the 2216 can acquire waveforms:

- **RECORD Mode**. The 2216 will acquire and display waveforms in RECORD mode, if:
  - The SEC/DIV is set between 50 ms/division and 20 µs/division. (With 512 points recordlength record mode changes from 20 ms to 2 µs).
  - If the 2216 clock source in the Clock Source menu (sub-menu of the Functions Menu) is set to AUX IN RECORD.

  A full record of the acquired waveform is updated each time a trigger event is recognized.

- **Slow Mode** (either **ROLL** or **SCAN** as selected in the Slow Display Menu). The 2216 will acquire and display waveforms in ROLL or SCAN mode:
  - With the SEC/DIV is set to slower than 50 ms/div (with 512 points recordlength 20 ms).
  - If the 2216 clock source in the Clock Source menu (sub-menu of the Storage Functions Menu) is set to AUX SLOW.

  In ROLL and SCAN mode, signals are continuously acquired and displayed. Sweep triggers are disabled in 'ROLL/SCAN' mode, except in SINGLE Sweep.

In RECORD and ROLL/SCAN mode (not in SINGLE Sweep), you may use the following procedure to display a signal on the screen:

Step 1. Switch the 2216 on.

Step 2. Press the '**CH 1**' button to on. Apply the signal to be displayed to the CH 1 input connector.

Step 3. Press the AUTO Setup button.

Step 4. Press the **DIGITIZE/FUNCTION** button to the ON state (STORE on), if not in store mode.

Step 5. Press the **SHIFT** and the **DIGITIZE/FUNCTION** button successsively to display the Function Menu.

Step 6. Define the **Trigger Position**, the **Record Size** and the **Clock Source** as desired in the respective sub-menus of the Function Menu.

Using Magnified Sweep Displays

A signal can be displayed on the screen in the x10 , x50, or FIT TO SCREEN magnifier position, as defined in the Magnify Menu.

To switch from store mode display to non-store mode display, press the DIGITIZE/FUNCTIONS button in the STORAGE section of the front panel.

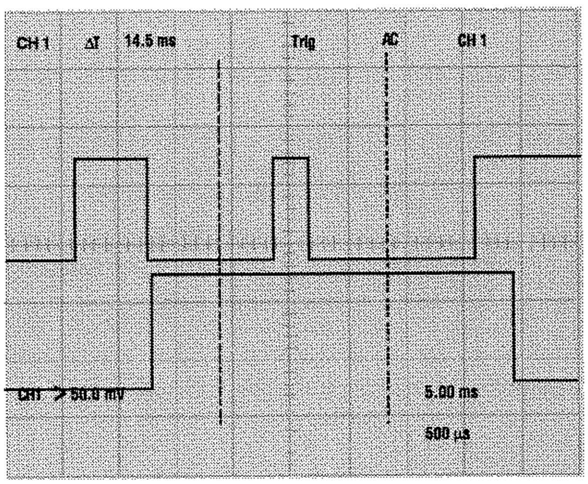


Figure 1-18: Example of an Alternate Sweep Display

You can use the following procedure to display the magnified signal (see Figure 1-18):

Step 1. Switch the 2216 on.

Step 2. Set the **SEC/DIV** switch for a sweep speed that permits you to select the area to be magnified.

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. Press the MAG/MENU button to activate the Magnify function.

Step 5. Press the **SHIFT** and the **MAG/MENU** button successively to obtain the **Magnify Menu** on the screen. Select with the bezel buttons the magnification factor:

- FIT TO SCREEN
- x10
- x50

NOTE
The magnified sweep rate is displayed in the crt readout.

Step 6. If Alternate Magnify is needed to display the magnified sweep and the unmagnified sweep on the crt screen alternately, press the '**Alternate**' bezel button to select ON.

Step 7. Adjust the vertical **POSITION** control and the **TRACE SEP**aration control as required to display the unmagnified and the magnified sweeps.

Using X-Y Display Mode

The 2216 oscilloscope can be used to produce X-Y displays in Non-Store as well as in Store mode (see also page 3-15 through 3-16).

X-Y Non-Store Mode

Use the following procedure to display signals in the X-Y non-store mode:

Step 1. Apply a vertical signal (Y-axis) to the **CH 2** input connector. Apply the horizontal signal (X-axis) to the **CH1** input connector.

Step 2. Select CH 1 and CH 2 to be displayed, and set the VOLTS/DIV and the POSITION to a proper display.

Step 3. Rotate the **TRACE INTENSITY** control fully counter-clockwise.

Step 4. Toggle the **X-Y/MENU** switch to X-Y ('X-Y' LED on).

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

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.

X-Y Store Mode

For X-Y measurement displays in store mode, use the following procedure:

Step 1. Press the **DIGITIZE** button to the on position (STORE LED lights).

Step 2. Press the **SHIFT** and the **X-Y** button successively to show the Digitize XY Menu.

Step 3. Select X1 and Y1 resp. with the GPK control for the first XY display. (X1 and Y1 selection may be: CH 1 through CH 4, Ref 1 through Ref 16, or NONE)

Step 4. Select X2 and Y2 resp. with the GPK control for the second XY display (X2 and Y2 selection may be: CH 1 through CH 4, Ref 1 through Ref 16, or NONE).

Step 5. Press the channel and the reference select buttons to display the X1, Y1, X2 and Y2 waveforms.

Step 6. Define with the **SEC/DIV** switch the sample rate for the XY signal if the Clock Source in the Function Menu is set to INTERN.

NOTE

With an external clock signal to the AUX input on the rear panel, and the Clock Source in the Function Menu set to AUX IN RECORD or AUX SLOW, you define the sample rate for the XY signal with an external signal.

Step 7. Use the horizontal positioning of the channels and references to display the section of the data that must be displayed in X-Y mode.

Step 8. Press the X-Y/MENU button to display the signals in X-Y mode.

Using Single Sweep Operation

The 2216 can be used in SINGLE sweep display in all display modes:

- Single sweep **in Non-Store** mode
- Single sweep **Store RECORD Store** mode
- Single sweep **Store ROLL/SCAN** mode

Single Sweep Non-Store Mode Measurements

Use the following procedure to display one single sweep in the SINGLE sweep trigger mode:

Step 1. Switch the 2216 on.

Step 2. Press '**CH 1**' channel button to display the CH 1 signal and make CH 1 the active channel (CH 1 LED is on).
Apply a test signal to the CH 1 input connector to set the VOLTS/DIV and the trigger LEVEL control correctly.

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 3. Set the **VOLTS/DIV** switch and adjust the vertical POSITION control to display the waveform correctly within the graticule area.

NOTE
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** switch to NORM and adjust the trigger LEVEL control carefully until the display is stable.

Step 5. Toggle the trigger **MODE** to SINGLE Sweep and check that the sweep triggers when the RESET button is pressed.

NOTE

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 single sweep **RESET** button is pressed again to set the sweep to the READY state.

Step 7. Disconnect the test signal from the CH1 input. Apply the random signal to the CH1 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.

Single Sweep Store Mode

The 2216 SINGLE sweep store mode can be operated in RECORD mode or ROLL/SCAN mode.

NOTE

With the 2216 in ROLL/SCAN mode, triggers are disabled in normal operation, but not in SINGLE Sweep.

Single Sweep in RECORD Mode

With the 2216 is in SINGLE Sweep Record mode, the last waveform acquired remains displayed.

When you press the RESET button, the trigger circuit is rearmed to accept a new trigger event. When that trigger event occurs, the full record is acquired and the display is updated.

With the vertical MODE in ALT and the trigger SOURCE in VERT MODE, and multiple channels 'on'. A new acquisition is only performed on one channel. The data in the non-triggered channel is not overwritten. When you press the RESET button again, the next channel is updated, etc.

For SINGLE Sweep RECORD mode, you can use the following procedure:

Step 1. Press the **DIGITIZE** switch to activate the store mode.

Step 2. Define the trigger point in the **Trigger Position Menu** (submenu of the Functions Menu) as needed for your measurement.

Step 3. Press the '**CH 1**' button to display CH 1 and make CH 1 the active channel.

Step 4. Apply a test signal to the CH 1 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 **VOLTS/DIV** switch and adjust the vertical **POSITION** control to display the waveform correctly within the graticule area.

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 **SINGLE** sweep and check that the display is updated when the RESET button is pressed.

NOTE

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 illuminates 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 single sweep **RESET** button is pressed again to set the sweep to the **READY** state.

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

Step 10. Until a 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 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.

Single Sweep in ROLL/SCAN Mode

In SINGLE sweep ROLL/SCAN mode, the 2216 display continues to roll although the trigger circuit is not armed.

Press the RESET button to arm the trigger circuit. Acquisition starts, and the pretrigger portion of the waveform record is filled. During the pretrigger time, the READY light blinks and triggers are disabled. When triggering is enabled, the READY LED lights continuously 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, the READY light dims, and the TRIG'D light is on. When the remaining portion of the record is filled, the TRIG'D light dims and the acquisition is stopped.

The time needed to fill the pretrigger and post-trigger portions of the record depends on :

- The sampling rate
- Setting of the trigger position.

In SINGLE sweep ROLL/SCAN mode, with the vertical MODE in ALT and the trigger SOURCE in VERT mode, and more than one channel is turned on, the channels are alternately acquiring data.

For SINGLE sweep ROLL/SCAN mode, use the following procedure:

Step 1. Press the **DIGITIZE** switch to activate the store mode.

Step 2. Define the trigger point in the **Trigger Position Menu** (sub-menu of the Functions Menu) as needed for your measurement.

Step 3. Press the '**CH 1**' button to display CH 1 and make CH 1 the active channel.

Step 4. Apply a test signal to the CH 1 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 **VOLTS/DIV** switch and adjust the vertical POSITION control to display the waveform correctly within the graticule area.

Step 6. Toggle the trigger MODE to **SINGLE** sweep and check that the display is updated when the **RESET** button is pressed.

NOTE

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 utton 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 7. 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 single sweep RESET button is pressed again to set the sweep to the READY state.

Step 8. Disconnect the test signal from the CH 1 input and apply the random signal to the CH 1 input and press the **RESET** button to set the acquisition system to the READY state.

Step 9. The trace starts rolling from the right to the left of the screen in ROLL mode, or a constant refresh of data is visible moving from left to right in SCAN mode. 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 pre-trigger time) the random trigger pulse occurs, and the posttrigger time period has expired the acquisition stops.

Step 10. Another acquisition cannot be started until the RESET button is pressed again to rearm the acquisition circuit.

Observing Aliases

Aliasing

Aliasing occurs in digitize mode when the highest frequency component of the input signal is greater than half the current sample rate. The oscilloscope cannot acquire the signal fast enough to construct an accurate waveform record. Figure 1-24 illustrates this by showing a slower aliased waveform on top of the actual input waveform.

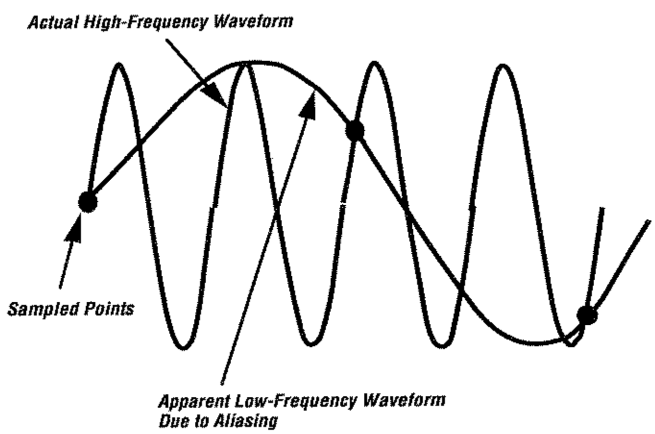


Figure 1-24: Aliasing

In digital sampling, a more accurate reproduction of a signal is possible when more samples of the signal are obtained. The 2216 samples 4000 times across the 10 horizontal divisions of the graticule. A sine wave spread across the full screen will be sampled 4000 times.

NOTE

With 512 points recordlength the 2216 samples 400 times across 10 horizontal divisions.

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.

At 20 µs per division, and a recordlength larger than 512 points, 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 without using special filters.

If the input frequency is increased beyond 8 MHz, soon less than two samples per period will be taken. 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 1-24).

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, The sampled waveform will visibly differ from the actual waveform.

Anti-Aliasing

In the event that an alias is suspected, two things may be done to determine whether the observed display is a correct representation of the actual waveform.

- 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.
- 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 SEC/DIV setting available on the 2216 in store mode is 20 µs per division (2 µs with a recordlength of 512 points).

Using Automated Measurements

There are various ways to measure properties of waveforms in store mode. You can use graticule, cursor, or automatic measurements.

Automatic measurements are generally more accurate than, for example, counting graticule divisions. During operation, the 2216 oscilloscope will continuously update and display these measurements.

Automatic measurements calculate waveform parameters from acquired data. Measurements are performed over the entire waveform or the region specified by the 'TIME' cursors (if 'Gating ON' is selected in the Measurement Menu).

The 2216 provides 15 different automatic measurements (see Table 1-1).

The readout of the measurement result is on the right side of the crt screen. One automatically updated measurement can be displayed at a time.

NOTE

To ensure maximum vertical accuracy in the measurement, the User Compensation function in the Setup Utility Menu should be performed before the measurement is started.

The following will be discussed:

Table 1-1: Measurement Definitions

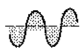
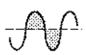
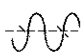
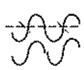
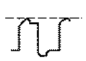
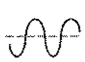
Name	Definition
 **Area**	Voltage over time measurement. The area over the entire waveform record or gated region, in volt-seconds. Area measured above ground is positive; area below ground is negative.
 **Cycle Area**	Voltage over time measurement. The area over the first cycle in the waveform, or the first cycle in the gated region, in volt-seconds. Area measured above ground is positive; area below ground is negative.
 **Cycle Mean**	Voltage Measurement. The arithmetic mean over the first cycle in the waveform, or the first cycle in the gated region.
 **Cycle Power**	Power measurement. The arithmic mean over the first cycle of the active waveform (or the first cycle in the gated region) over the product of both waveforms.
 **Cycle RMS**	Voltage measurement. The True Root Mean Square voltage over the first cycle in the waveform, or the first cycle in the gated region.
 **Frequency**	Timing measurement for the first cycle in the waveform or the gated region. The reciprocal of the period. Measured in Herz (Hz) where 1 Hz = 1 cycle per second.
 **Maximum**	Voltage measurement. The maximum amplitude. Typically the most positive peak voltage. Measured over the entire waveform or the gated region.
 **Mean**	Voltage Measurement. The arithmetic mean over the entire waveform record, or the gated region.

Table 1-1: Measurement Definitions (cont.)

Name	Definition
Minimum	Voltage measurement. The minimum amplitude. Typically the most negative peak voltage. Measured over the entire waveform or the gated region.
Negative Duty Cycle	Timing measurement for the first cycle in the waveform or the gated region. The ratio of the negative pulse width to the signal period expressed as a percentage. $NegativeDutyCycle = \frac{NegativeWidth}{Period} \times 100\%$
Peak to Peak	Voltage measurement. The absolute difference between the maximum and the minimum amplitude measured over the entire waveform record or the gated region. *Peak to Peak = Max. Value – Min. Value*
Period	Timing measurement. Time it takes for the first complete cycle to happen in the waveform or gated region. The reciprocal of frequency. Measured in seconds.
Positive Duty Cycle	Timing measurement for the first cycle in the waveform or the gated region. The ratio of the positive pulse width to the signal period expressed as a percentage. $PositiveDutyCycle = \frac{PositiveWidth}{Period} \times 100\%$
RMS	Voltage measurement. The True Root Mean Square voltage over the entire waveform, or the gated region.
Power	Power measurement. The arithmic mean over the product of both waveforms, or the gated region.

Getting a Stable Display

Prior to making measurements on an acquired waveform, you may press the RUN/STOP button in the STORAGE section of the front panel (see Figure 1-19), holding the acquired waveform and providing a more stable display for the measurement.

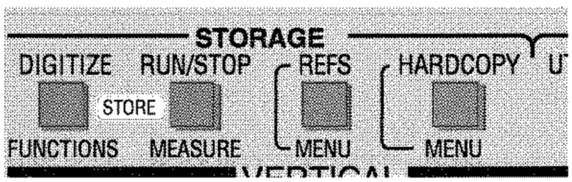


Figure 1-19: Storage Section of the 2216 Front Panel

Use the following procedure to STOP an acquisition in Record and in Roll /Scan) mode:

Step 1. Acquire a waveform.

Step 2. Pressing the **RUN/STOP** button while in RECORD mode causes the current display to be stopped immediately, and the display is not updated. "STOP" appears in the acquisition status field of the readout.

Step 3. Pressing the RUN/STOP button again, restarts the acquisition.

Step 4. Pressing the RUN/STOP button while in ROLL/ SCAN mode, causes the current acquisition to be stopped immediately. "STOP" appears in the acquisition status field of the readout.

Step 5. Pressing the RUN/STOP button again, causes the acquisition to continue where it was stopped.

Using an Automated Measurement

To work with an automatic measurement, you can use the following procedure to define the selected measurement:

Step 1. Press the SHIFT and the RUN/STOP/MEASURE button to display the **Measurement Menu** (see Figure 1-20).

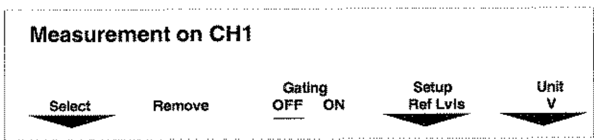


Figure 1-20: 2216 Measurement Menu

Step 2. Define with the '**Gating**' bezel button if you want to measure the complete waveform or a gated region of the waveform.

With 'Gating ON, two 'TIME' cursors are displayed to define a 'gate' in which the measurement action is taking place. The measurement 'gate' (the region between the two cursors) can be defined with the GPK control and the SELECT switch.

Step 3. Press the '**Select**' bezel button to display the **Select Measurement Menu** (see Figure 1-21).

Step 4. Select the measurement type as indicated in the Select Measurement menu. Selecting another measurement type replaces the previous measurement.

Step 5. After you have completed selecting a measurement type, toggle the 'More' bezel button to 'More 4 of 5'.

Step 6. Press the 'Previous Menu' bezel button to return to the Measurement Menu or press 'CLEAR MENU' to leave the Select Measurement Menu.

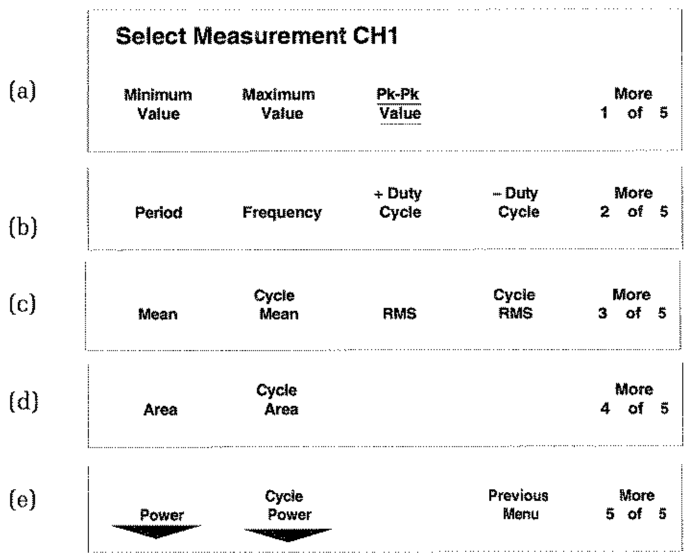


Figure 1-21a, b, c, d, e: 2216 Select Measurement Menu

Selecting a Measurement Unit

You need to define the vertical unit of measure if a unit other than Volts must be applied. The following procedure can be used to define the unit of measure:

Step 1. Press the **SHIFT** button and the **RUN/STOP/MEASURE** button to display the **Measurement Menu** (Figure 1-20).

Step 2. Press the '**Unit**' bezel button in the Measurement Menu to display the **Measurement Unit Menu** (see Figure 1-22).

Step 3. Press the 'Unit' bezel button in the Measurement Unit Menu to 'V' (Volts) or 'CUST' (Custom unit).

Step 4. If '**CUST**' is selected, the custom unit as defined in the Define Custom Unit (see section: *Using Custom Units page 1-61*)

Step 5. After completing the measurement unit definition, press the 'Previous Menu' bezel button to return to the Measurement Menu or press 'CLEAR MENU' to leave the Measurement Unit Menu.

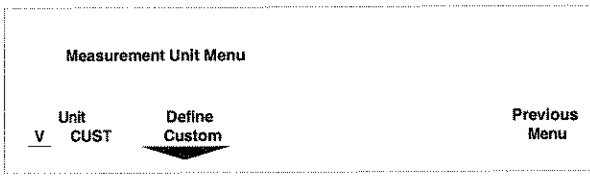


Figure 1-22: 2216 Measurement Unit Menu

Removing a Measurement

To remove a measurement from the display, use the following procedure:

Step 1. If you have not already selected the Measurement Menu, press the SHIFT button and the RUN/STOP / MEASURE button to display the **Measurement Menu**.

Step 2. Press the '**Remove**' bezel button to stop the measurement and remove the measurement readout from the screen.

Selecting a Measurement Reference Level

You may need to define a mid reference level in the 2216 for a waveform to be measured at a different mid reference level than the default level.

The mid reference level is used to determine the duration of a period of a waveform (see Figure 1-22a).

The mid reference level can be defined as a percentage of the peak-to-peak amplitude of the signal or as an absolute (voltage) value. The 2216 uses the mid reference level for all timing and cyclic measurements. For most measurements a mid reference level of 50% is appropriate.

The following procedure can be used to define a waveform reference level:

Step 1. If you have not already selected the Measurement Menu, press the SHIFT button and the RUN/STOP / MEASURE button to display the **Measurement Menu**.

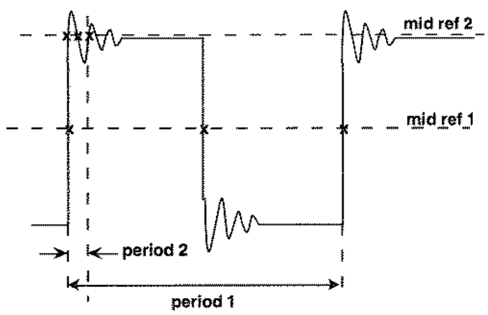


Figure 1-22a: Middle Reference Levels Influence on a Measurement

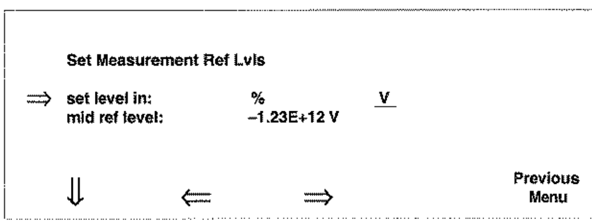


Figure 1-23: 2216 Set Reference Level Menu

Step 2. Press the '**Setup Ref Level**' bezel button to display the Set Measurement Reference Level menu.

Step 3. Press the '⇓' bezel button to select the menu line.

Step 4. Press the '⇐' or '⇒' bezel button to select the '**%**' or the '**V**' reference level unit.

Step 5. Press the '⇓' bezel button again to select the 'mid ref level' line.

Step 6. Define the desired mid ref level ('**Mid Ref, 'Mantisse'**, and '**Exponent'**) with the GPK control.

NOTE

To reinstall the 50% (0 V) mid ref position, press the 'Set to 50%' (set to 0 V) bezel button.

Step 7. Press the '**Previous Menu**' bezel button to go back to the Measurement Menu or press '**CLEAR MENU**' to leave the Setup Ref Level Menu.

Using References

Stored waveforms (references) can be used to compare them with the live waveform. The following procedures explain how to work with references:

- ❒ **Displaying** one or more stored reference waveform(s) from the reference memory via the Reference Readout (see Figure 1-25).
- ❒ **Saving** an active waveform as a reference via the Refs Menu (see Figure 1-26).
- ❒ **Deleting** a reference from the reference memory (Figure 1-27).
- ❒ **Renaming** a reference via the Rename Reference Menu (Figure 1-28).
- ❒ **Positioning** a reference on the screen via the position controls and the Refs Position Menu (Figure 1-30).

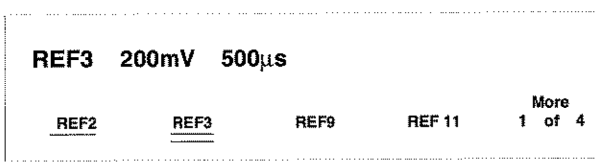


Figure 1-25: 2216 Reference Readout Menu

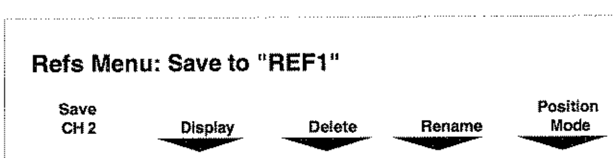


Figure 1-26: 2216 References Menu

Displaying a Reference

To display one or more stored reference-waveform(s), use the following procedure:

Step 1. Press the **REFS/MENU** button to display the References Readout (see Figure 1-25).

Step 2. Select the reference(s) to be displayed on the screen with the bezel button(s) from the menu.

NOTE
1. The last selected reference will become the active waveform.
2. A maximum of four references can be displayed on the screen.

Step 3. Position the reference(s) horizontally with the Horizontal POSITION control, and vertically with the Vertical POSITION control. The References Position Mode menu defines the effect of these controls.

NOTE
The vertical POSITION control does not affect the data stored in the reference memory, but it does set the vertical position of the reference at the time it is displayed.

Step 4. To remove an active reference from the screen, press the **CH/REF OFF** front panel button

Step 5. The Reference display can be expanded horizontally along with the live acquisition display when the horizontal display is changed in the Magnify Menu to the **'FIT TO SCREEN', x10 or x50** position.

NOTE
You can also display references from the References Menu. Press therefore SHIFT and REFS/MENU successively to display the REFS Menu. Press the 'Display' bezel button. Select a reference(s) in the Reference Display Menu.

Saving References

To save an active waveform in memory via the Reference Menu, you can use the following procedure:

Step 1. Acquire the waveform to be used as a reference waveform by using the previous Store Mode Display procedure (see page 1-28) and select it as active waveform.

Step 2. Press the **SHIFT** and **REFS/MENU** button successively to display the References Menu.

Step 3. Press the '**Save**' bezel button to store the displayed waveform in the reference memory.

NOTE

A new reference waveform is saved each time the SAVE button is pressed, until the reference memory is full.

Reference waveforms remain saved in a battery-backuped memory when the 2216 is turned off.

Deleting a Reference

To delete a reference from memory via the Reference Menu, use the following procedure:

Step 1. Press the **SHIFT** and **REFS/MENU** buttons successively to display the References Menu.

Step 2. Press the '**Delete**' bezel button to display the '**Delete from Memory**' menu (see Figure 1-27).

Step 3. Select with '**Previous Ref**' or '**Next Ref**' bezel button the reference to be deleted from the memory.

Step 4. Press the '**Delete Ref**' bezel button to delete the indicated reference from the memory and increase the amount of free reference memory.

Step 5. Press the '**Previous Menu**' bezel button to go back to the Reference Menu or press '**CLEAR MENU**' to leave the 'Delete from Memory' Menu.

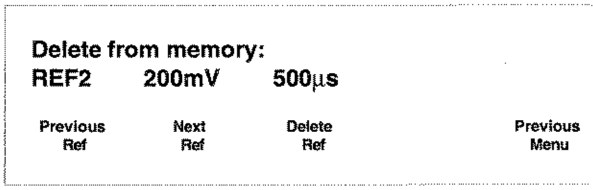


Figure 1-27: 2216 Delete Reference from Memory Menu

Renaming a Reference

Names of references can be changed in the **Rename Reference Menu** (see Figure 1-28).

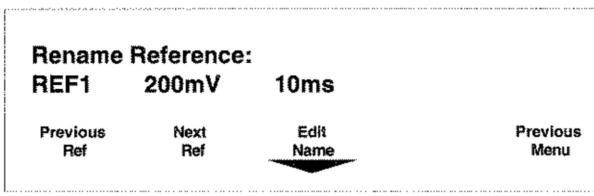


Figure 1-28: Rename Reference Menu

To change a name of an existing reference, use the following procedure:

Step 1. Press the **SHIFT** and **REFS/MENU** buttons successively to display the References Menu.

Step 2. Press the '**Rename**' bezel button to display the 'Rename Reference ' menu.

Step 3. Select with '**Previous Ref**' or '**Next Ref**' bezel button the reference to be renamed.

Step 4. Press the '**Edit Name**' bezel button to display the '**REFS Edit Name** ' menu (see Figure 1-29).

Step 5. Toggle the '**Select Position**' bezel button to select the character in the reference name that must be changed

Step 6. Press the **Char [x]** bezel button and select a new character with the **GPK** knob.

REFS Edit Name: "REF1"

Select Position	Char [R]	Insert Char	Delete Char	Previous Menu

Figure 1-29: 2216 References Edit Name Menu

Step 7. Press the '**Insert** ' bezel button to confirm the insertion of the new selected character in the reference name.

Step 8. Press the '**Previous Menu**' bezel button to go back to the Reference Menu or press '**CLEAR MENU**' to leave the 'REFS Edit Name ' menu.

Defining Positioning of References

The horizontal positioning of references and the function of the horizontal position control can be defined in the '**References Position Mode Menu**' (see Figure 1-30).

REFS Position Mode Menu

	H Lock NONE	Align Trig	Align Rec		Previous Menu
Next selectable Menu, Action, Units or Values	H Lock Menu	–	–		Refs Menu

Figure 1-30: 2216 Reference Position Mode Menu

To change the current positioning of the references, use the following procedure:

Step 1. Press the **SHIFT** and **REFS/MENU** buttons successively to display the References Menu.

Step 2. Press the '**Position Mode**' bezel button to display the 'REFS Position Mode Menu '.

Step 3. Press the '**HLock**' bezel button to select the 'Horizontal Lock Menu'.

Step 4. Select the NONE, REFS or ALL position, or press the 'Cancel' button to cancel the selected position and return to the Position Mode Menu.

NOTE

- *In 'NONE' changing the horizontal POSITION control will position all channels simultaneously, while one of the channels is the active waveform. The references can be positioned independently by making the specific reference the active waveform.*

- *In 'REFS' changing the horizontal POSITION control, will position all channels simultaneously, while a channel is the active waveform. If a reference is made the active waveform, all references will be positioned simultaneously.*

- *In 'ALL', the horizontal POSITION controls all waveforms simultaneously, regardless of the active waveform.*

- *Pressing the 'Align Trig' button will instantaneously align all displayed waveforms at their trigger point.*

- *Pressing the 'Align Rec' button will instantaneously align all displayed waveforms at their first sample.*

Using Cursors

Cursors can be used to measure differences (either in time or voltage) between two locations in a waveform. The measurement result of the distance between the two cursors is displayed in the readout. Cursors are used in Store mode and in Non-Store mode.

The cursor function is activated by simply pressing the **CURSOR/MENU** button. The cursor settings appear on the screen and the cursor measurement value is displayed in the crt readout.

By pressing the SHIFT and CURSOR/MENU button successively, the Cursors Menu is shown and the cursors can be defined.

In this section, we will discuss:

- Cursors
- Defining Cursors (page 1-59)

Cursors

Cursor Types

The 2216 has basically the following cursor types:

- VOLTAGE cursors (horizontal bars) measure vertical parameters (typically volts).
- TIME cursors (vertical bars) measure horizontal parameters (typically time or frequency).
- PAIRED cursors are TIME cursors, but the voltage difference between the crossing points of the cursors and the active waveform is also measured and displayed in the readout.

Cursor Modes

Cursors can be used in DELTA, TRACK, or SINGLE (absolute) mode.

- In DELTA mode, either cursor (dashed line) is movable, using the GPK control, and the other cursor (solid line) is fixed. The distance between the cursors is displayed in the readout.
- In TRACK mode, both cursors are dashed lines. Both cursors can be moved with the GPK control an equal amount until the limit of either one is reached. The distance between the cursors is displayed in the readout. The cursor measurement can be positive or negative, depending on the setting of the 'movable' cursor in DELTA mode.
- In SINGLE mode, one cursor is displayed. The SINGLE cursor can be moved with the GPK control. The distance between the vertical cursor and the trigger point is displayed in the readout (in s or Hz), or the distance between the horizontal cursor and ground level of the active waveform is displayed in the readout in Volts or custom units.

NOTE

For maximum vertical accuracy, perform User Cal in the Setup Utility Menu before making measurements in SINGLE mode.

Cursor Units

Several cursor measurement units can be selected, depending upon the measurement, such as:

- Delta volts
  - ΔV in Volts
  - RATIO (in %), expressed as a percentage of a previously set distance between the cursors (100%)
  - Custom Units as defined in the Custom Unit Menu
- Delta time
  - ΔT in seconds
  - RATIO (in %) expressed as a percentage of a previously set distance between the cursors (100%)
- Frequency
  - 1/ΔT in Herz (Hz)
  - PHASE (in $^{\circ}$) expressed in degrees of a previously set distance between the cursors (360°)

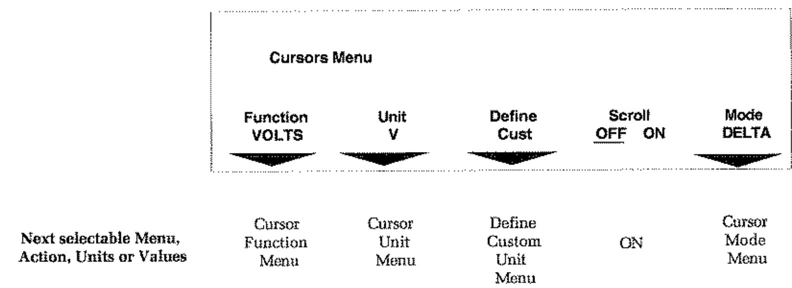


Figure 1-31: 2216 Cursors Menu (VOLT)

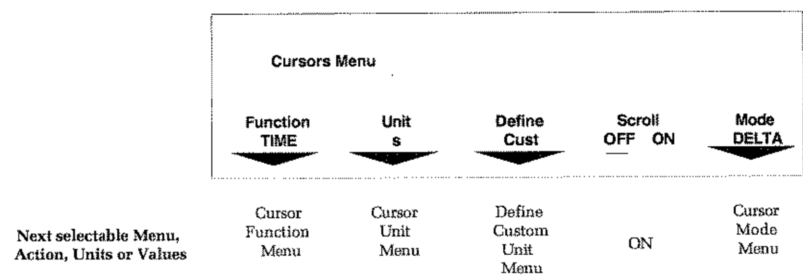


Figure 1-32: Cursors Menu (TIME)

Defining Cursors

The following items must be defined in the Cursors Menu (see Figure 1-31 and Figure 1-32) and sub-menus before they can be used for a measurement:

- Cursor Function
- Cursor Unit
- Cursor Mode
- Scroll ON or OFF

Use the following procedure to define cursors:

Step 1. Press the SHIFT and CURSORS / MENU buttons successively to display the Cursors Menu (see Figure 1-31).

Step 2. Press the '**Function**' bezel button to select the Cursor Function Menu.

Step 3. Select the '**TIME** ' cursor, the '**VOLTAGE**' cursor or '**PAIRED**' cursors in the Cursor Function Menu.

Step 4. Press the '**Unit**' bezel button to select the **Cursor Unit Menu.**

Step 5. Press the '**TIME**' bezel button to select the **Time Unit Menu**, or the '**VOLTS**' bezel button to select the **Voltage Unit Menu.**

Step 6. Select in the '**Time Unit Menu**": TIME (s), 1/TIME (Hz), RATIO (%) or PHASE (°).

Step 7. Select in the '**Voltage Unit Menu**": VOLT (V), CUSTOM (custom unit) or RATIO (%).

If CUSTOM is selected, define the custom unit in the **Define Custom Unit Menu** (see page 1-61).

Step 8. Press the '**Mode**' bezel button in the Cursor Menu to select the Cursor Mode Menu.

Step 9. Press the DELTA, TRACK, or SINGLE (absolute value) bezel button to select the mode.

Step 10. Press the '**Scroll**' bezel button to ON or OFF, as desired for the measurement.

Step 11. Define the cursor position(s) on the screen with the **GPK** control.

Press the **SELECT** button on the front panel to switch over to the other cursor (in DELTA or TRACK mode), and define the position of the cursor with the GPK control.

Step 13. The distance between the cursors will be displayed in the readout on the screen.

Step 14. Press CLEAR MENU to leave the Cursors Menu.

Using Custom Units

The 2216 can do a calculation on a "value" that is displayed as a measurement result. This calculation is called "custom unit" and can be useful to simplify understanding the measurement result of cursor measurements or automated measurements.

Custom units are defined in the 'Define Custom Unit Menu'.
Three different formulas can be selected to define a custom unit in the Define Custom Unit Menu:

1. $Y = A * V1 + B$
2. $Y = A * (V1 + B)$
3. $Y = A * {}^{10}\log (V1/ B)$

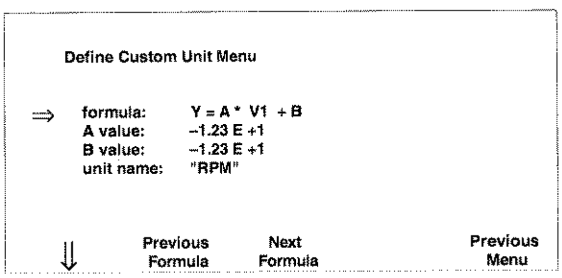


Figure 1-33: 2216 Define Custom Unit Menu

The parameters and constant factors in these formulas can be defined as follows:

- **Y** is the custom value to be displayed.
- **V1** is the value from the uncorrected measurement result.
- The **A-value** and **B-value** are user defined factors that depend on the actual measurement. They must be calculated by the user and are listed in scientific notation.
- The **Unit Name** is the resulting measurement unit (with a maximum of three characters).

Fomula Y = A * V1 +B and fomula Y = A * (V1 +B) are intended to be used with linear sensors.
Formula Y = A * ^{10}log (V1 / B) can be used in applications where levels are compared to a reference level.

In this section, the following will be discussed:

- Define Custom Unit Menu (page 1-62)
- Measurement Example (page 1-65)

'Define Custom Unit' Menu

The following items must be defined in the Define Custom Unit Menu to use custom units for a measurement:

- Formula
- A-value
- B-value
- Unit Name

To define the custom units, use the following procedure:

Step 1. Press the SHIFT and CURSORS /MENU buttons successively to display the **Cursors Menu** (see Figure 1-31).

Step 2. Press the '**Function**' bezel button to select the 'VOLTAGE' or 'PAIRED' cursors, as desired for the measurement.

Step 3. Press the '**Unit**' bezel button to select the **Cursor Voltage Unit Menu.**

Step 4. Press the '**CUST**" bezel button.

Step 5. Press the '**Define Custom**' bezel button to select the **Define Custom Unit Menu** (see Figure 1-33).

Step 6. Toggle the '⇓' bezel button to the Formula line.

Step 7. Select with the '**Previous Formula**' or the '**Next Formula**' bezel button the formula to be applied (see Figure 1-33).

Step 8. Toggle the '⇓' bezel button to the A-Value line (see Figure 1-34).

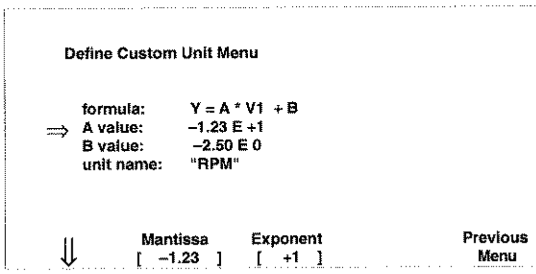


Figure 1-34: 2216 Define Custom Unit Menu (A and B Value line)

Step 9. Press the '**Mantissa**' bezel button and select with the GPK control the mantissa value to be applied.

Step 10. Press the '**Exponent**' bezel button and select with the GPK control the exponent to be applied.

Step 11. Toggle the '⇓' bezel button to the B-Value line and repeat step 9 an 10 (see Figure 1-34).

Step 12. Toggle the '⇓" bezel button to the 'unit name' line (see Figure 1-35).

Step 13. Toggle with the '**Select Position**' bezel button to the desired position.

Step 14. Press the '**Char**' bezel button and select with the GPK control the character to be applied.

Step 15. Toggle the '**Select Position**' bezel button to the next position and repeat step 16, etc.

Step 16. Press the '**Previous Menu**' bezel button to go back to the Define Custom Unit Menu or press **CLEAR MENU** to leave the Define Custom Unit Menu.

The Custom Unit calculation is defined now.

NOTE

These selections apply to the custom unit calculation on cursor measurements, as well as the calculation on automated measurements.

Define Custom Unit Menu

formula: Y = A * V1 + B
A value: –1.23 E +12
B value: –2.50 E 0
⇒ unit name: "RPM"

⇓	Select Position	Char [R]	Previous Menu

Figure 1-35: 2216 Define Custom Unit Menu (Unit name line)

Measurement Example

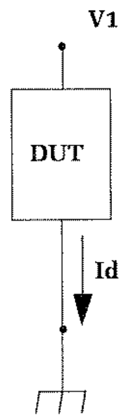


Figure 1-37: Power Measurement Example

Suppose, you want to measure the electrical power consumption in a device under test (DUT), as shown in Figure 1-37.

A power measurement is defined by the formula:

$$P = V1 * Id$$

where V1 is in Volts, Id is in Ampere, and P is in Watts.

The oscilloscope has voltage measurement inputs, so the current (Id) needs to be converted to a voltage signal. The custom unit calculation formulas can be used to compensate the current to voltage conversion.

You can use a Tektronix Current Probe in this application, for example a P6021 with a current probe amplifier (Tektronix type 134), to measure the current (Id) through the DUT.
Using a P6021, the output sensitivity of the current probe amplifier (Tektronix Current Probe Amplifier type134) is 50 mV/DIV.
If the input sensitivity of the current amplifier is set to 10 mA/DIV, Id can be calculated as:

$$Id = (10 \times 10^{-3} / 50 \times 10^{-3}) \times V_{CH2} \text{ (in Volts)}$$
$$= 0.2 * V_{CH2}$$

The power dissipation of the DUT is:

$$P = V1 * Id$$
$$= V1 * 0.2\ V_{CH2}$$
$$= 0.2\ V1 * V_{CH2}$$

The resulting power measurement unit is V^2 (square volts)
In order to display the power consumption correctly in Watts, define the custom unit in the Custom Unit Menu.
You can use the formula: Y = A * V1 + B for conversion.
The Custom Unit Menu should be defined as follows:

formula:	Y = A * V1 + B
A value:	0.2 E 0
B value:	0 E 0
unit name:	"W"

To perform a power measurement, use the following procedure:

Step 1. Connect a voltage probe (P6109B) to CH 1.

Step 2. Connect a P6021 current probe together with the 134 current probe amplifier to CH 2, and set the CH 2 VOLTS/DIV to 50 mV/DIV.

Step 3. Select in the Select Measurement Menu the 'Cycle Power' measurement (see page 1-45).

Step 4. Select 'CH 2' as the 'Power to' in the Cycle Power submenu.

Step 5. Make CH 1 the active channel (press CH 1 channel button) to perform the power measurement.

The result of the 'Cycle Power' automated measurement will be displayed in an adapted measurement unit (Watts) on the screen.

Making Hardcopies

The 2216 can make hardcopies in store mode, using the hardcopy feature.

NOTE
The CR/CR LF switch on your printer must be in the CR position.

You can create an image or a plot, depending on the selected output format in the Hardcopy Format Menu.

Waveform data or Status information can be plotted or printed by a plotter or printer which is connected to the 2216 Parallel Printer/ Plotter Interface connector on the rear panel.

A 2216 Option 10 (GPIB) and 2216 Option 12 (RS232) may also use the GPIB Interface connector or the Serial Communication Interface (RS232) connector as the hardcopy output.

Before making a hardcopy, be sure that the correct selections are made in the **Hardcopy Menu** and sub-menus (Figure 1-38).

The following will be discussed:

- **Start and Stop** a hardcopy on a Plotter/Printer (page 1-68)
- Selecting a Hardcopy **Mode** (page 1-69)
- Selecting a Hardcopy **Format** (page 1-71)
- Defining the Hardcopy **Layout** (page 1-72)
- **Naming** a Hardcopy (page 1-73)
- Selecting a Hardcopy **Output Port** (page 1-75)
- Defining the **RS232 Printer Output settings** (page 1-77)

Start/Stop Making a Hardcopy

To start a hardcopy action, press the **HARDCOPY/MENU** button. As a result the printer/plotter is initiated and the hardcopy process is started.

The on/off state of the hardcopy process is displayed by a 'PRN' message on the screen.

Press the HARDCOPY/MENU button again to stop the print action.

Press the SHIFT and the **HARDCOPY/MENU** button successively to display the **Hardcopy Menu** (see Figure 1-38).

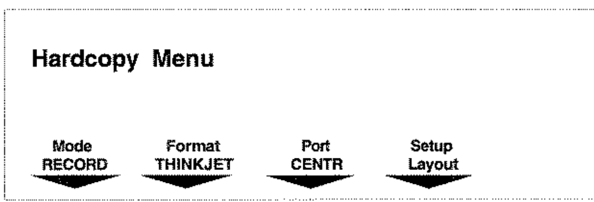


Figure 1-38: 2216 Hardcopy Menu

Select and define respectively the Hardcopy Mode Menu, the Hardcopy Format Menu, the Hardcopy Port Menu, and the Hardcopy Setup Layout Menu.

Selecting a Hardcopy Mode

The hardcopy mode and the hardcopy mode related selections can be selected in a **Hardcopy Mode Menu** (see Figure 1-39a).

Press the 'Mode' bezel button to select the Hardcopy Mode Menu. You can select three print modes:

- RECORD mode
- CHART mode
- STATUS mode

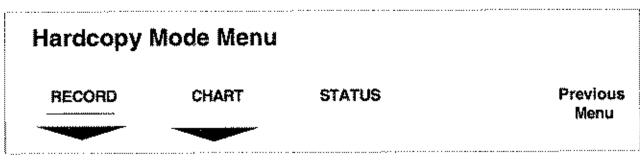


Figure 1-39a: 2216 Hardcopy Mode Menu

Press the bezel button concerned to select a hardcopy mode.
The record and chart mode selection automatically shows the Hardcopy Record Mode Menu (Figure 1-39b) or resp. the Hardcopy Chart Mode Menu (Figure 1-39c).

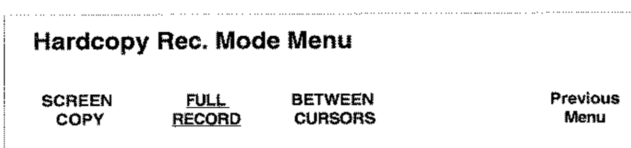


Figure 1-39b: 2216 Hardcopy Record Mode Menu

In **RECORD** mode, hardcopies of waveforms can be made. The Hardcopy Mode Menu is shown in Figure 1-39b. The following selections can be made:

- SCREEN COPY. A hardcopy of the crt screen display will be printed.
- FULL RECORD. A hardcopy of the complete record will be printed.
- BETWEEN CURSORS. A hardcopy of the gated part of the record (gated by vertical cursors) will be printed.

Hardcopy Chart Mode Menu

Time/Div [0.1 s]	Previous Menu

Figure 1-39c: 2216 Hardcopy CHART Mode Menu

In **CHART** mode, a chart-recorder is emulated by the 2216 printer driver for continuous printing of a ROLL/SCAN acquisition. The selection of the chart-recorder timebase is defined in theHardcopy Chart Mode Menu (Figure 1-39c). The timebase is set by the GPK control.

NOTE
In CHART mode you can use the EPS_FX, the EPS_LQ, and the THINKJET format.

In **STATUS** mode, a hardcopy is made of the 2216 settings.

Press the '**Previous Menu**' bezel button to return to the Hardcopy Mode Menu.

Selecting a Hardcopy Format

A hardcopy format is selected in the **Hardcopy Format Menu**, (see Figure 1-41), a sub-menu of the Hardcopy Menu.

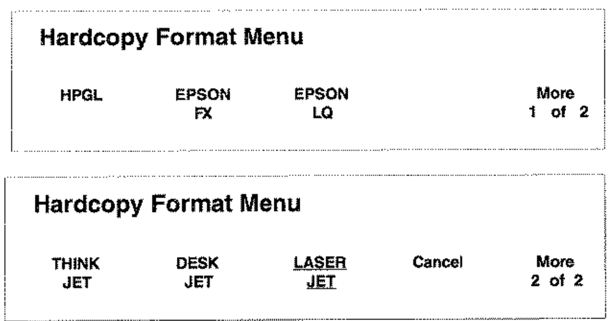


Figure 1-41: 2216 Hardcopy Format Menu

The following formats can be selected :

- HPGL
- EPSON FX
- EPSON LQ
- THINKJET
- DESKJET
- LASERJET

Use the following procedure to select a format:

Step 1. Press the **SHIFT** and the **HARDCOPY/MENU** button successively to display the Hardcopy Menu (Figure 1-38).

Step 2. Press the '**Format**' bezel button in the Hardcopy Menu to display the Hardcopy Format Menu .

Step 3. Select the hardcopy format with the appropriate bezel button.

Step 4. Release the bezel button or press the '**Cancel**' bezel button to go back to the Hardcopy Menu or press **CLEAR MENU** to leave the Hardcopy Format Menu.

Selecting the Hardcopy Layout

The hardcopy layout is defined in the **Hardcopy Layout Menu**, (see Figure 1-42), a sub-menu of the Hardcopy Menu.

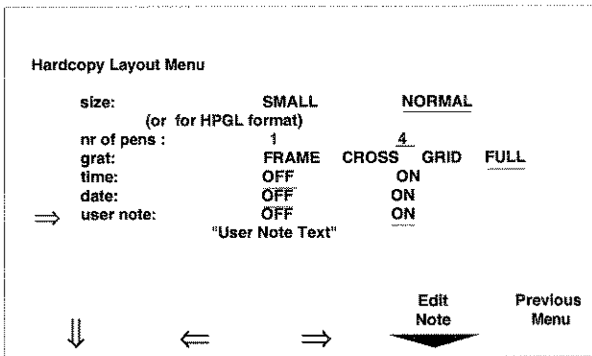


Figure 1-42: 2216 Hardcopy Layout Menu

The following layout parameters can be set:

- size of the hardcopy (non-HPGL only)
- number of pens (HPGL only) used by the plotter
- graticule representation on the hardcopy
- time
- date
- user note text

Use the following procedure to setup a hardcopy layout:

Step 1. Press the **SHIFT** and the **HARDCOPY/MENU** button successively to display the Hardcopy Menu (Figure 1-38).

Step 2. Press the '**Setup Layout** bezel button in the Hardcopy Menu to display the Hardcopy Layout Menu.

Step 3. Select a parameter line with the '⇓' bezel button.

Step 4. Select with the '⇐' or ' ⇒' bezel buttons the desired position of the layout parameter on the parameter line.

Naming a Hardcopy

When the '**user note**' line of the Hardcopy Layout Menu is selected, you may modify the '**user note**' text in the **Layout Edit Note Menu.**

```
   Hardcopy Edit Note Menu

   size:              SMALL           NORMAL
   (or)
   nr of pens :         1               4
   grat:              FRAME   CROSS   GRID    FULL
   time:              OFF             ON
   date:              OFF             ON
=> user note:         OFF             ON
                  "User Note Text"

  Select       Char         Insert      Delete      Previous
  Position    [ U ]         Char        Char        Menu
```

Figure 1-43: 2216 Hardcopy Edit Note Menu

Use the following procedure to change a 'user note' text:

Step 1. Press the **SHIFT** and the **HARDCOPY/MENU** button successively to display the Hardcopy Menu (Figure 1-38).

Step 2. Press the '**Setup Layout** bezel button in the Hardcopy Menu to display the Hardcopy Layout Menu.

Step 3. Select the '**user note**' line.

Step 4. Press the '**Edit Note**' bezel button in the Hardcopy Layout Menu to display the Hardcopy Layout Edit Note submenu.

Step 5. Select a character to be changed with the '**Select Position**' bezel button.

Step 6. Press the '**Char [u]**' bezel button.

Step 7. Select with the **GPK** control the character to be displayed in the text.

Step 8. Press the '**Insert Char**' bezel button to insert a character before the selected character in the text.

Step 9. To delete a character, select it with the 'Select Position' bezel button, and press '**Delete Char**' to delete the character from the text.

Step 10. Press the '**Previous Menu**' bezel button to return to the Hardcopy Menu or press **CLEAR MENU** to leave the Hardcopy Layout 'Edit Note' Menu.

Selecting a Hardcopy Output Port

A hardcopy output port (located on the rear panel) is selected in the **Hardcopy Port Menu**, (see Figure 1-44), a sub-menu of the Hardcopy Menu.

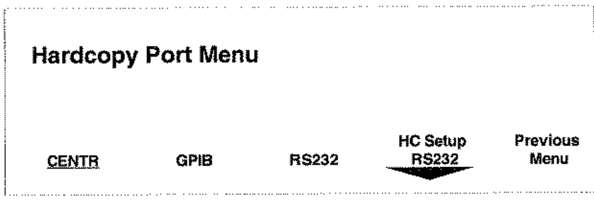


Figure 1-44 2216 Hardcopy Port Menu

A parallel printer/plotter interface connector is located on the rear panel of a standard 2216. The 2216 Option 10 and 2216 Option 12 also have a GPIB interface output connector or a RS232 interface output connector, or both for Option 10 +12. You can select the following hardcopy output ports:

- CENTRonics; a parallel printer/plotter interface output port connector.
- GPIB; a GPIB communication interface output port connector.
- RS232; a RS232 communication interface output port connector.

By pressing the HC Setup RS232 bezel button, the **Hard Copy Setup RS232** menu is displayed. In the **Hardcopy Setup RS232** menu the settings of the RS232 hardcopy interface are defined.

Use the following procedure to select a hardcopy output port:

Step 1. Press the **SHIFT** and the **HARDCOPY/MENU** button successively to display the Hardcopy Menu (Figure 1-38).

Step 2. Press the '**Port**' bezel button in the Hardcopy Menu to display the Hardcopy Port Menu .

Step 3. Select the CENTR, GPIB or RS232 hardcopy port with the appropriate bezel button.

Step 4. Press the '**Previous Menu**' bezel button to return to the Hardcopy Menu or press **CLEAR MENU** to leave the Hardcopy Port Menu.

Defining the RS232 Printer Output Settings

In the Hardcopy Port Menu of a 2216 Option 12, the RS232 hardcopy interface parameters are defined in the **HC Setup RS232 Menu** (see Figure 1-45), a sub-menu of the Hardcopy Port Menu.

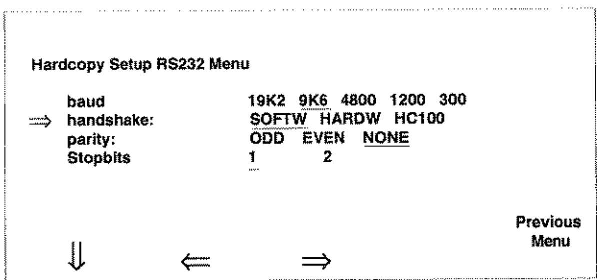


Figure 1-45: 2216 Hardcopy Setup RS232 Menu

The following parameters can be defined:

- Baudrate
- Handshaking mode
- Parity
- Number of Stopbits

Use the following procedure to define the settings in the HC Setup RS232 Menu:

Step 1. Press the **SHIFT** and the **HARDCOPY/MENU** button successively to display the Hardcopy Menu (Figure 1-38).

Step 2. Press the '**Port**' bezel button in the Hardcopy Menu to display the Hardcopy Port Menu .

Step 3. Press the '**HC Setup RS232**' bezel button in the Hardcopy Port Menu to display the HC Setup RS232 Menu.

Step 4. Press the '⇓' bezel button to select a parameter line.

Step 5. Press the '⇐' or '⇒' bezel buttons to select the desired RS232 parameter on the parameter line, etc.

Step 6. Press the '**Previous Menu**' bezel button to return to the Hardcopy Menu or press **CLEAR MENU** to leave the Hardcopy Menu.

Overview

The *At a Glance* section of this manual is split up in two chapters:

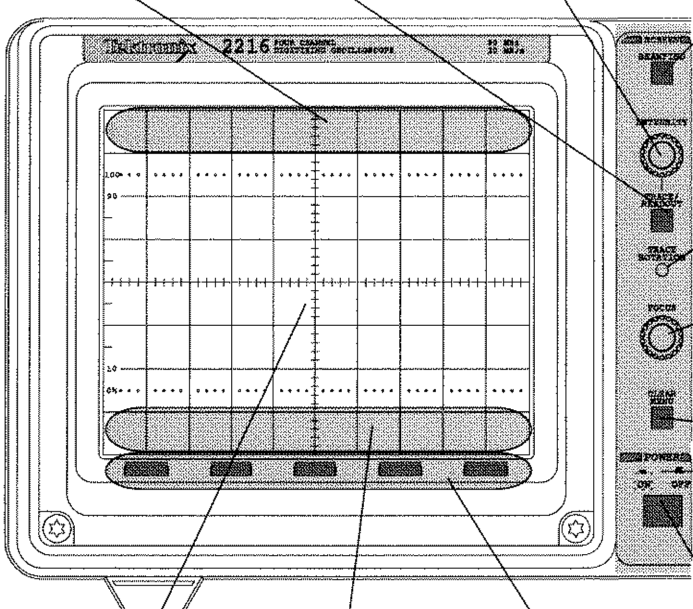
- The *At a Glance* chapter will help you understand and operate the 2216 by showing illustrations of the front and rear panel sections with locations and purposes of the knobs and buttons.
  The following illustrations are included:
  - The *SCREEN* map shows the parts, the locations and purposes of the knobs and buttons in the *SCREEN* section.
  - The *STORAGE* map, including the *CURSORS* features, the *SETUP* functions and the *General Purpose Controls*, show the locations and purposes of the various knobs and buttons.
  - The *VERTICAL* system map shows the locations and purposes of the various knobs, buttons and connectors in the *VERTICAL* section.
  - The *TRIGGER* and *HORIZONTAL* system map shows the locations and purposes of the various knobs and buttons in the *TRIGGER* and *HORIZONTAL* section.
  - The *Rear Panel Map* shows the locations and purposes of the various parts on the rear panel.

- The *Menu System* chapter contains general information about menus, an overview of the menu system, and a summary of menus.

  - *Alternate Menu*
  - *Functions Menus*
  - *Measurements Menus*
  - *References Menus*
  - *Hardcopy Menus*
  - *Setup Utility Menus*
  - *Setup Save/Recall Menus*
  - *Cursors Menus*
  - *X-Y Menu*

At a Glance

Screen Map



Storage Map – Storage, Setup, and Cursors Operation

Store Mode on/off Switch, page 1-11, 3-36

(+SHIFT) Store Mode Functions Menu, page 1-12,, 3-36

RUN/STOP Acquisition Switch, page 1-13, 3-43

(+SHIFT) Measurements Menu page 1-13, 3-44

Display REFERENCE Waveform(s), Menu Switch page 1-14, 3-49

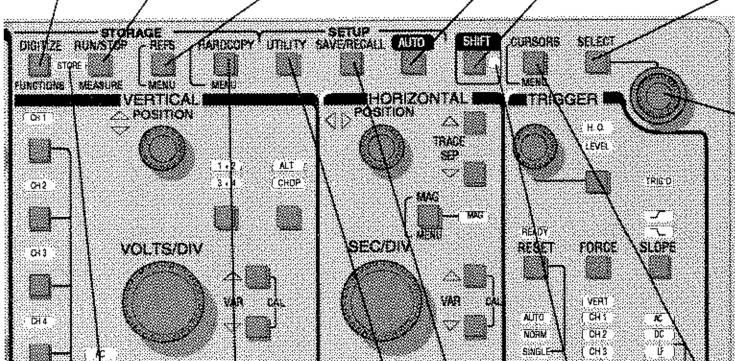
(+SHIFT) Waveform REFERENCES Menu page 1-14, 3-52

Setup AUTO Switch, page 1-17

SHIFT Function on/off Switch, page 2-9, 3-96

General Purpose Selection Switch, page 3-96

General Purpose Knob (GPK) page 3-96



Store Mode-on Indicator, page 1-11, 3-36

Hardcopy Function Switch, page 1-15

(+SHIFT) HARDCOPY Menu, page 1-15, 3-59

Setup Utility Menu Switch page 1-18 , 3-74

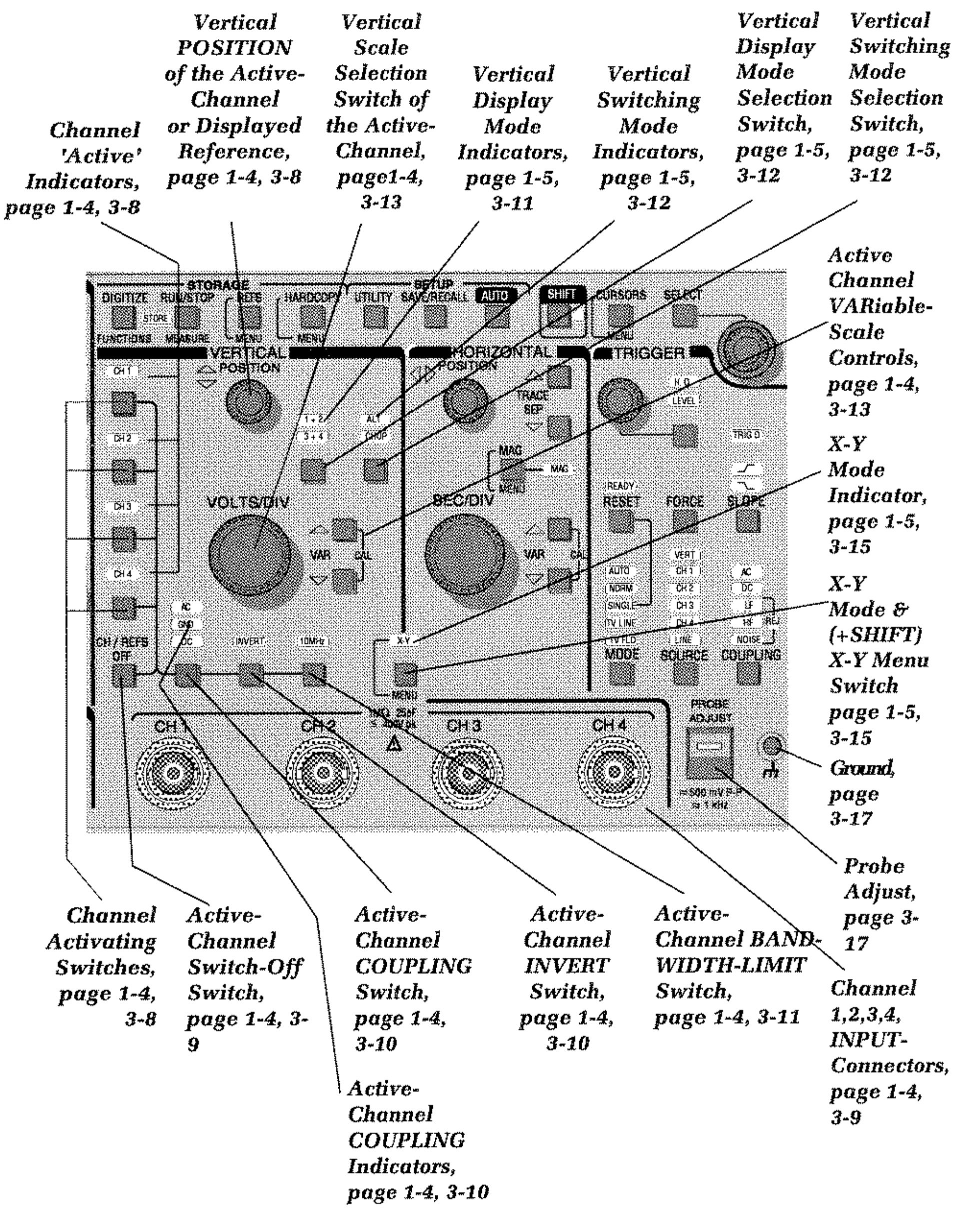
Setup Save/Recall Menu page 1-18, 3-83

Shift Function-on Indicator, page 3-96

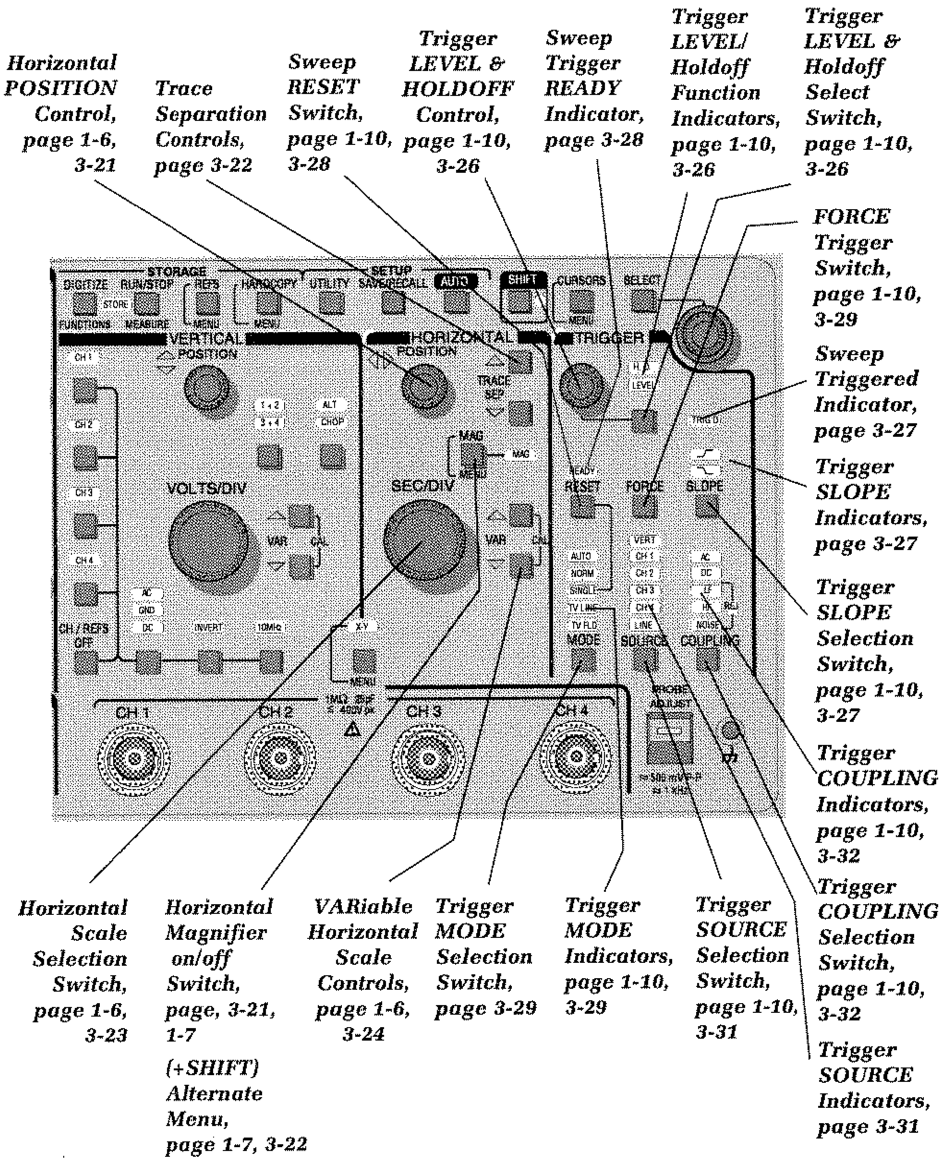
CURSORS Measurement on/off Switch, page 1-20

(+SHIFT) CURSORS Menu, page 1-21, 3-87

Vertical System Map



Horizontal Map – Triggering and Horizontal System



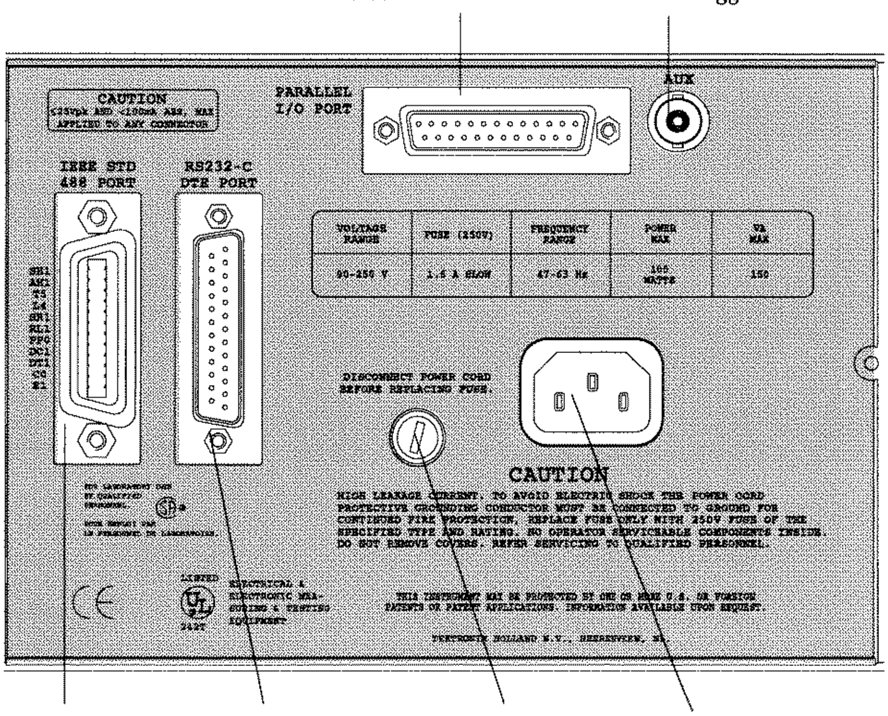
Rear Panel Map

Parallel I/O Port (Centronics ® Compatible), page 3-65, 3-68, 3-99

Auxilliary Input (page 3-75, 3-40, 3-98) for :

1. External Clock (Store Mode) or Z-Axis (Analog Mode), and

2. External Trigger



IEEE STD 488 PORT (Optional), page 3-79, 3-66 , 3-100

RS-232-C DTE PORT (Optional), page 3-81, 3-101

Fuse Holder, page 3-98

Power Cord Receptacle, page 3-98

Menu System

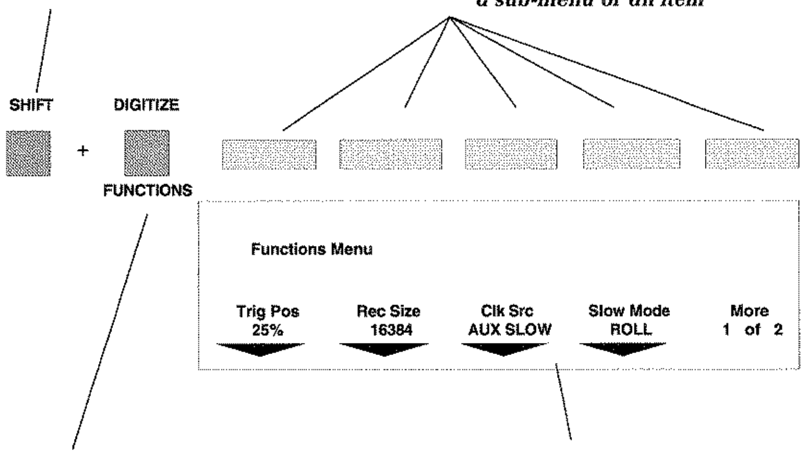
The 2216 oscilloscope is partly operated by controls on the front panel, and partly operated by a menu control system. See the *In Detail* section of this manual for a more detailed description.

The *Menu System* chapter contains general information about 2216 menus, such as:

To Operate a Menu

1. Press the SHIFT button prior to selecting a 'blue' menu indicated at the bottom of a front panel button

3. Press a Bezel button to select a sub-menu or an item



2. Press the Front Panel Button to select the Menu to be displayed

Menu Readout

Symbols in Menus

In the nomenclature of the 2216 menus, the following conventions are used:

- Descriptions of menu items are in lower case with the first character in upper case.
- Descriptions of selections are in upper case.
- Descriptions in menus in *Italic* can not be selected.

In the representation of the 2216 menus, the following symbols and expressions are used:


– Indicates that pressing the bezel button concerned, a sub-menu will be selected and displayed.

⇐ ⇒ ⇓
– Indicates that pressing the bezel button concerned, the selected value or line will be changed in the indicated direction.

Underlined – Indicates that the item is currently selected.

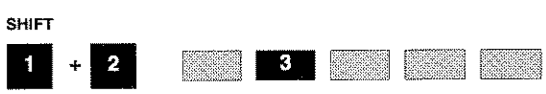
Dual Underlined – Indicates that the item is currently selected and active. (For References only).

[.............] – Indicates that pressing the bezel button, the brackets will appear together with the GPK (General Purpose Knob) symbol, and that the value can be changed by rotating the GPK.

Previous Menu – Indicates that pressing the bezel button, the previous selected menu will be displayed

Cancel – Indicates that pressing the bezel button, the previous selected menu will be displayed again without changes.

SHIFT – Press the SHIFT button prior to further select a 'blue' menu button.



– Figures indicate the sequence to successively press front panel buttons 1and 2, then bezel button 3, etc, to display a menu.

Overview of Menu System

The following menus are implemented in the menu system of the 2216:

- **Magnify Menu**
  - Magnify Menu (page 1-7, 3-21)
- **Storage Functions Menus**
  - Storage Functions Menu (1-12, 3-36)
  - Trigger Position Menu (page 1-12, 3-37)
  - Record Size Menu (page 1-12, 3-38)
  - Clock Source Menu (page 1-12, 3-39)
  - Slow Mode Menu (page 1-12, 3-41)
  - Limit Testing Menu (page 1-12, 3-42)
- **Measurements Menus**
  - Measurement on CHxxx Menu (page 1-13, 1-43, 1-47, 3-44)
  - Select Measurement Menu (page 1-13, 1-48, 3-45)
  - Power Second Waveform Menu (page 1-48, 3-45)
  - Set Reference Levels Menu (page 1-13, 1-49, 3-46)
  - Measurement Unit Menu (page 1-13, 1-48, 3-47)
  - Custom Unit Menu (page 1-13, 1-61, 3-48)
- **References Menus**
  - Reference Readout (page 1-14, 1-52, 3-51)
  - References Menu (page 1-14, 1-51, 52)
  - Reference Display Menu (page 1-14, 1-52, 3-53)
  - Delete References Menu (page 1-14, 1-53, 3-54)
  - Rename References Menu (page 1-14, 1-54, 3-55)
  - References Position Mode Menu (page 1-14, 1-55, 3-57)
  - Horizontal Lock Menu (page 3-58)
  - References Edit Name Menu (page 1-55, 3-56)
- **Hardcopy Menus**
  - Hardcopy Menu (page 1-15, 1-68, 3-60)
  - Hardcopy Mode Menu (page 1-15, 1-69, 61)
  - Hardcopy Record Mode Menu (page 1-15, 1-69, 3-61)
  - Hardcopy Chart Mode Menu (page 1-15, 1-70, 3-61)

Menu Summary

In this Menu Summary, menus of the 2216 are summarized.
The sequence of pressing front panel buttons and bezel buttons is indicated to select a menu.

The 2216 has the following menu groups:

- **Magnify Menu**
- **Functions Menus**
- **Measurements Menus**
- **References Menus**
- **Hardcopy Menus**
- **Setup Utility Menus**
- **Setup Save/Recall Menu**
- **Cursors Menus**
- **X-Y Menu**

Horizontal Magnify Menu

To show this menu: Press these front panel buttons and bezel buttons

Magnify Menu	SHIFT **1** MAG **2** MENU

Functions Menus

To show this menu:	Press these front panel buttons and bezel buttons						
Storage Functions Menu	SHIFT 1	DIGITIZE 2 FUNCTIONS					
Trigger Position Menu	SHIFT 1	DIGITIZE 2 FUNCTIONS	3				
Record Size Menu	SHIFT 1	DIGITIZE 2 FUNCTIONS		3			
Clock Source Menu	SHIFT 1	DIGITIZE 2 FUNCTIONS			3		
Slow Mode Menu	SHIFT 1	DIGITIZE 2 FUNCTIONS				3	
Limit Testing Menu	SHIFT 1	DIGITIZE 2 FUNCTIONS		4			3

Measurements Menus

To show this menu:	Press these front panel buttons and bezel buttons						
Measurement Menu	SHIFT 1	RUN/STOP 2 MEASURE					
Select Measurement Menu	SHIFT 1	RUN/STOP 2 Measure	3				
Power Second Waveform Menu	SHIFT 1	RUN/STOP 2 Measure	3,8	(8)			4,5,6,7
Setup Measurement Reference Levels Menu	SHIFT 1	RUN/STOP 2 Measure				3	
Measurement Unit Menu	SHIFT 1	RUN/STOP 2 Measure					3
Define Custom Unit Menu	SHIFT 1	RUN/STOP 2 Measure		4			3

References Menus

To show this menu:	Press these front panel buttons and bezel buttons						
References Readout		REFS 1 MENU					
References Menu	SHIFT 1	REFS 2 REFS MENU					
Display References Menu	SHIFT 1	REFS 2 MENU		3			
Delete References Menu	SHIFT 1	REFS 2 MENU			3		
Rename References Menu	SHIFT 1	REFS 2 MENU				3	
References Edit Name Menu	SHIFT 1	REFS 2 MENU			4	3	
References Position Mode Menu	SHIFT 1	REFS 2 MENU					3
References Horizontal Lock Menu	SHIFT 1	REFS 2 MENU	4				3

Hardcopy Menus

To show this menu:	SHIFT	HARDCOPY (MENU)	Bezel 1	Bezel 2	Bezel 3	Bezel 4	Bezel 5
Hardcopy Menu	1	2					
Hardcopy Mode Menu	1	2	3				
Hardcopy Record Mode Menu	1	2	3,4				
Hardcopy Chart Mode Menu	1	2	3	4			
Hardcopy Format Menu	1	2		3			
Hardcopy Port Menu	1	2			3		
Hardcopy Port Setup RS232 Menu	1	2			3	4	
Hardcopy Setup Layout Menu	1	2				3	
Hardcopy Layout Edit Note Menu	1	2				3,4	

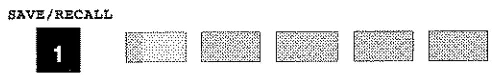
Setup Utility Menus

To show this menu:	Press these front panel buttons and bezel buttons					
	UTILITY					
Setup Utility Menu	1					
Setup Utility Configuration Menu	1	2				
Setup Utility Status Display	1		2			
Setup Utility Programmable GPIB Menu	1	3				2
Setup Utility Programmable RS232 Menu	1		3			2
Hardcopy Setup Programmable RS232 Menu	1			3		2
Setup Utility User Compensation Menu	1	4				2,3

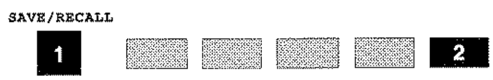
Setup Save/Recall Menus

To show this menu: Press these front panel buttons and bezel buttons

Setup Save/Recall Menu



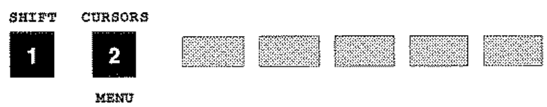
Setup Edit Name Menu



Cursors Menus

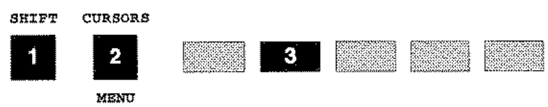
To show this menu: Press these front panel buttons and bezel buttons

Cursors Menu

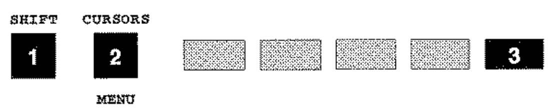


Cursors Function Menu

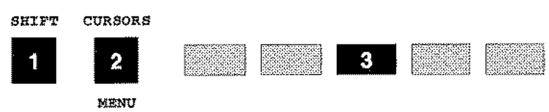
Cursors Unit Menu



Cursors Mode Menu



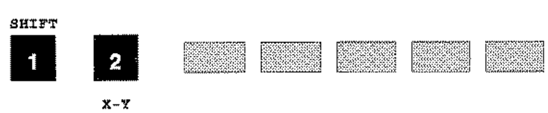
Define Custom Unit Menu



X-Y Menu

To show this menu: Press these front panel buttons and bezel buttons

X-Y Menu



Overview

The *In Detail* section provides more detailed information of the functions and locations of the 2216 controls, menus, connectors, and indicators on the front and rear panel. This section also contains a description of the CRT Readout, a Maintenance subsection and a subsection for Probes you can use with the 2216.

NOTE

The 2216 front panel 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.

In Detail is split up in the following sub-sections:

Screen Display and Power

In this section the various parts and controls of the **SCREEN** section of the front panel are discussed.
On the 2216 screen the following is displayed:

- Measured Signals
- Setup Information
- Menu Information
- Automated Measurement Result Information
- Messages

Screen Controls

See Figure 3-1 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 eliminate 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.

You can make 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.

You can make time measurements by counting 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.

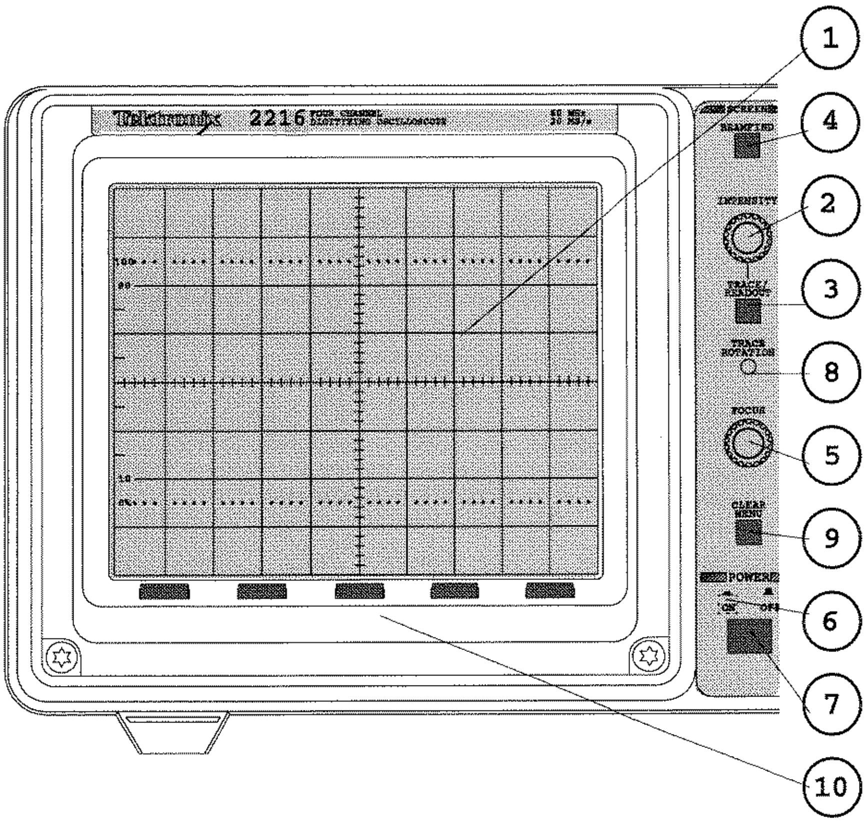


Figure 3-1: Power, Display Controls, and Power-on Indicator

NOTE
Positioning of a display on the center graticule lines enables you to take advantage of the 0.2 division minor graticule markings .

(2) (3) INTENSITY Control and TRACE/READOUT Switch

With the INTENSITY control you can adjust:

- The trace intensity, if the TRACE/READOUT switch is toggled to the 'TRACE' position.
- The crt readout intensity, the cursor intensity, the reference waveform intensity, the intensity of the measurement results and messages, with the TRACE/READOUT switch toggled to the 'READOUT' position.

(4) 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. With the Horizontal POSITION control an the Vertical POSITION control the signal can be positioned inside the graticule area.

(5) 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.

(6), (7) Power ON Indicator and POWER ON/OFF Switch

The POWER ON/OFF switch turns the instrument power on or off. The Power ON indicator lights up when the power is turned on.

8

Trace Rotation Control

Normally the trace will be parallel to the center horizontal graticule line, and TRACE ROTATION adjustment will not be required. If necessary,you can readjust the trace alignment with a small-bladed insulated screwdriver or alignment tool.

9

CLEAR MENU Switch

You can remove a menu from the display by pressing the CLEAR MENU button.

10

Bezel Button Switches

You can change selections from a selected menu or have the 2216 perform a function in that menu, by pressing a bezel button switch which is associated with that menu location.

The lower two divisions of the screen are used to display a menu or readout information. However, some menus use the complete screen to display a menu.

Vertical Operation

This section describes the vertical deflection system of the 2216 in the **VERTICAL** section of the 2216 front panel (see Figure 3-2).

General

The 2216 has four fully featured vertical channels with calibrated deflection factors from 5 mV per division to 10 V per division at full bandwidth (60 MHz). The vertical deflection factor is extended to 1 mV/division and 2 mV/division at a reduced bandwidth of about 10 MHz.

Independent bandwidth limiting (10 MHz) for each active channel is possible with the bandwidth limit switch without affecting the bandwidth of the other channels.

The variable VOLTS/DIV gain control (VAR) has a range that is sufficient to overlap the next VOLTS/DIV setting.

All channels can be switched on or off separately.

Channels can be inverted and add mode functionality is available, so you can use the 2216 as a limited dual-differential oscilloscope using the CH 1+2 and the CH 3+4 modes.

The 2216 has the following vertical modes:

- CH 1, CH 2, CH 3, CH 4
- CH 1+2, CH 3+4
- ALT, CHOP

Vertical Controls and Connectors

See Figure 3-2 for the location of items 11 through 23.

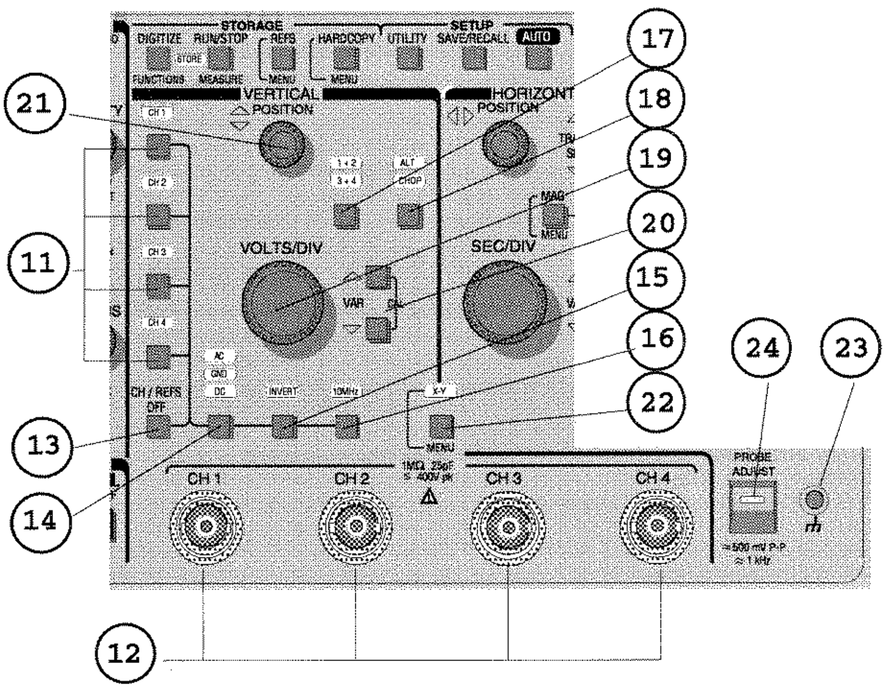


Figure 3-2: 2216 Vertical Controls and Connectors

(11) **Vertical Channel-On Switches**

CH 1, CH 2, CH 3 and CH 4 channel switches determine which channel is selected and active. A ground symbol (⏚) at the left side of the screen indicates the approximate ground level of the active channel or reference.

Only one vertical channel at a time is active. The vertical controls act upon the active channel.

The active channel is indicated by a lighted LED, located above a switch button of one of the channel select switches.

Pressing the channel switch of an active channel another time will activate the 'Identify' function (see page 3-13).

You can add a non-displayed channel to the display by pressing the SHIFT button and a channel button of a non-displayed channel, without changing the active channel.
Likewise, you can remove a displayed channel from the display by pressing the SHIFT button and a channel button of a displayed channel, without changing the active channel.

An active channel can be influenced by the following switches and controls:

- POSITION control
- INVERT switch
- AC-GND-DC switch
- VOLTS/DIV switch
- CH/REF OFF switch
- 10 MHz switch
- VAR control switches
- Channel switch

NOTE
Channel selection switches are not used to select the trigger source.

12 **CH 1, CH 2 , CH 3, and CH 4 Input Connectors**

CH 1, CH 2 , CH 3, and CH 4 input connectors pass the input signals on to the CH1, CH 2, CH 3, and CH 4 vertical deflection systems.

Coding-ring contacts on the input connectors are used to automatically switch the scale factor displayed by the crt readout when a probe with probe coding (for example a Tektronix P6109B) is used.

In X-Y non-store mode, the X-Y combinations are the automatic result of the selected channels or add mode, resulting in a maximum of trhee X-Y waveforms. A signal connected to the CH 2, CH 3, CH 4 or CH 3+4 inputs provides vertical deflection (Y-axis). Signals connected to the CH 1 or CH 1+2 inputs provides the horizontal deflection (X-axis).
In X-Y store mode, the combinations of the X and Y axis are selected in the Digitize X-Y Menu. A maximum of two X-Y waveforms can be displayed simultaneously.

13 **CH/REF OFF Switch**

The CH/REF OFF switch turns off an active channel or a selected, active reference. As a result, another selected channel or reference will be made active.

14

AC-GND-DC Input Coupling Switch

The AC-GND-DC input coupling switch selects the method of coupling the input signal of the active channel input connector to the vertical attenuator. The coupling is indicated by a lighted channel LED. Each channel can be set to AC, DC, or GND (ground).

AC - The input signal is AC coupled to the vertical deflection and signal acquisition systems. The DC component of the input signal is blocked.
The lower –3 dB bandpass is 10 Hz or less.
Selection of AC input coupling is indicated in the readout by a tilde symbol (~) in the associated channel VOLTS/DIV readout.

GND - Grounds the input of the vertical deflection channel and provides a zero (ground) reference voltage display (does not ground the input signal). Selection of GND input coupling is indicated in the readout by a ground symbol in the associated channel VOLTS/DIV readout.

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

15

Channel Invert Switch (INVERT)

A displayed waveform will be inverted by pressing the 'INVERT' button. The INVERT LED lights. An invert symbol (↓) is displayed in the readout of that channel.

Pressing the 'INVERT' button again restores the normal mode.

The 2216 can be operated as a differential oscilloscope by using the CH 1+2 mode and/or the CH 3+4 mode as differential amplifier(s). Therefore, one channel of each mode must be set to the INVERT position.

With CH 1+2 and CH 3+4 displayed simultaneously, the 2216 operates as a dual-differential amplifier. The capabilities as a differential amplifier however are limited.

Differential modes (CH 1+2 and CH 3+4) can also be applied in X-Y format.

16

Bandwidth Limit Switch (10 MHz)

The bandwidth limit switch decreases the bandwidth in non-store mode of an active channel. It is indicated by a lighted band-width LED ("10 MHz"). The bandwidth is limited to approximately 10 MHz. Pressing the '10 MHz' switch again restores the full bandwidth.

"B_L " is displayed in the readout of the channel(s) concerned.

NOTE
Bandwidth limiting is not available in store mode because the limited bandwidth of the digital acquisition system.

17

CH 1+2/CH 3+4 Mode Switch

The CH 1+2/CH 3+4 mode switch select the CH 1+2 or CH 3+4 vertical (added) modes for display.

CH 1+2 – CH1 and CH2 input signals are added, resulting in a CH 1+2 signal.
A "+" symbol appears in the readout.

In CH 1+2 mode, the 2216 can be operated as a limited differential amplifier if one of the channel signals is inverted. Therefore, toggle the INVERT switch of CH1 or CH2 to the invert position.

If one of the two input channels is switched off with the CH/REF OFF switch, the add mode will be switched off.

CH 3+4 – CH3 and CH4 input signals are added, resulting in a CH 3+4 signal.
A "+" symbol appears in the readout.

In CH 3+4 mode, the 2216 can be operated as a limited differential amplifier if one of the channel signals is inverted. Therefore, toggle the INVERT switch of CH 3 or CH 4 to the invert position.

If one of the two input channels is switched off with the CH/REF OFF switch, the add mode will be switched off.

18

Alternate / Chopped (ALT/CHOP) Switch

The Alternate / Chopped (ALT/CHOP) switch selects between the Alternate or Chopped vertical mode. At least two channels must be selected.

If Alternate mode is selected in combination with the 'VERT' trigger source selection, the trigger source is alternating between the selected channels.

NOTE

With vertical alternate mode on, and the trigger source in 'VERT', note that asynchronous signals are synchronously displayed .

Alternate / Chopped in Non-Store

In non-store alternate mode, channel waveforms are alternately displayed. Switching between the channels occurs at the end of the sweep during retrace.

In chopped mode, multiple traces are displayed synchonously on the screen. The selected channels are continuously multiplexed at a chopped frequency of about 500 kHz.
Chopped mode is especially useful with relatively slow timebase settings. With high speed timebase settings, the chopped mechanism could become visible. In that case, alternate mode is advisable.

Alternate / Chopped in Store Mode

In store mode, the Alternate / Choppedl mode selection has no effect on the display of the signals. The major use of the alternate mode feature is to to enable or disable the alternate vertical triggering with 'VERT' triggering source.

19 VOLTS/DIV Switch

The VOLT/DIV knob selects the vertical channel deflection factor of the active channel. The deflection factor ranges from 1 mV to 10 V per division in a 1-2-5 sequence.

The VOLTS/DIV knob setting of each selected channel is displayed in the crt readout. The readout of a channel is not displayed when a channel is switched to OFF.

If properly coded probes are connected to a vertical channel input connector, the crt VOLTS/DIV readout will reflect the correct deflection factor of the display.

IDENTIFY coding will result in "IDENT" being displayed in stead of the VOLTS/DIV readout. The corresponding waveform will be repositioned or the display is blanked to enable identification.

20 Variable VOLTS/DIV Control (VAR)

The Variable (VAR) control provides a continuously variable deflection factor of a selected channel between two calibrated positions of the VOLTS/DIV control.

The Variable (VAR) control range is sufficient to have overlapping ranges.
Pushing the lower VAR control switch reduces the vertical sensitivity. Pushing the upper VAR control switch increases the vertical sensitivity.

The uncalibrated condition is indicated in the readout by a greater-than symbol (">") or smaller than symbol ("<") in front of the affected channel readout.

Pushing both VAR buttons simultaneously restores the calibrated status, and the symbol in front of the affected VOLTS/DIV readout disappears.

21 Vertical POSITION Control

The vertical POSITION controls the vertical display position of a displayed signal of the active channel in Y-t format.

When the trace is positioned outside the graticule area, an arrow sign (↑) is displayed at the top graticule line, or an (↓) at the lower graticule line, depending of the position of the trace.

In X-Y mode, the 'vertical' positioning can have a horizontal positioning effect on the display when that channel is selected to be the X-signal.
In add mode, the positioning of the CH 1+2 signal is effected by the CH 1 and CH 2 vertical positioning. The positioning of the CH 3+4 signal in add mode is effected by the CH 3 and CH 4 vertical positioning.

22

X-Y / MENU Switch

The X-Y/MENU switch has two functions:

- Pressing the X-Y/MENU switch selects the X-Y format (in store mode as well as in non-store mode).
- Pressing the SHIFT and the X-Y/MENU switch successively, shows the **Digitize X-Y Menu** (selections can be defined only in store mode).

X-Y Non-Store Mode

In non-store mode, CH 1, CH 2, CH 3, and CH 4 are used to create the X- and/or Y- deflection (see also page 1-33). The selected channels automatically determine if channels will be displayed as X-axis or Y-axis (see Table 3-4).
As a result, a maximum of three X-Y waveforms can be displayed.

X-Y Store Mode

In store mode, the **Digitize X-Y Menu** is used to select the X- and Y-deflection (see Figure 3-2a). A maximum of two X-Y waveforms can be displayed.
Any stored waveform (CH1....CH4, and REF1....REF16) can be selected to be displayed as X1, Y1, X2 or Y2.
If add mode is selected, CH 1 or CH 2 selection in the Digitize X-Y Menu will be interpreted as CH 1+2, and CH 3 or CH 4 selections as CH 3+4.

Press a bezel button in the X-Y menu of the channel to be set. Select the waveform to be displayed with the GPK control.

NOTE

Selecting 'OFF' in either the X or Y will turn-off that specific X-Y waveform.

Table 3-4: Switch Table Y-t to X-Y Format in Non-Store Mode

Y-t Format	Function after pressing X-Y		
Selected Channels	X-Axis	Y-Axis	Number of Waveforms
CH 1, CH 2	CH 1	CH 2	1
CH 1, CH 3	CH 1	CH 3	1
CH 1, CH 4	CH 1	CH 4	1
CH1, CH3, CH4	CH1	CH3, CH4	2
CH 1, CH 3+4	CH 1	CH 3+4	1
CH 1+2, CH 3	CH 1+2	CH 3	1
CH 1+2, CH 4	CH 1+2	CH 4	1
CH 1+2, CH 3+4	CH 1+2	CH 3+4	1
CH 1, CH 2, CH 3	CH 1	CH 2, CH 3	2
CH 1, CH 2, CH 4	CH 1	CH 2, CH 4	2
CH 1, CH 2, CH 3+4	CH 1	CH 2, CH 3+4	2
CH 1+ 2, CH 3,CH 4	CH 1+2	CH 3, CH 4	2
CH 1, CH 2, CH 3, CH 4	CH 1	CH 2, CH 3, CH 4	3

Digitize X-Y Menu

	X1 [CH1]	Y1 CH4	X2 REF1	Y2 REF12	
Next selectable Menu, Action, Units or Values	CH1-4 or Ref 1-16 selected with the GPK	Y1 can be selected with GPK	X2 can be selected with GPK	Y2 can be selected with GPK	–

Figure 3-2a: 2216 Digitize X-Y Menu

23 Ground Connector

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

24 PROBE ADJUST Connector

The probe adjust output provides an approximately 0.5 V, square-wave voltage (at approximately 1 kHz) for use in compensating voltage probes (see also page 1-25).

NOTE

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

Horizontal Operation

This section describes the horizontal deflection system. The knobs and switches are situated in the **HORIZONTAL** section on the 2216 front panel. (see Figure 3-3).

General

The 2216 Oscilloscope can be used in two different horizontal display modes:

Horizontal Non-Store Display Mode

In the Non-Store (analog) mode, the 2216 provides a calibrated sweep speed range from 0.5 s per division to 0.05 μs per division.

The variable timing control (VAR) increases the non-store sweep time per division by a factor of up to 2.5 times the calibrated time per division.

The magnifier (MAG) magnifies the horizontal display by a factor 10 or 50 around the center graticule line. The magnifier rate is defined in the Magnify Menu.
The maximum sweep speed can be extended to 1 ns/div. The x50 magnification is not calibrated on the 4, 2 and 1 ns/div ranges.

The Alternate Magnifier feature is defined in the Magnify Menu and used to display the magnified and unmagnified sweep alternately on the crt screen.

In Alternate Magnifier mode, the magnified sweep can be repositioned vertically with the Trace Seperation control (TRACE SEP).

Horizontal Store Display Mode

In Store (digital) mode, the 2216 provides a calibrated sweep speed range from 50 s to 20 μs per division.

The maximum sample rate is 20 megasamples per second (20 MS/s).

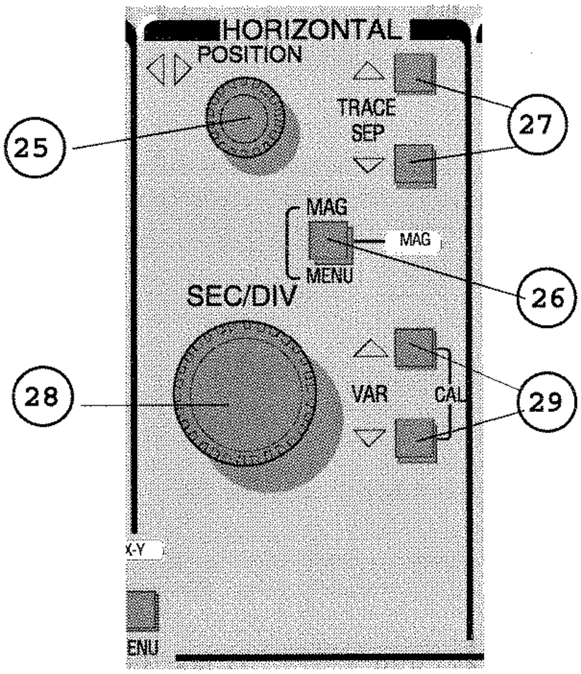


Figure 3-3: 2216 Horizontal Controls and Switches

The stored record length per waveform can be selected in the Record Size Menu (a sub-menu of the Functions Menu) from 512 points to 16384 points.

A maximum of sixteen waveforms may be stored in the 64KB reference memory as reference waveforms via the Reference Menu.

A reference waveform can be recalled for display and comparison with the current acquisition waveform by pressing the REFS button, and selecting the reference.

Horizontal Controls and Switches

See Figure 3-3 for the location of items 25 through 29.

25 **Horizontal POSITION Control**

The Horizontal POSITION control positions the displayed waveforms horizontally, including a x10 or x50 magnified sweep, over the following range:

- In non-store mode at least one-sweep-length
- In store mode at least one record length

The difference between non-store and store settings is mainly that the DIGITIZE function must be activated.

In X-Y (non-store mode) format, the horizontal POSITION control is disabled. In X-Y (store mode) format, the horizontal POSITION control controls which part of the acquired waveform is displayed.

26 **MAG/MENU Switch**

The MAG/MENU Switch activates or de-activates the magnifier function. In X-Y format, the MAGNIFY switch is disabled.

The magnified trace is the part of the unmagnified trace around the centre vertical graticule line. In store mode, with Δt cursors selected, the selected magnifier will also magnify the cursors as they are attached to the waveform(s).

When the SHIFT button and the MAG/MENU button are pressed successively, the Magnify Menu is selected and displayed (see Figure 3-4) and the required magnification mode can be selected.

Pressing CLEAR MENU removes the menu from the screen.

	Magnify Menu			
	Alternate OFF ON	Fit To Scr	x10	x50
Next selectable Menu, Action, Units or Values	ON	–	–	–

Figure 3-4: 2216 Horizontal Magnify Menu

The following selections can be made in the Magnify Menu with the bezel button switches:

- The **Alternate ON/OFF** bezel button switches the horizontal alternate mode ON or OFF. In Alternate ON, the magnified and the unmagnified trace(s) will be displayed on the crt screen alternately.
- The **'x10'** Magnifier bezel button selects the x10 magnifier mode.
- The **'x50'** Magnifier bezel button selects the x50 magnifier mode.
- The **'FIT TO SCREEN'** bezel button is only active in DIGITIZE mode. A complete record is compressed to a display of 10 divisions, regardless of the selected record length.

27 **TRACE SEParation control**

The vertical position of the magnified traces can be changed with the TRACE SEParation control, when the alternate magnifier mode is selected.

Pressing the TRACE SEParation buttons will move the magnified trace(s) according to the indicated direction of the switches.

TRACE SEParation is disabled in X-Y format.

28 **SEC/DIV Switch**

The SEC/DIV switch selects calibrated sweep rates in a 1-2-5 sequence. The sweep ranges are:

- 50 s to 20 µs per division in store mode
- 0.5 s to 0.05 µs per division in non-store mode.

The SEC/DIV readout reflects the currently selected horizontal deflection factor. Horizontal deflection factors of magnified sweeps will also be displayed in the readout.
In store mode, with the Clock Source set to INTERN, the SEC/DIV switch determines:

– the acquisition mode (RECORD or ROLL/SCAN)
– the sampling rate

There are two different acquisition modes with respect to the SEC/DIV switch setting (see also Table 3-5):

1. **RECORD** mode – A full record of the acquired waveform is updated each time a trigger event is recognized.
   The acquisition mode is RECORD at sweep speeds of 20 μs to 50 ms per division for all recordlength, except 512 data points (see Table 3-4). When 512 data points is selected, RECORD acquisition mode is selected for sweep speeds of 2μs to 20 ms per division.
2. **ROLL/SCAN** mode – Continuously acquires and displays signals. Triggers are disabled except in SINGLE sweep. The store mode is **ROLL/SCAN** at sweep speeds of 0.1 s to 50 s per division for all recordlengths, except 512 (see Table 3-4). When 512 data points is selected, ROLL/SCAN is activated at sweep speeds of 50 ms to 50 s per division.

   ROLL/SCAN mode can be displayed as ROLL or SCAN, as selected in the Slow Mode Menu (sub-menu of the Functions Menu).

   - In **ROLL** mode, the waveform display scrolls from right to left across the screen with the latest samples appearing at the right. As new data points are acquired, the previous data rolls towards the left side of the screen. The effect is similar to that of a chart recorder.
   - In **SCAN** mode, the latest acquired data overwrites the existing waveform from left to right on the screen.

Setting the trigger Mode to SINGLE sweep will cause the 2216 to operate in the triggered ROLL/SCAN mode. Triggers are enabled after the pretigger period. When a trigger occurs, the acquisition continues during the post trigger period and then stops.

Table 3-4: 2216 Sample Rate versus Timebase Selection

Timebase Selection	Display Mode with Records of 4096-128K	Sample Rate	Display Mode with Records of 512 points	Sample Rate
2 µs/div	n.a.	–	RECORD	20 MS/s
5 µs/div	n.a.	–	RECORD	8 MS/s
10 µs/div	n.a.	–	RECORD	4 MS/s
20 µs/div	RECORD	20 MS/s	RECORD	2 MS/s
50 µs/div	RECORD	8 MS/s	RECORD	800 kS/s
0.1 ms/div	RECORD	4 MS/s	RECORD	400 kS/s
0.2 ms/div	RECORD	2 MS/s	RECORD	200 kS/s
0.5 ms/div	RECORD	800 kS/s	RECORD	80 kS/s
1 ms/div	RECORD	400 kS/s	RECORD	40 kS/s
2 ms/div	RECORD	200 kS/s	RECORD	20 kS/s
5 ms/div	RECORD	80 kS/s	RECORD	8 kS/s
10 ms/div	RECORD	40 kS/s	RECORD	4 kS/s
20 ms/div	RECORD	20 kS/s	RECORD	2 kS/s
50 ms/div	RECORD	8 kS/s	ROLL/SCAN	800 S/s
0.1 s/div	ROLL/SCAN	4 kS/s	ROLL/SCAN	400 S/s
0.2 s/div	ROLL/SCAN	2 kS/s	ROLL/SCAN	200 S/s
0.5 s/div	ROLL/SCAN	800 S/s	ROLL/SCAN	80 S/s
1 s/div	ROLL/SCAN	400 S/s	ROLL/SCAN	40 S/s
2 s/div	ROLL/SCAN	200 S/s	ROLL/SCAN	20 S/s
5 s/div	ROLL/SCAN	80 S/s	ROLL/SCAN	8 S/s
10 s/div	ROLL/SCAN	40 S/s	ROLL/SCAN	4 S/s
20 s/div	ROLL/SCAN	20 S/s	ROLL/SCAN	2 S/s
50 s/div	ROLL/SCAN	8 S/s	ROLL/SCAN	0.8 S/s

29

Variable SEC/DIV Control (VAR)

The variable SEC/DIV control continuously varies the sweep time per division to at least 2.5 times the calibrated time per division in non-store mode.

Pushing the upper part of the VAR control reduces the sweep-time/division. Pushing both VAR buttons simultaneously restores the calibrated status.

In uncalibrated position, a greater-than symbol (">") is displayed in front of the SEC/DIV readout.

The VARiable SEC/DIV is disabled in store mode.

Triggering

In this section the functions of the trigger switches and controls are discussed (see Figure 3-5).

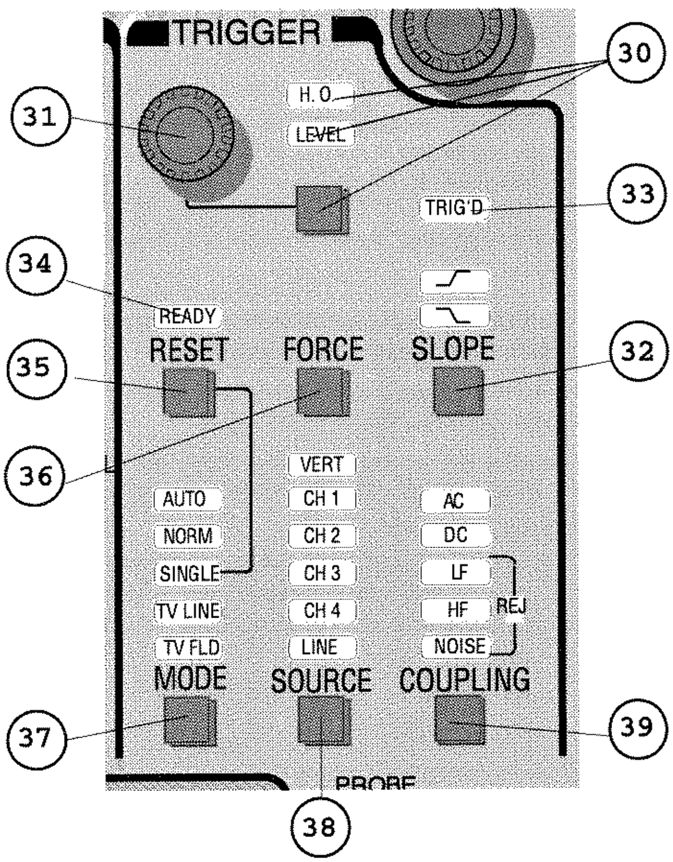


Figure 3-5: Trigger Switches, Controls and Indicators

Trigger Controls, Switches and Indicators

See Figure 3-5 for the location of items 30 through 39.

30 31 HOLDOff & Trigger LEVEL Switch

The Holdoff/Trigger Level switch toggles between the Holdoff control (H.O.) and the Trigger Level control (LEVEL).
The LED of the selected function lights.

- The **Holdoff** control adjusts the holdoff time.
  The holdoff is a variable time period after every sweep during which triggering is disabled. By rotating the trigger Level/ Holdoff control, the holdoff time is adjusted.
  The percentage of the maximum holdoff time for the selected timebase setting, is displayed in the readout for a few seconds.

- The **Trigger Level** control selects the amplitude point on the trigger signal that produces triggering.

  When the trigger circuit produces a pulse to start a sweep or acquisition, the TRIG'D LED lights.

  The selected amplitude voltage is displayed as a voltage readout in the trigger coupling field in the crt readout, referenced to the input signal.

  Trigger related settings are shown in the readout of the upper right part of the screen. Trigger source, trigger level and trigger coupling will be displayed when available.

32 **Trigger SLOPE Switch**

The trigger SLOPE switch selects either the positive or negative going slope of the trigger signal to start a sweep.
The LED indicator of the selected slope lights.

33 **TRIG'D Indicator**

The TRIG'D LED indicator is turned on when triggering occurs.

34 **READY Indicator**

The READY LED indicator turns on in SINGLE sweep trigger mode, when the trigger circuit is armed by pressing RESET button, awaiting a triggering event.
The READY indicator turns off as soon as a trigger event occurs.

(35)

RESET Switch

Pressing the RESET button, in SINGLE sweep trigger mode, the trigger circuit is armed for one single sweep in non-store mode or one single acquisition in store mode

Triggering requirements are the same as in NORM trigger Mode. After completing a triggered non-store SINGLE sweep or a store SINGLE sweep acquisition, pressing the RESET button again rearms the trigger circuitry to accept the next triggering event.

After pressing the RESET button in store mode SINGLE sweep, the pre-trigger portion f the acquisition memory will be filled before the trigger circuit is armed. During that period of time, the READY light is blinking.

The pretrigger portion of the acquisition memory starts filling after the RESET button is pressed. The READY indicator is turned on permanently when the pretrigger part of the memory is full.
Then, the storage acquisition system is ready to accept a trigger event. The 'Trigger Position' in store mode is defined in the FUNCTIONS Menu, resp. Trigger Position Menu (see Figure 3-6).

Trigger Position Menu

Trig Pos	Set To	Set To	Set To	Previous
[25%]	10%	50%	90%	Menu

Figure 3-6: 2216 Trigger Position Menu

36 **FORCE Trigger Switch**

Pressing the FORCE trigger switch forces a sweep to start immediately:

- In non-store mode, pressing the FORCE button forces the sweep to start, and releasing the button will make the sweep stop.
- In store mode, pressing the FORCE button will generate a single trigger event.

37 **Trigger MODE Switch**

The trigger MODE switch determines completely the non-store sweep triggering mode.
In store mode however, the triggering operation depends on the trigger MODE and the position of the SEC/DIV switch (RECORD or ROLL/SCAN mode).
The LED for the selected trigger MODE lights.
The following MODE selections can be made:

- **AUTO Triggering**
  - In **non-store** mode, AUTO triggering occurs on trigger signals that have adequate amplitude and a repetition rate of about 20 Hz or faster. In the absence of a proper trigger signal, an auto-trigger is generated and the sweep runs free.
  - In **store mode with RECORD** mode acquisition, the functionality is similar to the non-store mode. The trigger point indicator (intensified dot) is visible on the generated trace, at the position selected by the pretrigger setting, as selected in the FUNCTIONS menu.
  - In **store mode ROLL/SCAN** mode acquisition, triggering is disabled.

- **NORM**
  NORMal triggering mode permits triggering at all sweep rates (an auto-trigger is not generated in the absence of an adequate trigger repetition rate). NORMal trigger mode will generate a sweep or acquisition when a valid trigger condition occurs.
  In store mode ROLL/SCAN acquisition mode, triggering is disabled

- **SINGLE** sweep
  In SINGLE sweep trigger mode, the sweep or acquisition can be started by a trigger pulse to display one sweep or acquisition.
  A RESET switch pulse must be generated to arm the trigger circuitry to accept a trigger event. The arming of the trigger circuit is indicated by the READY led. When the 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 pulse) signal.

  The triggering level is automatically set. The trigger COUPLING switch is disabled. In absence of an adequate trigger signal, the sweep (or acquisition) runs free. The instrument otherwise behaves as in AUTO.

  "TV Line" is displayed in the trigger readout field.

- **TV Field (TV FLD)**
  TV FIELD triggering permits stable triggering on a television field (vertical sync pulse) signal. The trigger COUPLING switch is disabled. In absence of an adequate trigger signal, the sweep (or acquisition) runs free. The instrument otherwise behaves as in AUTO.

  "TV Fld" is displayed in the trigger readout field.

38

Trigger SOURCE Switch

The trigger SOURCE switch selects the source of signal for the trigger generator circuitry. The following selections can be made:

- **VERT Mode (Vertical Mode)**
  Trigger signals are obtained from the CH 1, CH 2, CH 3 or CH 4 vertical amplifiers.

  In alternate vertical mode, trigger signals are obtained alternately from CH 1, CH 2, CH 3 or CH 4.
  In CHOP vertical mode, the trigger signal source is the channel which is lowest in number of the displayed channels.

  "VERT" is displayed in the trigger source readout field.

- **CH 1 Mode**
  The triggering signal is obtained from CH1.
  With CH1 in INVERT position, the polarity of the internal CH1 trigger signal is also inverted.

  "CH1" is displayed in the trigger source readout field.

- **CH 2 Mode**
  The triggering signal is obtained from CH2.
  With CH2 in INVERT position, the polarity of the internal CH2 trigger signal is also inverted.

  "CH2" is displayed in the trigger source readout field.

- **CH 3 Mode**
  The triggering signal is obtained from CH3.
  With CH3 in INVERT position, the polarity of the internal CH3 trigger signal is also inverted.

  "CH3" is displayed in the trigger source readout field.

- **CH 4 Mode**
  The triggering signal is obtained from CH4.
  With CH4 in INVERT position, the polarity of the internal CH4 trigger signal is also inverted.

  "CH4" is displayed in the trigger source readout field.

- **LINE Mode**
  In LINE Mode, an attenuated ac power line signal is routed to the trigger circuit.

  "LINE" is displayed in the trigger source readout field.

39

COUPLING Switch

The trigger COUPLING switch selects the method of coupling for the signal applied to the trigger circuit.
Trigger COUPLING selection is disabled if either TV-Line or TV-Field mode is selected.
The following selections can be made:

- **AC Coupling**
  The vertical input signal is capacitively coupled to the trigger circuit, and the dc component is blocked.

  "AC" is displayed in the trigger readout field.

NOTE
AC coupling is useful for triggering on waveforms that have a large dc-offset.

- **DC Coupling**
  All frequency components of the input signal are coupled to the trigger circuit (dc to full bandwidth).
  The trigger voltage-LEVEL is displayed on the trigger readout as a voltage, referenced to the input signal.

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

- **NOISE Rejection Coupling**
  All frequency components of the input signal are coupled to the trigger circuitry, but the sensitivity is reduced.

  "Noise" is displayed in the crt trigger readout field.

NOTE
NOISE Rejection is useful for improving stability when the signal is accompanied by low-level noise.

- **HF Rejection Coupling**
  High-frequency components (above 30 kHz) are rejected (attenuated) from the trigger input signal.

  "HF rej" is displayed in the trigger readout field.

NOTE

HF Rejection coupling is useful for providing a stable display of low-frequency components of complex waveforms by eliminating high-frequency interference from the trigger signal.

- **LF Rejection Coupling**
  Low-frequency components (below 30 kHz) are rejected (attenuated) from the trigger input signal.

  "LF rej" is displayed in the trigger readout field.

NOTE

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

Storage Functions and Menus

This sub-section is split-up in the following chapters (see Figure 3-7):

- Digitize & Functions Menus (page 3-36) 40
- Run/Stop Acquisition & Measurements Menus (page 3-43) 42
- References & References Menus (page 3-49) 43
- Hardcopy & Hardcopy Menus (page 3-59) 44

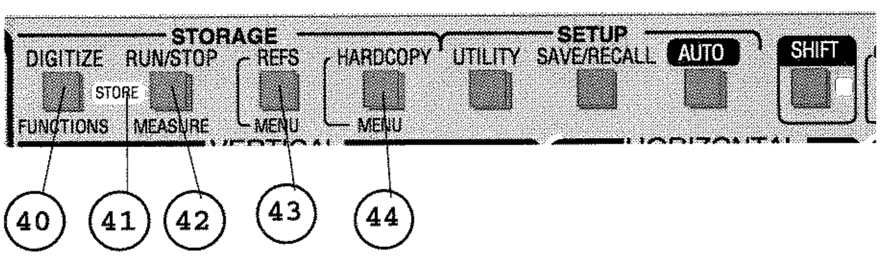


Figure 3-7: 2216 Storage Functions and Menu Switches

DIGITIZE/ FUNCTIONS Menu Switch

40 The DIGITIZE/ FUNCTIONS menu switch (see Figure 3-7) has two functions:

- Pressing the DIGITIZE switch, you toggle between the non-store or the store mode.

  When store mode is selected, the "STORE" LED lights.

  When switched to non-store, the store acquisition is turned off, and the last waveform acquired in store mode remains in memory until the power is switched off.
- Pressing the SHIFT and the DIGITIZE/ FUNCTIONS switch successively, the **Storage Functions Menu** is displayed (see Figure 3-8).

Storage Functions Menu

	Trig Pos 25%	Rec Size 16384	Clk Src AUXSLOW	Slow Mode ROLL	More 1 of 2
Next selectable Menu, Action, Units or Values	Trigger Position Menu	Record Size Menu	Acquisition Clock Source Menu	Slow Display Mode Menu	Page 2 of 2

Storage Functions Menu

	Average [16]	Limit Testing	More 2 of 2
Next selectable Menu, Action, Units or Values	GPK select 2, 4, 8, 16, 32, 64, 128.	Limit Testing Setup Menu	Page 1 of 2

Figure 3-8: Storage Functions Menu

In the Storage Functions menu you can select the following sub-menus and setting:

- **Trigger Position Menu** (page 3-37)
- **Record Size Menu** (page 3-38)
- **Clock Source Menu setting** (page 3-39)
- **Slow Mode Menu** (page 3-41)
- **Average** (page 3-41)
- **Limit Test Setup Menu** (page 3-42)

Trigger Position Menu

The trigger position on the acquired record is defined by pressing one of the bezel buttons in the Trigger Position menu (see Figure 3-9).

Trigger Position Menu

	Trig Pos [25%]	**Set To 10%**	**Set To 50%**	**Set To 90%**	**Previous Menu**
Next selectable Menu, Action, Units or Values	Set Trig. point with GPK control: 0-100%	Trig. point to 10%	Trig. point to 50%	Trig. point to 90%	Functions Menu

Figure 3-9: 2216 Trigger Position Menu

The following selections can be made:

- **'Trig Pos'**
  The trigger position point must be defined with the GPK control.
- **'Set To 10%'**
  The trigger position is set to 10 % of the recordlength.
- **'Set To 50%'**
  The trigger position is set to 50 % of the recordlength.
- **'Set To 90%'**
  The trigger position is set to 90 % of the recordlength.
- **'Previous Menu'**
  The 'Functions Menu' is selected again.

Record Size Menu

Press the '**Rec Size**' bezel button in the Functions menu to select the Record Size Menu (see Figure 3-10).

The Record Size is defined as the number of points per acquired record.

Record Size :

Set to 512	Set to 4096	Set to 8192	Set to 16384	More 1 of 2

Record Size :

Set to 32768	*Set to 65536*	*Set to 131072*	Cancel	More 2 of 2

Figure 3-10: 2216 Record Size Menu

NOTE

Record sizes above 16348 points require the Option 1M to be installed. If not installed, the selections will be indicated in Italic.

The selection 512 points is displayed with a resolution of 40 samples per division. The other selections are displayed with 400 samples per division

With Option 1M installed, 32768, 65536, and 131072 points per record can be selected as well.

Press the '**Cancel**' button to leave the Record Size Menu and return to the Storage Functions menu.

Clock Source Menu

Press the '**Clock Source**' bezel button in the Functions Menu to select the Clock Source Menu (see Figure 3-11). You can select whether the clock pulse for the A/D-convertors in the 2216 is derived from the internal clock source or an external clock source.

Clock Source Menu

	INTERNAL	AUX IN RECORD	AUX IN SLOW	Cancel
Next selectable Menu, Action, Units or Values	Internal clock dependson SEC/DIV setting	External clock setting max. 10 MHz	External clock setting max. 4 kHz	Storage Functions Menu

Figure 3-11: 2216 Clock Source Menu

Clock Function

The clock pulse for the A/D-converters determines the moment at which the A/D-converters sample the input signal. The 2216 has two ways of handling the resulting samples:

- As a **RECORD**
  Samples from the A/D-converters are stored in a fast acquisition memory. After a trigger event, samples are stored until this memory is filled to the installed recordlength and the acquisition process stops acquiring input samples.
  The contents of the acquisition memory are transferred to a (slower) display memory. After the transfer is finished, the acquisition process of acquiring input samples is started again.
- As a single sample (**Slow Mode**)
  Samples from the A/D-converters are directly transferred to the display memory. In Slow Mode, you also select the way the sampled input signal is handled (**ROLL or SCAN**) before it is displayed on the crt.
  No trigger event is needed (unless single sweep is selected) and new samples simply overwrite old samples.

NOTE

Fast SEC/DIV settings are possible by handling samples as a RECORD. This is not possible when the samples are handled individually (therefore the name "Slow Mode").
The main disadvantage of handling samples as a record becomes visible at slow SEC/DIV settings and at a long recordlength. The time needed to fill the acquisition memory can become quite long and starts to influence the liveliness of the display.
Handling samples individually solves this disadvantage, as the samples are directly transferred to the display.

In the Clock Source Menu (Figure 3-11) you can select:

- **'INTERNAL'**
  The time between consecutive samples is determined by the SEC/DIV switch position. The sample rate is established as indicated in Table 3-4 (page 3-24).

- **'AUX IN RECORD'**
  The time between consecutive samples is determined by the clock pulses provided via the AUX connector on the rear panel.
  The samples are handled as a record and the input frequency range can be between 0 Hz and 10 MHz.

- **'AUX IN SLOW'**
  The time between consecutive samples is determined by the clock pulses provided via the AUX connector on the rear panel. The acquisition is continuous. All samples are acquired. The input frequency range can be between 0 Hz and 4 kHz.
  The way the acquisition will be displayed, is selected in the Slow Mode Menu.

The relation between the clock pulse frequency and the resulting display on the CRT is given by the following formula:

$$\text{Timebase: SEC/DIV} = \frac{\text{SD}}{\text{Clock Frequency}}$$

The sample display SD = 40 for a recordlength of 512 points and SD = 400 for all other recordlengths.
The Clock Frequency is expressed in Herz (Hz)

Slow Mode Menu

Press the '**Slow Mode**' bezel button in the Functions Menu (Figure 3-8) to select the Slow Mode Menu (Figure 3-12).

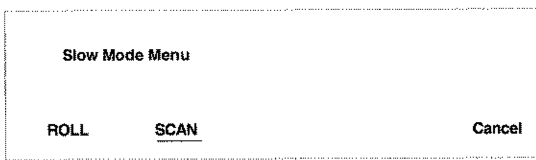


Figure 3-12: 2216 Slow Display Mode Menu

You can select the display of the samples on the CRT if the acquisition is continuous (Slow Mode):

- **'ROLL' Display**
  The acquired data is displayed so that new samples are added to the rightmost position of the display memory, causing the displayed signal to move from right to left.
- **'SCAN' Display**
  The acquired data is displayed so that a new sample is added to the right of the previous sample, causing the previous displayed signal to be overwritten by the new signal.

'AVERAGE'

Press the '**AVERAGE**' bezel button in the Functions Menu to enter or leave the average display mode. Averaging reduces the random noise in a displayed waveform.

Waveforms are the result from each new acquisition and the previously averaged waveform. The selected value determines the averaging ratio between the new and old data. The maximum usable record length is 16K per acquisition.

The averaging number (2, 4, 8, 16, 32, 64, 128 or OFF) can be selected by pressing the 'AVERAGE bezel button, or the GPK control.

Limit Test Setup Menu

The 2216 can compare an acquired waveform with an upper and a lower waveform. The waveform of the active channel is tested. Reference waveforms can be selected in the Limit Test Setup Menu to be used as upper and lower waveforms.
You can interprete the 'Limit Test Setup Menu' in this example as follows:

> *"DISPLAY the acquired waveform if the status is set to ON, and ANY point of the acquired waveform is OUTSIDE the REF1 upper limit, or REF3 lower limit".*

Press the '**Limit Testing**' bezel button in the Functions menu to select the Limit Test Setup Menu (see Figure 3-13).

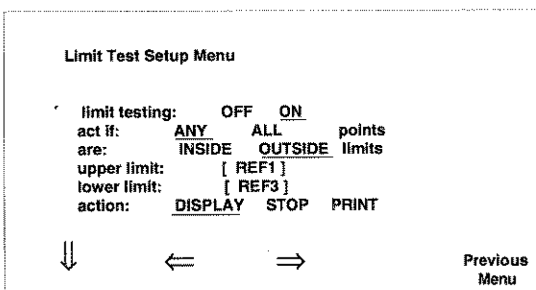


Figure 3-13: 2216 Limit Test Setup Menu

The parameters of the limits can be defined in the menu by using the arrow buttons. The following actions can be selected:

- **DISPLAY**
  All acquisitions will be tested but only the ones that meet the testcondition are displayed.
- **STOP**
  The acquisition is automatically set to STOP when the testcondition is met.
- **PRINT**
  All acquisitions that meet the testcondition will automatically start the hardcopy task.

Press the '**Previous Menu**' bezel button to select the Storage Functions Menu again.

RUN/STOP / MEASURE Menu Switch

42 The RUN/STOP / MEASURE switch has two functions:

- Pressing the RUN/STOP/MEASURE switch (see Figure 3-14) stops and starts the acquisition.

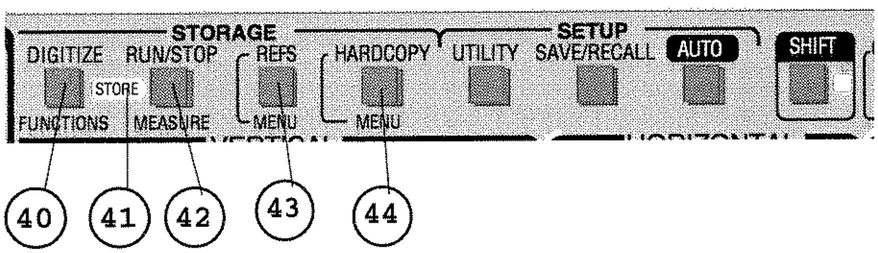


Figure 3-14: Storage Functions and Menu Switches

When STOP is selected, "STOP" appears in the readout acquisition status field.

- Pressing the SHIFT and the RUN/STOP/MEASURE switch successively, the **Measurements Menu** is displayed (see Figure 3-15).

Measurement Menu

Automated measurements on an active waveform is defined in the **Measurement Menu** and sub-menus (see Figure 3-15).

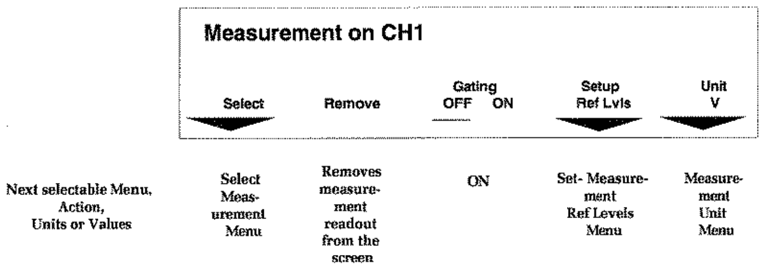


Figure 3-15: 2216 Measurements Menu

NOTE
If you select a different active channel or active reference, the bezel button of the selected measurement in the Select Measurement Menu must be pressed again.

You can select in the Measurements Menu:

- **Select Measurement Menu** (see page 45).
- **Remove** measurement setting (see page 46).
- **Gating ON/OFF** setting (see page 46).
- **Setup Measurement Ref Levels** Menu (see page 46).
- **Measurement Unit** Menu (see page 47)
- **Define Custom Unit** Menu (sub-menu of the **Measurement Unit** Menu) (see page 48)

Select Measurement Menu

Press the '**Select**' bezel button to select the '**Select Measurement Menu**' (see Figure 3-16a,b,c,d,e).
The following measurements can be selected (one at a time):

- Area
- Cycle Mean
- Cycle RMS
- – Duty Cycle
- Mean
- Minimum Value
- Period
- RMS
- Cycle Area
- Cycle Power
- + Duty Cycle
- Frequency
- Maximum Value
- Peak to Peak
- Power

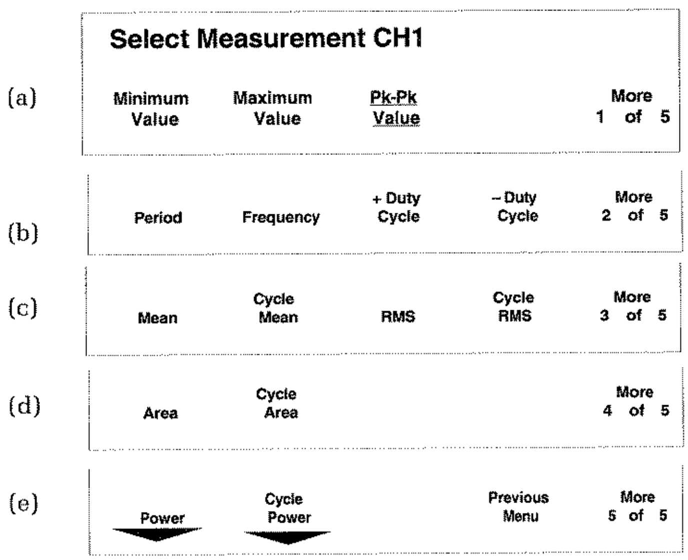


Figure 3-16 a, b ,c, d, e: 2216 Select Measurement Menus

For more information about automated measurements, see *Using Automated Measurements,* page 1-43 through 1-50.

Remove Measurement

Press the '**Remove**' bezel button to remove a selected measurement from the screen.

Gating ON/OFF Setting

By toggling the '**Gating**' bezel button, gating will be switched to ON or OFF.

With 'Gating' set to ON, two 'TIME' cursors are displayed on the screen to define the measurement 'gate'. The gating feature lets you limit measurements to a specified portion of the waveform.

With 'Gating' set to OFF, the oscilloscope measures over the entire waveform record.

The position of the gate cursors will be set with the GPK control. To select the other 'gate cursor', press the SELECT switch and position it with the GPK control.

Setup Reference Levels Menu

Press the '**Setup Ref Levels**' bezel button to select the Set Measurement Reference Level Menu (see Figure 3-17a,b,c).

Definition

*A **Mid Ref Level** is that level of a waveform that sets the middle reference level.*

The default level is 50%. The 'mid ref level' can be selected as a percentage or as a voltage.

Once you define a mid reference level, the 2216 will use it for all measurements requiring that level.

For more information about Selecting a Measurement Reference Level in automated measurements, see *Using Automated Measurements,* page 1-49 through 1-50 and *Appendix D: Algorithms.*

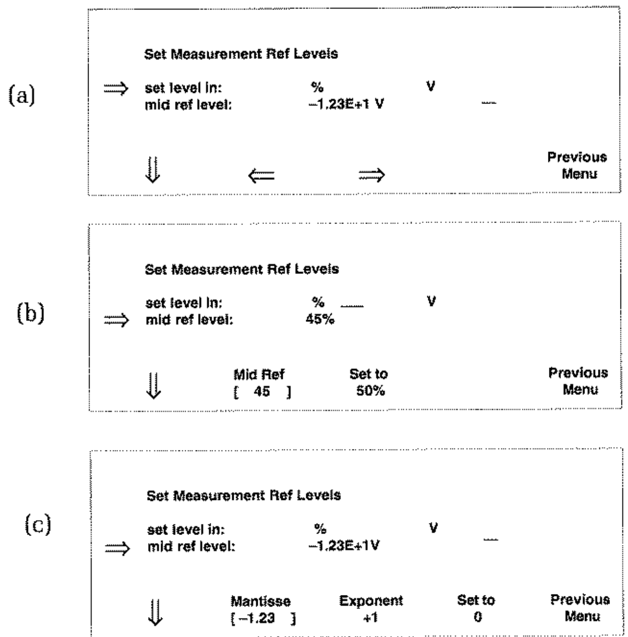


Figure 3-17 a, b, c: 2216 Set Measurement Reference Level Menu

Measurement Unit Menu

Press the '**Unit**' bezel button to select the **Measurement Unit Menu** (see Figure 3-18).

The unit is selected as a voltage or as a customised unit. Custom units are defined in the **Define Custom Unit Menu** (see Figure 3-19).

NOTE
The 2216 has one set of custom unit selections for Cursor units and Measurement units. Selections made in the Measurement Unit Menu will affect the custom unit selection in the Cursors Menu.

For more information about using Custom Units, see *Chapter 1: Using Custom Units*, page 1-61 through 1-67.

Measurement Unit Menu

	Unit V CUST	Define Custom	Previous Menu
Next selectable Menu, Action, Units or Values	Custom Unit	Define-Custom Unit Menu	Measure-ment Menu

Figure 3-18: 2216 Measurement Unit Menu

Define Custom Unit Menu

formula: Y = A * V1 + B
A value: -1.23 E +1
B value: -1.23 E +1
unit name: "RPM"

	⇓	Previous Formula	Next Formula	Previous Menu
Next selectable Menu, Action, Units or Values	Next line downwards	–	–	Measurement Unit Menu

Figure 3-19: 2216 Define Custom Unit Menu

REFS/ MENU Switch

43

The REFS/MENU switch (see Figure 3-20) has two functions:

- Press the REFS/MENU switch to select the **Reference Readout** (see Figure 3-21). The selected references (underlined) are displayed on the screen. The dual underlined reference is the active reference
- Pressing the SHIFT and the REFS/MENU switch successively, the **References Menu** is displayed (see Figure 3-22).

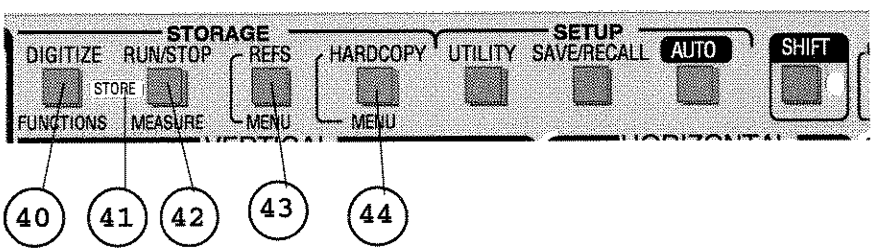


Figure 3-20: Storage Functions and Menu Switches

General

Active waveforms can be stored as a reference in memory and can be displayed from that memory to compare them with the currently acquired waveform. The total available memory for storing waveforms is 64K, so a maximum of 16 wave forms of 4 K each can be stored.

When storing a waveform, the 2216 assigns the waveform a default ID string (e.g. REF3) in the Reference Readout (see Figure 3-21). The name of the string can be changed in the References Edit Name Menu (see Figure 3-25).

If there is not enough memory available to store a waveform, the user is informed by a message on the screen. To free memory, delete one or more stored waveform(s) via the 'Delete' menu (see Figure 3-23)

Displaying References

Press the REFS button to display the Reference Readout (see Figure 3-21).

The Reference Readout shows the references stored in memory. If a reference name is underscored once, this reference is selected to be on display. If a reference name is underscored twice, it is selected to be the active waveform on the display.
From the Reference Readout example (Figure 3-21) can be read that three stored waveforms are available, of which two already are displayed (REF2 and REF3).

REF3 is the active waveform in this example.

Note
The CH 1 through CH 4 LED's are off. The display settings of the active waveform are displayed (200mV and 500µs).

For more information about using reference waveforms, see *Using References*, page 1-51 through 1-56.

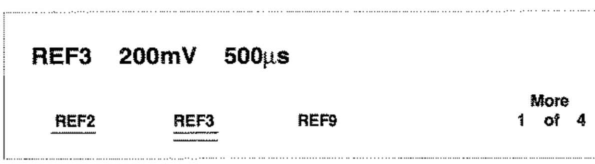


Figure 3-21: 2216 Reference Readout

Add/Remove a Reference to/from Display

Press the bezel button of a reference to display it on the screen and make it the active reference

Pressing the CH / REFS OFF switch removes the active reference from the crt screen and the next selected reference will become the active reference.

Press the SHIFT and the bezel button of a not-selected reference successively to select and display that reference on the screen, without changing the active reference.

A maximum of four stored waveforms can be displayed simultaneously.

Press the SHIFT button and the bezel button of a selected reference successively to remove a selected reference from the screen.

Reference Menu: Save to REF1

	Save CH 1	Display	Delete	Rename	Position Mode
Next selectable Menu, Action, Units or Values	Save the active waveform (CH 1)	Reference Display Readout	Delete REFS Menu	REFS Rename Menu	REFS Position Menu

Figure 3-22: 2216 References Menu

References Menu

The References Menu (see Figure 3-22) has the following sub-menus and settings:

- **'Save CH1'**
  The current active waveform (in this example: CH1) will be saved (page 3-53).

NOTE
If an added mode is selected, the CH 1 and CH 2 readout text will be CH 1+2 and the CH 3 and CH 4 text will be CH 3+4.

- **'Display'**
  The **Reference Display Menu** will be displayed (page 3-53).
- **Delete References Menu** (page 3-54)
- **Rename References Menu** (page 3-55)
- **References Edit Name Menu** (page 3-56)
  (a sub-menu of the Rename References Menu)
- **References Position Mode Menu** (page 3-57)
- **Horizontal Lock Menu** ((page 3-58)
  (a sub-menu of the References Position Mode Menu)

For more information about using reference waveforms, see: *Using References,* page 1-51 through 1-56.

Save CH 1

Press the '**Save CH 1**' bezel button to save the active waveform in reference memory.

The name after 'Save' is the currently active waveform.

Display

Pressing the '**Display**' reference button will display the **Reference Display Menu** (Figure 3-22a,b). References stored in memory can be selected to be displayed on the screen.

(a)

REF3 200mV 500µs

	REF2	REF3	REF9	REF 11	More 1 of 2
Next selectable Menu, Action, Units or Values	REF2 active	–	REF9 on and active	REF11 on and active	Page 2 of 2

(b)

REF3 200mV 500µs

	REF15			Previous Menu	More 2 of 2
Next selectable Menu, Action, Units or Values	REF15 on and active	-	-	Reference Menu	Page 1 of 2

Figure 3-22a,b : Reference Display Menu

The Reference Display Menu can be operated the same way as the Reference Readout (see page 3-51).

Press CLEAR MENU to leave the Reference Display Menu.

Delete Reference Menu

Press the '**Delete**' bezel button in the References Menu to select the 'Delete References Menu' (see Figure 3-23). The currently active reference is displayed, together with its readout.

Delete from memory:
REF2 200mV 500µs

Previous Ref	Next Ref	Delete Ref	Previous Menu

Figure 3-23: Delete References Menu

The following selections can be made:

– **'Previous Ref'**
  Selects the previous stored reference waveform.

– **'Next Ref'**
  Selects the reference waveform next in the row of stored references.

– **'Delete Ref'**
  Deletes the selected reference waveform from memory.

Rename Reference Menu

Press the '**Rename**' bezel button in the References Menu to select the '**Rename References Menu**' (see Figure 3-24). The active reference is displayed, together with its readout.

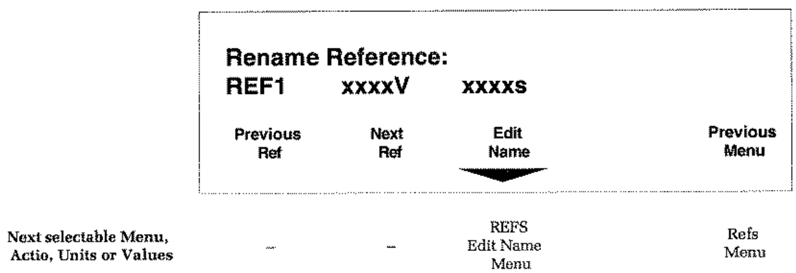


Figure 3-24: 2216 Rename References Menu

The following selections can be made:

- **'Previous Ref'**
  Selects the previous stored reference waveform.

- **'Next Ref'**
  Selects the reference waveform next in the row of stored references.

- **'Edit Name'**
  Selects the Edit Name Menu.

For more information about using reference waveforms, see: *Using References,* page 1-51 through 1-56.

Edit Name Menu

Press the '**Edit Name**' bezel button in the Rename Reference Menu to select the '**REFS Edit Name Menu**' (see Figure 3-25). The active reference is displayed, together with its readout.

REFS Edit Name: "REF1"

	Select Position	Char [R]	Insert Char	Delete Char	Previous Menu
Next selectable Menu, Actio, Units or Values	Select next character on the line	Select character with GPK or bezel button	Insert selected character	Delete selected character	Rename Reference menu

Figure 3-25: 2216 REFS Edit Name Menu

The following selections can be made:

- **'Select Position'**
  Selects the position of the character to be changed.

- **'Char'**
  Selects the character setting. The character to be displayed can be selected with the GPK control.

- **'Insert Char'**
  Inserts a character in the reference name.

- **'Delete Char'**
  Removes a character in the reference name.

For more information about using reference waveforms, see: *Using References,* page 1-51 through 1-56.

References Position Mode Menu

Press the '**Position Mode**' bezel button in the References Menu to select the '**REFS Position Mode Menu**' (see Figure 3-26).

The horizontal position of the references related to the live waveforms are defined in the REFS Position Mode Menu.

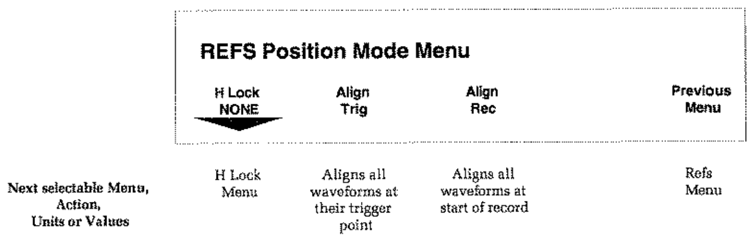


Figure 3-26: 2216 REFS Position Mode Menu

The following selections can be made:

– Press the 'H Lock' bezel button to select the '**Horizontal Lock Menu**' (see Figure 3-27). The following positions can be selected:

- 'NONE'
  The selected references can be positioned independently by the horizontal POSITION control.
- **'REFS'**
  Changing the horizontal POSITION control will position all channels simultaneously, when a channel is active. If a reference is active, the horizontal POSITION control will position all references simultaneously.
- **'ALL'**
  Changing the horizontal POSITION control will position all waveforms simultaneously, regardless of the active waveform.
- **'Cancel'**
  The H Lock menu is cancelled and the REFS Position Mode Menu is displayed.

	Horizontal Lock Menu			
	NONE	REFS	ALL	Cancel
Next selectable Menu, Action, Units or Values	Selects NONE	Selects REFS	Selects ALL	REFS Position Mode Menu

Figure 3-27: 2216 Horizontal Lock Menu

- **'Align Trig'**
  Horizontally aligns all displayed waveforms at their trigger point instantaneously.

- **'Align Rec'**
  Horizontally aligns all displayed waveforms at "start of record" instantaneously.

For more information about using reference waveforms, see: *Using References,* page 1-51 through 1-56.

HARDCOPY/MENU Switch

44 The HARDCOPY/MENU switch (see Figure 3-28) has two functions:

- Pressing the HARDCOPY/MENU switch initiates a printer/plotter connected to the 2216 to print/plot a copy of the screen display, a part of the screen display, or a complete record, using the settings of the Hardcopy Menu.
  Pressing the HARDCOPY/MENU switch again stops the hardcopy action. The on/off state of the hardcopy process is displayed by a 'PRN' message on the screen.
- Pressing the SHIFT and the HARDCOPY/MENU switch successively, the **Hardcopy Menu** is displayed (see Figure 3-29).

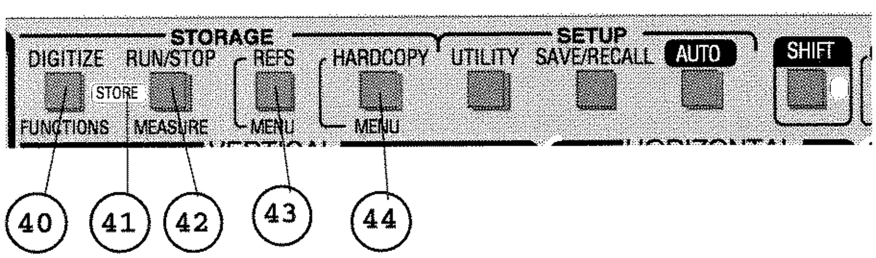


Figure 3-28: Storage Functions and Menu Switches

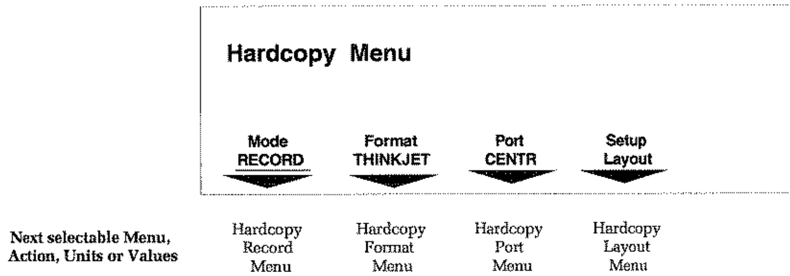


Figure 3-29: Hardcopy Menu

The Hardcopy Menu has the following sub-menus:

- **Hardcopy Mode Menu** (page 3-61)
- **Hardcopy Record Mode Menu** (page 3-62)
  (Sub-menu of the Hardcopy Mode Menu)
- **Hardcopy Chart Mode Menu** (page 3-63)
  (Sub-menu of the Hardcopy Mode Menu)
- **Hardcopy Format Menu** (page 3-64)
- **Hardcopy Port Menu** (page 3-65)
- **Hardcopy Setup RS232 Menu** (page 3-69)
  (sub-menu of the Port Menu)
- **Hardcopy Setup Layout Menu** (page 3-70)
- **Hardcopy Layout Edit Note Menu** (page 3-71)
  (sub-menu of the Layout Menu)

Hardcopy Mode Menu

Press the '**Mode**' bezel button of the Hardcopy Menu to select the **Hardcopy Mode Menu** (see Figure 3-30).

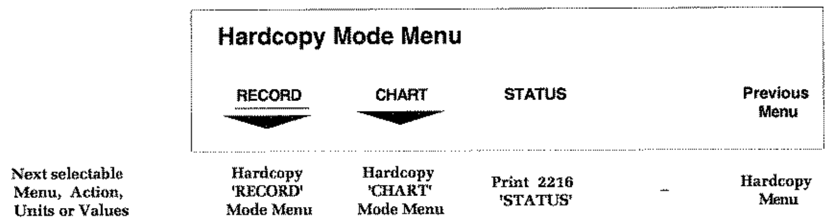


Figure 3-30: 2216 Hardcopy Mode Menu

Press the '**Mode**' bezel button to select the '**Hardcopy Mode Menu**' (see Figure 3-30). An underscore indicates if 'RECORD', 'CHART', or 'STATUS' hardcopy mode is selected.

Hardcopy Rec. Mode Menu

	SCREEN COPY	FULL RECORD	BETWEEN CURSORS		Previous Menu
Next selectable Menu, Action, Units or Values	Select Screen Copy	Sslect Full Record	Select Between Cursors	–	Hardcopy Mode Menu

Figure 3-31a: 2216 Hardcopy Record Mode Menu

In the Hardcopy Mode Menu the following selections can be made:

- **Hardcopy Record Mode Menu (RECORD)**
  In hardcopy RECORD mode (see Figure 3-31a), a copy of the complete record or a part of the record will be made on a printer or plotter. In Hardcopy Record Mode the following selections can be made:

  - **'SCREEN COPY'**
    The part of the record that is displayed on the screen will be printed.
  - **'FULL RECORD'**
    The complete record will be printed.
  - **'BETWEEN CURSORS'**
    The part of the record that is gated by two 'TIME' cursors will be printed.

Hardcopy Chart Mode Menu

	Time/Div [0.1 s]				Previous Menu
Next selectable Menu, Action, Units or Values	0.1 s to 1 day per div. setting	–	–	–	Hardcopy Mode Menu

Figure 3-31b: 2216 Hardcopy Chart Mode Menu

– **Hardcopy Chart Mode Menu (CHART)**
In hardcopy CHART mode (see Figure 3-31b), a printer using fan-fold paper is connected to the output port for continuous printing of the acquisition.

NOTE
CHART Mode is only available when the acquisition is in Slow Mode (ROLL or SCAN).

In Hardcopy Chart Mode the Time/Div speed of the recorder is selected with the GPK control or with the 'Timebase bezel button.

NOTE
The time/div. position setting of the striprecorder is independent of the setting of the timebase.

– **Hardcopy Mode Menu (STATUS)**
In hardcopy STATUS mode, a copy of all the settings of the 2216 will be printed.

For more information about using hardcopy modes, see: *Making Hardcopies*, page 1-69 through 1-70.

Hardcopy Format Menu

Press the 'Format' bezel button in the Hardcopy Menu to select the '**Hardcopy Format Menu**' (see Figure 3-32).

Hardcopy Format Menu

	HPGL	EPSON FX	EPSON LQ		More 1 of 2
Next selectable Menu, Action, Units or Values	Select HPGL	Select Epson-FX	Select Epson-LQ	–	Page 2 Of 2

Hardcopy Format Menu

	THINK JET	DESK JET	LASER JET	Cancel	More 2 of 2
Next selectable Menu, Action, Units or Values	Select Thinkjet	Select Deskjet	Select Laserjet	Hardcopy Menu	Page 1 of 2

Figure 3-32: 2216 Hardcopy Format Menu

The following printer drivers can be selected:

- 'HPGL'
- 'EPSON FX'
- 'EPSON LQ'
- 'THINKJET'
- 'DESKJET'
- 'LASERJET'

For more information about hardcopy formats, see: *Making Hardcopies*, page 1-71.

Hardcopy Port Menu

Press the 'Port' bezel button in the Hardcopy Menu to select the '**Hardcopy Port Menu**' (see Figure 3-33).

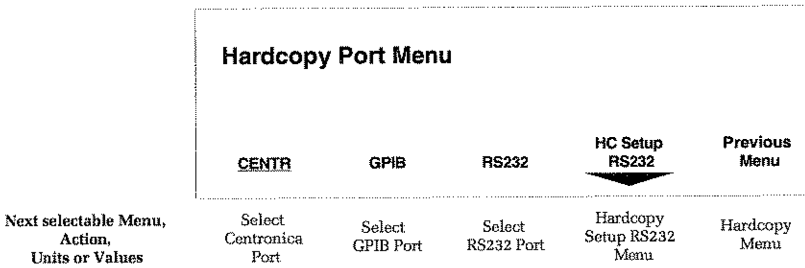


Figure 3-33: Hardcopy Port Menu

NOTE
Menu settings requiring to options that are not installed, will be shown in Italics in the Hardcopy Port Menu.

The following selections can be made:

– **Centronics (CENTR) port**
The Parallel Output Port can be connected to a Centronics compatible printer.

A PC to Centronics printer/plotter cable (Tektronix Part Number 012-1214-00) must be connected from the printer to the Parallel printer/plotter interface connector (25-pin D-type female connector) on the rear panel of the 2216 .

Table 3-6 lists the functions of each pin of the connector.

Table 3-6: 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

– **GPIB Output Port (Option 10 only)**
Pressing the 'GPIB' bezel button, you select the GPIB output port in the Hardcopy Port Menu as the printer port in a 2216 Option 10. The 2216 now is set to TALKER ONLY.

A GPIB compatible printer must be connected to the 2216 GPIB output port with a GPIB cable (Tektronix Part Number 012-0991-01).

The printer must be set to LISTENER ONLY (see your printer manual).

The function of each pin of the connector is shown in Table 3-7.

Table 3-7: 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)

NOTE
If the Hardcopy Port Menu is set to 'GPIB', and 'ON-LINE' is selected in the 'Setup Utility Programmable GPIB Menu', the Hardcopy Port Menu setting will change to 'CENTR'.

- **RS232 Output Port (Option 12 only).**
  Pressing the 'RS232' bezel button in the Hardcopy Port Menu, you select the RS232 output port as the printer output port in a 2216 Option 12.

  A RS232 compatible printer must be connected to the RS232 interface connector on the rear panel of the 2216.

  A gender changer (Tektronix Part Number 131-4923-00) and a RS-232-C cable (Tektronix Part Number 012-1423-00) should be used to connect the printer and the RS232 interface connector (a 25-pin male Sub-D connector).

  The RS232 hardcopy interface parameters must be defined in the HC Setup RS232 Menu (Figure 3-34)

  Table 3-8 lists the function of each pin of the RS-232-C DTE port (male).

Table 3-8: 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)

Hardcopy Setup RS232 Menu

Press the 'HC Setup RS232' bezel button in the Hardcopy Port Menu to select the Hardcopy Setup RS232 Menu (see Figure 3-34).

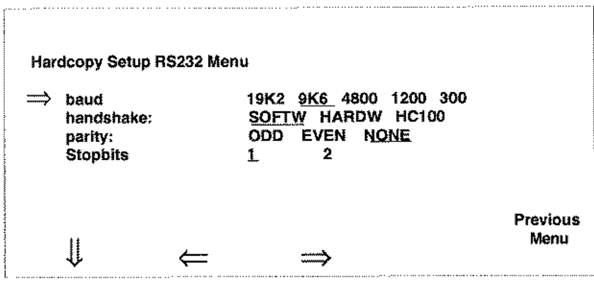


Figure 3-34: 2216 Hardcopy Setup RS232 Menu

NOTE

1. *Hardcopy Port Setup RS232 Menu settings are independent from the 'Setup Utility Progr RS232 Menu' settings*
2. *'Handshake' HARDW selects handshaking with DSR and CTS signals.*
3. *'Handshake' HC100 selects handshaking with DSR only (Tektronix HC100 plotter).*

The following selections can be made:

- **Baudrate** (19K2, 9K6, 4800, 1200, and 300)
- **Handshaking** (SOFTW, HARDW or HC100)
- **Parity** (ODD, EVEN or NONE)
- **Number of stopbits** (1 or 2)

NOTE

If the HC Port Menu is set to 'RS232', and 'ON-LINE' is selected in the 'Setup Utility Programmable RS232 Menu', the Hardcopy Port Menu setting will change to 'CENTR'.

For more information about selecting hardcopy ports, see: *Making Hardcopies*, page 1-75 through 1-78.

Hardcopy Layout Menu

Press the 'Setup Layout' bezel button in the HC Menu to select the '**Hardcopy Layout Menu**' (see Figure 3-35).

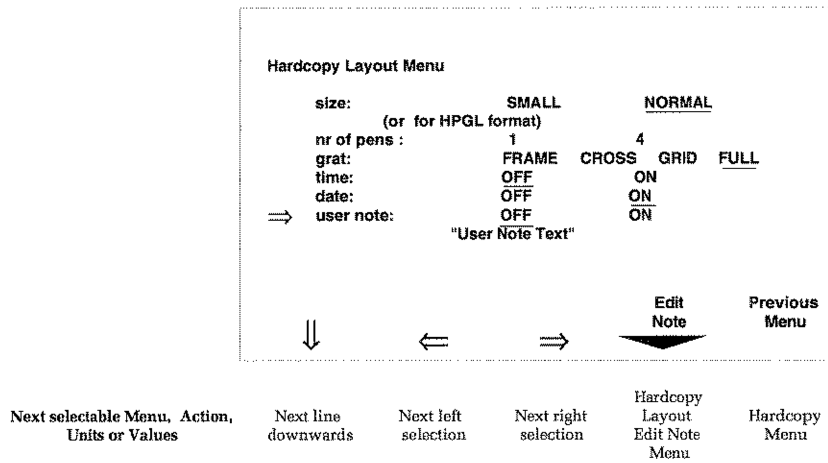


Figure 3-35: Hardcopy Layout Menu

The following selections can be made:

– '**size**' of the hardcopy for most printers:
  - **SMALL** (± 1:1)
  - **NORMAL** (± 2:1)
– '**number of pens**' must be selected for HPGL plotters
– '**graticule**' representation:
  - **FRAME** - Only the frame of the graticule will be copied.
  - **CROSS** - The graticule frame with a cross inside and minor divisions will be copied.
  - **GRID** - A frame with a cross inside and major divisions will be copied.
  - **FULL** -A frame with a cross inside, together with major and minor divisions will be copied.

- '**time**' - The' time' can be set to ON to be printed with the hardcopy.
- '**date**' - The 'date' can be set to ON to be printed with the hardcopy.
- '**user note**'- The 'user note' can be set to ON to be printed with the hardcopy. The user note text can be changed in the Edit Note Menu.

Hardcopy Edit Note Menu

Press the '**Edit Note**' bezel button in the Hardcopy Layout Menu to select the Hardcopy Edit Note menu (Figure 3-36).

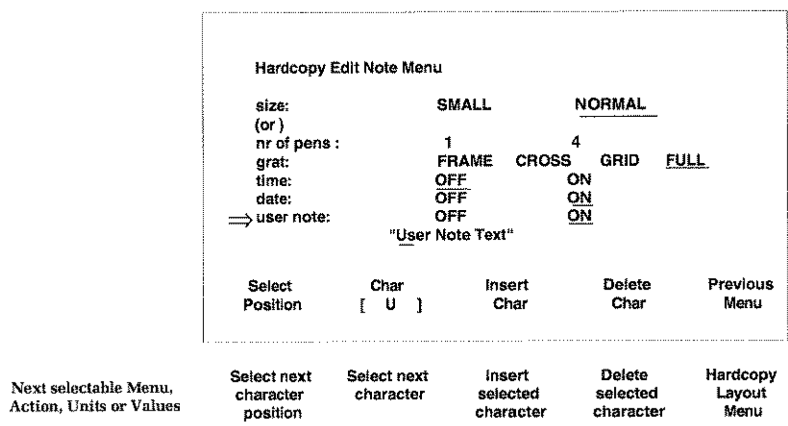


Figure 3-36: 2216 Hardcopy Layout Edit Note Menu

A 'user text' can be composed as pointed out in: *Making Hardcopies*, page 1-73.

Setup Functions and Menus

General

The *Setup Functions and Menus* sub-section (see Figure 3-37) is split-up in the following chapters:

- ❒ Setup UTILITY Functions and Menus (page 3-74) 45
- ❒ Setup SAVE/RECALL Function and Menus (page 3-84) 46
- ❒ Setup AUTO Function (page 3-86) 47

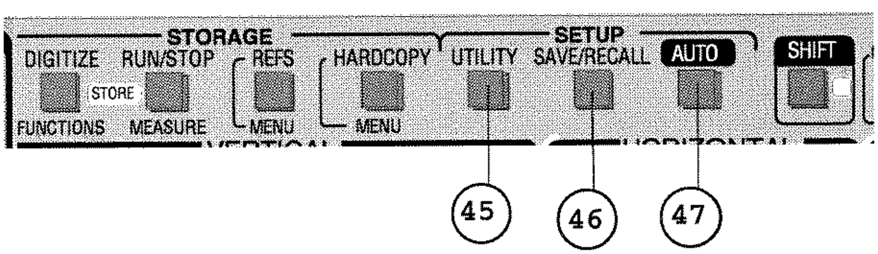


Figure 3-37: 2216 Setup Functions

UTILITY Menu Switch

45 Press the UTILITY menu switch (see Figure 3-37) to select the Setup Utility Menu on the screen. The 2216 can be configurated, Option 10 and Option 12 settings can be defined, and the user can make compensations with the User Comp. Menu.

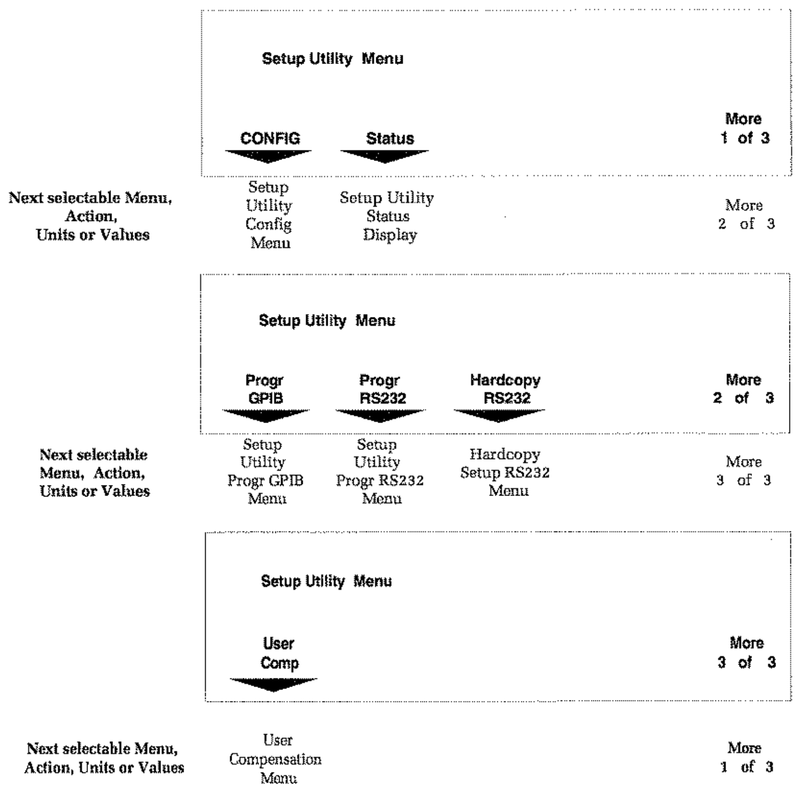


Figure 3-38: Setup Utility Menu

NOTE
Menu settings requiring to options that are not installed, will be indicated in Italic.

The following selections can be made:

- **Setup Configuration Menu** (see page 3-75)
- **Status Display of the 2216** (see page 3-78)
- **Setup Programmable GPIB Menu** (see page 3-79)
- **Setup Programmable RS232 Menu** (see page 3-81)
- **Hardcopy RS232 Setup Menu** (see page 3-82)
- **User Compensation Menu** (see page 3-83)

Setup Utility Configuration Menu

Press the '**Config**' bezel button in the Setup Utility Menu to select the **Setup Utility Configuration Menu** (see Figure 3-39).
In this menu the configuration of the 2216 will be defined.

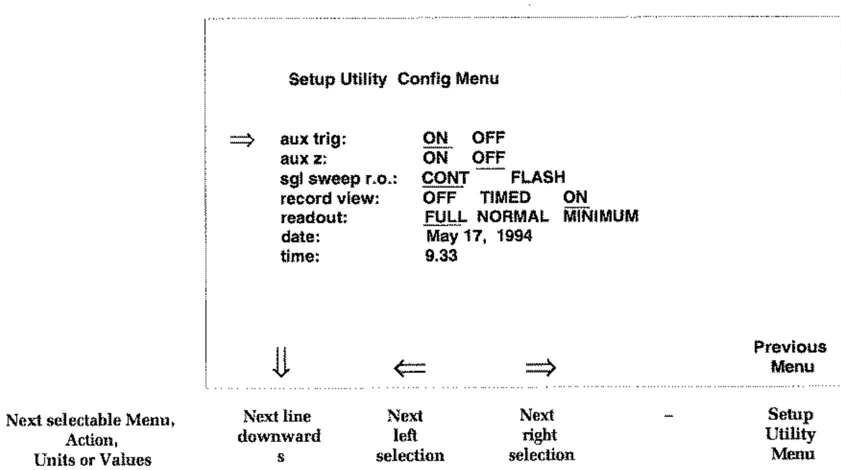


Figure 3-39: 2216 Setup Utility Configuration Menu

The following selections can be installed :

– **'aux trig'** line
Select the external trigger input (AUX-input on rear panel) ON or OFF with the ' ⇒ ' and the ' ⇐ ' bezel buttons.

– **'aux- z'** line
Select the external Z-axis input ON or OFF with the ' ⇒ ' and the ' ⇐ ' bezel buttons.

NOTE
The AUX -input on the rear panel can also operate as the AUX CLOCK input, if set in the Clock Source Menu.

– **'sgl sweep r.o.'** line
Select the readout display mode in single sweep with the ' ⇒ ' and the ' ⇐ ' bezel buttons:

- **CONT**: The readout is displayed continuously.
- **FLASH**: The readout is displayed after a single sweep has been generated.

– **'record view'** line
Select the record view display mode (see Figure 3-40) with the ' ⇒ ' and the ' ⇐ ' bezel buttons:

- **OFF**: the record view is not displayed.
- **ON** : the record view is displayed continuously.
- **TIMED**: the record view is only displayed for a few seconds if a setting of the 2216 is changed.

The Record View readout represents the following items of an acquired record:

- The complete acquired record is displayed as a dotted line.
- The position of the 4K-points crt display (displayed as two square brackets) on the record.
- The trigger point position on the record (displayed as an intensified dot).
- The position of the TIME cursors (displayed as two vertical lines).
- The size of the record length.

NOTE
The selection of a long record (>4096 points) will affect the update rate of the 2116.

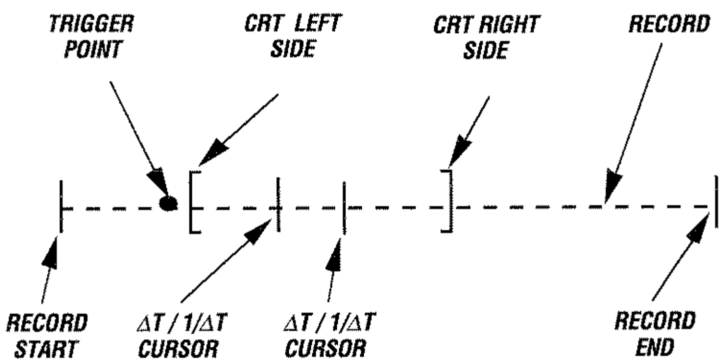


Figure 3-40: 2216 Record View Readout

- '**readout**' line
  Select the amount of readout information with the ' ⇒ ' and the ' ⇐ ' bezel buttons:
  - **FULL**; a maximum of readout information is displayed.
  - **NORMAL**; the readout of the active controls are displayed.
  - **MINIMUM**; a minimum of readout information is displayed.
- '**date**' line
  Select the 'month', the 'year' and the 'day' with the appropriate bezel buttons (see Figure 3-41).

  The month, day and year can also be defined with the GPK control.
- '**time**' line
  Select the 'Hour' and 'minutes' with the appropriate bezel buttons.

  The hour and minutes can also be defined with the GPK control.

Setup Utility Config Menu

aux trig:	OFF	ON		
aux z:	OFF	ON		
sgl sweep r.o.:	CONT	FLASH		
record view:	OFF	TIMED	ON	
readout:	FULL	NORMAL	MINIMUM	
⇒ date:	May 17, 1993			
time:	9.33			

	⇓	Day 17	Month [May]	Year 1994	Previous Menu
Next selectable Menu, Action, Units or Values	Next line downwards	Set with GPK	Set with GPK	Set with GPK	Setup Utility Menu

Figure 3-41: 2216 Setup Utility Configuration Menu ('date' line)

Setup Utility Status Display

Press the '**Status**' bezel button in the Setup Utility Menu to select the **Setup Utility Status Display** (see Figure 3-42).
In this display the instrument configuration is summarized.

Setup Utility Status Display

Type, S/N:	2216, 700101
Firmware:	V1.0.22
GPIB:	not installed
RS232:	installed
Long Record:	not installed

Cancel

Next selectable Menu, Action, Units or Values	–	–	–	–	Setup Utility Menu

Figure 3-42: 2216 Setup Utility Status Display

Setup Programmable GPIB Menu (Option 10 only)

Press the '**Progr GPIB**' bezel button in the Setup Utility Menu to select the **Setup Programmable GPIB Menu** (see Figure 3-43). In this menu the GPIB settings of the 2216 will be defined.

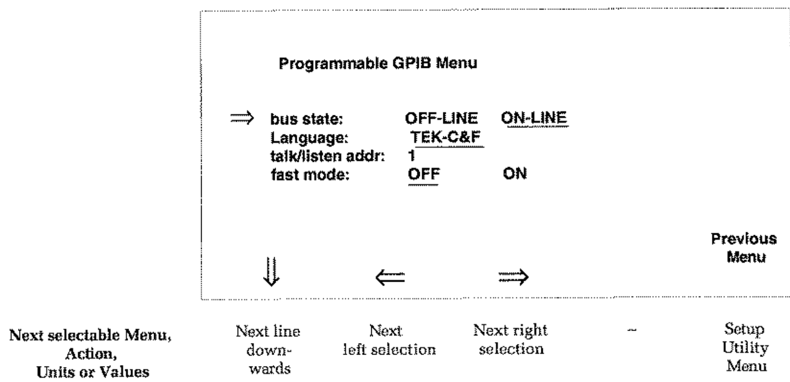


Figure 3-43: 2216 Setup Programmable GPIB Menu

The following selections can be made :

- '**bus state**' line.
  The 'bus state' can be set with the ' ⇒ ' and the ' ⇐ ' bezel buttons, to:
  - **OFF-LINE** status
  - **ON-LINE** status

- '**Language**' line
  The command language of the programmable interface is defined on this line.

- '**talk/listen address**' line.
  The talk/listen address number can be defined with the bezel button and the GPK control (see Figure 3-44).

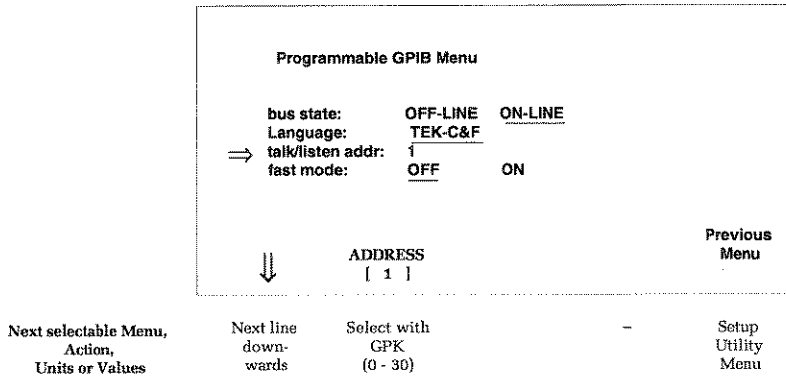


Figure 3-44: 2216 Setup Utility Programmable GPIB Menu ('talk/listen addr' line)

– '**fast mode**' line.
  The programmable GPIB interface can be set to the 'fast' mode using the ' ⇒ ' and the ' ⇐ ' bezel buttons.

  When set to **ON**, the hardware and the software of the 2216 are optimized for maximum communication speed.

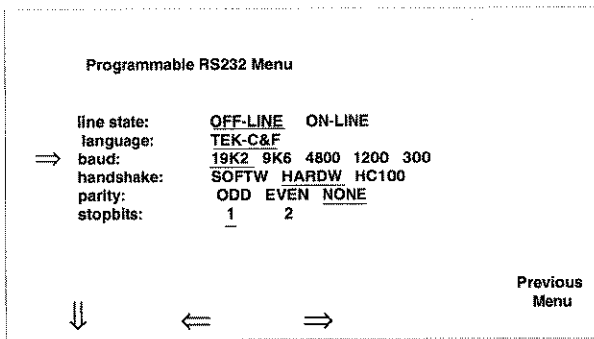
  For more information, see your 2216 Programmers Manual.

NOTE

If 'GPIB' is selected in the Hardcopy Port Menu, and the 'bus state' in the Setup Utility Programmable GPIB Menu was ON-LINE, the 'bus state' becomes OFF-LINE.

Setup Programmable RS232 Menu (Option 12 only)

Press the '**Progr RS232**' bezel button in the Setup Utility Menu to select the **Setup Programmable RS232 Menu** (see Figure 3-45). In this menu the RS232 interface settings are defined.



Next selectable Menu, Action, Units or Values	Next line downwards	Next left selection	Next right selection	–	Setup Utility Menu

Figure 3-45: 2216 Setup Programmable RS232 Menu

The following selections can be made :

- '**line state**' line.
  - **OFF-LINE**. The 2216 is not connected to the bus.
  - **ON-LINE** . The 2216 is connected to the bus.
- '**Language**' line
  The command language of the programmable interface is defined on this line.
- '**baud rate**' line.
- '**handshaking**' line.
- '**parity**' line.
- '**stopbits**' line

For more information about the RS232 programmable interface, see your 2216 Programmers Manual.

NOTE
If 'RS232' is selected in the Hardcopy Port Menu, and the 'line state' in the Setup Utility Programmable RS232 Menu was ON-LINE, the 'line state' now becomes OFF-LINE.

Hardcopy Setup RS232 Menu (Option 12 only)

Press the 'Hardcopy RS232' bezel button in the Setup Utility Menu to select the **Hardcopy Setup RS232 Menu** (see Figure 3-45a).

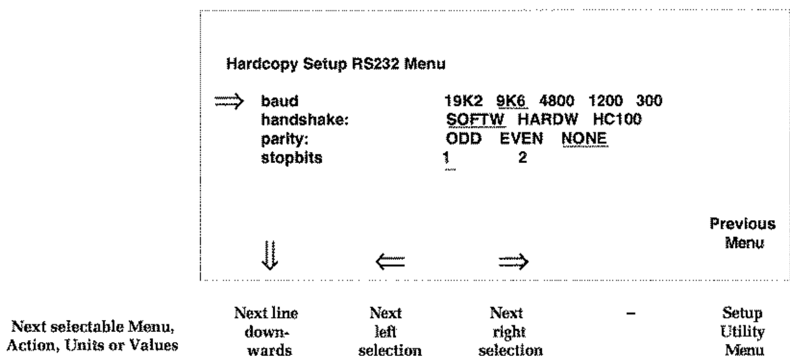


Figure 3-45a: 2216 Hardcopy Setup RS232 Menu

For more information about the Hardcopy Setup RS232 Menu, see: *Hardcopy & Hardcopy Menu*, page 3-69.

User Compensation Menu

Press the '**User Comp**' bezel button in the Setup Utility Menu to select the **User Compensation Menu** (see Figure 3-46).

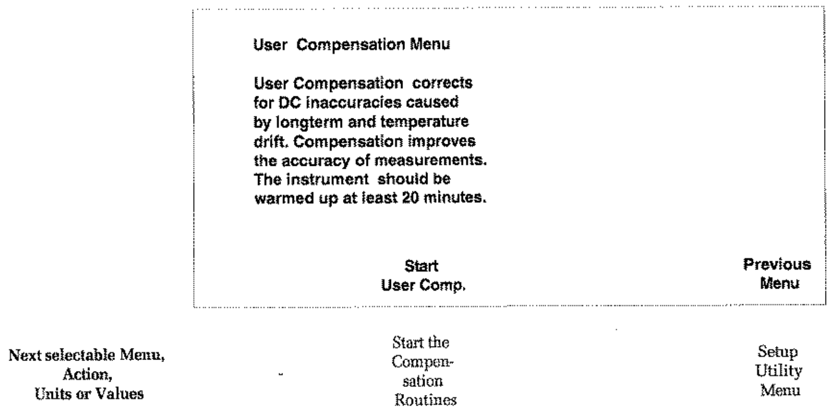


Figure 3-46: 2216 Setup Utility User Compensation Menu

The following selections can be made :

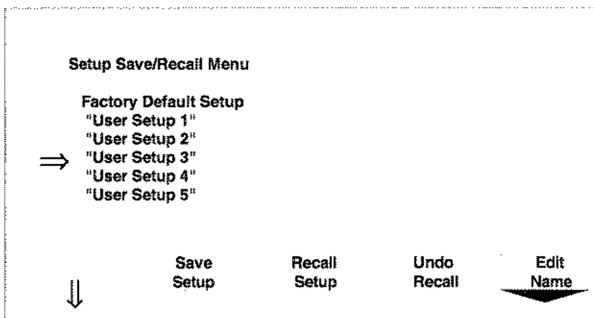
- **Start User Compensation**
  A routine is started to compensate for drift of the vertical amplifiers.
- **Previous Menu**
  The Setup Utility Menu will be recalled.

SAVE/RECALL Menu Switch

46 Press the SAVE/RECALL menu switch (see Figure 3-47) to display the **Setup Save/Recall Menu**.

Front panel setups can be stored in memory and also recalled from that memory. The Factory Default Setup and five 'user-settable setups' can be saved.

Names of stored setups can be changed in the Edit Name submenu.



Next selectable Menu, Action, Units or Values	Nex line downwards	Save current Setup	Recall selected Setup	–	Setup Edit Name Menu

Figure 3-47: Setup Save/Recall Menu

The following selections can be made:

- '⇓'
  Selects the next saved front panel setup.
- **'Save Setup'**
  Saves the currently used front panel setup in memory with the name of the selected menu-line, and deletes the last saved setup from that memory.

Settings that are not affected by a SAVE/RECALL operation, are:

- Settings in the Programmable GPIB Menu.
- Settings in the Programmable RS232 Menu.
- Settings in the Hardcopy Menu (except 'Timebase' in the Hardcopy Chart Mode Menu).
- Settings in the Hardcopy Setup RS232 Menu.
- The state of the DISplay:BFInid command.
- The state of the DISplay:OFF command.
- The state of the 'record view' in the Setup Utility Config Menu.
- The active waveform.

Setup Edit Name Menu

"User Setup 3"

	Select Position	**Char [S]**	**Insert Char**	**Delete Char**	**Previous Menu**
Next selectable Menu, Action, Units or Values	Next position on menu line	Select character with GPK	Insert selected character	Delete selected character	Setup Save/ Recall Menu

Figure 3-48: 2216 Setup Edit Name Menu

- **'Recall Setup'**
  Recalls the selected front panel setup to become the new front panel setup.

- **'Undo Recall '**
  Undoes the action of the 'Recall Setup' bezel button. The previous front panel setup will be installed again.

- **'Edit Name'**
  Selects the **Setup Edit Name Menu** (see Figure 3-48).
  A name of a selected front panel setup can be changed in this menu.

The following selections can be made:

- **'Select Position'**
  Selects the next character on the menu line.
- **'Char'**
  A different character can be selected with the GPK control.
- **'Insert Char'**
  Inserts a selected character, replacing the existing character on the menu line.
- **'Delete Char'**
  Deletes a selected character on the menu line.
- **'Previous Menu'**
  Recalls the Setup Save/Recall Menu.

47

Setup AUTO Feature

Press the Setup **AUTO** button to activate the 2216 **Setup AUTO** feature.
Front panel functions are automatically set to scale and trigger unknown waveforms to fit inside the graticule area.

The following functions are set by the AUTO setup feature:

- Vertical scaling
- Horizontal scaling
- Triggering
- Screen controls

A stable, automatically triggered display of at least one channel appears on-screen with a timebase setting to display two to five cycles of the triggered waveform.

Cursors and Cursor Menus

In this sub-section, the cursors will be discussed (Figure 3-49):

- CURSORS/MENU Switch and Cursor Menus (48)
- General Purpose Knop (GPK)(page 3-96) (49)
- SELECT Switch (page 3-96) (50)
- SHIFT Function Switch (page 3-96) (51)

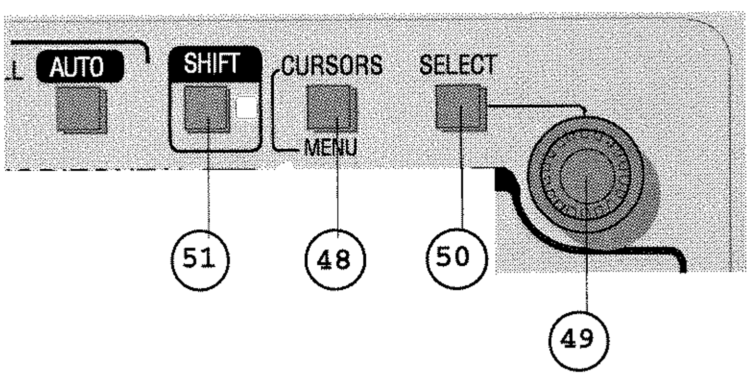


Figure 3-49: CURSORS/MENU Switch, General Purpose Knob Control, SELECT Switch, and SHIFT Function Switch

CURSORS/MENU Switch

48 Cursors are activated by pressing the CURSORS/MENU switch.

Before applying cursors, the following items should be defined in the Cursors Menu:

- The cursor function (VOLTAGE, TIME or PAIRED cursors)
- The cursor unit
- The cursor mode (DELTA, TRACK, or SINGLE)
- Scrolling ON or OFF

For more information about cursor functions, cursor modes, and cursor units, see: *Using Cursors*, page 1-58 through 1-60, and *Using Custom Units*, page 1-61 through 1-66.

Cursors Unit Menu

Press the '**Unit**' bezel button in the Cursors Menu to select the **Cursors Unit Menu** (see Figure 3-51).

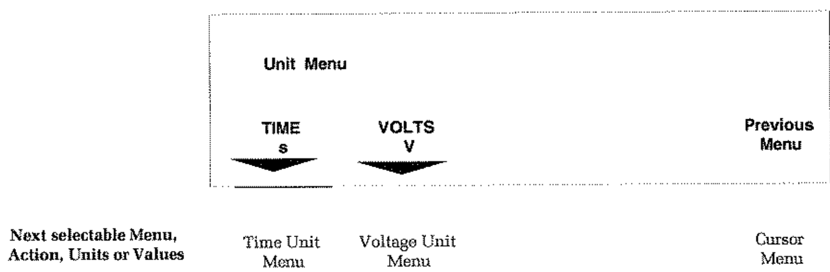


Figure 3-51: Unit Menu

Two types of a Cursor Unit Menu can be selected:

– **Voltage Unit Menu** (see Figure 3-52)

– **Time Unit Menu** (see Figure 3-53)

	Voltage Unit Menu				
	VOLT V	CUSTOM rpm	RATIO %		Cancel
Next selectable Menu, Action, Units or Values	Cursors Menu	Cursors Menu	Cursors Menu		Cursors Menu

Figure 3-52: 2216 Voltage Unit Menu

Voltage Unit Menu

The following selections can be made:

- 'VOLT' units.
  The distance between the VOLTS cursors is expressed in volt.
- 'CUSTOM' units.
  The distance between the VOLTS cursors is expressed in customised units (for example rpm).

  For more information about custom units and how to apply them, see: *Using Custom Units*, page 1-61 through 1-66.
- 'RATIO'.
  The distance between the cursors is expressed as a percentage of a previous set distance between the cursors (100%) and the current distance (xx%) between the cursors.

  The ratio is set to 100% at the moment the 'RATIO' bezel button is pushed in the Voltage Unit Menu.

Time Unit Menu

	TIME	1/TIME	RATIO	PHASE	Cancel
	s	Hz	%	0	
Next selectable Menu, Action, Units or Values	Cursor Menu	Cursor Menu	Cursor Menu	Cursor Menu	Cursor Menu

Figure 3-53: 2216 Time Unit Menu

Time Unit Menu

The following selections can be made:

- 'TIME'
  The distance between the TIME cursors is expressed in seconds.
- '1/TIME"
  The distance between the TIME cursors is expressed in Herz.
- 'RATIO'
  The distance between the TIME cursors is expressed in a percentage of a previous set distance between the cursors (100%) and the current distance (xx%) between the cursors.

  The ratio is set to 100% at the moment the 'RATIO' bezel button is pushed.
- 'PHASE'
  The distance between the TIME cursors is expressed in degrees of a previous set distance between the cursors (360^0) and the current distance (xx^0) between the cursors.

Cursors Mode Menu

Press the '**Mode**' bezel button to select the **Cursors Mode Menu** (see Figure 3-54) in the Cursors Menu.

	Cursors Mode Menu				
	DELTA	TRACK	SINGLE		Cancel
Next selectable Menu, Action, Units or Values	Cursors Menu	Cursors Menu	Cursors Menu	–	Cursors Menu

Figure 3-54: 2216 Cursors Mode Menu

The following selections can be made :

- **'DELTA'**
  Two cursors are displayed. The dashed cursor can be moved with the GPK control. The other cursor (solid line) is fixed.
- **'TRACK'**
  Both cursors are dashed. Both cursors are moved simultaneously with the GPK control.
- **'SINGLE'**
  One cursor is displayed and can be moved with the GPK control.
  Time readout of a Single cursor will be the distance to the trigger position.
  Voltage readout of a Single cursor will be the voltage relative to ground level.

NOTE

Before you start making voltage measurements in SINGLE cursor mode, perform a drift compensation with the 'User Compensation Menu', a sub-menu of the 'Setup Utility Menu' (see page 3-83)

Cursors Define Custom Unit Menu

By pressing the 'Define Custom' bezel button in the Cursors Menu, the Cursors Define Custom Unit Menu (see Figure 3-55) is selected.

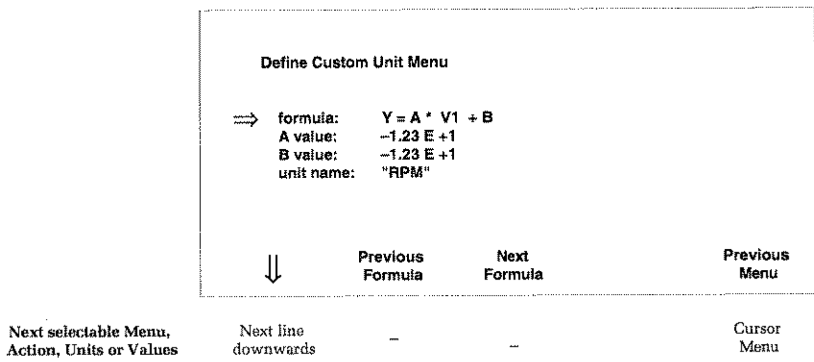


Figure 3-55: 2216 Cursors Define Custom Unit Menu

The following selections can be made :

- '⇓'
  The next menu line will be selected.
- **'Previous Formula'**
  The previous formula from the available formulas will be selected.
- **'Next Formula'**
  The next formula from the available formulas will be selected.

To define parameters for custom units, see:
Using Custom Units, page 1-61 through 1-66.

Scroll ON or OFF

If 'Scroll' is selected to 'ON', and a TIME cursor is moved off the screen with the GPK, the horizontal POSITION control is automatically changed to keep the cursor on the screen.

General Purpose Knob

49 The **General Purpose Knop (GPK)** control on the upper right side of the front panel can be used to define values and parameters in menus, to position cursors, etc.
If the GPK can be used for changing a setting, a symbol is shown in the readout.

SELECT Switch

50 The **SELECT** switch is used to select the other cursor if the 'DELTA' cursor function is selected in the Cursors Mode Menu.

SHIFT Switch

51 The **SHIFT** switch is generally used to select the 'second' function of front panel functions. When pressed, the SHIFT indicator lights. You can select:

- A **Menu**
  Press the SHIFT and a Menu button successively to select and display a Menu.

NOTE

The text and the matching line of a menu function is printed in blue on the bottom side of a front panel button.

- A **Channel**
  Press the SHIFT and a Vertical Channel switch successively, to display a channel on screen, or to remove a displayed channel from the screen, without changing the active channel.
- A **Reference**
  Press successively the SHIFT button and a Reference bezel button in the Reference Readout Menu to display a reference on screen, or to remove a displayed reference from the screen, without changing the active reference.

Rear Panel

The 2216 can be operated from an ac power source with a 90-250 VAC range, as indicated on the **Rear Panel**. In this section the parts on the rear panel will be discussed (see Figure 3-56)

- Fuse Holder (52)
- Power Cord Receptacle (53)
- Auxilliary Input (54)
- Parallel I/O Port (55)
- IEEE STD 488 Port (Optional) (56)
- RS-232-C DTE Port (Optional) (57)

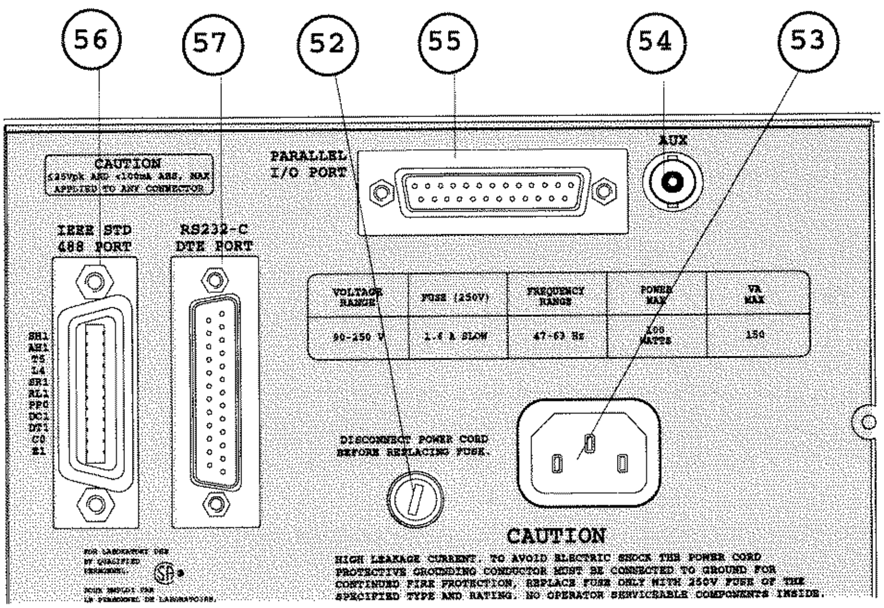


Figure 3-56: 2216 Connectors and Power Fuse on Rear Panel

Fuse Holder

52 The Fuse Holder contains the ac-power-source fuse (1.6 A Slow for 90-250VAC). The rear panel nomenclature informs you about fuse rating and line voltage range.

Power Cord Receptacle

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

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

Auxilliary Input Connector (AUX)

54 The AUX input function is defined in the Setup Utility Config Menu (see page 3-75). The auxilliary input connector (AUX) provides an input for:

- **External clock signals** to the storage acquisition circuit in store mode.

  The external clock of the 2216, as defined in the Clock Source Menu. (see page 3-40), can be set to:

  - AUX IN RECORD (0–10MHz)
  - AUX IN SLOW (0–4kHz)
- **Z-Axis input** which is selectable in the Setup Utility Configuration Menu.

  The usable input frequency range is dc to 5 MHz. 5V input signal causes a noticeable modulation
- **External Trigger input** which is selectable in the Setup Utility Configuration Menu.

  The trigger signal frequency range is from dc to 10 MHz in store and non-store mode.

Parallel I/O Port

55 The 2216 has standard a parallel printer interface implemented for printers/plotters with a Centronics compatible interface.

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 2216.

Step 2. Select settings in the Hardcopy Menu (See also page 3-60 through 3-66 and 1-67 through 1-78)

Step 3. Press the HARDCOPY/MENU button to initiate the printer/plotter connected to the 2216.

GPIB (IEEE STD 488.2 1992) – Interface Connector (Option 10 only)

56 With Option 10 installed, the 2216 is fully remote programmable by a controller (PC).

The GPIB Interface provides ANSI/IEEE STD 488.2 1992 compatible electrical and mechanical connection to the GPIB (General Purpose Interface Bus). The 2216 Option 10 also complies to Tektronix Standard Codes and Formats 4-91.

For more information, see your Programmer Manual.

The function of each pin of the GPIB-connector is shown on page 3-67.

The GPIB settings are defined in the Programmable GPIB Menu (see page 3-80).

To make hardcopies via the GPIB interface, select the GPIB-port in the Hardcopy Port Menu (page 3-65 through 3-67).

RS-232-C DTE – Interface Connector (Option 12 only)

57 With Option 12 installed, the instrument is fully remote programmable by a controller (PC).

The Serial Communication Interface provides an RS-232-C interface connection meeting the EIA RS-232-C standard for data terminal equipment.

For more information, see your Programmer Manual.

The function of each pin of the RS232-connector is shown in Table 3-8 on page 3-68.

The RS232 interface settings are defined in the Programmable RS232 Menu (see page 3-80).

To make hardcopies via the RS232 interface, select the RS232-port in the Hardcopy Port Menu (page 3-65 through 3-67) and define the hardcopy settings in the Hardcopy Setup RS232 Menu (page 3-69).

Appendix A: Options & Accessories

This section presents a general description of the 2216 options and accessories.

- Standard Accessories
- Options
- 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 2216 (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	070-8903-00
1	Reference	070-8904-00

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.

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 02

A Front Panel Cover and Accessories Pouch is provided.

Option 1M

This option provides in store mode selectable record lengths up to 131072 data points (128K) per acquisition on four channels.

Table A-2: Power Cord Options

Option	Description	Tektronix Part Number
Standard		
(North American)	120 V, 60 Hz, 74 in.	161-0230-01
Fuse	1.6 A, 250 V, Slow	159-0003-00
Option A1		
(Universal Euro)	220 V, 50 Hz, 2.5 m	161-0104-06
Fuse	1.6 A, 250 V, Slow	159-0003-00
Option A2		
(United Kingdom)	240 V, 50 Hz, 2.5 m	161-0104-07
Fuse	1.6 A, 250 V, Slow	159-0003-00
Option A3		
(Australian)	240 V, 50 Hz, 2.5 m	161-0104-05
Fuse	1.6 A, 250 V, Slow	159-0003-00
Option A4		
(North American)	220 V, 50 Hz, 2.5 m	161-0104-08
Fuse	1.6 A, 250 V, Slow	159-0003-00
Option A5		
(Switzerland)	220 V, 50 Hz, 2.5 m	161-0167-00
Fuse	1.6 A, 250 V, Slow	159-0003-00

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 488.2-1992)*. 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 *2216 Programmer Manual*, delivered with Option 10.

GPIB connector pin-outs are described in *Section 3: In Detail*. page 3-67.

The GPIB option parameters are set in the Setup Utility GPIB Menu (see also Section 3: *InDetail*, page 3-79 and page 100).

Option 12 (RS-232-C)

Option 12 provides an RS-232-C serial communications interface.

The interface implemented conforms to EIA RS-232-C standard.

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 *2216 Programmer Manual,* delivered with Option 12.

The RS-232-C interconnection plug is described in Section 3: *In Detail:* page 3-68.

The RS-232-C parameters can be set in the Setup Utility GPIB Menu (see also Section 3: *InDetail,* page 3-81 and page 101).

Option 23

Two P6129B 1x /10x Readout Passive Voltage Probes are provided.

Optional Accessories

The following optional accessories are recommended for use with the 2216.

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	070-8902-00
Programmer Manual	070-8905-00

Viewing Hoods

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

Fuses

Fuse, 1.6 A, 250 V, 3AG, Slow	159-0003-00

Voltage Probes

Differential 1X/10X Probe	P6046
Active Probe, 10X FET	P6202A
Active Probe Power Supply (for P6202A)	1101A
1X Probe	P6101B
10X Probe	P6109B

Optional Accessories (cont.)

Voltage Probes	Tek Part Number
1X-10X Selectable	P6129B
100X High Voltage	P6009
1000X High Voltage	P6015A Opt 1R
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
Plotters	
Plotter	HC100 Opt. 02

Appendix B: Specifications

This subsection presents an introduction about the user interface, and three subsections for each of the three classes of characteristics:

- *Nominal Traits*
- *Warranted Characteristics*
- *Typical Characteristics*

User Interface

This oscilloscope uses the front-panel buttons and knobs and the bezel buttons to control its numerous functions and menus.

Function Groups

The front-panel controls are grouped according to function: SCREEN, VERTICAL, HORIZONTAL, TRIGGER, STORAGE, SETUP, and Cursor.
Within each group, the functions are set directly by their own front-panel knob, or via a menu.

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. There are also crt readouts of every installed menu, results of automated measurements, and results of cursor measurements.

Nominal Traits

This subsection contains a collection of tables that list the various *nominal traits* that describe the 2216 Analog & Digital Storage Oscilloscope. Included are electrical and mechanical traits.

Nominal traits are described using simple statements of fact such as "Four 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	Four, full-featured (CH 1, 2, 3, and 4)
Digitizers, Number of	Four, all 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 according to Figure B-1	400 V (DC + peak AC) or 800 V AC p-p at 10 kHz or less; derate with increased frequency
Range Sensitivity, CH 1,2, 3, 4	1 mV to 10 V in a 1-2-5 settings sequence
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
Alternate Magnifier	The magnified and the unmagnified traces are displayed alternately (as selected in the Alternate Menu)
Magnification Factor	X10 and X50 the SEC/DIV setting
Store Range, Seconds/Division	50 s to 20 μs per division
Record Length	4096, 8192 and 16384 data points; 400 points per division across the graticule area 512 data points; 40 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 Coupling	AC, DC, Low Frequency Rejection, High Frequency Rejection, and Noise Rejection.
(lower –3 dB point)	
DC - coupled	DC to full bandwidth
AC - coupled	10 Hz to full band width
NOISE REJ - coupled	DC to full bandwidth
Trigger Source	CH 1, CH 2, CH 3, CH 4, Vert. Mode, Line.
Trigger Mode	Auto, Normal, Single Sweep, TV Line, and TV field
Trigger Point Selection (Store mode)	0% to 100%(selected in the Trigger Position Menu)

Table B-4: Nominal Traits – Cursors

Name	Description
Cursor Types	TIME and VOLTAGE cursors
Cursor Resolution	VOLTAGE: 100 points per division in non-store and 25 points in store mode. TIME: >100 steps per division in non-store, 400 steps in store mode in x1, 40 steps in store mode in MAG x10, 8 steps in store mode in MAG x50, 400 steps in store mode in FIT TO SCREEN. 50 steps/div in store mode with a record length of 512 points

Table B-5: 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. Each major division is divided into five subdivisions. Percentage marks for the measurement of rise and fall times are located on the left side of the graticule.

Table B-6: 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 1992 and to Tektronix Standard Codes and Formats 4-91
Fuse Rating	1.6 A, 250 V, slow blow for 90 - 250 VAC

Table B-7: 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

Warranted Characteristics

This sub-section list the various *warranted characteristics* that describe the 2216 Analog & Digital Storage Oscilloscope. Included are electrical and environmental characteristics.

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

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 B-16. 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 B-8 thru Table B-16) are valid when the instrument has been adjusted at an ambient temperature between +20^{0} C and +30^{0} C, has had a warm-up period of at least 20 minutes, and is operating at an ambient temperature between 15^{0}C and +35^{0} C (unless otherwise stated).

Table B-8: Warranted Characteristics – Vertical System

Name	Description
Accuracy, DC Gain	±3%
Rise Time (Non-Store)	
1 mV/ DIV, 2mV/DIV	≤ 35 ns (0° C to +40° C ambient)
5 mV/DIV to 10 V/DIV	≤ 5.8 ns (15° C to +35° C ambient)
	Risetime is calculated fromthis formula:
	Rise Time = 0.35 / Bandwidth(–3dB)
Aberrations (non-store)	Measured with a five-division reference signal, centered vertically, from a 50 Ω source driving a 50Ω precision coaxial cable terminated in 50 Ω at the input connector of a vertical channel(in calibrated position). (15°C to 35°C).
1 mV/DIV, 2mV/DIV, 5mV, 10mV/DIV, and 20 mV/DIV	+4%, –4%, 6% p-p or less
50mV/DIV, 0.1 V/DIV, 0.2 V/DIV 0.5V/DIV, 1 V/DIV, and 2 V/DIV	+6%, –6%, 6% p-p or less
5 V/DIV, 10 V/DIV,	+12%, –12%, 12% p-p or less
Bandwidth (Non-Store)(-3 dB)[a]	
1 mV/DIV and 2 mV/DIV	DC to at least 10 MHz (0° C to +40° C ambient)
5 mV/DIV to 10 V /DIV	DC to at least 60 MHz (15° C to +35° C ambient) [b]

[a] **Measured with a vertically centered six division reference signal, from a 50 Ω source driving a 50 Ω precision coax cable terminated in 50 Ω at the input connector and at the Volts/Div VARiable Control in calibrated position.**

[b] **High amplitude high frequency signals may appear distorted due to the action of the clamp-circuit in the vertical amplifier. In case of distortion, reduce the vertical sensitivity.**

Table B-9: Warranted Characteristics – Horizontal System

Name	Description
Timebase Accuracy [a]	
(Non-Store)	(+15° C to +35° C)
X1	±3%
X10 Magnifier	±4%
X50 Magnifier	±5%
Differential Accuracy [d]	
(Non-Store)	(+15° C to +35° C)
X1	±5%
X10	±8%
X50	±9%
Variable Sweep (VAR)	
(non-store)	Decreases the sweep speeds by at least 2.5 times over the calibrated SEC/DIV setting.

[a] **Sweep accuracy and Differential Accuracy 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 9th division of the unmagnified sweep.**

[b] **Measured over center eight divisions.**

[c] **Max. 10 nsec/Div**

[d] **Differential Accuracy is measured over any two of the center eight divisions. Exclude the first 50 ns of the x10 magnified sweep, and the first 100 ns of the x50 magnified sweep. Exclude beyond the 9th division of the unmagnified sweep.**

Table B-10: Warranted Characteristics – Triggering System

Name	Description
Sensitivity [a], with Coupling AC	0.35 division from 50 Hz to 5 MHz, increasing to 1.2 division at 60 MHz
Sensitivity [a], with Coupling DC	0.35 division from DC to 5 MHz, increasing to 1.2 division at 60 MHz
Sensitivity [a], with Coupling LF REJ	0.35 division from 50 kHz to 5 MHz, increasing to 1.2 division at 60 MHz
Sensitivity [a], with Coupling HF REJ	0.35 division from DC to 20 kHz
Sensitivity [a], with Coupling NOISE REJ	1.4 division from DC to 5 MHz, increasing to 3.0 division at 60 MHz
Sensitivity [a], with Coupling TV LINE	1.0 Division
Sensitivity [a], with Coupling TV FIELD	1.0 Division Composite Sync.signal

[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.**

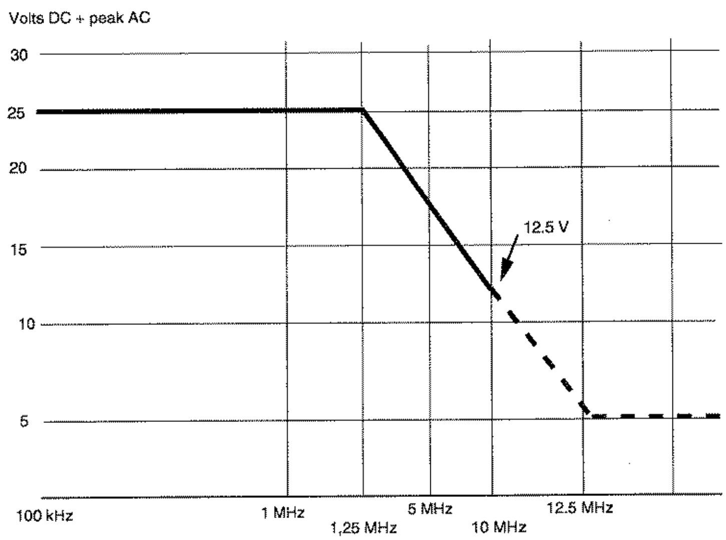


Figure B-1: Maximum Input Voltage Versus Frequency Derating Curve for the AUX Input Connector

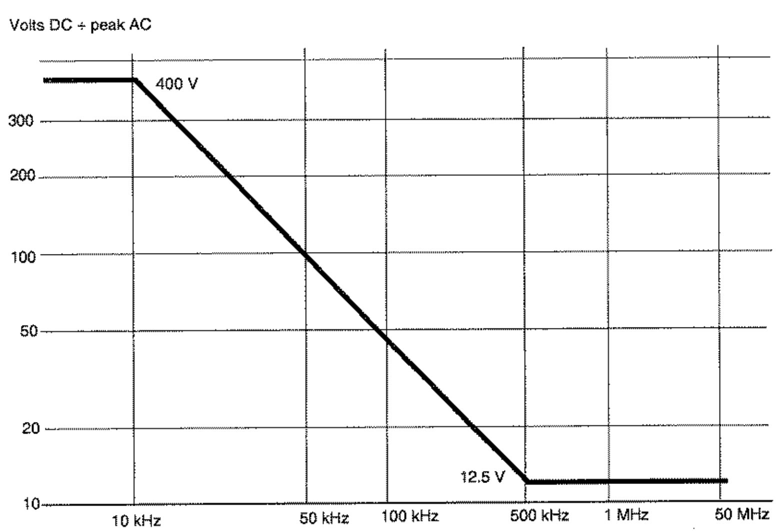


Figure B-2: Maximum Input Voltage Versus Frequency Derating Curve for the CH 1, CH 2, CH 3, and CH 4 Input Connectors

Typical Characteristics

This subsection contains tables that list the various *typical characteristics* that describe the 2216 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-11: Typical Characteristics – Vertical System

Name	Description
Range of VAR control	Range is sufficient to to increase or decrease the deflection factor to the next uncalibrated VOLTS/DIV setting.
Bandwidth Limit (Non-Store)	Independent switchable for each Channel
5 mV/Div to 10 V/Div	–3dB at ≥10 MHz and ≤17.5 MHz –6 dB or more at 25 MHz
Bandwidth (Non-Store) 0° C - 40° C	
5 mV/DIV to 10 V/DIV	DC to at least 48 MHz
Bandwidth (Store)	
1 mV/DIV to 10 V /DIV	DC to at least 2 MHz
AC Lower Cut-off Frequency	10 Hz or less at –3dB
Cross Talk (Channel Isolation) any two channels having	≥ 100:1 at 10 MHz in non-store, and at 2 MHz in store mode, for equal Volts/Division and Coupling settings.
CMRR Non-Store (Common Mode Rejection Ratio)	
5 mV/DIV to 10V/DIV	≥ 10: 1 at 20 MHz [a]
1 mV and 2 mV/DIV	≥10:1 at 1 MHz
CMRR (Store)	
5 mV/DIV to 10V/DIV	≥10:1 at 2 MHz [a]
1 mV and 2 mV/DIV	≥10:1 at 1 MHz
Chopped Switching Rate	500 kHz ± 30%
Position Control Range	± 12 Divisions from graticule center

[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.**

Table B-11: Typical Characteristics – Vertical System (cont.)

Name	Description
Setability	Maximum vertical jump while positioning the trace: ≤ 0.05 division
CH I, CH 2, CH 3, CH 4 Input Impedance	1 MΩ ± 2% parallel with 25 pF ± 2.0 pF Channels are matched within 1 pF
Vertical Position Registration	Switching from Non-Store to Store the trace shift must be less than ± 0.5 division at graticule center.
Vertical Differential Accuracy (Store)	Graticule indication of voltage cursor difference is within ±2% of readout value, measured over the center six divisions

Table B-11: Typical Characteristics – Horizontal System

Name	Description	
Differential Accuracy (+0° C to +40° C)		
X1	±6.25%	
X10 Magnifier	±10%	
X50 Magnifier	±11.25%	
Accuracy (+0° C to +40° C)		
X1	±4%	
X10 Magnifier	±5%	
X50 Magnifier	±8%	
TRace SEPeration Control Range.	+/– 4 divisions ± o.3 division	
Horizontal POSITION Control Range	Start of the trace will position right of the center vertical graticule line in x1. The start of the 11-th division will position left of the center vertical graticule line. The start of the 100-th division will position left of the center vertical graticule line in x10 magnifier. The start of the 500-th division will position left of the center vertical graticule line in x50 magnifier.	
Displayed Trace Length	Greater than 10 divisions.	
Registration of Unmagnified and Magnified Traces	≤ 0.2 division (Trace aligned to the center vertical graticule line)	
AUX CLOCK Input Frequency		
RECORD Mode	DC to 10 MHz	
ROLL Mode	DC to 4 kHz	
AUX CLOCK Duty Cycle	Low (min.)	High (min.)
RECORD	50 ns	50 ns
ROLL	50 µs	125 ns
AUX CLOCK Logic Thresholds	Low	High
	≤0.5 V	≤2.1 V

Table B-12: Typical Characteristics – Triggering System

Name	Description
P-P AUTO Lowest Usable Frequency	± 20 Hz
Trigger Level Control Range	
SOURCE: VERT, CH1, CH2, CH3, CH4, LINE	May be set to any voltage level of the waveform that can be displayed.
Trigger Level Resolution	Better than 10 levels per division
Trigger Level Readout Accuracy	± (0.3 division + 5% of reading) with less than eight divisions vertical input signal
Holdoff Control Range	At least a factor 1:8 (0.5s...10µs) At least a factor 1:6 (5µs....50ns)
Coupling (–3 dB)	
LF REJ - coupled(lower –3 dB)	30 kHz ±25 %
HF REJ - coupled (upper –3 dB)	30 kHz ±25 %
AUX- Input (External trigger input)	
Sensitivity	TTL Level (Low ≤0.5 V, High ≥ 2.1 V)
Usable Frequency Range	DC to 10 MHz
Trigger Jitter	
Non-store	≤500 ps (when triggered)
Store 50 ms to 20 µs	1 sample interval + 500 ps or less
Horizontal Differential Accuracy	Graticule indication of Time cursor difference is within ±2% of readout value, measured over the center eight divisions or Fit To Screen.

Table B-13: Typical Characteristics – Z–Axis System

Name	Description
AUX- Input (Z-Axis input)	
Sensitivity (Non Store)	5-V causes noticeable modulation [a]
Usable Frequency Range (Non-Store)	DC to 5 MHz

Table B-14: Typical Characteristics – Cursor System

Name	Description		
TIME Cursors Position Control Range			
Non-store	0.5 div left of first graticule line to 10.5 division right of the first graticule line.		
Store	Full record length		
TIME Cursor Accuracy (Readout Display)	Within <below> % of the time readout value + 2% of one horizontal division.		
Non-Store	x1	MAG x10	MAG x50
+15°C to 35°C	4%	5%	6%
+0°C to 40°C	5%	6%	9%
Store +0°C to 40°C	± 0.1 % of the sweep		
VOLTAGE Cursor Position Control Range	+/– 4.5 Divisions from the center graticule line		
VOLTAGE Cursor Accuracy (Readout Display)	± (3% of reading + 2% of one vertical division + high frequency display errors)		

[a] **Positive going input decreases the intensity**

Table B-15: Typical Characteristics – X-Y Mode

Name	Description
X-Y Accuracy (Non-Store)	
X-Axis Deflection Factor [a]	Within ±5%
Y-Axis Deflection Factors [a]	Same accuracy as vertical deflection system
X-Y Bandwidth (Non-Store)	
BandwidthX-Axis [b] (-3 dB)	DC to at least 2MHz
BandwidthY-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 in Non-store	± 3 degrees from DC to 150 kHz
Dynamic Range	≥ +/– 4 divisions

[a] **Measured with a dc-coupled, five-division reference signal**

[b] **Measured with a five-division reference signal**

Table B-16: Typical Characteristics – PROBE ADJUST

Name	Description
Output Voltage	0.5 V ±5%
Repetition Rate	1 kHz ± 20%

Table B-17: Typical Characteristics – CRT Display

Name	Description
Geometry	
Vertical	0.1 div. at 8x8 cm (centered) area 0.2 div. at 8x10 cm (centered) area
Horizontal	0.1 div. at 6x10 cm (centered) area 0.2 div. at 8x10 cm (centered) area
Trace Rotation Range	Adequate to align the trace with the center horizontal graticule line.
Y-Axis Orthogonality	≤0.1 div.over eight vertical divisions

Table B-18: Typical Characteristics – Environmental, Safety, and Reliability

Name	Description
Environmental Requirements	The instrument will meet the MIL-T-28800 E requirements for Type III, Class 5, Style D equipment, except where noted otherwise, and Tektronix Standard 062-2853-00, Class 5, except EMI and limited to 40° C.
Temperature	
Operating [a]	0° C to +40° C (+32° to +104° F)
Non-operating [a]	–40° C to +75° C (–60° to +167° F).
Altitude	
Operating	To 4,570 metres (15,000 feet) [b]
Non-operating	To 15,240 metres (50,000 feet) [b]
Humidity	
Operating and non-operating [c]	95%, –5% to +0% relative humidity for 30° C or below. 75%, –5% to +0% relative humidity for 31° C to 50° C. Operating [c] at +30° C to +40° C for all modes of operation.Non-operating [c] at+30° C to +50° C
EMC (Electromagnetic Compatibility)	Meets council directive 89/336/EEC
EMI [d]	Meets requirements per EN55.011, VDE871-B, FCC part 18, EN60555-2
EMS	Meets requirement s per EN50082-1 (IEC801-2, 3, 4, 5). 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-18: Typical Characteristics – Environmental, Safety and Reliability (cont.)

Name	Description
Electrostatic Discharge	Withstands discharge of up to 20 kV. Test performed with probe containing a 500 pF capacitor with 1 kΩ resistance charged to the test voltage. Conforms to Tektronix Standard 062-2862-00.
Vibration	
Operating	15 minutes along each of three major axes at a total displacement of 0.013 inch p-p (2.4 g at 55 Hz) with frequency varied from 5 Hz to 55 Hz to 5 Hz in 15 minutes sweep. Hold for 10 minutes at 55 Hz or at resonance dwell in each of the three major axes. All major resonances must be above 55 Hz. Meets requirements of MIL-28800E, para 4.5.5.3.1.
Shock	
Non-operating	30 g, half-sine, 11 ms duration, three shocks per axis each direction, for a total of 18 shocks as per Tektronix Standard 062-2858-00 Meets requirements of MIL-28800E, except limited to 30g.
Bench Handling Test	Four-inch drop per Tektronix Standard 062-2858-00. Meets requirements of MIL-28800E, para 4.5.5.4.3. [e]
Transportation	
Packaged Vibration Test	Meets the limits of the National Safe Transit Association test procedure 1A-B-1
Packaged Drop Test	Meets the limits of the National Safe Transit Association test procedure 1A-B-2 with a 30-inch drop.

Table B-18: Typical Characteristics – Environmental, Safety and Reliability (cont.)

Name	Description
Reliability	The MBTF (Meantime Between Failures), using REV D parts count prediction values, is 13000 hours at 25°C.

[a] Tested to MIL-T-28800E, para 4.5.5.1.
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 28800E para 4.5.5.1. 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] Edge lifted four inches and allowed to free fall onto a solid wooden bench surface.

Table B-19: Typical Characteristics – Mechanical Specifications

Name	Description
Weight with power cord	± 7 kg
Domestic Shipping Weight	± 11 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)

Appendix C: Performance Tests

This Performance Test contains a collection of procedures for checking that the 2216 Analog & Digital Storage Oscilloscope performs as warranted.

The performance checks described are:

- Vertical Checks
- Horizontal Checks
- Triggering Checks

These performance check procedures are used to verify the instrument's performance requirements statements listed in *Appendix B: 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 2216 and the male connector to the AC power source.
2. Connect the test equipment, as indicated in the Equipment Required list, to the 2216 oscilloscope.
3. Press the **POWER** button to on.
4. 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:1kHz to 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: 50 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 1 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 SG5010 Oscillator
5. Pulse Generator	Repetition rate: 1 kHz. Output amplitude: 5 V.	Signal source for Storage and external clock checks.	Tektronix PG502 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. 2.5X Attenuator	Ratio: 2.5X. Impedance: 50 Ω. Connectors: BNC	Vertical compensation and triggering checks.	Tektronix Part Number 011-0076-02.
15. Adapter male-to-tip plug	Connectors: BNC .	Signal interconnection.	Tektronix Part Number 175-1178-00.
16. Interface Cable		Signal interconnection.	Tektronix Part Number 012-1214-00.

[a] Requires a TM 500-Series Power Module.

Preparation

The Performance Verification Procedure is divided in subsections to be able to 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-accessible 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 subsection.

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-minutes warm-up period. All tolerances specified are for the instrument only and do not include test-equipment error. Most of the test equipment used requires a warrm-up period to ensure the specified accuracy.

Index to Performance Tests

Vertical Checks

Horizontal Checks

Triggering Checks

Vertical Checks

These procedures check the 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 set-up will be indicated in the procedures, if necessary.

Equipment Required (see Table C1) :

Calibration Generator (Item 1)
Levelled 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)
2.5X BNC Attenuator (Item 14)
BNC Male-to-Tip Plug (Item 15)

Initial Control Settings

Vertical (CH 1 , 2, 3, 4)

POSITION .... Midrange
MODE .... CH 1 (CH 2,3,4 Off)
VOLTS/DIV .... 1 mV
VARiable .... CAL
AC-GND-DC .... DC

Horizontal

POSITION .... Midrange
MAG .... Off
SEC/DIV .... 0.5 ms
VARiable .... CAL

Trigger

HOLDOFF .... Fully ccw
LEVEL .... Midrange
SLOPE .... Positive Going
MODE .... AUTO
SOURCE .... VERT
COUPLING .... DC

Procedure Steps

Step 1. Check Deflection Accuracy

a. Connect a 5 mV standard-amplitude signal from the calibration generator via a 50 Ω BNC coaxial cable to the **CH 1** 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.

c. Repeat a. and b. for INVERT switch ON

d. Repeat a. , b. , and c. with DIGITIZE in STORE mode.

e. Repeat a., b., c., and d. for CH 2, CH 3, and CH 4.

f. Disconnect the testequipment from the instrument.

Table C-2
Deflection Accuracy Limits

VOLTS/DIV switch setting	STANDARD amplitude signal	ACCURACY limits (divisions)
1 mV	5 mV	4.85 to 5.15
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
10 V	50 V	4.85 to 5.15

Step 2. Check Non-Store (Analog) Bandwidth

a. SET:

VOLTS/DIV (CH 1) .... 5 mV
Mode .... CH 1 (CH 2, 3, 4 Off)
SEC/DIV .... 10 μs

b. Connect the levelled sine-wave generator output via a 50 Ω BNC coaxial cable and a 50 Ω BNC termination to the **CH 1** 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.

h. Repeat part a. through f. for CH 2, CH3, and CH 4.

i. SET:

VOLTS/DIV CH 1 .... 1 mV
Mode .... CH 1 (CH 2, 3, 4 Off)
SEC/DIV .... 10 μs

j. Set the levelled 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 greater than10 MHz.

m. Repeat part i. through l. for 2 mV/Division.

n. Repeat part i. through m. for CH 2, CH 3, and CH 4.

o. Disconnect test equipment from the instrument.

Step 3. Check High Frequency Compensation

a. SET:

VOLTS/DIV .... 1 mV (CH1,2,3,4)
AC-DC-GND .... DC (CH1,2,3,4)
Vertical .... CH 1 (CH 2,3, and 4 Off)
SEC/DIV .... 0.2 µs
Trigger SOURCE .... VERT

b. Connect the fast rise square-wave generator output from the Calibration Generator via a 50 Ω BNC coaxial cable, a 10X attenuator, a 2.5X attenuator and a 50 Ω BNC termination to the **CH 1** input connector.

c. Set the generator to produce an output with a risetime of 1 ns and five-division display.

d. Set the top of the display to the center horizontal graticule line with the vertical **POSITION** control.

e. CHECK – That the high frequency display aberrations are less than 0.2 division.

f. Repeat part a. through e. for **2 mV/DIV** to **20 mV/DIV**.

g. CHECK – That the high frequency display aberrations of the VOLTS/DIV ranges from **50 mV/DIV** through **0.2 V/DIV** are less than 0.3 division.

h. CHECK – That the high frequency display aberrations of the **0.5 V/DIV** to **2V/DIV** range are less than 0.3 division.

i. CHECK – That the high frequency display aberrations of the VOLTS/DIV ranges from **5 V/DIV** through **10 V/DIV** are less than 0.6 division.

j. Repeat part a. through i. for CH 2, CH 3, and CH 4.

Horizontal Checks

These procedures check the characteristics for the horizontal display system that are listed under *Warranted Characteristics* in *Appendix B: Specifications*. Make a test equipment setup 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, 2, 3, 4)

POSITION .... Midrange
MODE .... CH 1
VOLTS/DIV .... 0.5 V
VARiable .... CAL
AC-GND-DC .... DC

Horizontal

POSITION .... Midrange
MAG .... Off
SEC/DIV .... 50 ns
VARiable .... CAL

Trigger

HOLDOFF .... Fully ccw
LEVEL..................................... Midrange
SLOPE .... Positive Going
MODE .... AUTO
SOURCE .... VERT
COUPLING .... AC

Procedure Steps

Step 1. Check Non Store Timing Accuracy and Linearity

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** 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 differential accuracy 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.

f. Press the **SHIFT** and **MAG/MENU** button successively to display the 'Magnify' menu.

g. Press the '**Alt Mag**' bezel button to OFF and the '**x10**' bezel button to on.

h. Press the **MAG/MENU** button to activate the x10 magnifier.

i. SET:

SEC/DIV .... 10 ns

j. Select 10 ns time markers from the time-marker generator.

k. 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.

l. CHECK – Timing accuracy is within 4 % (0.32 division at the tenth vertical graticule line), and the differential accuracy is within 8% (0.16 division over any two of the center eight divisions). Exclude any portion of the sweep past the 90th magnified division and exclude the first 50 ns.

m. Repeat parts j. through l. for the remaining **SEC/DIV** and timemark generator setting combinations as shown in Table C-3.

n. Press the '**x50**' magnifier bezel button in the 'Magnify' menu.

n. SET:

SEC/DIV .... 10 ns

o. Select 10 ns time markers from the time-marker generator.

p. 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.

q. CHECK – Timing accuracy is within 5 % (0.40 division at the tenth vertical graticule line), and the differential accuracy is within 9% (0.18 division over any two of the center eight divisions). Exclude any portion of the sweep past the 9th unmagnified division.

r. Repeat parts p and q 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.

s. Press the **CLEAR MENU** button and disconnect the test-equipment from the 2216.

Table C-3
Settings for Timing Accuracy Checks

SEC/DIV Switch Setting	Time-Mark Generator Setting		
	X1	MAG X10	MAG X50
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

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 2,3,4 Off)
CH 1 VOLTS/DIV .... 0.1 V
VARiable .... CAL
AC-GND-DC .... DC

Horizontal

POSITION .... Midrange
MAG .... Off
SEC/DIV .... 0.5 ms
VARiable .... CAL

Trigger

HOLDOFF .... Fully ccw
LEVEL .... Midrange
SLOPE .... Positive Going
MODE .... AUTO
SOURCE .... VERT
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** 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
AUTO	Positive Slope
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** 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 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 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** 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 at 0.1 V/DIV.

b. Set the SEC/DIV to 50 ns.

c. 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.

d. Disconnect the test equipment from the instrument.

Step 5. TV Field Trigger Sensitivity

a. SET:

Vertical MODE .... CH 1
VOLTS/DIV (CH 1) .... 1 V
SEC/DIV .... 0.2 ms
Trigger SLOPE .... Negative Going
Trigger MODE .... TV FLD

b. Connect the TV signal generator video output to the **CH 1** 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:

INV .... ON
Trigger SLOPE .... Positive Going

f. CHECK – That a stable display is obtained.

g. Disconnect the test equipment from the instrument.

Step 6. TV Line Trigger Sensitivity

a. SET:

Vertical MODE .... CH 1
VOLTS/DIV (CH 1) .... 1 V
SEC/DIV .... 20 μs
Trigger SLOPE .... Negative Going
Trigger MODE .... TV LINE

b. Connect the TV signal generator video output to the **CH 1** 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 of a TV line can be obtained.

e. Disconnect the test equipment from the instrument.

Appendix D: Algorithms

Measurement Variables

The 2216 oscilloscope measures several values that are used to calculate measurements.

High - is the 100% (highest) voltage reference value.

$$High = Max$$

See description of Maximum (*Max*) on page D-6)

Low - is the 0% (lowest) reference value calculated.

$$Low = Min$$

MidRef - is a calculated voltage value between High and Low.

$$MidRef = \frac{High + Low}{2}$$

See description of Minimum (*Min*) on page D-7)

RecordLength - is the number of data points in the time base. You set it with the **Record Size Menu** (sub-menu of the Storage Functions Menu).

Start - is the location of the start of the measurement zone (X-value). It is 0 samples unless you are making a gated measurement. When you use gated measurements, it is the location of the left vertical cursor.

End - is the location of the end of the measurement zone (X-value). It is (*RecordLength* - 1) samples unless you are making a gated measurement. When you use gated measurements, it is the location of the right vertical cursor.

Hysteresis - The hysteresis band is 10% of the waveform amplitude. It is used in *MCross1, MCross2,* and *MCross3* calculation.
For example, once a crossing has been measured in negative direction, the waveform data must fall below 10% of the amplitude from the *MidRef* point before the measurement system is armed and ready for a positive crossing. Similarly, after a positive *MidRef* crossing, waveform data must go above 10% of the amplitude before a negative crossing can be measured. Hysteresis is useful when you are measuring noisy signals, because it allows the digitizing oscilloscope to ignore minor fluctuations in the signal.

MCross Calculations

MCross1, MCross2, and MCross3 - refer to the first, second, and third *MidRef* cross times, respectively. See figure D-1.

The polarity of the crossings does not matter for these variables, but the crossings alternate in polarity; that is, *MCross1* could be a positive or negative crossing, but if *MCross1* is a positive crossing, *MCross2* will be a negative crossing.

The oscilloscope calculates these values as follows:

1. Find the first *MidRefCrossing* in the waveform record or the gated region. This is *MCross1*.

2. Continuing from *MCross1*, find the next *MidRefCrossing* in the waveform record (or the gated region) of the opposite polarity of *MCross1*. This is *MCross2*.

3. Continuing from *MCross2*, find the next *MidRefCrossing* in the waveform record (or the gated region of the same polarity as *MCross1*. This is *MCross3*.

MCross1 Polarity - is the polarity of the first crossing (no default). It can be rising or falling.

StartCycle - is the starting time for cycle measurements. It is a number with values between 0 and (*RecordLength* - 1), inclusive.

StartCycle = MCross1

EndCycle - is the ending time for cycle measurements. It is a number with values between 0 and (*RecordLength* - 1), inclusive.

EndCycle = MCross3

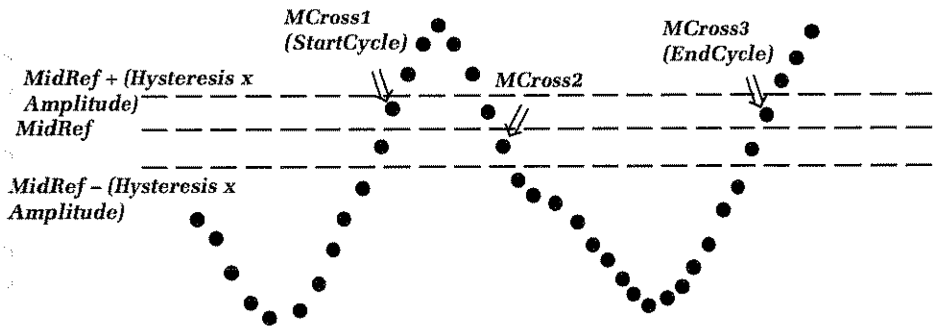


Figure D-1: MCross Calculations

Waveform [<0 ... RecordLength - 1>] - holds the acquired data.

Measurement Algorithms

The automated measurements are defined and calculated as follows.

Amplitude

$$Amplitude = High - Low$$

Area

The arithmetic area for one waveform. Remember that one waveform is not necessarily equal to one cycle. For cyclical data you may prefer to use the cycle area rather than the arithmetic area.

if *Start* = *End* then return zero.

Cycle Area

Amplitude (voltage) measurement. The area over one waveform cycle. For non cyclical data, you might prefer to use the Area measurement.

if *StartCycle* = *EndCycle* then return zero.

$$CycleArea = \int_{StartCycle}^{EndCycle} Waveform(t)dt$$

Cycle Mean

Amplitude (voltage) measurement. The mean over one waveform cycle. For non cyclical data, you might prefer to use the Mean measurement.

if *StartCycle* = *EndCycle* then return the value at *StartCycle*.

$$\text{CycleMean} = \frac{\displaystyle\int_{StartCycle}^{EndCycle} Waveform(t)dt}{(EndCycle - StartCycle) \times SampleInterval}$$

Cycle Power

The mean of the multiplication of two voltages over one cycle.
If *StartCycle* = *EndCycle* then

$$CyclePower = Waveform1[Start] \times Waveform2[Start]$$

Otherwise,

$$Cycle\ Power = \frac{\displaystyle\int_{StartCycle}^{EndCycle} Waveform1(t) \times Waveform2(t)\ dt}{(EndCycle - StartCycle) \times SampleInterval}$$

Cycle RMS

The true Root Mean Square voltage over one cycle.

If *StartCycle* = *EndCycle* then *CycleRMS* = *Waveform[Start]*

Otherwise,

$$Cycle\ RMS = \sqrt{\frac{\int_{StartCycle}^{EndCycle} (Waveform(t))^2 dt}{(EndCycle - StartCycle) \times SampleInterval}}$$

Frequency

Timing measurement. The reciprocal of the period. Measured in Hertz (Hz) where 1 Hz = 1 cycle per second.

If *Period* = 0 or is otherwise bad, an error is returned.

Frequency = *1/Period*

Maximum

Amplitude (voltage) measurement. The maximum voltage. Typically the most positive peak voltage.

Examine all *Waveform [ ]* samples from *Start* to *End* inclusive and set *Max* equal to the greatest magnitude *Waveform [ ]* value found.

Mean

The arithmetic mean for one waveform. Remember that one waveform is not necessarily equal to one cycle. For cyclical data you may prefer to use the cycle mean rather than the arithmetic mean.

If *Start* = *End* then return the value at *Start*.

Otherwise,

$$Mean = \frac{\int_{Start}^{End} Waveform(t)dt}{(End - Start) \times SampleInterval}$$

Minimum

Amplitude (voltage) measurement. The minimum amplitude. Typically the most negative peak voltage.

Examine all *Waveform [ ]* samples from *Start* to *End* inclusive and set *Min* equal to the smallest magnitude *Waveform [ ]* value found.

Negative Duty Cycle

Timing measurement. The ratio of the negative pulse width to the signal period expressed as a percentage.

NegativeWidth is defined in **Negative Width** below.

If *Period* = 0 or undefined then return an error.

$$NegativeDutyCycle = \frac{NegativeWidth}{Period} \times 100\%$$

Peak to Peak

Amplitude measurement. The absolute difference between the maximum and minimum amplitude.

$$PeaktoPeak = Max - Min$$

Period

Timing measurement. Time taken for one complete signal cycle. The reciprocal of frequency. Measured in seconds.

$$Period = MCross3 - MCross1$$

Positive Duty Cycle

Timing measurement. The ratio of the positive pulse width to the signal period, expressed as a percentage.

PositiveWidth is defined in **Positive Width**, following.

If *Period* = 0 or undefined then return an error.

$$PositiveDutyCycle = \frac{PositiveWidth}{Period} \times 100\%$$

Power

The mean of the multiplication of two voltages.
If *Start= End* then

$$Power = Waveform1[Start] \times Waveform2[Start]$$

Otherwise,

$$Power = \frac{\int_{Start}^{End} Waveform1(t) \times Waveform2(t)\, dt}{(End - Start) \times SampleInterval}$$

RMS

Amplitude (voltage) measurement. The true Root Mean Square voltage.

If *Start* = *End* then *RMS* = the value at *Waveform [Start]*.

Otherwise,

$$RMS = \sqrt{\frac{\int_{Start}^{End} (Waveform(t))^2 dt}{(End - Start) \times SampleInterval}}$$

Appendix E: 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.

Locations and possible types of information displayed are illustrated in Figure E-1. Messages and warnings will also be displayed on the crt.

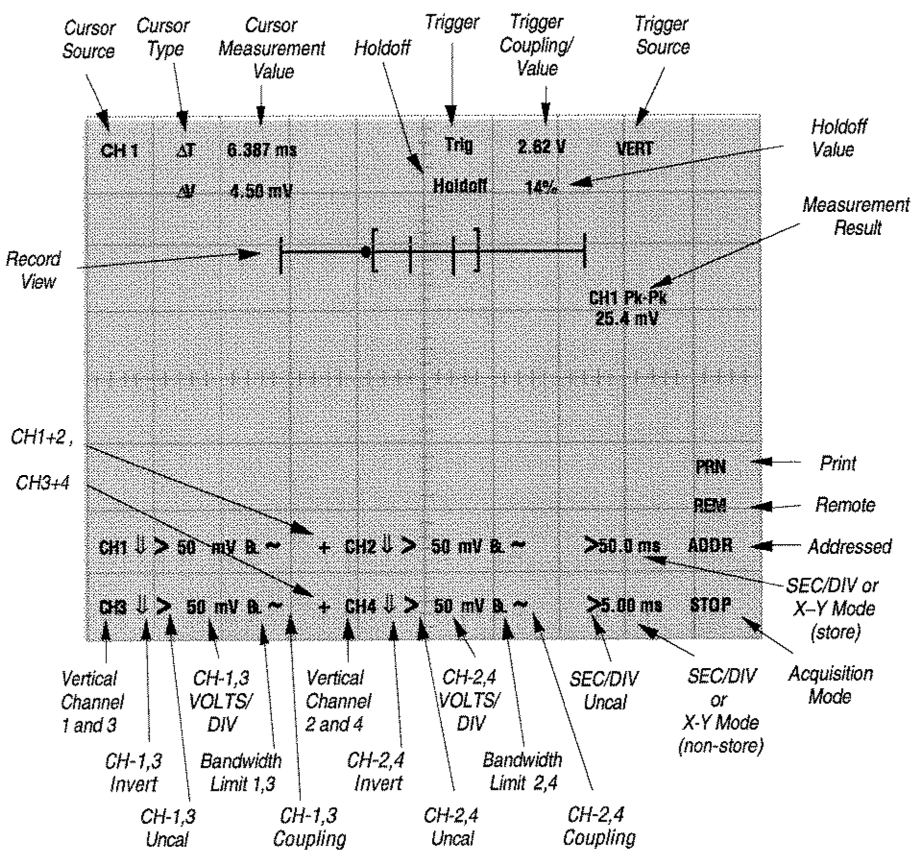


Figure E-1: CRT Readout Display Fields

Readout Overview

On the rows in the upper graticule divisions the following readouts are displayed :

- Cursor Source
- Cursor Type
- Cursor Measurement Value
- Trigger
- Trigger Coupling or Value
- Trigger Source
- Holdoff percentage
- Record View Bar
- Measurement Results

On the rows in the bottom graticule divisions the following readouts are displayed :

- CH 1, CH 3 (if selected)
- CH 1, CH 3 Inverted
- CH 1, CH 3 Uncalibrated
- CH 1, CH 3 Vertical Deflection Factor
- CH 1, CH 3 Bandwidth Limited
- CH 1, CH 3 Coupling
- ADD Sign for CH 1+2 and CH 3+4
- CH 2, CH 4 (if selected)
- CH 2, CH 4 Inverted
- CH 2, CH 4 Uncalibrated
- CH 2, CH 4 Vertical Deflection Factor
- CH 2, CH 4 Bandwidth Limited
- CH 2, CH 4 Coupling
- Horizontal Deflection Factor (unmagnified sweep)
- Horizontal Deflection Factor (magnified sweep)
- Horizontal Uncalibrated
- Remote Control Indication
- Printing Indication
- Acquisition Mode
- Addressed Indication

Upper Readouts

Cursor Source

The cursor source indicates the active channel or the active reference that has been selected. The following sources can be selected:

- CH1, CH 2, CH 3, CH 4, CH 1+2, CH 3+4
- REF 1..........16

Cursor Type

The cursor type indicates the Δ function that has been selected. in the Cursors Function Menu. Basically, there are two cursor types:

- TIME cursors:
  - ΔT,1/ΔT
  - Ratio, Phase
  - PAIRED cursors
- VOLTAGE cursors
  - ΔV
  - Ratio
  - Customised Name

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

The ΔV and associated Ratio Cursors are displayed as horizontal lines on the crt.

PAIRED cursors are typically ΔT/1/ΔT (TIME) cursors, but the voltage difference between the crossing points of the cursors and the displayed signal are also measured and displayed as @V (absolute value).

Cursor Units

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)
- Custom Units

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 Coupling or Value

The Trigger Coupling / Trigger Value readout field indicates the method of coupling or the dc voltage 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
- CH 3
- CH 4
- VERT
- AUX
- LINE

Holdoff Percentage

The holdoff percentage is displayed for a few seconds in the second row.

Record View Readout

If the "Record View" is set to ON or TIMED in the Setup Utility Configuration Menu:

- the Record View will be displayed continuously in the ON state.

- the Record View will be displayed during some time in the TIMED position, after one of the front panel control settings has been changed.

Measurement Results

Results from automated measurements are displayed on the right side of the crt on the third and fourth division.

Lower Readouts

Vertical Channel Selection

The Vertical Channel fields show which channel has been selected.
The upper channel readouts are split -up respectively in CH 1 and CH 2, and the lower channel readouts in CH 3 and CH 4.
If a channel is switched off, the readout is also removed from the screen.

Vertical Channel Inverted

A down arrow ("⇓") is displayed if a channel is inverted.

Vertical Channel Uncalibrated

A ">" or a "<" sign appears in front of the VOLTS/DIV readout of a channel if the VAR switches are not in the calibrated position.

Vertical Channel Deflection

The Vertical Channel Deflection readout fields indicate the current VOLTS/DIV deflection settings of a channel.

Vertical Channel Bandwidth Limit

"$\mathbf{B}_L$ " appears after the VOLTS/DIV readout, if the bandwidth of a channel is limited, and the "10 MHz" LED lights.

Vertical Channel Input Coupling

If the vertical input of a channel is AC coupled, a "~" sign appears after the VOLTS/DIV or "B_L " readout.

CH 1+2 and CH 3+4 (Add Mode)

If the instrument is set in the CH 1+2 or CH 3+4 added mode a " + " sign appears between the CH 1 and CH 2 readout and/or the CH 3 and CH 4 readout.

Horizontal Deflection Factor / X-Y

The horizontal deflection factor readout can indicate:

- The current SEC/DIV deflection setting in Y-t mode in store and non-store.
- "X-Y" in X-Y non-store mode.
- The magnified SEC/DIV deflection setting in "Alternate" Y-t mode in store and non-store.

The horizontal deflection factor readout in the second bottom row indicates:

- The unmagnified SEC/DIV deflection setting in "Alternate" Y-t mode in store and non-store.
- "X-Y" in X-Y store mode.

Horizontal Deflection Uncalibrated

A " > " sign appears in front of the SEC/DIV readout, if the VAR switches are not in the calibrated position.

A "≈" sign appears in front of the SEC/DIV readout, if the SEC/DIV is set to the 1, 2, or 4 ns/div positions, to indicate the settings are approximate.

Acquisition Mode

The acquisition readout field indicates whether the acquisition is in "ROLL" or "SCAN" mode or stopped ("STOP").

In "RECORD" mode, there is no readout in this readout field. This field is only active in the store mode.

Addressed (ADDR)

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

Remote Control (REM)

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

Printing (PRN)

The PRN readout field is active if the instrument is sending data to a printer/plotter in the HARDCOPY mode.

Appendix G: 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, digitising 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 Interval
The time duration of the waveform record divided by the record length. The digitising oscilloscope displays one data point for every acquisition interval.

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 General Purpose 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 digitising oscilloscope digitises 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.

Area
Measurement of the waveform area taken over the entire waveform or gated region. Expressed in volt-seconds. Area above ground is positive; area below ground is negative.

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 or display 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 of the oscilloscope that automatically produces a stable waveform of usable size. Autoset sets up front-panel controls based on the characteristics of the active waveform. A successful autoset will set the volts/div, time/div, and trigger level to produce a coherent and stable waveform display.

Average acquisition Mode
The oscilloscope acquires and displays a waveform that is the averaged result of several acquisitions. That reduces the apparent noise. The oscilloscope acquires data as in the sample mode and then averages it according to a specified number of averages.

Bandwidth
The highest frequency signal the oscilloscope can acquire or display 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.)

Coupling
The association of two or more circuits or systems in such a way that power or information can be transferred from one to the other. You can couple the input signal to the trigger and vertical systems several different ways.

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.

Cycle area
A measurement of waveform area taken over to one cycle. Expressed in volt-seconds. Area above ground is positive; area below ground is negative.

Cycle mean
An amplitude (voltage) measurement of the arithmetic mean over one cycle.

Cycle Power
Power measurement. The arithmic mean over the first cycle of the active waveform (or the first cycle in the gated region) over the product of both waveforms

Cycle RMS
The true Root Mean Square voltage over one cycle.

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.

Delay time
The time between the trigger event and the acquisition of data.

Digitising
The process of converting a continuous analog signal such as a waveform to a set of discrete numbers representing the amplitude of the signal at specific points in time. Digitising is composed of two steps: sampling and quantising.

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

Display System
The part of the oscilloscope that shows waveform, measurements, menu items, status, and other parameters.

External Trigger Source
A trigger source derived from a non-displayed external signal through the auxiliary input connector (AUX).

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.

Gated Measurements
A feature that lets you limit automated measurements to a specified portion of the waveform. You define the area of interest using the vertical cursors.

General purpose knob
The General Purpos knob is located in the upper right corner of the front panel. You can use it to change the value of assigned parameters or cursors.

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, and connects the vertical system to ground.

Hardcopy
An electronic copy of the display, in a format usable by a printer or plotter.

High
The value used as 100% in automated measurements (whenever high ref, mid ref, and low ref values are needed as in fall time and rise time measurements). May be calculated using either the min/max or the histogram method. With the min/max method (most useful for general waveforms), it is the maximum value found. With this histogram method (most useful for pulses), it refers to the most common value found above the mid point.

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.

Horizontal bar cursors

The two horizontal bars that you position to measure the voltage parameters of a waveform. The oscilloscope displays the value of the active (movable) cursor with respect to ground and the voltage value between the bars.

Inverted Waveform

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

Intensity

Displays brightness.

Knob

A rotary control.

Low

The value used as 0%in automated instruments (whenever high ref, mid ref, and low ref values are needed as in fall time and rise time measurements). May be calculated using either the min/max or the histogram method. With the min/max method (most useful for general waveforms), it is the minimum value found. With the histogram method (most useful for pulses), it refers to the most common value found below the mid point.

Major Division

One mark dividing the screen either horizontally or vertically for measurement purposes. The 2216 has eight major vertical divisions and ten major horizontal divisions.

Maximum

Amplitude (voltage) measurement of the maximum amplitude. Typically the most positive peak voltage.

Mean
Amplitude (voltage) measurement of the arithmetic mean over the entire waveform.

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

Menu
A group of related controls for an oscilloscope function that the oscilloscope displays across the bottom of the screen.

Menu buttons
Bezel buttons under the menu display. They allow you to select items in a menu.

Minimum
Amplitude (voltage) measurement of the minimum amplitude. Typically the most positive peak voltage.

Minor Division
Subdivision of major divisions for more accurate measurement. Minor divisions are seen as marks along the horizontal and vertical center lines. The 2216 has five minor divisions in each major division in both directions.

Negative duty cycle
A timing measurement representing the ratio of the negative pulse width to the signal period, expressed as a percentage.

Negative overshoot measurement
Amplitude (voltage) measurement.

$$\textit{Negative Overshoot} = \frac{\textit{Low - Min}}{\textit{Amplitude}} \ x\ 100\%$$

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 of frequency. Measured in seconds.

Phase
A timing measurement between two waveforms of the amount one leads or lags the other in time. Phase is expressed in degrees, where 360° comprise one complete cycle of one of the waveforms. Waveforms measured should be the same frequency or one waveform should be a harmonic of the other.

Positive duty cycle
A timing measurement of the ratio of the positive pulse width to the signal period, expressed as a percentage.

Positive overshoot
Amplitude (voltage) measurement.

$$\text{Positive Overshoot} = \frac{\text{Max - High}}{\text{Amplitude}} \times 100\%$$

Post-trigger
The part of the waveform record data that occurs after the trigger event.

Power
Power measurement. The arithmic mean over the product of two waveforms, or a gated region.

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.

Quantizing
The process of converting an analog input that has been sampled, such as a voltage, to a digital value.

Real-time sampling
Sampling where the digitising 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 digitising 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 timebases (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 Acquisition Mode
The oscilloscope creaes a record point by saving the first sample during each acquisition interval. That is the default mode of the acquisition.

Sampling
The process of capturing an analog input, such as a voltage, at a discrete point in time and holding it constant so that it can be quantised. Two general methods of sampling are: real-time sampling and equivalent-time sampling.

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.

Selected waveform
The waveform on which all measurements are performed, and which is affected by vertical position and scale adjustments.

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
A trigger and display mode in which the instrument generates a single sweep after being triggered.

Slope
The direction at a point on a waveform. You can calculate the direction by computing the sign of the ratio of change in the vertical quantity (Y) to the change in the horizontal quantity. The two values are rising and falling.

Store Mode
A mode in which the instrument is set to the digital storage mode.

Time Base
The set of parameters that let you define the time and horizontal axis attributes of a waveform or waveform record. The time base determines when and how long to acquire record points, or display a waveform.

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 or analog mode. Possible time-base store modes are Record and Roll.

Toggle Button
A button that when pressed, allows you to select sequentially 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 Level
The level the trigger signal must cross to generate a trigger.

Trigger Light
A light on the 2216 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 fractions of a volt per division.

Vertical bar cursors
The two vertical bars you position to measure the time parameter of a waveform record. The oscilloscope displays the value of the active (movable) cursor with respect to trigger and the time value between the bars.

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 fraction 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 or 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.

Y-t Format
A display where the vertical position of the displayed waveform reflects signal level and the horizontal position reflects time.

Appendix M:Maintenance and Repair

The 2216 is covered by a standard Tektronix three-year warranty. If the 2216 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, please have available:

- the instrument serial number
- firmware version number

The serial number is located at the top right of the rear panel. The firware identification number can be found in the Setup Utility Status Display, a sub-menu of the Setup Utility Menu (see Section 3, page 3-74).

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.

Error Message

If your instrument displays:

```
Battery backup RAM error
```

you are notified that data saved in battery backup was lost. Basically the result will be that stored instrument setups and reference waveforms have disappeared.

During normal operation, this will occur when the two alkaline batteries inside the instrument, are low (typical battery life is more than three years).

Contact your Tektronix Service Center to replace the batteries.

Appendix P:Probes

This section intends to help you select the right probe for your application, how to connect a probe, and how to adjust the low-frequency compensation of a probe. The following probe types will be discussed:

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

The 2216 standard instrument is supplied with two x10 probes (Tektronix type P6109B) which are useful for a wide variety of tasks. For special measurement situations, you need different probes.

Additional probes are optional (listed in Appendix A).
You may also use Table P-1 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 representative.

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 2216. 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 P6009 and the P6015A high voltage probes for 1MΩ inputs. The P6009 can handle a maximum input voltage of 1.5 kV DC + peak AC and the P6015A 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 a 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.
The dynamic range of active probes is typically ±10 to ± 15 V.

Some active probes are also referred to as "FET" probes. The 2216 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
- 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.

A current probe can be applied 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.

A variety of Tektronix current probes can be applied in the 2216 oscilloscope, 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 which provides you the capability to measure AC currents.
- The P6022, with an 134 current probe amplifier, that is 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 2216.

Differential signal processing takes place in the probe itself, resulting in high common-mode signal rejection at higher frequencies. Differential probe-tip signal processing minimizes 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 Tektronix P6046 Differential Probe can be used with a 2216. This is a 100 MHz differential amplifier in probe form which connects one oscilloscope input channel.

Table P-1: Summary of Tektronix Measurement Probes for the 2216 Oscilloscope

Probe Type	Description/ Attenuation	Loading (R_{in}, C_{in})	Bandwidth at –3 dB
P6101B	1X Passive Probe	1 MΩ , 100 pF	DC to 15 MHz
P6109B	10X Passive Probe	10 MΩ , 13 pF	DC to 100 MHz
P6121	10X Passive Probe Tip/Head Style : Sub miniature	10 MΩ , 11 pF	DC to 100 MHz
P6062B	1X / 10X Passive Switchable Probe	1/10 MΩ , 105/14 pF	DC to 100 MHz
P6009	100X High Voltage Passive Probe (1.5 kV max.)	10 MΩ , 2.5 pF	DC to 120 MHz
P6015A	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
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 pick-up 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 2216 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.

NOTE

To get the best waveform fidelity, 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

For probe adjustment, see page 1-25.

Appendix I: Index