TEK

070-6960-00
Product Group 45

SCD1000/SCD50000

TRANSIENT WAVEFORM RECORDER

INSTRUCTION MANUAL

First Printing JUN 90

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Instrument Serial Numbers

Each instrument has a serial number on an insert, tag, or stamped on the chassis. The first number or letter 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:

B00000 - Tektronix, Inc., Beaverton, Oregon, USA
300000 - Sony/Tektronix, Japan
700000 - Tektronix Holland, NV, Heerenveen, The Netherlands

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GUIDE TO SCD1000/SCD000 DOCUMENTATION

The SCD1000/SCD5000 Documentation Package includes the following:

- 1 Single-Volume Instruction Manual
- 1 Single-Volume Instrument Interfacing Guide
- Reference Guide

ABOUT THIS MANUAL

The SCD1000/SCD5000 Instruction Manual contains the following sections:

- Section 1 - Introduction. Contains an instrument description, a list of standard accessories, and a list of optional accessories.
- Section 2 - Preparation For Use. Contains installation instructions, including power, switch settings, signal cabling, diagnostics, incoming inspection, and packaging for reshipment.
- Section 3 - Operating Instructions. Contains three major sections. The first describes controls, connectors, and indicators. The second contains initial power-up instructions and instrument familiarization. The third section contains information about the Display Unit.
- Section 4 - Specifications. Contains tables describing the environmental, electrical, and physical characteristics of the instrument.
- Section 5 - Options. Lists and describes instrument options.
- Section 6 - Instrument Interfacing Guide. Explains the necessary details of operating the instrument over the GPIB interface. Contains information on the following:

  Setting up the instrument for GPIB operation
  Determining the GPIB address
  Introduction to the GPIB standard
  Interface messages
  Complete GPIB command set used to operate the instrument
  GPIB command reference table
  SRQ and Event tables
  Programming examples
  Integrating the SCD Series into 7912 AD/HB Systems
  Reference cards - ASCII/IEEE

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OPERATORS SAFETY SUMMARY

The Safety Summary is a listing of all safety precautions in the manual. These precautions are gathered here in a single place for convenient review of all precautions, and each also appears at a place in the manual where the reader receives the most benefit from the precaution.

TERMS

IN THIS MANUAL

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

AS MARKED ON EQUIPMENT

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

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

SYMBOLS

IN THIS MANUAL

⚠ This symbol indicates where applicable cautionary or other information is to be found.

AS MARKED ON EQUIPMENT

DANGER—High voltage

Protective ground (earth) terminal

ATTENTION—refer to manual

SAFETY ITEMS

Power Source

This instrument is intended to operate from a power source which does not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection through the grounding conductor in the power cord(s) is essential for safe operation.

Grounding the instrument

This instrument is grounded through the grounding connector of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle. A protective ground connection through the instrument is essential for safe operation.

Danger arising from loss of ground

Upon loss of the protective-ground connection, all accessible conductive parts can render an electric shock.

Use the proper fuse

To avoid fire hazard, use only fuses specified in the instrument's parts list. A replacement fuse must meet the type, voltage rating, and current rating specifications required for the fuse that it replaces.

Do not operate in explosive atmosphere

To avoid explosion, do not operate the instrument in an explosive atmosphere.

Do not remove covers or panels

To avoid personal injury, the instrument covers should be removed only by qualified service personnel. Do not operate the instrument without covers and panels properly installed.

GENERAL INFORMATION

- Product Overview
- Features
- Accessories

PRODUCT OVERVIEW

General Description

The SCD5000 and SCD1000 waveform recorders are designed to capture low nanosecond and picosecond single shot events. Whether the application involves Laser, ESD, EMP, Particle Accelerators or other high speed single shot phenomena, SCD series waveform recorders can capture the event of interest with excellent fidelity and resolution.

The maximum acquisition rate of 200 giga samples per second provides time resolution to 5 picoseconds. With time windows from 5 nsec to 100 µs, the SCD series recorders provide flexible acquisition windows. The SCD1000 delay line gives approximately 2.5 ns of pretrigger information.

The SCD5000 and SCD1000 are single channel waveform recorders. The SCD5000 uses direct access with input sensitivity of 5 volts with an offset range of ±4.0 volts. Signals are DC coupled. The SCD1000 provides input signal conditioning with 100 mV to 10V full scale input ranges, offset capability, signal invert and AC or DC coupling. There are two input channels which can be configured to multiplex two signals or algebraically add two input signals to the single channel waveform recorder.

The waveform record length is selectable between 256, 512 or 1024 waveform data points, with 11 bits of vertical resolution (2048 levels). With 16 built-in waveform locations (four using non-volatile memory), multiple trigger events can be stored into separate storage locations using Auto-advance acquisition mode. Averaging acquisition mode allows up to 1024 acquisitions to be averaged for an improved signal -to-noise ratio. Each record is time and date stamped for later comparison. There are 10 nonvolatile settings storage locations for quick instrument setup.

The SCD waveform recorders can be controlled over the IEEE-488 interface or from the display unit attached to the front of the instrument. The display unit provides the ability to control operating parameters, view up 4 waveforms at one time, make cursor measurements on any displayed waveform and view status of instrument operation. It can also be used as operator display device with 2 user-definable buttons and up to 16 lines of text that can be printed on the screen.

FEATURES

Table 1-1 is a brief list of SCD1000 and SCD5000 features. Refer to Section 4 for a full list of Specifications.

TABLE 1-1
SCD WAVEFORM RECORDERS OVERVIEW

Feature	Description	
	SCD1000	**SCD5000**
	Inputs	
Number of Acquisition Channels	1 channel	1 channel
Vertical Modes	1-Channel (Ch A or Ch B) or algebraic sum of both (Add and Invert)	1 channel
Input Voltage Range	Programmable from 100 mV to 10.0 V Full-scale in a 1, 2, 5 sequence	5 V Full-scale (fixed)
Input Offset Range	±250 % of input voltage range	±4 V
Input Coupling	AC, DC, or OFF	DC only
Bandwidth	1 GHz	4.5 GHz
	Timebase & Memory	
Time Windows	5 ns to 100 µs	
Programmable Record Lengths	256, 512, 1024 points	
Maximum Number of Records	16; record 0 reserved for text only	
	Triggering	
Triggering Sources	Any vertical mode, external (Analog) input, GPIB command, or Display Unit Key	External input, internal time calibrator signal, GPIB command, or Display Unit Key
Trigger Level	Internal: AC coupling: ±100% of full-scale range; DC coupling: ±50% of full-scale range	AC coupling only ±50% of vertical range
Trigger Delay	Up to 5 times the time window; programmable in percent or seconds. Approximately 2.5 ns of pre-trigger information is displayed with 0 delay setting	
Trigger Level Units	Selectable as % of full-scale input range (internal only) or volts	
Trigger Slope	Positive or Negative	
Internal calibration	Automatic adjustment of Vertical, Horizontal, Trigger, and CRT circuitry	
Factory Initialization Settings	Stored in ROM. All instrument and GPIB settings can be initialized to their factory settings at any time.	

ACCESSORIES

The SCD waveform recorders have the following Standard and Optional Accessories:

**TABLE 1-2
STANDARD ACCESSORIES**

Quantity	Desccription	Tektronix part number
1	Power Cord, 3-wire, 2.5 meter; U.S. 120 V, 15A, 60 Hz	161-0066-12
1	Instruction Manual	070-6960-00
1	Interfacing Guide	070-7315-00
1	Quick Reference Card	070-7316-00
2	Rack Rail Sets	351-0375-01
4	Screws	212-0672-00
4	Washers	210-0910-00
4	Nut Assemblies	220-0805-00

**TABLE 1-3
OPTIONAL ACCESSORIES**

Description	Tektronix part number
Service Manual	070-6963-00
GPIB Cables, Double Shielded, Low EMI	
1 meter	012-0991-01
2 meters	012-0991-00
4 meters	012-0991-02
Type N male to SMA male adapter	015-1009-00
SMA female to female adapter	015-1012-00
Type N male to BNC female adapter	103-0045-00
Type N male to GR adapter	017-0021-00

The instrument options are discussed in Section 5 of this manual.

PREPARATION FOR USE

- Operating Power Information
- Environmental Considerations
- Rackmounting
- Switch Settings
- External Interfacing
- Incoming Inspection
- Packaging for Shipment

OPERATING POWER INFORMATION

Safety

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

Line Voltage

The SCD1000 and SCD5000 operate from either a 120 V or 240 V nominal ac power source with a line frequency ranging from 48 Hz to 440 Hz. The line voltage selector on the rear panel indicates the voltage source required by the waveform recorder (Figure 2-1). Before connecting the power cord to a power source, check that the voltage at the power source falls within the selected voltage range listed on the label near the line voltage selector. If the line voltage of the instrument needs to be changed, use a small-blade screwdriver to switch the line voltage selector on the rear panel.

CAUTION *This instrument may be damaged if operated from a power source line voltage outside the range shown on the label near the line voltage selector on the rear panel. Damage may also occur if the wrong size power input line fuse is installed in the rear panel of the instrument. If the instrument is set for 120 operation and is connected to a 220 power source, an internal line fuse will blow. It should be replaced only by a qualified service person.*

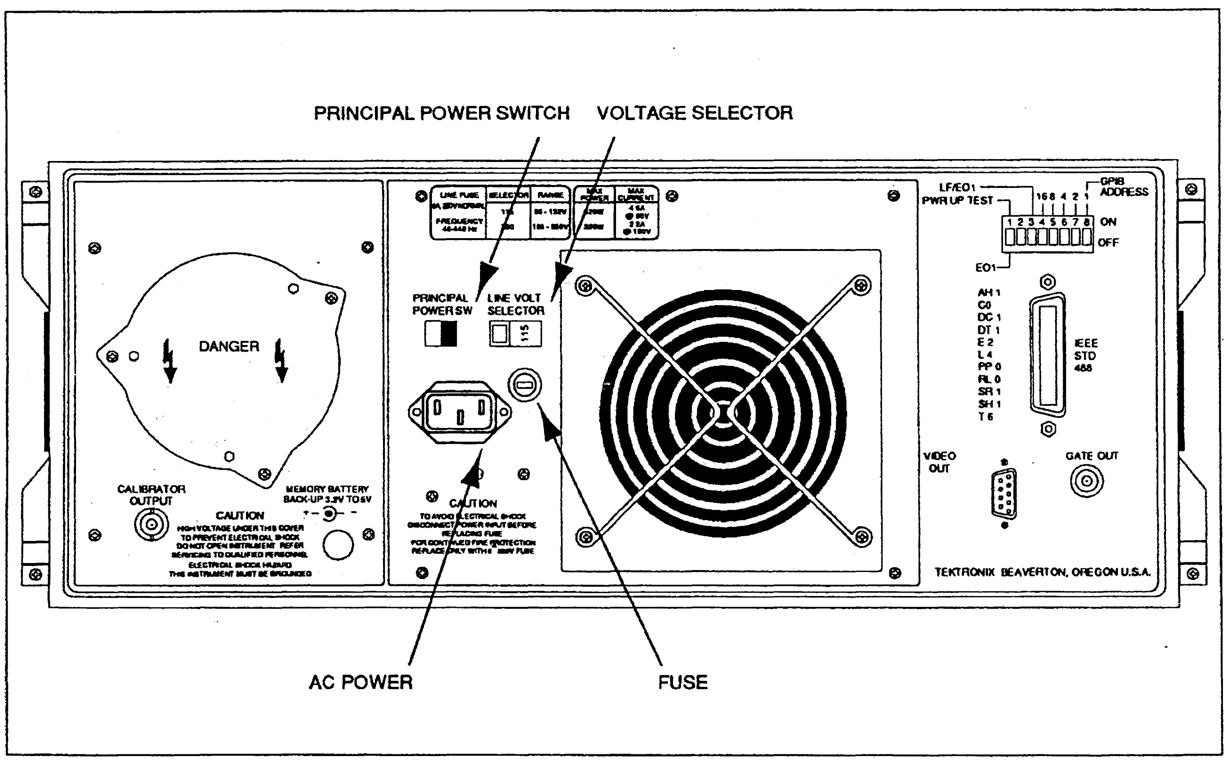


Figure 2-1. Line Voltage Selector, Line Fuse, Power Cord Receptor

Line Fuse

To verify the proper value of the instrument's power input line fuse, perform the following:

1. Unplug the instrument from line voltage.
2. Press in the fuse-holder cap and release it with a counterclockwise rotation.
3. Pull the cap (with the attached fuse inside) out of the fuse holder.
4. Verify the proper fuse value (Table 2-1).
5. Install the proper fuse, if required, and reinstall the fuse-holder cap by carefully pushing it in while rotating it clockwise (CW).
6. Plug the instrument into line voltage receptacle.

TABLE 2-1
LINE VOLTAGE RANGES & FUSES

Line Voltage Indicator	Voltage Range	Line Fuse
115 V, nominal	90-132 Vac	6A, 250 V, normal blow
230 V, nominal	180-250 Vac	6A, 250 V, normal blow

Power Cord

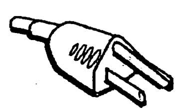
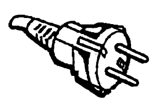
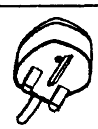
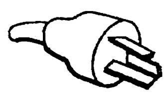
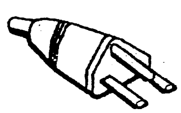
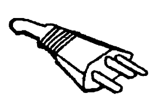
This instrument has a detachable three-wire power cord with a three-contact plug for connection to both the power source and protective ground (Figure 2-1). The protective ground contact on the plug connects (through the power cord protective grounding conductor) to the accessible metal parts of the instrument. For electrical shock protection, insert this plug into a power source outlet that has a properly grounded protective-ground contact.

WARNING **This instrument operates from a single-phase power source, and has a detachable three-wire power cord with a two-pole, three-terminal grounding-type plug. The voltage to ground (earth) from either pole of the power source must not exceed the maximum rated operating voltage of 250 volts.**

Before making connection to the power source, be sure that the voltage selector is set to match the voltage of the power source and that the power source receptacle has a suitable plug (two pole, three-terminal, grounding type). Do not defeat the grounding connection. Any interruption of the grounding connection can create an electric shock hazard.

Instruments are shipped with the required power cord as ordered by the customer. Information on the available power cords is presented in Table 2-2. Part numbers are listed in Section 5, Options.

TABLE 2-2
POWER CORD AND PLUG ID INFORMATION

Plug Configuration	Usage	Nominal Line-Voltage (AC)	Reference Standards	Option #
	North American 120V 15A	120V	[1] ANSI C73 .11 [2] NEMA 5-5-P [3] IEC 83	STANDARD
	Universal Euro 220V/16A	240V	[4] CEE (7), II, IV, VII [3] IEC 83	A1
	UK 240V 13A	240V	[5] BS 1363 [3] IEC 83	A2
	Australian 240V/15A	240V	[6] ASA C112	A3
	North American 240V/15A	240V	[1] ANSI C73 .20 [2] NEMA 6-15-P [3] IEC 83	A4
	Switzerland 220V/10A	220V	[7] SEV	A5

1 ANSI – American National Standards Institute
2 NEMA – National Electrical Manufacturer's Association
3 IEC – International Electrotechnical Commission
4 CEE – International Comission on Rules for the Approval of Electrical Equipment
5 BS – British Standard Institution
6 AS – Standards Association of Australia
7 SEV – Schweizerischer Elektroteknischer Verein

ENVIRONMENTAL CONSIDERATIONS

Instrument Cooling

To prevent instrument damage from overheating, adequate internal airflow must be maintained. A clearance of 2 inches on the side and 1 inch on the rear must be maintained for proper cooling to take place.

Before turning on the instrument, be sure that the air intake and exhaust holes on the instrument are free from any obstructions to airflow. The SCD waveform recorders typically generate 700 Btu's/hour (based on 200 Watts typical power). An internal fan moves 100 cfm of air for cooling. Cooling is automatically regulated according to the power supply temperature.

Temperature

The SCD waveform recorders can be operated in an environment where the ambient temperature is between +5° C and +40° C. For storage lengths over an hour, the temperature should be between -20° C and +60° C. After storage at temperatures outside the operating limits, allow the chassis to reach a normal operating temperature before applying power.

CAUTION *Storage in temperatures below -20° C will damage the Liquid Crystal Display (LCD).*

Humidity

The SCD waveform recorders can be operated in 30% to 85% relative humidity (non-condensing). The instrument can be stored in 20% to 90% relative humidity, (non-condensing).
If condensation occurs on the instrument or any circuitry following storage at low temperatures, allow all condensation to evaporate before applying power to the instrument.

RACKMOUNTING

Refer rack selection and actual installation of rackmounting hardware to qualified service personnel.
The instrument should be mounted using the slides provided with the instrument in the recommended rackmounting configuration, anchoring both front and rear chassis tracks:

- rack height: 7 inches
- rack width: 19 inches
- rack depth: 30 inches
- instrument weight: 54 pounds (see Specifications)

SWITCH SETTINGS

A set of eight switches on the waveform recorder's rear panel set the SCD's GPIB operation and Power-Up Self-Test execution. See Section A of the Instrument Interfacing Guide for setting these switches before operation.

EXTERNAL INTERFACING

Signal Cabling

The SCD waveform recorders allow connection of the following input and output cables. Some channel input parameters vary depending on the model of the waveform recorder. These differences are described below.

SCD1000

- two signal inputs (front panel connectors)
- external trigger input (front panel connector)
- IEEE-488.1 bus using a standard GPIB connector (rear panel connector)
- calibrator signal output (rear panel connector)
- VGA video output (rear panel connector)
- gate signal output (rear panel connector)

SCD5000

- one signal input (front panel connector)
- external trigger input (front panel connector)
- calibrator signal output (front panel connector)
- IEEE-488.1 bus using a standard GPIB connector (rear panel connector)
- VGA video output (rear panel connector)
- gate signal output (rear panel connector)

Signal Inputs

The SCD1000 includes two input channels. (Either of the two signal inputs can be selected or they can be added.) The SCD5000 includes one input channel. Input cables are connected to front panel connectors. The signal inputs have a 50 ohm impedance on both waveform recorder models.

On the SCD1000, input signals can be AC or DC coupled. On the SCD5000, only DC coupling is provided.

DC coupled signals should not exceed 5 Vrms (0.5W into 50), or should be limited to 0.25 Wsec pulses not exceeding 25 V peak. AC coupled signals should not exceed 100 V (DC + peak AC). The AC energy component should not exceed 0.25 Wsec.

CAUTION *When AC coupling signals greater than 25 V DC, set the input coupling to OFF (SCD1000 only) to allow the input capacitor to pre-charge.*

External Trigger Input Signal

An external trigger signal can be connected to the front panel EXT TRIG connector. The DC component of the trigger signal must not exceed 100 V. The AC component should be limited to 0.2 watts average or 25 V peak. The input impedance is nominally 50 Ω.

IEEE 488 Cabling

The IEE-488.1 (GPIB) connector on the rear panel allows waveform recorder control over the GPIB. Connect the IEEE 488 cable (available as an optional accessory) between the rear panel connector and the bus controller or the nearest instrument on the bus. More information on the GPIB is provided in Section 6. GPIB cabling and interconnection conventions must be observed for proper operation.

Video Output

The SCD's are configured at the factory for providing video signals compatible with VGA video monitors (640 x 400 lines resolution). See Figure 2-2. Internal jumpers on the MPU circuit board can be set to alter the signal pinout and polarity for monochrome displays and video copy processors. See the Service Manual for additional information.

PIN	SIGNAL
1	Ground
2	N/C
3	Video
4	Video
5	Video
6	Horizontal Sync
7	N/C
8	Vertical Sync
9	N/C

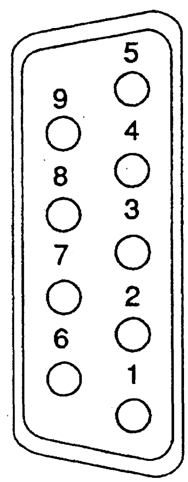


Figure 2-2. VIDEO Connector Pinout (Factory configuration).

SCD Rear Panel	MULTISYNC TTL (DIGITAL) INPUT COLOR MONITOR 15 PIN D CONNECTOR
1	5 (Ground)
2	
3	1 (Video)
4	2 (Video)
5	3 (Video)
6	13 Horiz. Sync.
7	
8	14 Vert. Sync.
9	

Figure 2-3. Adapting the rear panel connector to a VGA monitor connector.

INCOMING INSPECTION

Introduction

The tests in this section should be run in the order indicated. After the instrument has had power applied for 20 minutes, Test 1 (Diagnostics) should be run to ensure that the instrument is in general working order. If diagnostics fails, the instrument should be returned to an authorized service center for servicing. After diagnostics has passed, Test 2 should be run to ensure that the internal standards are within specification. If they are outside the limits, the performance of the instrument cannot be guaranteed, and the instrument should be returned to an authorized service center for servicing. Test 3 (Internal Calibration) should then be run before proceeding with instrument operation.

NOTE

This procedure is only intended to verify the general operation of the instrument. It DOES NOT verify that the instrument meets all specifications. In order to verify that the instrument meets all specifications, use the Performance Verification Procedure in Section 4 of the SCD1000/SCD5000 Service Manual (Part Number 070-6963-00).

If at any time during the tests the instrument fails to meet a test limit, then it should be returned to an authorized service center for servicing, identifying the test failed and limits exceeded.

The test should be run in a stable environment with the temperature between 20° C and 30° C and provisions made for adequate airflow to the instrument (i.e. the ventilation ports on the rear, sides, and front should be unobstructed). The ambient temperature should not change by more than 5° C during the tests.

Line supply should lie within the limits of 90 to 132 v_{rms} or 180 to 250 v_{rms}.

Table 2-3 lists the tests to be run.

TABLE 2-3
LIST OF TESTS FOR INCOMING INSPECTION

Test Number	Test Name	Description
1	Diagnostics	Verifies general operating condition of the instrument
2	Calibrator	Checks internal calibration reference signals
3	Self-Cal	Performs verification of internal timing, vertical gain & offset, and trigger level circuitry of the instrument

Internal Diagnostics and Internal Calibration

Diagnostics and Internal Calibration can be run either from the IEEE-488 interface or the display unit. See section 6, Interfacing Guide, for more information on the associated GPIB commands. See section 3, Operating Procedures, for information about how to invoke Diagnostics and Internal Calibration from the Utility Mode Menu.

The internal diagnostics test the following:

- **PROCESSOR SYSTEM**, including system ROM, RAM, NV-RAM, GPIB system, and system timer module
- **FRONT PANEL**, including the LCD, front panel circuitry, & MPU front panel interface
- **ACQUISITION SYSTEM**, including functioning of the digital acquisition control and data path

Internal calibration performs the following:

- **VERTICAL**

SCD1000 Sets the gain and offset range, and the Normal and Invert offset zero level for Channels A, B, and Add.

SCD5000 Sets the input range, offset range, and the offset zero level.

- **HORIZONTAL**

Sets Window timing accuracy and Trigger Delay minimum and maximum values.

- **TRIGGER**

SCD1000 For DC coupling, sets the internal level range and offset for both slope settings; for internal and external.

SCD5000 Sets trigger level and slope for external trigger.

- **CRT**

For each window size, sets the CRT intensity and focus to be used when an instrument initialize is performed. The initialized intensities are also used to set the current operating intensity for each window size after the CRT cal is run. Sets the orthogonality of the CRT's Write Gun with relation to the Read Gun.

Required Equipment

Table 2-4 lists the required equipment to complete the incoming inspection procedures.

TABLE 2-4
LIST OF REQUIRED EQUIPMENT FOR INCOMING INSPECTION

Instrument Name	Recommended or Equivalent
5 1/2 digit Digital Multimeter (DMM)	Tektronix DM 5120
250 MHz Digital Counter	Tektronix DC 5010
1 MHz Signal Generator	Tektronix SG 503
Miscellaneous Parts	
SCD1000	
Qty. 1: 50 ohm coaxial cable (3 ft long)	Tek PN 012-0482-00
Qty. 2: N to BNC adapters	Tek PN 103-0045-00
SCD5000	
Qty. 1: 50 ohm coaxial cable (3 ft long)	Tek PN 012-0482-00
Qty. 1: 50 ohms coaxial cable (10 in long)	Tek PN 012-0118-00
Qty. 2: N to BNC adapters	Tek PN 103-0045-00
Instrument Controller with IEEE-488 Interface	

Test 1 Diagnostics

The general operating condition of the instrument is ascertained by running the internal diagnostic routines.

Setup

Apply power to the waveform recorder.

Procedure

1. Invoke the internal diagnostic routines via IEEE-488 by sending the instrument the command:

   TEST SYS:ALL

   or

   Invoke the internal diagnostic routines via the optional display unit by selecting the Utility Mode Menu. In the function menu which appears when the Utility Mode Menu is selected, select the Next Menu function. This will cause an alternate function menu to appear. In this menu select the InstTest function. This will invoke a self-test of the entire instrument.

2. If the self-test routines fail, return the instrument to an authorized service center for servicing.

TABLE 2-5
TEST LIST

Number	Name	Subsystem	Description
1	Real-time Clock	MPU	Checks for proper operation of the clock used to set the waveform time stamps.
2	GPIB	MPU	Confirms operationof the GPIB system excluding the bus drivers.
3	Bus Error	MPU	Forces a MPU bus error to confirm the bus error detection circuitry is operational.
4	Timer	MPU	Tests the timer used by the operating system for operation at the proper interrupt rate.
5	ROM0 Part Number	MPU	Checks the MPU board EPROM location and does checksum test
6	ROM1 Part Number	MPU	Same as test 5
7	ROM2 Part Number	MPU	Same as test 5
8	ROM3 Part Number	MPU	Same as test 5
9	Display Unit ROM Part Number	MPU	Check for the proper EPROM on the Front Panel circuit board.
10	NVRAM	MPU	Checks the NVRAM on the MPU board.
11	Video	FP	Checks the RAM on the MPU board used for the LCD display.
12	Button	FP	Checks the push button logic on the Front Panel board.
13	Front Panel Communication	FP	Confirms the link between the MPU and the Display's Front Panel circuit board.
14	Digital Acquisition With Memory Test	DIG	Checks the waveform recorder's control system.
15	Digital Acquisition Without Memory Test	DIG	Checks the waveform recorder's control system and memory.
16	Serial Bus	DIG	Confirms the internal serial communications bus is operational.

Test 2

Cal Time Frequency

Setup

The accuracy of the internal calibration reference signal is verified using a digital counter.

Refer to Figure 2-5 for proper connections. Connect the Calibrator Output connector on the rear of the SCD1000 or the front of the SCD5000 through a 50 ohms coax cable to the DC5010 Counter/Timer.

Digitizer Setup

Cal Out	Time
Cal Time	4 ns

Counter Setup

Mode	Period
Trigger Level	Auto (680 mV or 2.1 V for SCD5000)
Trigger Slope	+
Coupling	DC
Attenuation	X1 (SCD1000) X5 (SCD5000)
Termination	50 ohms

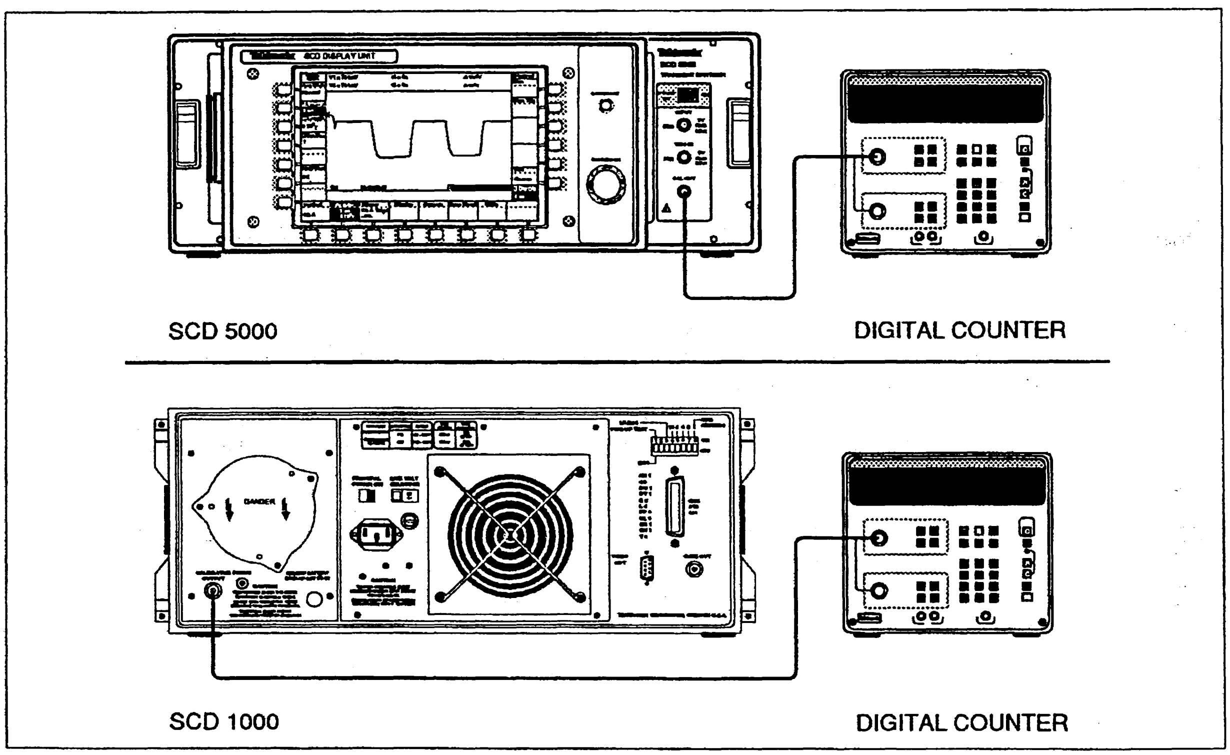


Figure 2-4. Internal Clock Frequency Test Setup

Procedure

1. Set the counter averaging to AUTO (or highest accuracy setting possible).
2. From the Utility Menu (5th level), select EXT CAL (CAL OUT on SCD5000) to Time.
3. Adjusting CAL TIME settings from 4 ns to 80 µs according to the steps in the following table.
4. Verify that the measured period (or frequency) matches the SCD CAL TIME readout value for all settings (4 ns to 80 µs), within 0.1% tolerance:

CALIBRATOR TIMING MEASUREMENTS

Cal Range	Frequency	Tolerance
4 ns	250.000 MHz	±250 kHz
8 ns	125.000 MHz	±125 kHz
16 ns	62.500 MHz	±62.5 kHz
40 ns	25.000 MHz	±25 kHz
80 ns	12.500 MHz	±12.5 kHz
160 ns	6.250 MHz	±6.25 kHz
400 ns	2.500 MHz	±2.5 kHz
800 ns	1.250 MHz	±1.3 kHz
1.6 µs	625.0 kHz	±625 Hz
4 µs	250.0 kHz	±250 Hz
8 µs	125.0 kHz	±125 Hz
16 µs	62.50 kHz	±62.5 Hz
40 µs	25.00 kHz	±25 Hz
80 µs	12.50 kHz	±12.5 Hz

Reference Voltage

The amplitude of the internal voltage reference is verified using a digital multimeter.

Setup

SCD1000 - Connect a Tek DM5120 DMM through a 50 ohm coax cable directly to the Calibrator output connector (The Calibrator Output connector is on the rear of the SCD1000 or the front of the SCD5000).
SCD5000 - Connect a 50 ohm terminator directly to the Calibrator output connector. Connect the DM5120 through a 50 ohm coax cable to the 50 ohm terminator.

Digitizer Setup

Cal Out	Ampl
Cal Ampl	2.50 V

DMM Setup

Mode	DC Volts
Range	Auto

Procedure

SCD1000:

1. From the Utility Menu (5th menu level), select EXT CAL to AMPL.
2. While adjusting CAL AMPL according to the following table, check the calibrator voltage to ±(0.1% + 1mV) accuracy on all ranges:

Calibrator Ampl.	Measurement (min.)	Measurement (max.)
+2.5 V	2.4965 V	2.5035 V
+2.0 V	1.997 V	2.003 V
+800 mV	0.7982 V	0.8018 V
+400 mV	0.3986 V	0.4014 V
+200 mV	198.8 mV	201.2 mV
+80 mV	78.92 mV	81.08 mV
+40 mV	38.96 mV	41.04 mV
0.0 V	+1.0 mV	-1.0 mV
-40 mV	-38.96 mV	-41.04 mV
-80 mV	-78.92 mV	-81.08 mV
-200 mV	-198.8 mV	-201.2 mV
-400 mV	-0.3986 V	-0.4014 V
-800 mV	-0.7982 V	-0.8018 V
-2.0 V	-1.997 V	-2.003 V
-2.5 V	-2.4965 V	-2.5035 V

3. Adjust CAL AMPL to the first of the two values given in the first column of the table below.
4. Mark down the amplitude measured by the DVM = A1.
5. Adjust the CAL AMPL to the second of the two values given in the first column of the table. Mark down the amplitude measured on the DVM = A2.
6. Add the absolute values of A1 and A2 for the Δ Volts measurement: A1 + A2 = Delta Volts.
7. Check the calibrator voltage Δ Volts accuracy to within the specification limits given in the table below.
8. Repeat steps 3 through 7 above for all the rows of the table below.

Calibrator Amp.	Δ V Measurement (min)	Δ V Measurement (max)
+2.5 V, -2.5 V	4.990 V	5.010 V
+2.0 V, -2.0 V	3.992 V	4.008 V
+800 mV, -800 mV	1.597 V	1.603 V
+400 mV, -400 mV	798.4 mV	801.6 mV
+200 mV, -200 mV	399.2 mV	400.8 mV
+80 mV, -80 mV	159.7 mV	160.3 mV
+40 mV, -40 mV	79.84 mV	80.16 mV

SCD5000:

1. From the Utility Menu (5th menu level), select CAL OUT to AMPL.

2. While adjusting CAL AMPL according to the following table, check the cali brator voltage to ±(0.1% + 1mV) accuracy on all ranges:

Calibrator Ampl.	Measurement (min.)	Measurement (max.)
+4 V	+3.995 V	+4.005 V
+3 V	+2.996 V	+3.004 V
+2 V	+1.997 V	+2.003 V
+1 V	+0.998 V	+1.002 V
+0.5 V	+498.5 mV	+501.5 mV
0.0 V	+1.0 mV	-1.0 mV
-0.5 V	-498.5 mV	-501.5 mV
-1 V	-0.998 V	-1.002 V
-2 V	-1.997 V	-2.003 V
-3 V	-2.996 V	-3.004 V
-4 V	-3.995 V	-4.005 V

3. Adjust CAL AMPL to the first of the two values given in the first column of the table below.

4. Mark down the amplitude measured by the DVM = A1.

5. Adjust the CAL AMPL to the second of the two values given in the first column of the table. Mark down the amplitude measured on the DVM = A2.

6. Add the absolute values of A1 and A2 for the Δ Volts measurement:
   A1 + A2 = Δ Volts

7. Check the calibrator voltage Δ V accuracy to within the specification limits given in the table below.

8. Repeat steps 3 through 7 abovc for all of the rows in the table.

Calibrator Ampl.	Δ Measurement (min.)	Δ Measurement (max.)
+4 V, -4 V	7.984 V	8.016 V
+3 V, -3 V	5.988 V	6.012 V
+2 V, -2 V	3.992 V	4.008 V
+1 V, -1 V	1.996 V	2.004 V
+0.5 V, -0.5 V	0.998 V	1.002 V

Test 3
Internal Calibration

Internal timing circuitry, vertical gain, offset gain, and trigger level gain of the instrument is verified by running the internal calibration routines. A calibration-in-process may be terminated by pressing any front-panel key or sending any GPIB command.

Setup

Apply power to the waveform recorder. If calibrating a SCD5000, connect a cable from the front panel Cal Out to the input.

Procedure

1. Invoke CRT calibration routines via IEEE-488 by sending the instrument the command:

   CALIBRATE CRT

   After intensity is calibrated (which takes approximately 2 minutes), the waveform recorder will prompt the user. At this time, connect a 1 MHz 80 mV_{p-p} signal from the SG503 to the CHA input connector of the SCD1000. If an SCD5000 is being calibrated, connect a 1 MHz 3 Vp-p signal from the SG503 to the input connector of the instrument. Press any front panel button for the CRT calibration to continue.

   The instrument will wait approximately 1 minute for the user to connect the proper signal and press any menu button. If the instrument times out (> 1 minute), it will report a calibration failure for the CRT. If this happens, run CRT calibration again, making sure to connect the proper signal within the time limit. (The user will hear the bell "ticking" while waiting for the user to connect the signal and press a button. The "ticking" speeds up as timeout approaches.)

2. For SCD 5000's connect the calibrator output to the signal input using the 8" cable.

3. Run system calibration routines via IEEE-488 by sending the instrument the command:

   CALIBRATE ALL

   The instrument will wait approximately 1 minute for the user to connect the proper signal and press any menu button. If the instrument times out (> 1 minute), it will report a calibration failure for the CRT. If this happens, run CRT calibration again, making sure to connect the proper signal within the time limit. (The user will hear the bell "ticking" while waiting for the user to connect the signal and press a button. The "ticking" speeds up as timeout approaches.)

4. If the calibration routines fail, return the instrument to an authorized service center for servicing.

PACKAGING FOR SHIPMENT

It is recommended that the original carton and packing material be saved for shipping the waveform recorder. If the original materials are unfit or not available, package the instrument as follows:

1. Use a corrugated cardboard shipping carton having a test strength of at least 275 pounds and with an inside dimension of at least six inches greater than the instrument dimensions.

2. If the instrument is being shipped to a Tektronix Service Center, enclose the following information:
   - the owner's address,
   - name and phone number of a contact person,
   - type and serial number of the instrument,
   - reason for return,
   - a complete description of the service required.

3. Completely wrap the instrument with polyethylene sheeting, or an equivalent, to protect the instrument case and to prevent entry of harmful substances into the instrument.

4. Cushion the instrument on all sides using three inches of padding material or urethane foam, tightly packed between the carton and the instrument.

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

6. If the instrument is being shipped to a Tektronix service center, mark the address of the Tektronix Service Center and also your own return address on the shipping carton in two clearly visible locations.

OPERATING INSTRUCTIONS

- Instrument Familiarization
- Initial Instrument Setup
- Operator's Procedures
- Examples
- Acquisition Concepts
- Acquisition/Display Models
- Instrument Function Reference

INSTRUMENT FAMILIARIZATION

Front Panel Controls, Connectors, and Indicators

The SCD1000 and SCD5000 can be controlled either over the GPIB using the waveform recorder's command set, or from the Display Unit. The command set follows the IEEE-488.1 GPIB protocol and is described in Section 6 of this manual. Frequent references in this section of the manual are made to the command set. Refer to Section 6 for more information when necessary. Control of the instrument from the Display Unit is described in this section.

Front panel controls and indicators of the SCD1000 and SCD5000 waveform recorders are located around the Display Unit. The Display Unit can be removed from the instrument as described in Removing/Replacing Display Unit later in this section. Controls and indicators of the Display Unit are described later in this section.

CAUTION *Removal and installation of the Display Unit must be done with the instrument power turned off.*

The following descriptions cover both the SCD1000 (Figure 3-1a) and SCD5000 (Figure 3-1b) waveform recorders. A description that applies to only one of the instruments is noted in the description.

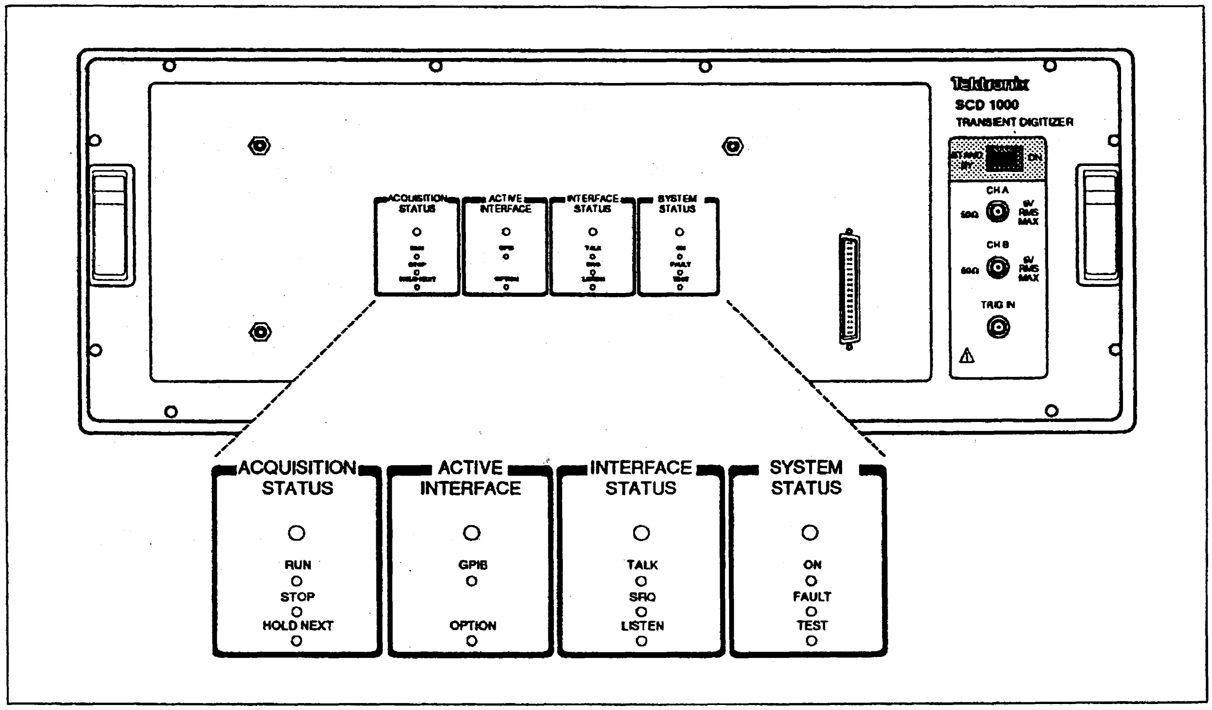


Figure 3-1a. SCD1000 Front Panel Controls, Connectors, and Indicators

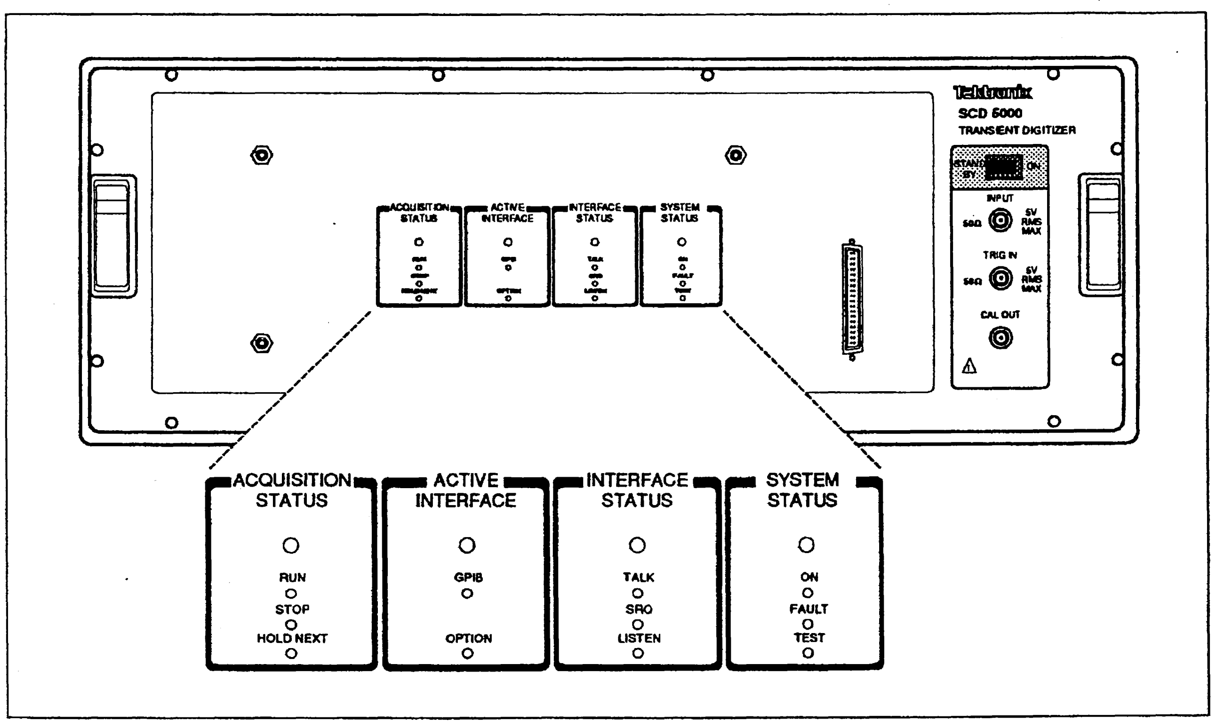


Figure 3-1b. SCD5000 Front Panel Controls, Connectors, and Indicators

Front Panel Controls

ON/STANDBY Switch: Turns the instrument ON and OFF when the rear panel principal power switch is ON.

Connectors

DISPLAY UNIT: Connects to the Display Unit when attached. This is the signal and power interface between the waveform recorder and the Display Unit.

CHA/CHB (INPUT SCD1000 Only): Provides input connections for signal acquisition. Input impedance is 50 ohms when the waveform recorder is turned on. Impedance is 500 K ohms when the power is turned off.

CAL OUT (SCD5000 Only): Outputs the calibrator signal selected from the Utility Menu or GPIB. On the SCD5000, this signal must be physically connected to the input connector using a cable when calibrating the instrument. On the SCD1000, the CAL OUT connector is located on the rear panel, but an internal signal path to the inputs is provided for calibration. A cable is not required.

EXT TRIG: Provides connection for triggering on an external signal.

Indicators

The following indicators are located on the mainframe's front panel, behind the Display Unit.

ACQUISITION STATUS:

RUN (green): Lights to indicate the waveform recorder is running, digitizing, and storing data.

STOP (red): Lights to indicate no digitization is in process.

HLDNEXT (yellow): Lights to indicate the waveform recorder is in the HoldNext state. An acquisition has taken place, but no further acquisitions will take place until the waveform recorder is started again.

ACTIVE INTERFACE:

GPIB (green): Lights to indicate the GPIB interface is active.

OPTION (yellow): Reserved for future use.

INTERFACE STATUS:

TALK (green): Lights to indicate the waveform recorder is TALK addressed.

SRQ (red): Lights to indicate the waveform recorder has asserted the GPIB Service Request Line.

LISTEN (yellow): Lights to indicate the waveform recorder is LISTEN addressed.

Front Panel Indicators (cont)

SYSTEM STATUS:

ON (green): Lights when the waveform recorder has been turned on (both the rear panel principal power and front panel ON/STANDBY switches are on).

FAULT (red): Lights to indicate that a fault condition has occurred during the power-up self-test.

TEST (yellow): Lights to indicate the waveform recorder's internal test routines are in process.

Rear Panel Controls, Connectors, and Indicators

The SCD1000 and SCD5000 rear panels differ slightly. The SCD1000 rear panel contains the CAL OUT connector, while the SCD5000 has the connector on the front panel. Otherwise the rear panels are identical. Rear panel controls, connectors, and indicators are shown in Figure 3-2a (SCD1000) and Figure 3-2b (SCD5000).

Controls

PRINCIPAL POWER SWITCH: Turns ac power to the waveform recorder on and off. This switch must be ON to turn on the waveform recorder.

LINE VOLTAGE SELECTOR: Selects the ac line voltage to be either 110 V or 220 V nominal.

REAR PANEL FOCUS: The rear panel focus does not require adjustment. See the Service Manual for information.

INSTRUMENT SWITCHES: Set various waveform recorder operating parameters, including Power-up test bypass, GPIB terminator, and GPIB address. Figure 3-3 illustrates these switches.

The address switches are binary-encoded switches (1, 2, 4, 8, and 16). Setting the switch to ON is equivalent to its binary value. The sum of the values equals the GPIB address. Addresses 0 through 30 are valid operating addresses. The factory-set address for the SCD1000 is 4; the SCD5000 address is 5. Address 31 is equivalent to OFF BUS.

Refer to Section 6 of this manual for more information on switch settings.

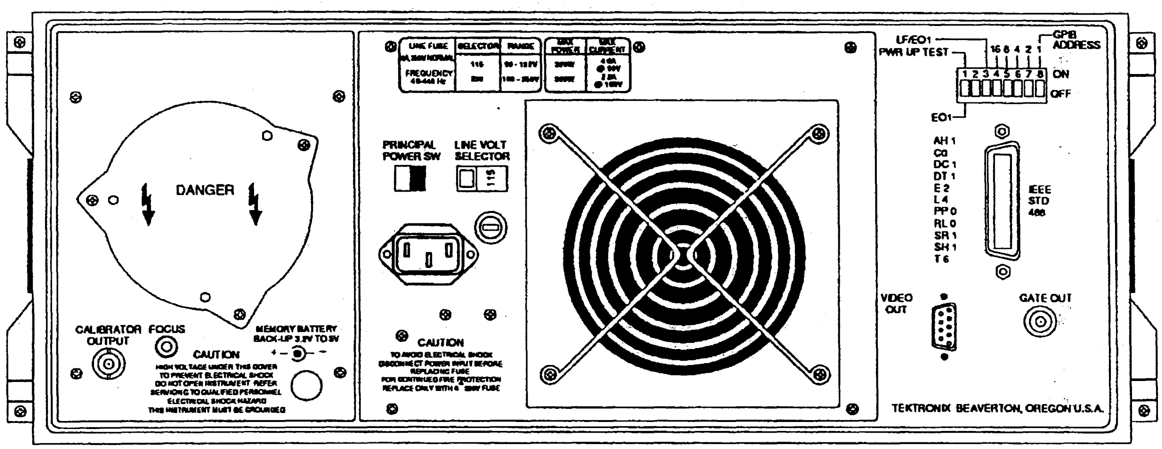


Figure 3-2a. SCD1000 Rear Panel Controls, Connectors and Indicators

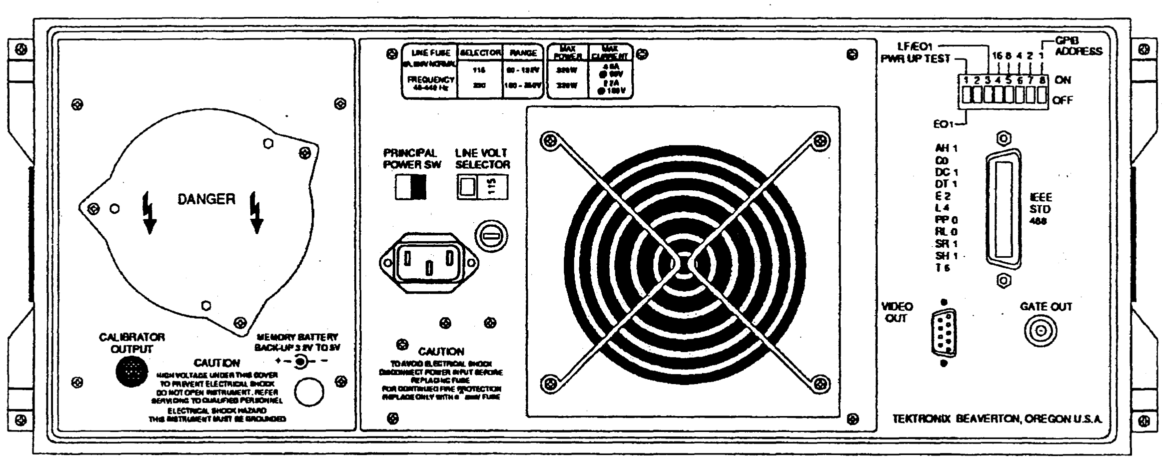


Figure 3-2b. SCD5000 Rear Panel Controls, Connectors and Indicators

Connectors

AC POWER INPUT: Accepts 98 to 250 V nominal power source from 48 to 440 Hz.

FUSE HOLDER: Contains the ac line fuse (6 A, 250 V, normal blow for 115 V or 230 V operation).

GPIB CONNECTOR: Compatible with IEEE-488.1 cable connector.

VIDEO OUT: Supplies VGA-compatible video signal for connection to a monitor or hardcopy unit.

GATE OUT: Supplies a TTL-level signal that goes HIGH when the acquisition sweep begins to write the input signal onto the target.

CALIBRATOR OUT: (SCD1000 only.) Outputs calibrator signal. See **CAL OUT** (SCD5000 only) earlier in this section.

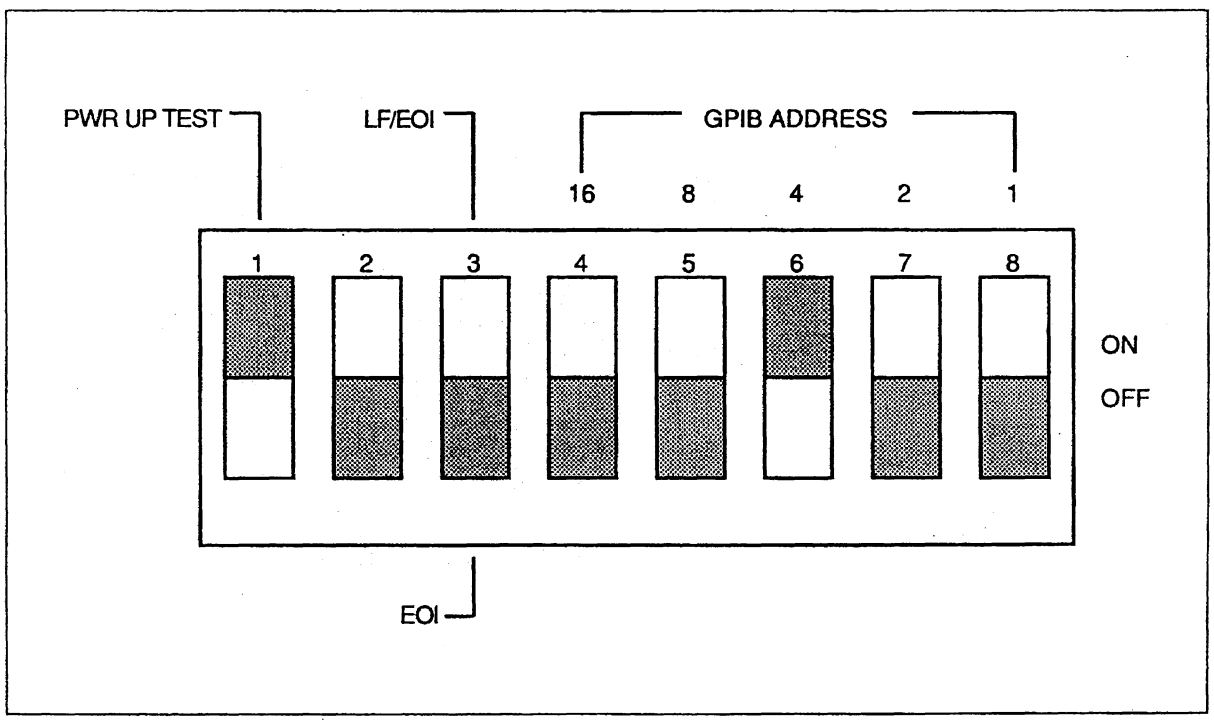


Figure 3-3. Instrument Switches

INITIAL INSTRUMENT SETUP

Power ON

Before turning on the power for the first time, be sure to read the Operator's Safety Summary and Section 2, **PREPARATION FOR USE.**

CAUTION *If the waveform recorder has been stored in an environment outside its specified operating temperature, do not turn on the power until the instrument has stabilized to an ambient temperature within its specified operating temperature range. If moisture has collected on the instrument, allow the moisture to evaporate before powering up.*

The waveform recorder has two power switches: the **PRINCIPAL POWER** switch (on the rear panel) and the **ON/STANDBY** switch (on the front panel). To power up the instrument, first make sure the rear panel PRINCIPAL POWER switch is ON, then turn on the front panel ON/STANDBY switch.

Power OFF

To turn the waveform recorder completely off, first set the front panel ON/STANDBY switch to STANDBY, then turn off the rear panel PRINCIPAL POWER switch.

Before powering off during a normal power-off sequence, the waveform recorder stores in non-volatile memory the current instrument settings. These settings are re-established when the waveform recorder is later powered up. If power is turned off or interrupted during a self-test or while performing a normal operation, the instrument may not properly save these settings. The settings are then set to factory default.

In addition to saving the current settings, up to 10 different instrument settings can be saved in non-volatile memory for quick recall. Saving settings can be done over the GPIB (SAVE command) or from the Display Unit. Refer to Section 6 of this manual for more information on the SAVE command. The Display Unit's SaveRecall functions are described later in this section.

Self-Test & Diagnostics

The SCD waveform recorders perform internal self-test routines each time the instrument is powered up. The power-up self-test can be bypassed by setting the rear panel switch PWR UP TEST switch to OFF. Power-up self test routines require no user interaction.

If any test fails, the following occur:

- the instrument attempts to run while reporting an Internal Error event code over the GPIB (see Section 6D of this manual for Event Codes)
- the front panel FAULT indicator (beneath the Display Unit) lights to indicated a fault
- a descriptive message is displayed in the Message/Measurements Zone of the Display Unit.

Self-Test & Diagnostics (cont)

The power-up self-test consists of two parts: the **Kernel Tests** and the **Essential Diagnostics Tests**. Kernel tests include the microprocessor, processor RAM and ROM, and the GPIB communication system tests. These tests verify that all the resources needed by the operating system are working.

Once the kernel tests have passed, the operating system is activated.

The first task of the operating system is to execute the Essential Diagnostics tests, which assure that all basic subsystems properly function. No kernal or essential diagnostics are performed in "Hurry-up" mode.

Self-test can also be initiated over the GPIB (using the TEST command) or from the Display Unit. See Section 6 for more information on the TEST command.

The SCD waveform recorders also provide calibration routines for the following subsystems. These routines are only initiated from the Display Unit or over the GPIB, and are not part of the power-on sequence.

CALIBRATE HORIZONTAL: Performs self-calibration of the horizontal sweep circuits.

CALIBRATE TRIGGER: Performs self-calibration of trigger circuits.

CALIBRATE VERT: Performs self-calibration of Gain and Offset vertical circuits.

CALIBRATE CRT: Performs self-calibration of the CRT circuits.

CALIBRATE ALL: Executes all calibration routines.

Refer to Section 6C of this manual for more information on the CALIBRATE command. The Display Unit calibration function is described later in this section.

Initialization

Once the power-up self-test has successfully completed, the SCD waveform recorders automatically returned to the settings that existed prior to the power being turned off. If initialization to factory default settings is desired, initialization can be invoked from the Display Unit or over the GPIB. Over the GPIB, the instrument settings (Panel), the GPIB (GPIB), or both can be initialized. From the Display Unit menus, any mode, function, or the entire instrument (Panel) can be initialized. Initialization procedures are described later in this section.

Table C-17 in Section 6C lists the factory default settings for the SCD waveform recorders.

OPERATOR'S PROCEDURES

Display Unit Overview

The SCD waveform recorders can be controlled over the GPIB or from the Display Unit (shown in Figure 3-4 attached to a waveform recorder). The instrument's GPIB command set is described in Section 6. The Display Unit is described in the remainder of this section.

The Display Unit provides instrument control and display of digitized waveform data and instrument status on a high-resolution Liquid Crystal Display (LCD). Instrument control is through several "soft keys" around the perimeter of the LCD. Key functions change depending on the operating mode of the instrument and the soft keys previously pressed. A label displayed on the LCD next to a key defines the current function of that key.

The Display Unit plugs into the waveform recorder. It is easily removed as described in Removing The Display Unit below.

The LCD is a backlit, high-resolution display (640 x 400 pixels). Up to 64 characters by 16 rows of text can be displayed on the screen. A CONTRAST adjustment knob allows changes in contrast.

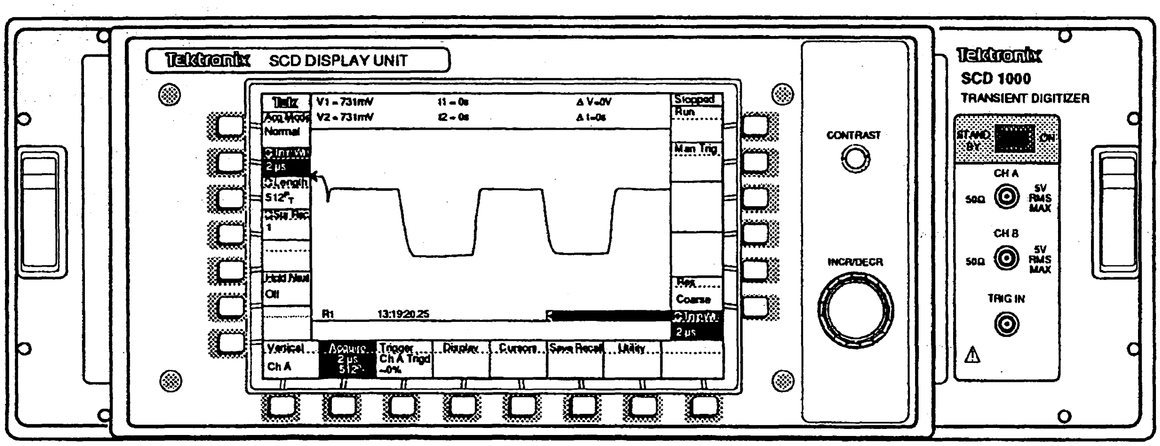


Figure 3-4. SCD1000 Waveform Recorder With Display Unit Attached

Removing/Replacing Display Unit

The Display Unit is a removeable device. It is attached to the waveform recorder front panel by four "clasps" that engage posts on the instrument's front chassis. The clasps are engaged and disengaged by the handle on the left side of the Display Unit (see Figure 3-5). By firmly pulling the handle to the left, the clasps are disengaged. The Display Unit can then be removed by pulling the unit forward, away from the waveform recorder.

When re-installing the Display Unit, make sure the handle is completely pulled out. Place the Display Unit onto the waveform recorder, making sure the display connector properly mates. Slide the handle to the right to engage the clasps and secure the Display Unit to the waveform recorder.

CAUTION *Make sure the handle is pressed all the way in. If the handle is not pressed in all the way, the Display Unit is not secured to the instrument, and it may fall off.*

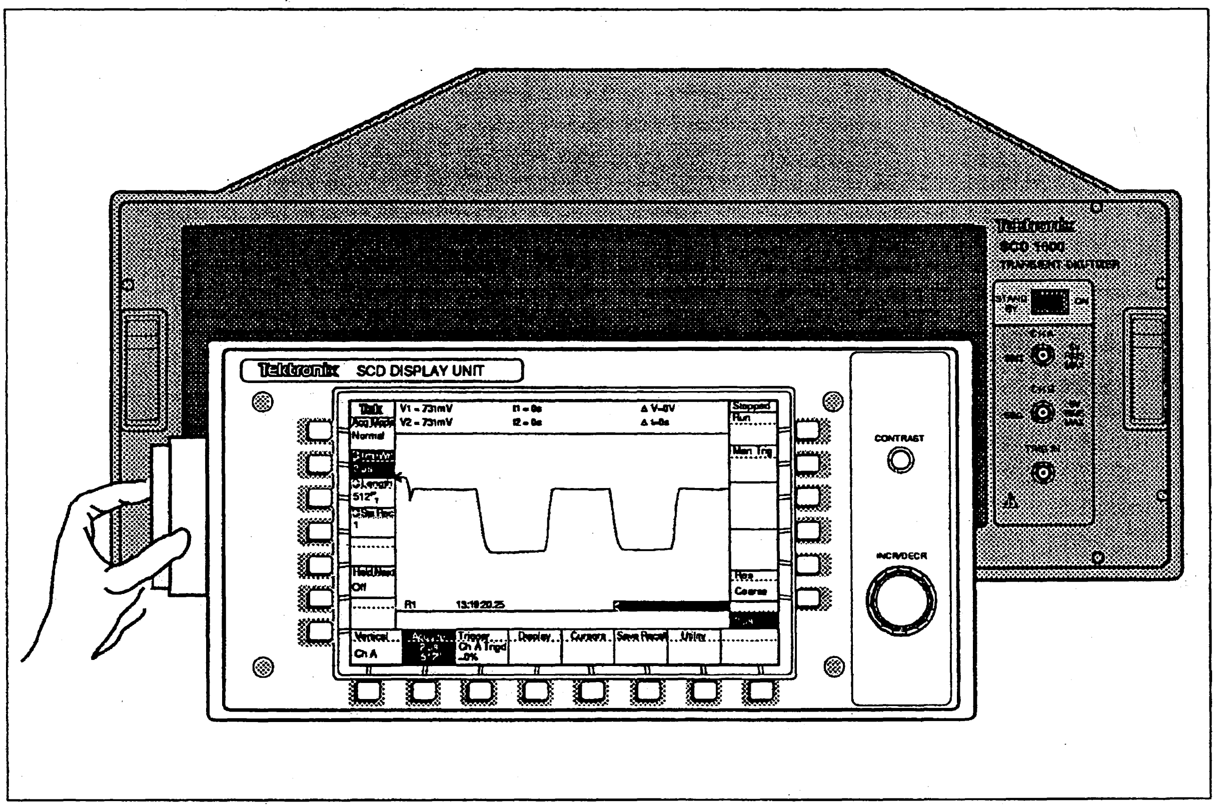


Figure 3-5. Securing the Display Unit

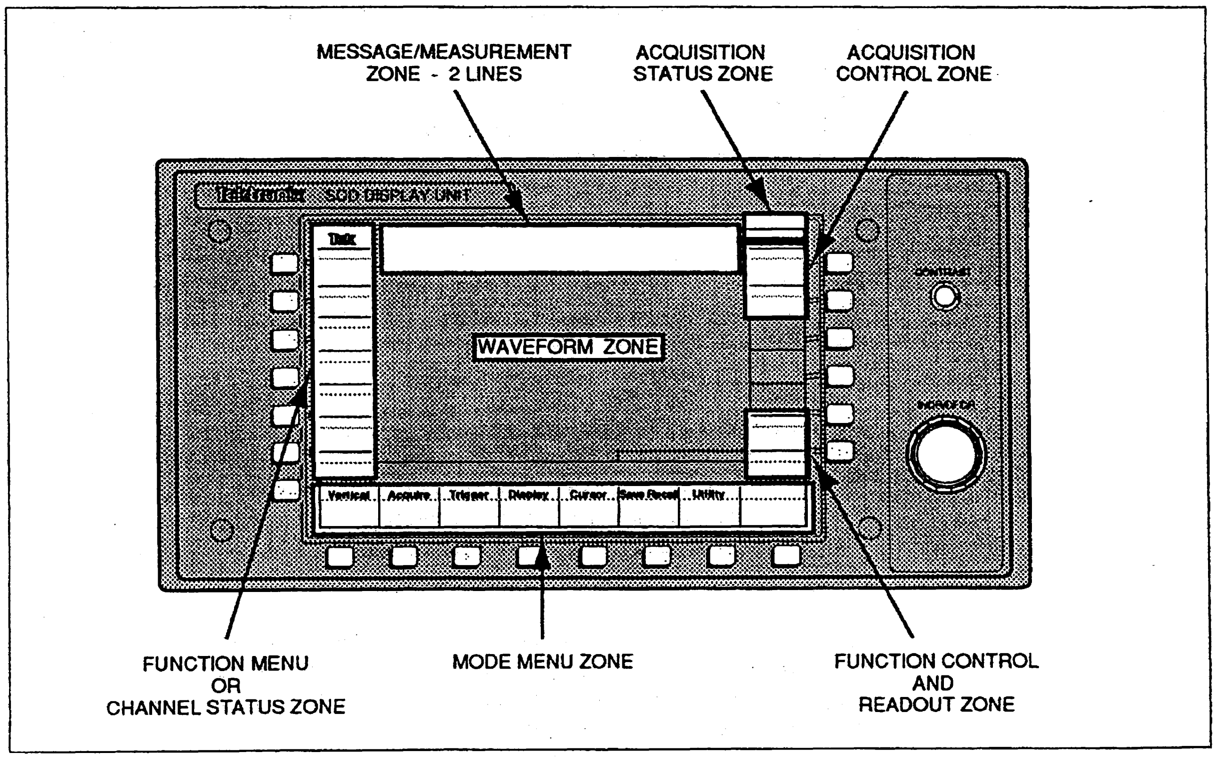


Figure 3-6. Display Unit Display Zones

Display Unit Operation Zones

The Display Unit includes six display zones, as illustrated in Figure 3-6. These zones contain soft key menus and settings, waveform data, messages, and waveform recorder status information.

Mode Menu Zone

The mode menu zone is always displayed when the Display Unit is on. Mode menu labels are described in Key Labels above.

Function Menu/ Channel Status Zone

This zone displays the function key labels when a mode is active or vertical channel status information when no mode is active.
Each channel's status includes the vertical mode (Ch A, Ch B, or Add), vertical range and coupling, offset value, and the vertical expansion factor.

Acquisition Status Zone

This zone displays the current state of the waveform recorder:
Stopped indicates the system has stopped acquiring data.
Running indicates the system is acquiring data.
HoldNext indicates the system has completed an acquisition and the HoldNext acquisition mode is on.

Knob Readout Zone

This zone displays the last parameter that was set by the knob and its current value. Turning the knob affects the value in this zone.

Message/Measurements Zone

This zone displays error messages, warning messages, or measurement results from the two cursors or expansion point. When any error or warning occurs from the front panel or the GPIB, an appropriate error/warning message is written in the message zone. This message remains until a new message replaces the current one, or until a cursor position is changed or the Cursors mode key is activated. The last 10 messages are saved and can be recalled using the SaveRecall functions.

Cursors must be turned on for measurement information to be displayed.

Cursors

Cursor measurements include absolute time and voltage for each cursor and the Δt (or 1/t) and Δ amplitude between the cursors. The cursors can be assigned to the same display window or different display windows.

This zone is shared amongst all functions that use it, so the information displayed here is a result of the last function that used it. None of the functions has priority over any other function; this means if an error message is displayed in the area and the cursor function is requested, the cursor will display its readout in the area, overwriting the error message. The last ten messages are saved in nonvolatile memory, from where they can be reviewed with the RECALL STATUS function of the SaveRecall mode (described later in this section of the manual).

Waveform Zone

This zone displays waveform data in 1, 2, or 4 windows. Each window can display one waveform and several indicators. Waveform displays with one window, two windows, and four windows are shown in Figures 3-7, 3-8, and 3-9. Waveform zone indicators are shown in Figure 3-10.

The horizontal axis for each window covers 512 sample points. The vertical axis for each window covers 256 sample points (1 window), 128 sample points (2 windows), or 64 sample points (4 windows).

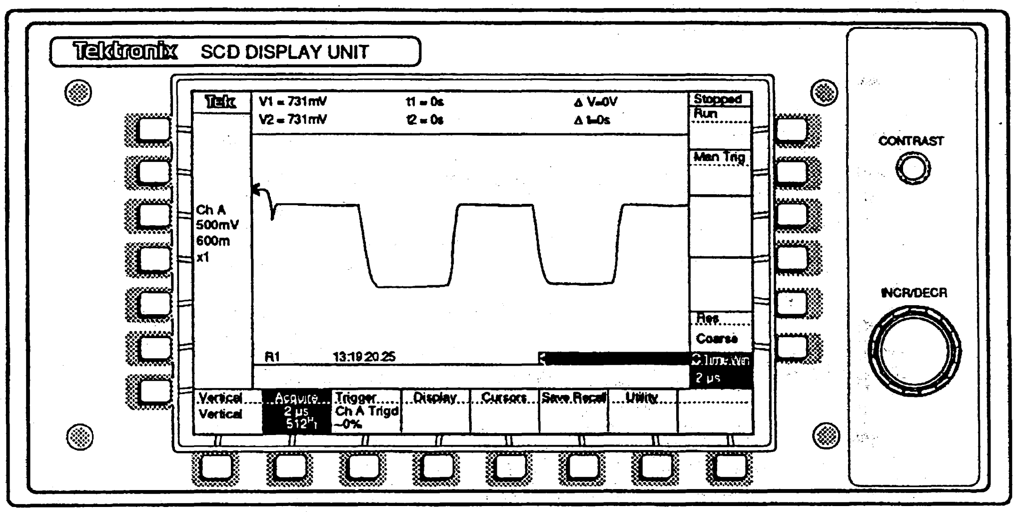


Figure 3-7. Single Waveform Displayed

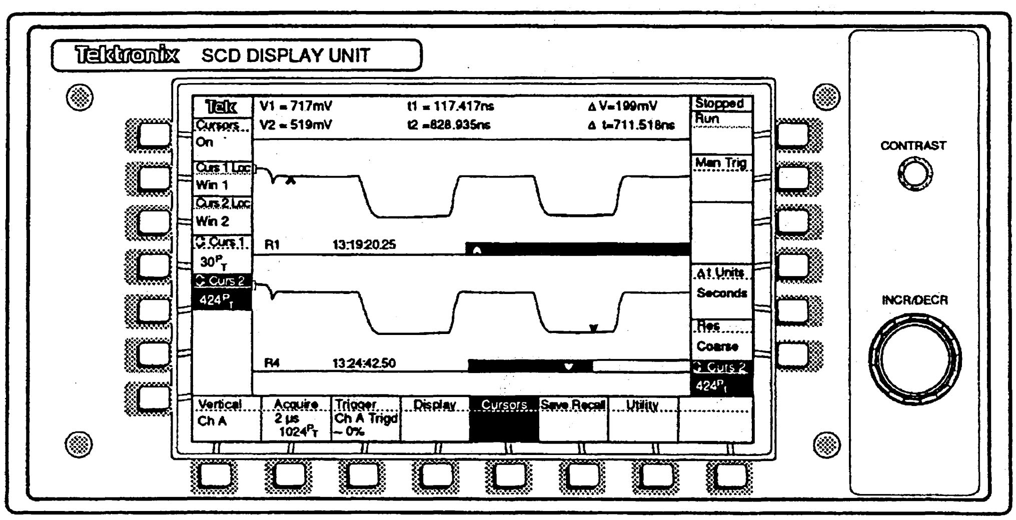


Figure 3-8. Two Waveforms Displayed

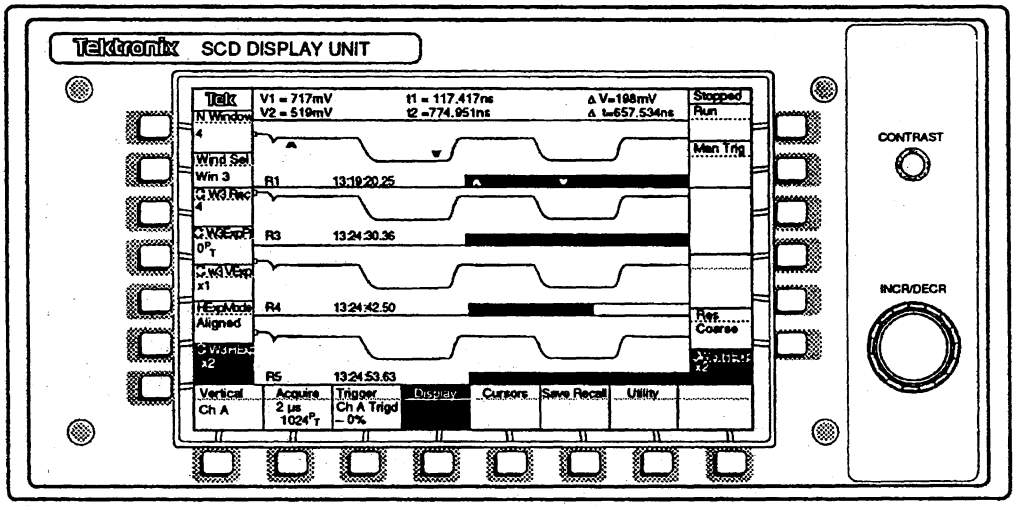


Figure 3-9. Four Waveforms Displayed

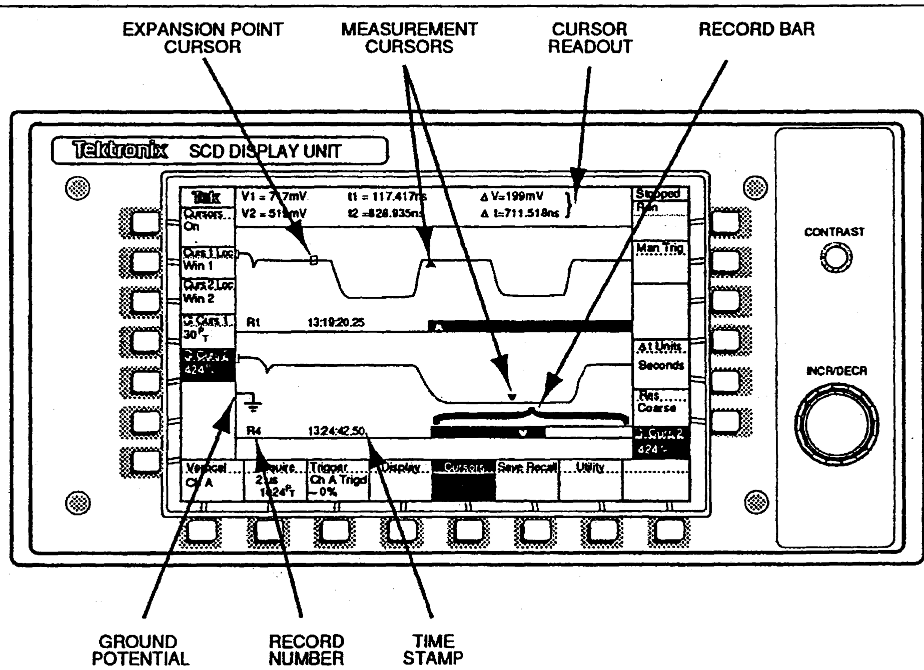


Figure 3-10. Waveform Zone Indicators

Display Unit Operation

Keys

Keys around the display are labelled on the LCD to indicate what a key will do when pressed. Keys are grouped into different functional groups. In addition, a large knob allows quickly setting numeric parameters accessed by some soft keys as explained later. Figure 3-11 identifies the key types and knob. The following paragraphs describe each group and the knob.

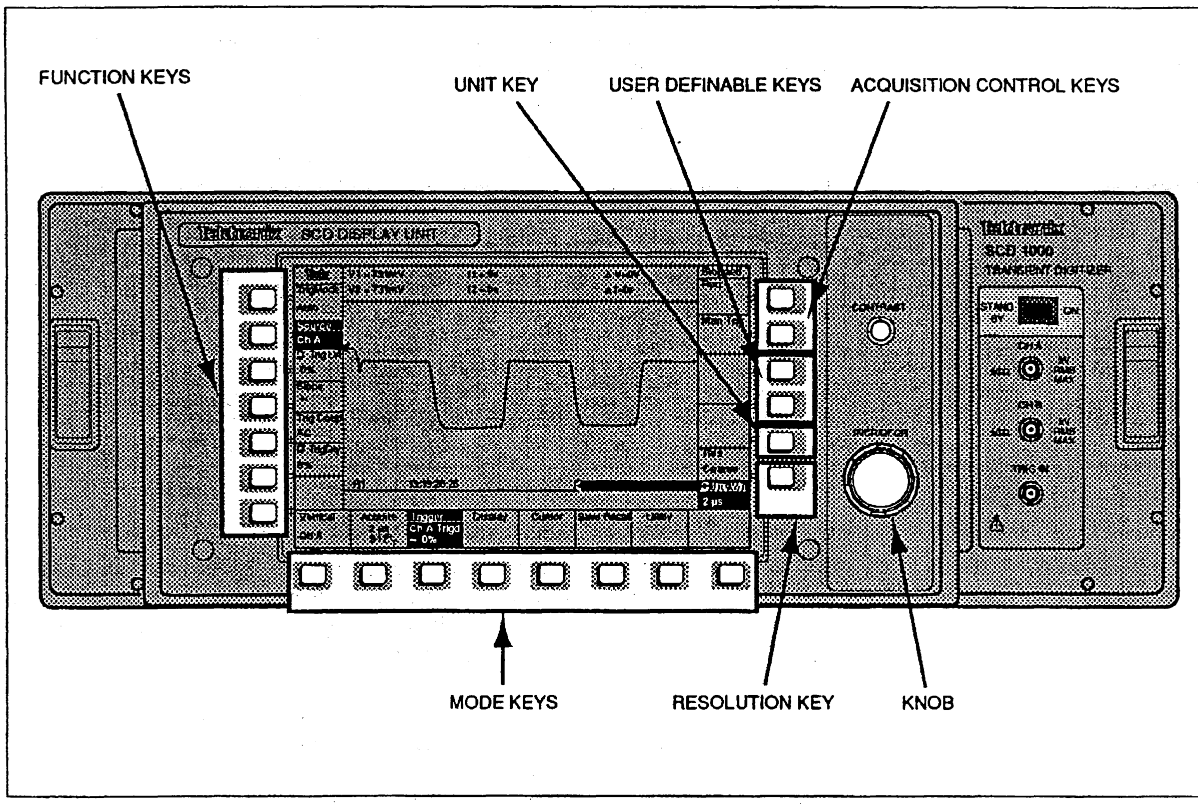


Figure 3-11. Display Unit Key Types and Knob

Display Unit Operation (cont)

Acquisition Control Keys

Manual Trig: Triggers the waveform recorder and forces an acquisition to start. The waveform recorder must be in the Run or HoldNext state for manual trigger to initiate an acquisition.

Run/Stop: Immediately stops any acquisition in progress. "Stopped" appears above the key label. If stopped, pressing the key causes the system to reset and begin the acquisition process, displaying "Running" above the key label. If the acquisition state is HoldNext, the label above the key displays "HoldNext" when the waveform recorder is ready to acquire data and awaits a valid trigger. When acquisition is completed, the stopped state is entered.
Instrument control from the Display Unit is more responsive when acquisition is stopped.

Mode Keys

The mode keys along the bottom of the Display Unit select one of the setup modes (Vertical, Acquire, Trigger, Display, Cursors, SaveRecall, and Utility). The mode keys allow changing waveform recorder parameters associated with a common group of functions such as the vertical input parameters, trigger parameters, etc. Modes are described in Function Reference in this section.

When a mode key is pressed, the label is displayed in reverse video (white text on a black background) to indicate the mode is active. If a mode key is active, a function menu appears along the left side of the LCD next to the soft keys (Function Keys). When no mode is active, the area next to the function keys displays waveform vertical status information (explained in Display Zones).

The function keys select a single parameter to be changed. When a function key is pressed, the label is displayed in reverse video to indicate it has been selected. If the parameter has a numeric value, the value is changed using the knob. If the parameter value is indicated by text, such as AC, it is changed by pressing the function key. Functions are described in Function Reference in this section.

Function Keys

Although there are seven function keys, the number of functions depends on the selected mode. Some modes, such as SaveRecall, use all seven function keys. Other modes, such as Utility, have more than seven functions. When more than seven functions are required, a NextMenu key selects the next group of functions.
Function key menu labels are always replaced with Channel Vertical Status information when no mode key is active.

User-Programmable Keys

User-programmable keys can be defined (both labels and functions) by the user. The key labels and functions are programmed by GPIB USER commands. When a user-programmable key is pressed, it generates a unique SRQ and Event Report over the bus. See Section 6 for more information.

Units Key

The units key changes the units for some of the numeric values adjusted using the knob. For example, when the cursor 1 position key is selected, the cursor can be positioned with the knob in terms of seconds or points. The units key selects the units used.

Resolution Key

The resolution key selects the size of step when incrementing or decrementing a numeric value. The step size varies with the parameter. The selections are Coarse (large step) or Fine (small step).

Knob (Incr/Decr)

The knob increments or decrements a waveform recorder parameter with a numeric value, such as Time Window, Record Number, Start Record, etc. A readout to the left of the knob indicates the function being adjusted and its current numeric value. As the knob is turned, the value increments or decrements depending on the direction the knob is turned. A "click' sounds for every incremental or decremental step if the knob beeper is turned on.

The knob always affects the most recently selected function with a numeric value. Although another function that does not have a numeric value is selected after the knob has been used, the knob can still change the function labelled next to the knob. This allows the user to adjust parameters such as cursor placement, after changing non-numeric parameters such as input coupling.

Using the Mode and Function Keys

The following steps describe how to change a parameter using the mode and function keys:

1. Select a mode by pressing one of the mode keys.

The selected mode label is displayed in reverse video. To deselect a mode, press the key again or press another mode key. Appropriate function keys appear in the function key zone when a mode is active. Each function key label includes its current value.

2. Select a function to change by pressing the desired function key.

If the functional parameter value is indicated by text (e.g., AC), change it by pressing the function key repeatedly until the desired value is displayed.

If the functional parameter value is a numeric (indicated by a knob icon in the label), turn the knob to increment or decrement the value. Press the Units key if available to change the units of the values. Press the Resolution key to change the step size of the value.

Key Labels

Function keys are identified by labels when a mode is activated. When no mode is active, the function key labels are removed, and waveform vertical status information is displayed in place of the labels.

Function key labels include the function key name with the current functional setting shown below the name. As the setting is changed, either with the function key or knob, the setting changes. (If the setting is changed with the knob, the setting also appears next to the knob.)

Mode key labels are not removed. They always identify the group of functions the mode keys affect. In addition to the mode name, some mode key labels include some settings of the mode as follows:

Vertical displays the current vertical mode (Ch A, Ch B, Add, or External). (SCD1000 only.)
Acquire displays the current time window setting and the current record length (256, 512, or 1024 points).
Trigger displays the source, slope, and delay of the trigger event.
Display is blank.
Cursor is blank.
SaveRecall is blank.
Utility is blank.
Typical mode key values displayed in the menu label are shown in Figure 3-6 and Figure 3-11.
Display Zones

Waveforms

Waveforms can be captured horizontally as 256, 512, or 1024 sample points. The acquisition record length determines the number of sample points used to capture the waveform. All waveforms are digitized to 2048 levels of vertical resolution. Since the window's horizontal axis is 512 sample points, waveforms captured with 256 sample points will cause every other pixel to be illuminated on the display.

Waveforms can be expanded vertically and horizontally to show the sampled data in more detail. However, only waveforms captured with 1024 sample points can be expanded horizontally by a factor of 2. When vertical and horizontal expansion factors are 1, the waveform is scaled to fit within the display window. The number of windows displayed and the vertical expansion factor affect the ratio of displayed points to sampled points along the vertical axis (amplitude). See the expansion descriptions in Function Reference later in this section for more information.

Record Number

The record number identifies the currently displayed record. The record is selected by a function key (Wx Rec) in the Display mode.

Time Stamp

The time stamp indicates the time of day the data was acquired. The date/time clock of the waveform recorder is used to determine the acquisition time. The date/time clock is set using the Utility mode functions.

Ground Potential Indicator

The small ground symbol is used to indicate ground potential. If the signal offset is greater than the vertical range of the window, the ground indicator may not be displayed in the window.

Cursors

If turned on, cursors are identified by "v" and "^" symbols. Cursors do not have to be placed in the same window.

Record Bar

The record bar provides an approximate indication of the current display and the cursor locations relative to the entire record. The portion of the record that is currently displayed is shown as a black band in the record bar. If the entire record is shown on screen, the rectangle is completely black. Only when a 1024 sample record is horizontally expanded will the record bar indicate a partial record display.

Cursor locations in the record bar are indicated by the v and ^ symbols.

EXAMPLES

The following examples are provided to help the new user become familiar with some of the basic functions of the SCD waveform recorders.

In addition to the SCD waveform recorder you will need the following:

Quantity	Description
1	SCD1000 or SCD 5000 transient waveform recorder with display unit and Type N connectors
1	PG502 Pulse Generator in Tektronix TM500 mainframe or equivalent
2	Type N male to BNC female adapter, Tektronix PN 103-0045-00
2	BNC cables

Initial setup

In this section the instrument is powered up and initialized to a known state.

1. Verify the PRINCIPLE POWER switch located on the rear of the instrument is OFF. Verify that the ON/STANDBY switch located on the front panel is set to STANDBY.

2. Plug the power cord into an appropriate ac power source outlet supplying the correct nominal voltage (check the line voltage switch on the rear panel). Verify that the PUPTST dip switch (switch number 8) is on (set to 1).

3. Set the PRINCIPLE POWER switch ON. Press the ON/STANDBY switch to the ON position. The SCD1000/SCD5000 will perform a self test. If the self test fails, an error message is displayed on the display unit.

4. Allow the instrument to warm up for at least 20 minutes (for maximum accuracy).

5. Press the SAVE/RECALL button located on the bottom of the display unit. Press the INIT button twice to reset the instrument to a predefined state. You should see a ground trace on the display unit.

Acquiring a signal

The following instructions show how to acquire and display a signal from a pulse generator. A Tektronix PG502 Pulse Generator (risetime <1 ns) is recommended for this tutorial. If a PG502 is unavailable, use a generator with a fast risetime.

NOTE

This example assumes that the instrument is starting from default settings.

Step	Product	Description
1	SCD1000 SCD5000	Connect the PG502 output to the SCD1000 CHA input Connect the PG502 output to the SCD5000 CH input and connect trigger out to Ext trigger in.
2	PG502, PG503 or equivalent	Set the PG502 250 MHz pulse generator as follows: • Output (Volts): Low level: -2 V, High level: 2 V • Period: ≤4.5 ns (Set variable X5, about 12 noon position) • Pulse Duration: ≤2 ns (Set variable fully counter clockwise, X1) • Back Term: Out
3	SCD1000 SCD5000	Set SCD1000 as follows: • Press SAVE/RECALL, then press INIT button twice to initialize the SCD1000 to factory settings. • Press VERTICAL, select : range: 5 V (SCD1000 only) • Press ACQUIRE, select: TIMEWIND: 5 nS • Press TRIGGER, select: MODE: Normal TRIGGER LEVEL: 15% TRIG DELAY: 1.000 nS • If SCD is not acquiring, press Run/Stop button (upper right button)
4	SCD1000 or SCD5000	Now that a signal is being displayed, some of the advanced features of the SCD waveform recorder can be utilized.

Making cursor measurements

Step	Function	Description
1	Run/Stop	• If SCD is acquiring, press Run/Stop button (upper right button) to enter the STOPPED state.
2	Cursor	• Press CURSORS button, then CURS 1 to select cursor 1. • Turn the INCR/DECR knob to move cursor to desired location (for example, 178 pt).
3	Cursor	• Press CURS 2 button to select cursor 2. • Turn the INCR/DECR knob to move cursor to desired location (for example, 326 pt).
4	Top of Display	The top of the display has absolute voltage (V1 & V2), absolute time (t1 & t2) and relative time & voltage (Δt & ΔV) measurements.

Notes:

1. The user can select the type of timing measurement, either time or 1/time (frequency). This is selected by pressing the UNITS button (lower right side) near the INCR/DECR knob.

2. If more than one window is displayed, the cursors can be placed in any window. For example, cursor 1 can be in window 1 and cursor 2 can be in window 4. Each window can display a different record.

3. For best efficiency for cursor measurements, it is best to place the waveform recorder in the Stopped state before executing cursor measurements.

4.Cursors must be turned off to run Debug mode.

SCD Scanning Setup

The scan converter tube must properly be set up for accurate capture of all waveforms, especially for fast transient events. ACQUIRING DATA later in this section explains the concepts and reasons for proper adjustment. Without proper adjustment, the write beam can over-write the target, producing erroneous waveform data, or fast waveform transitions can be completely missed.

Two adjustments are provided for setup: Intensity and Focus. Both of these parameters are set at the factory for optimum waveform capture at the fastest writing speed. However, user adjustment of Intensity may be necessary according to the waveform being recorded.

Extremely fast waveform events, such as fast transients and short risetimes may require a higher beam intensity to capture the waveform. Adjustments should be done using a waveform identical or similar to the one being captured.

The utility menu function, Inten, allows adjustment of intensity and viewing of the CRT's target image without centroid processing. The Thresh (Threshold) function and unprocessed target image aids in detecting excessive intensity. Threshold adjustment allows determining how hard the target has been written.

Step	Description
1	Acquire a waveform that is identical or similar to the one to be acquired for final capture.
2	Press the Utility mode key to select utility functions.
3	Press the NextMenu function key until the top function key is Thresh. Notes: The Display Unit displays the acquired waveform data as stored in the linear array. Notice that all waveform points stored for each horizontal position, instead of the just the centroided data, are shown on the display against a graticule. If the intensity is too high, the waveform will appear too thick because of too much waveform data.
4	Press the Intens function key to adjust the intensity. Then re-acquire the waveform.
5	Turn the knob slightly to change the intensity setting. The intensity range is from 0 to 100%. Proper intensity adjustment allows the entire waveform to be clearly written on the Display Unit without the waveform appearing too thick. This adjustment may take some experimenting with to learn the limits of scan conversion capture abilities and the requirements of the waveform.
6	Press the Thresh function to adjust the displayed representation of the target. By adjusting the threshold with the knob, the thickness of the written trace can be seen to vary. With a high threshold setting (63) a very thin or possibly missing portions of the trace can be seen. With a threshold setting of 0 an uninterrupted waveform should be seen. The 0 threshold setting is useful for detecting linear array overflow (see Acquiring Data). Optimum intensity setting occurs when a uniform but thin trace of the waveform is visible using a threshold setting of 63 without blooming of linear array overflow indications when using a threshold setting of 0.
7	To return to normal waveform display, press the NextMenu function key or the Utilities mode key.

Saving and recalling stored instrument setups

Up to ten instrument setups can be stored in non-volatile storage.

SAVE SETTINGS

Step	Function	Description
1	Save/Recall	• Press SAVE/RECALL button, then SAVESEL button.
2	Save/Recall	• Select the setting location (1 to 10) with the INCR/DECR knob
3	Save/Recall	• Press SAVE SET to store the settings in the selected location.
4	Save/Recall	• Press the INIT button twice to reset the instrument to factory defaults. Now go to Recall settings below to recall the stored settings.

RECALL SETTINGS

Step	Function	Description
1	Save/Recall	• Press SAVE/RECALL button, then RCL SEL button.
2	Save/Recall	• Turn the INCR/DECR knob to select the setting to be recalled.
3	Save/Recall	• Press RCL SET to recall settings from the selected location. If SCD is not acquiring, press Run/Stop button to enter the RUN state.

Notes:
1. In the **SAVE/RECALL** menu, there is a button labeled **SECURE**. When this button is pressed twice, it erases all settings and waveform memory.

2. The **INIT** button can initialize all settings by pressing INIT twice. An individual mode (vertical, acquire, etc). can be initialized by pressing the INIT key followed by the desired mode key.

Using Auto-Advance recording

Auto-Advance sequentially fills up to 16 records as fast as the waveform recorder is ready to acquire the waveforms. Auto-Advance can be useful when repetitive, but unique signals (like laser pulses) need to be quickly captured.

Step	Function	Description
1	Run/Stop	• If SCD is acquiring, press RUN/STOP button (upper right button) to enter the STOPPED state.
2	Acquire	• Press ACQUIRE button, select: ACQ MODE: AUTO ADV Note: The only other choice is NORMAL.
3	Acquire	• Verify that STAREC (start record) is set to 1 (it should be after an INIT). If not, press STAREC and using INCR/DECR knob to set to 1. • Press N Rec button • Turn the INCR/DECR knob until the number 16 is displayed.
4	Acquire	• Press HOLDNXT button until ON is displayed. This instructs the SCD to enter the STOPPED state when all 16 records are filled.
5	Run/Stop	• Press Run/Stop button (upper right button) to start acquiring the data. When all 16 events have been captured, the SCD will enter the STOPPED state.
6	Display	• Press DISPLAY button, then press W1 REC. • Turn the INCR/DECR knob to view record 1 thru 16 contents.

Notes:

1. SCD waveform recorders allow the user to select where a waveform is acquired (using STAREC). This means that acquisition into different records can also be done manually by changing the starting record while in the NORMAL mode (1 record acquisition).

2. The start record for Auto-Advance can be any record.

3. Option 1P (fast waveform capture option) increases the capture rate from about 2 waveforms/sec to 10 waveforms per second (512 point waveform).

ACQUISITION CONCEPTS

Scan Conversion

Scan conversion is a method of quickly storing a fast analog signal so that it can be digitized at a slower rate. It is one of the methods of the Fast In, Slow Out (FISO) concept, where a fast signal is captured and held in some analog storage buffer and then slowly read out for digitazation

One simple scan conversion method is to take a picture of the faceplate of a CRT as the trace sweeps. The fast signal now has been captured on film, and one can take a long time to slowly read out the trace deflection versus time. Using film can be expensive and time consuming; this led to another type of scan conversion becoming popular in the 1950s, when the first "true" scan converters consisted of TV cameras pointed at the faceplates of oscilloscopes. This scheme allowed the capture and display of fast signals at TV rates (1/30 sec) provided the trace on the phosphor was bright enough. Unfortunately, the lack of sufficient trace intensity for most measurements kept the scheme from being widely used.

In the Tektronix SCD Series waveform recorders, intensity problems are surmounted by writing the signal directly on a semiconductor diode target at a high rate by a special high bandwidth electron gun. The gaussian charge distribution corresponding to the trace location is stored on the target until read out by a different electron gun at a slower rate. It is the levels detected by the read gun, from the opposite side of the target,that are converted to digital values of the charge level sensed. This avoids all the losses inherent in converting electron energy into light in the phosphor, imaging the light from the phosphor with a lens system, converting the light into a charge distribution on a photosensitive target in a TV camera, and then converting the information into a digital representation of the signal.

The scan-converter tube used in the SCD1000 is shown in Figure 3-12. It consists of two facing electron guns with a silicon diode target array positioned between them. This is conceptually the same as two CRT's joined at a common faceplate. The read and write beams scan regions on opposite sides of the target. The target consists of

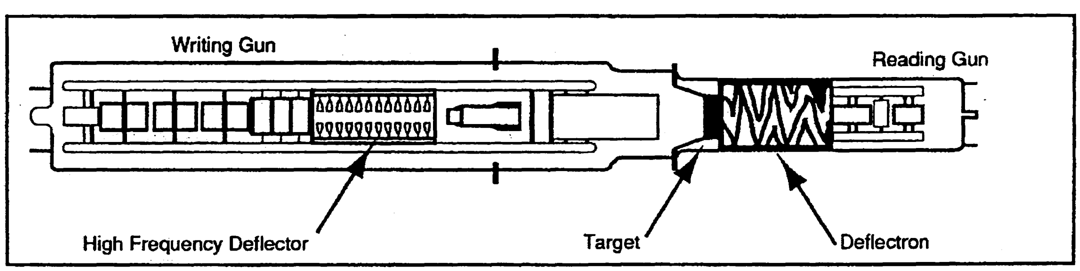


Figure 3-12. The scan converter tube used in the SCD1000

Writing the data

diodes at a density of about 1,000,000 diodes per square centimeter.
The input signal is applied to the high-bandwidth deflection structure of the writing gun which is similar to a high-performance oscilloscope CRT.

The SCD1000 writing gun has a 1 GHz bandwidth with a helical deflection structure driven by the amplified input signal and the horizontal plates driven by a triggered sweep ramp from the time base. The reading gun operates as a high speed video camera, scanning the target using a rectangular raster.

The SCD5000 writing gun is identical to the SCD1000 writing gun, except for a state-of-the-art high bandwidth 50Ω helical deflection structure directly driven by the input signal. The deflection structure for the SCD5000 has a non-gaussian frequency response which allows faster risetime performance than the analog bandwidth usually would suggest. In most instruments, risetime is directly related to the analog bandwidth using the formula:

$$t_{rise} = \frac{350}{\text{Bandwidth (GHz)}} \text{ [psec]}$$

If you measure the SCD5000 analog bandwidth using sine waves, the –3 dB point is ≈4.5 GHz. This gives a calculated gaussian response for the risetime of about 78 psec. If you measure the risetime using a fast step, it typically will be <65 psec. This is because the SCD5000 writing gun attenuates high frequency signals at a slower rate than would be expected with a gaussian response. The deflection structure maintains pulse characteristics without over peaking of the high frequency signal components. The result is a clean step response for extremely fast risetime events.

The silicon diode array target is shown if Figure 3-13. The low-speed reading beam continuously scans the target from top to bottom, left to right as shown in Figure 3-14. This scanning reverse biases each diode in the array.

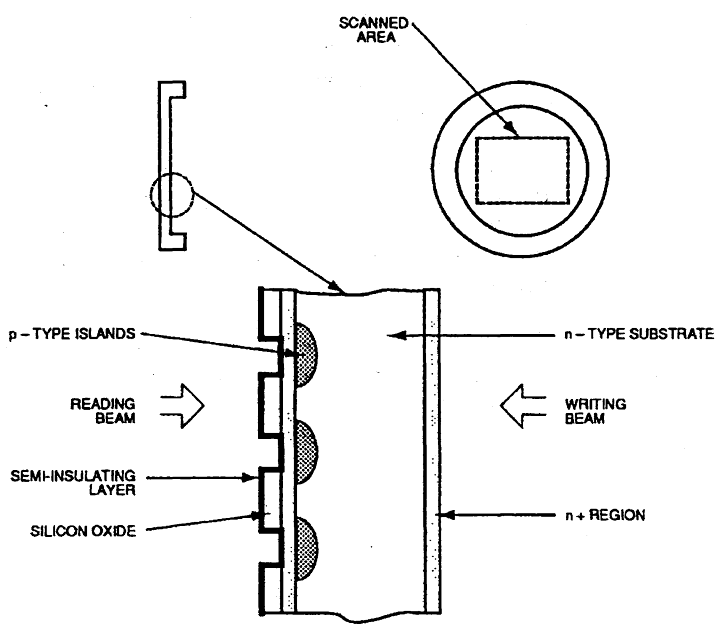


Figure 3-13. Reading and writing beam interaction on target

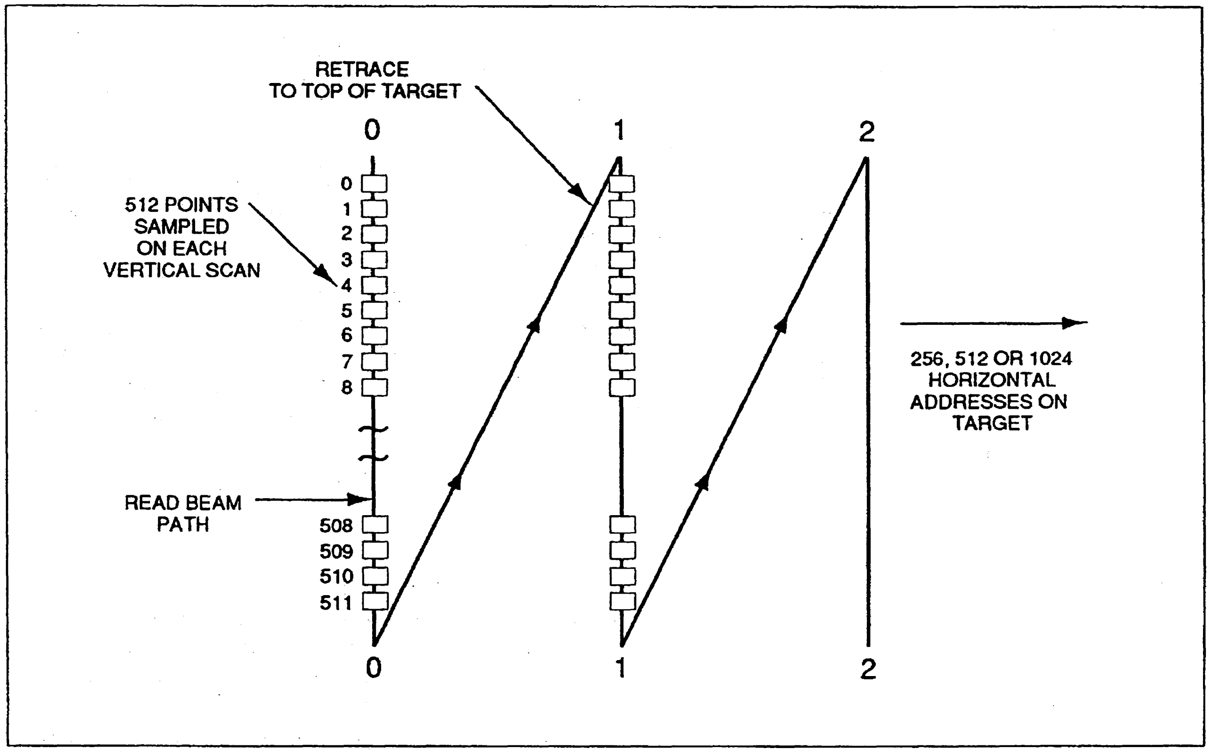


Figure 3-14. Reading gun scans target vertically.

Reading the data

When a high-speed input signal is applied to the SCD Series, the writing gun writes the waveform on the target by discharging the target diodes. Then, as the reading gun scans one of these "written" diodes, read gun beam current flows to reverse bias the diode. The beam current returning to the target is digitized during the vertical scan every 20 nanoseconds to one of sixty-four charge levels.

The resulting lower speed digital signal is used to reconstruct the high-speed input signal. This arrangement of shared target between a fast writing gun and a slower reading gun results in a fast input, slow output waveform recorder which allows high analog bandwidth (up to 4.5 GHz) with high amplitude and time resolution of fast transient events.

The horizontal scan step increment is determined by the selected number of points (either 256, 512, 1024). The larger the number of points, the smaller the horizontal increment of the vertical scan.

Linear & Reference arrays

The digitized charge data is stored in a 256K buffer called the linear array after a reference array (which contains background target information) is subtracted point by point from the raw digitized data. The reference array provides a map of the diode target that allows correction for differences in target element charge capability. The reference array is set at the factory. If an aberration in the target causes problems, the reference array can be updated at any time from the display unit or via GPIB. When the SETREF RUN command is sent via GPIB or the SETREF button is pushed in the utility menu, the SCD waveform recorder scans the diode target and updates the reference array.

The linear array & reference array data is available via the GPIB using LINARRAY? and REFARRAY? queries. The reference array correction can be turned on & off using the SETRef ON|OFF command.

Centroid processing

The electron writing beam and the diode response to the beam is gaussian by nature. Therefore, when a single vertical line is scanned, the charge distribution across that scan will have a gaussian distribution of charge. Centroid processing takes the charge data stored in the linear array and processes the data to find the center of charge resulting in a single vertical value for each horizontal element.

The entire scan conversion process is illustrated in Figure 3-15. In the illustration, the pixels charged from a single vertical scan are digitized using an A/D converter. If the difference between the digitized data from the diode target and the corresponding value from the reference array is greater than the noise floor, then the digitized data is stored in the linear array along with a location tag. The linear array data is then centroid processed and stored into one of sixteen waveform locations.

The reference array, linear array and centroid data is available over the GPIB. Linear array (without centroid processing it is referred to as the target image) and centroid data is available for viewing on the display unit. The reference array can be displayed on the display unit by, for example, sending the commands:

1. Save the current settings: SAVE # (where # is one of the stored setting locations)

2. INIT the instrument: INI

3. Recall the saved settings: RECA#

4. Use the ABStouch command to select the Utility Mode menu: ABS 6,8.

Centroid processing within the SCD functions on a single vertical scan line at a time. The algorithm is a weighted average calculation that transforms X data (current scan line number), Y data (vertical location) and Z data (charge) into a single YT waveform array coordinate. Because the charge distribution is gaussian, a weighted average yields an accurate determination of the peak charge on the vertical scan with the peak representing the center of the trace. The basic algorithm is:

$$Y[X] = \frac{\sum_{i=1}^{n} Y_i * Z_i}{\sum_{i=1}^{n} Z_i}$$

Note: n = number of data points in a vertical scan

Centroid processing (cont)

A minimum threshold charge (Z) level is used to provide rejection of low level noise that may appear in the system. This cutoff (Z charge) is calculated as a percentage of the peak for each scan line. The typical value for the threshold is about 30 percent.

The waveform capture rate is largely determined by the time it takes to centroid the linear array data.

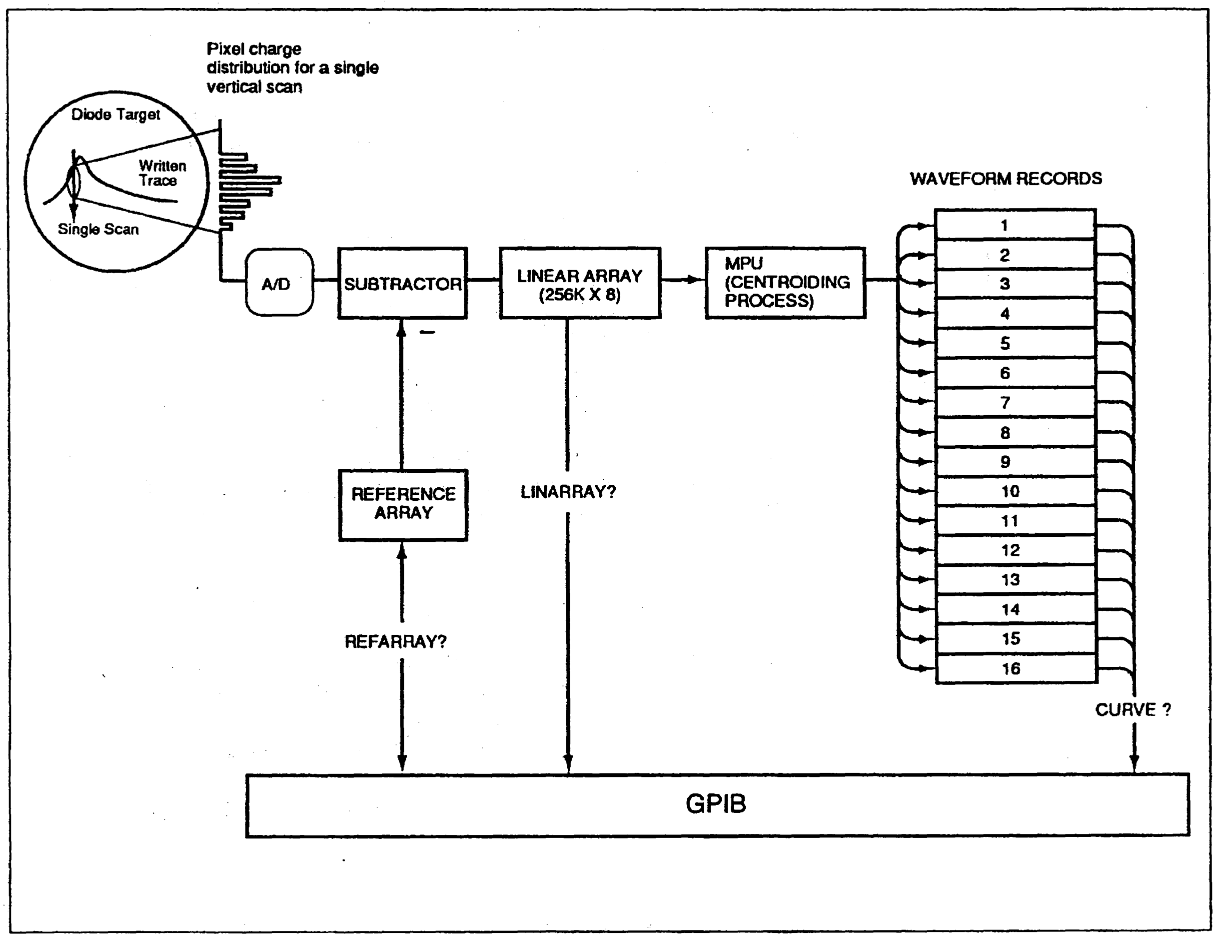


Figure 3-15. Data Storage and Processing.

ACQUIRING DATA

The SCD's operate much like other cathode ray oscilloscopes for viewing waveforms with the centroided display or with the target image. Although this similarity carries over to acquiring data in most respects, some further considerations apply.

Defects

A portion of the scan converter target that is read as data whether or not it is struck by the writing beam is called a defect. While the ideal is no defects, a few may be present on the target (see CRT target specifications).

Defects can be caused by burns that result from too high intensity levels for extended periods. Protective hardware and firmware reduce the possibility of burning, but care should be taken to avoid on-going acquisition of identical signals at high intensity levels. Apparent defects can be caused by improper calibration. Refer calibration to qualified service personnel for adjustment of the instrument within the limits stated in the service manual. Attempts to enhance performance by adjusting the instrument outside these limits can degrade performance, causing such problems as apparent defects, reduced writing rate and inaccurate centroiding.

Defects are normally removed from the target data automatically. The automatic removal can be turned off with the GPIB command SETREF OFF. When on, any areas detected when SETREF was last run are removed. Defects are removed to prevent their interfering with the centroiding process. A defect that falls on a written portion of the target will be subtracted resulting in a void in that small portion of the waveform. The void is not visible on the displayed centroided waveform because as part of the centroiding process any missing points are interpolated. The voids are visible if the target image is viewed using the CRT Setup Utility Mode menu. The areas detected as defects that will produce voids are viewable on the display using, for example, the following GPIB commands:

1. Save the current settings: SAVE # (where # is one of the stored setting locations).
2. INIT the instrument: INI.
3. Recall the saved settings: RECA #.
4. Use the ABStouch command to select the CRT set-up Utility Mode menu: ABS 6, 8.
5. Select the reference array: RAW REFA.

A listing of the defect is obtainable using the REFList? command.

The type of signal being captured along with the intensity, focus, amplitude and time window setting affect the displayed waveform. These factors interact requiring some understanding of their interdependence to obtain best results.

Interpolation

Insufficient write beam intensity will result in portions of the target not being written. This may be the result of too low an intensity or incorrect focus setting, or an abrupt change in the signal as might occur when a fast-edge square wave is captured using a long time window. When a portion of the target is not written, centroiding will interpolate between the previous and next written points with a straight line. Small numbers of missing points will not be noticeable. Large numbers of missing points can produce distorted waveform data. Waveform data contained in the GPIB curve is flagged if the point was interpolated by setting bit 15 (2nd most significant bit) to 1. Acquisitions containing missing points produce an error message. This error message is always generated for acquisitions containing missing points when the acquire mode is Hold Next. If Hold Next is off, the error will only be generated on the first occurance after the acquire state is set to run. It may be impossible to prevent missing points on some waveforms. By limiting the posting of the missing points error message, other messages such as cursor measurements are not interfered with.

Linear Array Overflow

Excessive intensity and/or under sampled signal can produce a linear array overflow error. This occcurs when more than 1/4 of a read scan line detects written data on the target. The most common cause of this error is when a waveform or portion of a waveform contains a large number of transitions in a small enough time that for the current time window setting the individual transitions can not be resolved. The linear array overflow message will be generated and centroiding will produce a line through the center of the area causing overflow. Overflow can be confirmed by viewing the target image with the CRT set-up Utility menu. See Figure 3-16. Like the missing point error message, linear array overflowerror messages will always be generated when Hold Next is on, but will only appear after the first occurance when Hold Next is off.

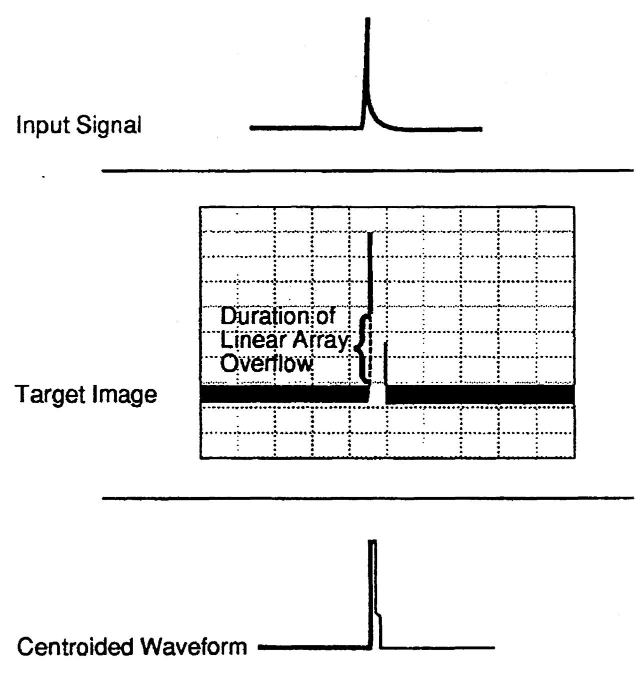


Figure 3-16. Duration of Linear Array Overflow.

Intensity Adjustment

The critical parameter in acquiring data with the scan converter is writing intensity. This is affected by the intensity and focus controls, sweep speed (set by the time window), instrument operating temperature and trace slope (caused by changes in amplitude of the input signal).

A step transition can result in missing data during the transition or blooming before and after the transition (or both). If intensity is set too low, a portion of the trace is missing as shown in Figure 3-17. If intensity is set too high, the trace blooms where it travels more slowly, and the top and bottom portions of the waveform overlap. The solution is to increase the sweep rate, reducing the slope of the transition, and to increase the intensity enough to write the transition.

The Intensity control requires careful attention when digitizing a waveform with a fast transition. Although blooming on the slow portion (top and bottom) of the trace should be avoided.

Another waveform that requires a careful balance between intensity and sweep speed is shown in Figure 3-18. If the intensity is increased to capture the abrupt transition at the top and bottom of the waveform as shown in part b of the figure, blooming causes the peak value to be underestimated when the top and bottom of the trace are centroided. Increasing the sweep speed to reduce the number of cycles for less abrupt tansitions will improve the data.

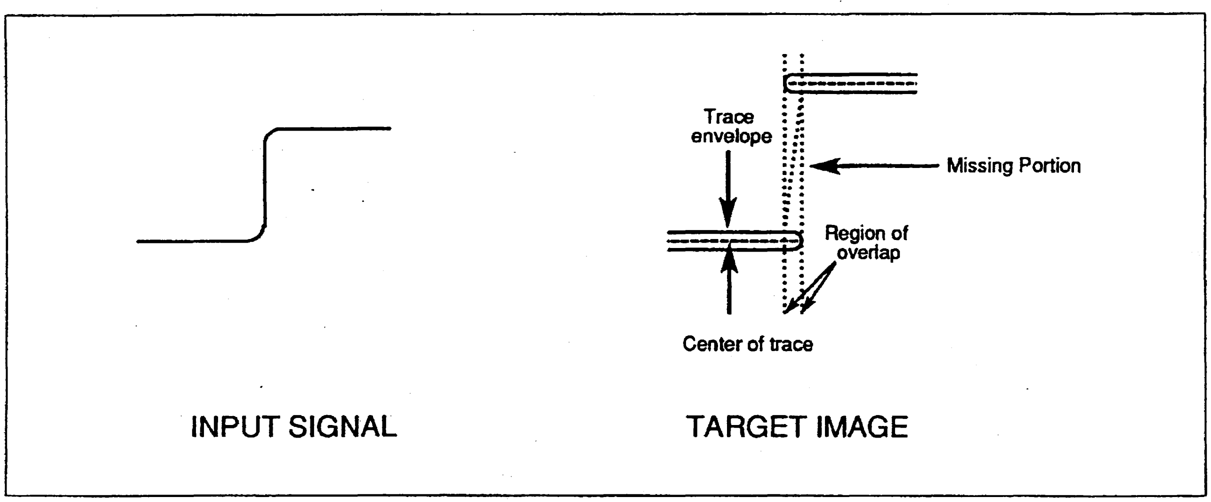


Figure 3-17. Blooming on a step transition.

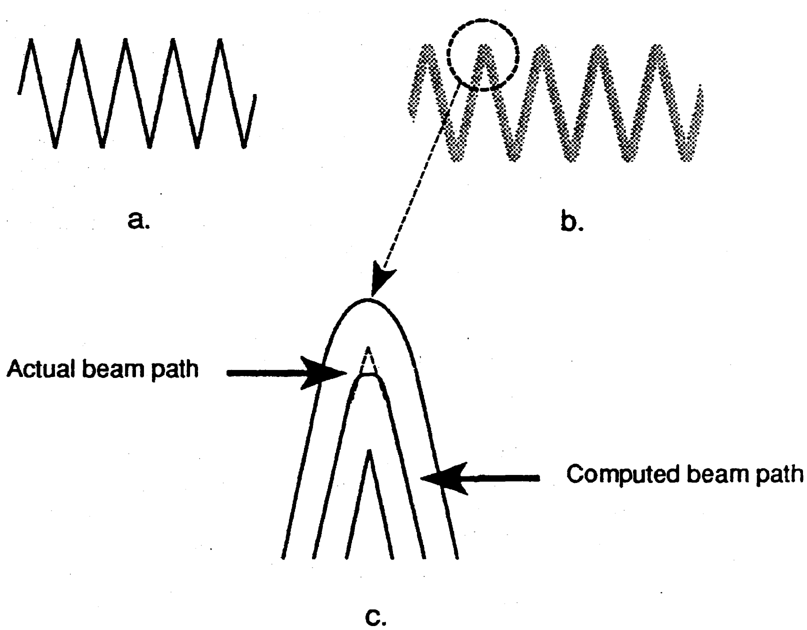


Figure 3-18. Under estimation of trace peak due to blooming.

Intensity Adjustment (cont)

The highest quality digitization will be accomplished by setting the intensity using a signal identical or similar to the one to be captured. Adjustment of intensity is best set using the Threshold (Thresh) function in the Utility menu. Intensity should be set to produce a narrow and uniform trace with a Threshold setting as high as possible. Signals filling a small portion of the digitizer vertical range require lower intensity setting than signals that cover the full range, so an intensity adjustment may be necessary after a change in vertical range. For most Time windows this will be a setting of a 63. For the shortest time windows it may need to be reduced. For most signals, on the fastest window (5 ns) the intensity can simply be set to 100%.

Focus Adjustment

Focus determines the concentration of the writing beam and is slightly dependent on the intensity setting. Each time window maintains its own focus and intensity settings so adjustment of focus is not normally required. Adjustment of focus is not critical for the longer time windows, but it is critical to achieve the best writing of the target on the fastest (5 and 10 ns) time windows. To insure the focus is optimum, it should be set with a signal that is at the writing limit of the CRT. For the SCD 1000 a 1 GHz signal, amplitude 80% of vertical range, and 5 ns time window should be used to adjust focus of equally written rising and falling slopes of the sinewave. For the SCD 5000 a 4.5 GHz sine wave should be used.

ACQUISITION/DISPLAY MODEL

This section describes the concepts of signal acquisition and display using the SCD1000 and SCD5000 waveform recorders. Figure 3-19 illustrates a typical input signal. V_{+pk} and V_{-pk} represent the maximum and minimum amplitudes, while V_{ss} represents the steady state value of the input signal.

In order to capture and display a portion of this input signal, the signal must go through several processes illustrated in Figure 3-20. These processes are the acquisition process, storage process, centroiding process, and display process.

The acquisition process defines the portion of the signal to be captured and stored in acquisition memory. The storage process assures integrity of the captured waveform data by removing false data from the waveform data due to digitized aberrations of the target diodes. The resultant data is placed in the linear array. (Once the input signal has been stored, it is available for display or transmission to an external device via the GPIB port.) The centroiding process mathematically processes the data to achieve a single waveform data point on the vertical axis for every interval along the horizontal axis. The display process defines all or part of the acquired waveform to be displayed.

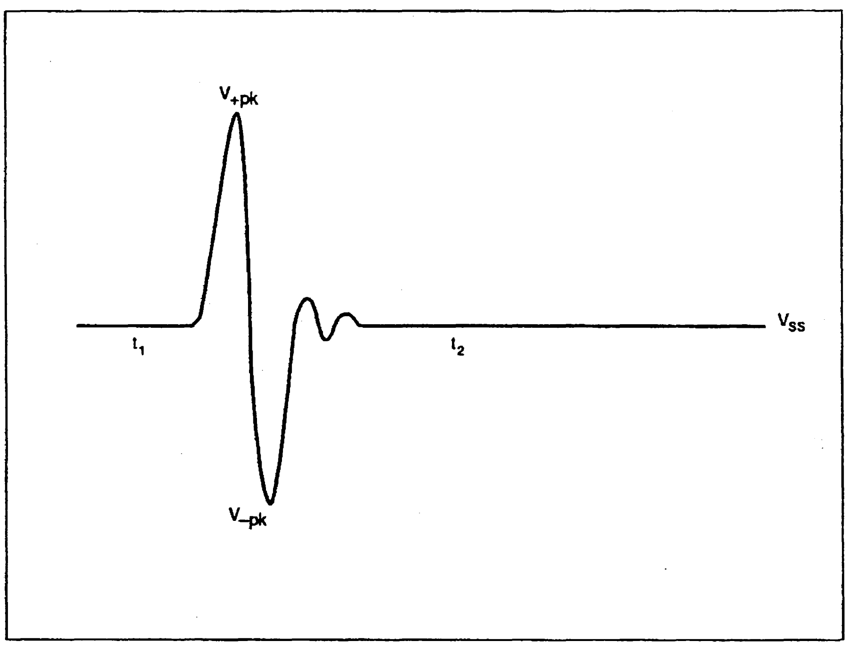


Figure 3-19. Typical Input Signal

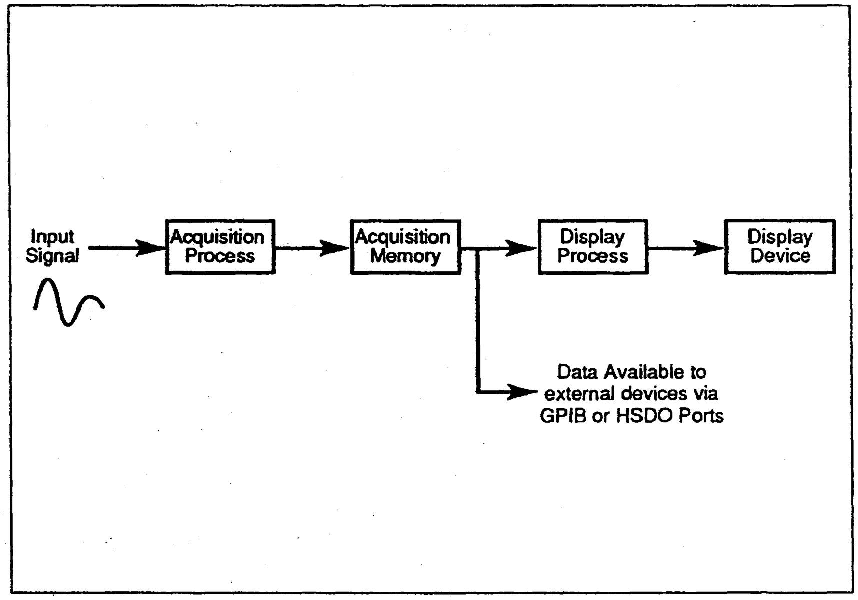


Figure 3-20. SCD Processes

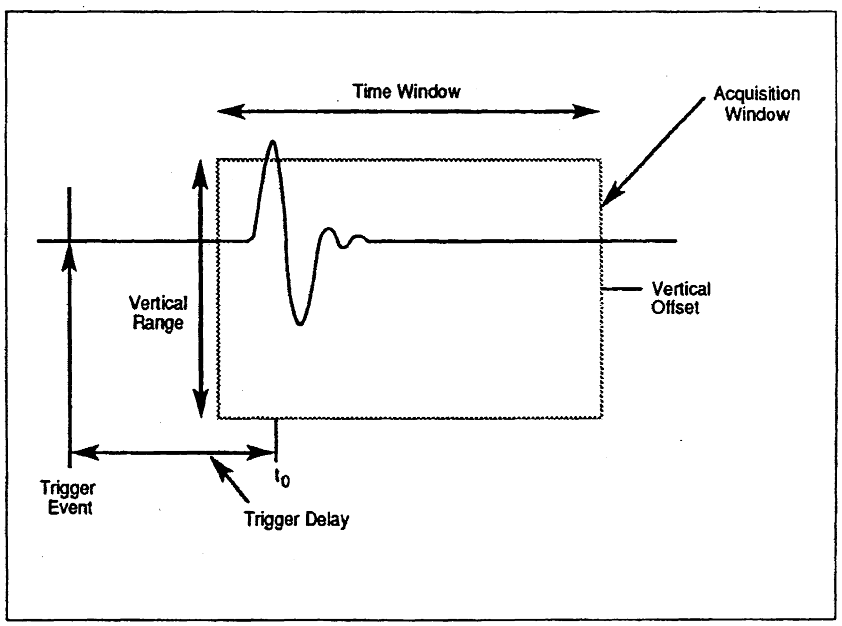


Figure 3-21. Acquisition Parameters & Acquisition Window

Acquisition Process

The acquisition process can be illustrated as a window through which is "seen" a portion of the signal (Figure 3-21). Only the portions of the input signal that are seen through the acquisition window are acquired. Through the various waveform recorder functional parameters, the user defines window parameters, such as height, width, and position, in order to select the portion of the signal to be captured.

An acquisition process is the filling of all required records with waveform data. The process consists of a sequence of events (the acquisition sequence) which is repeated for each record to be filled. The following acquisition sequence must occur in the listed order for a record to be filled:

- recognition of the trigger event
- recording of time of acquisition (time stamp)
- expiration of the trigger delay
- writing of the input signal on the target
- reading of the target
- subtracting aberrations
- storing the data in memory (linear array)
- centroid processing and storage

The sequence is repeated for each record to be filled. Records are consecutively filled from a specified start record through the specified number of records (up to 16) set by the acquisition system functions. The number of records to be filled could be only one, or it could be all 16 records.

If an acquisition process is started after a previous one finishes, previously filled records are overwritten.

The vertical size and position of the acquisition window determine the vertical portions of the waveform that are captured. These two parameters allow the user to capture the entire waveform's peak to peak swing, or a portion of the waveform's swing. Care must be taken to avoid waveform distortion due to amplifier overload when only a portion of the vertical range of a signal is acquired. (The SCD5000 does not use an amplifier, so overload distortion will not occur)

The vertical size of the acquisition window is set by the waveform recorder's *Vertical Range* function of the vertical mode. The larger the vertical range, the greater the acquisition window's vertical size and thus the larger (in amplitude) the signal that can be acquired.

Vertical Size and Position

The SCD1000's vertical range is from 100 mV to 10 V; SCD5000 vertical range is fixed at 5 V. Because the SCD5000 has a fixed vertical range, it is necessary to attenuate any signal that exceeds its input range limit. Attenuation is also necessary when attempting to capture signals that exceed the maximum adjustable limit of the SCD1000.

The vertical position of the acquisition window is set by the waveform recorder's *Vertical Offset* function of the vertical mode. The vertical offset value is defined as the center of the acquisition window, allowing the center of the acquisition window to be position at other than ground potential (within the limits of the waveform recorder's offset limits).

Notice that if V_{ss} , the average DC level of the signal, (see Figure 3-22) is other than ground potential, it is necessary to include V_{ss} in the Vertical Range setting or to adjust the acquisition window's vertical position (vertical offset setting).

Increasing vertical offset moves the window up (Figure 3-22); decreasing the vertical offset moves the window down (Figure 3-23). (Note that it is the window being positioned, not the waveform.) If V_{ss} is +500 mV, adjusting the Vertical Offset positively from 0 volts moves the window up. The signal offset remains at +500 mV. SCD1000 vertical offset can be from ±250 mV to ±25 V; SCD5000 vertical offset limits are ±4 V.

Vertical offset to center the signal in the acquisition window is calculated as

$$\text{Vertical Offset} = (V_{+pk} - V_{-pk})/2$$

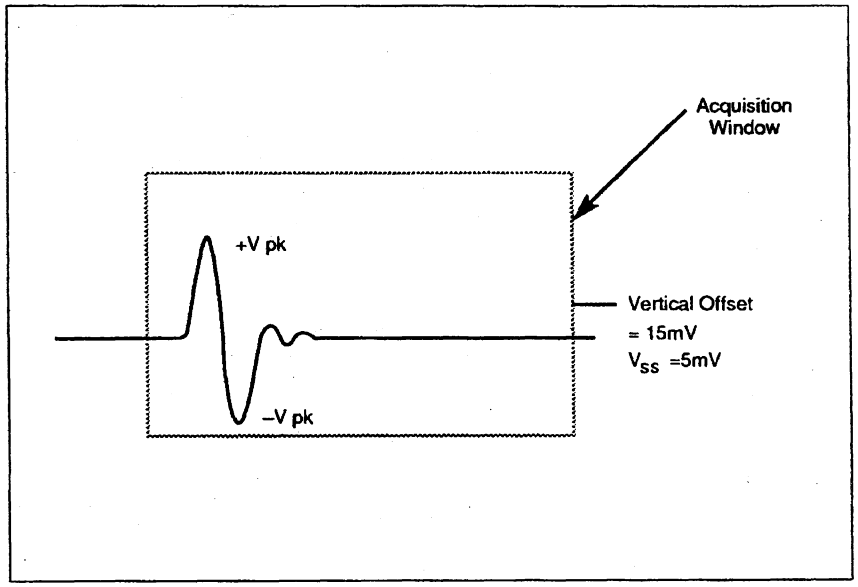


Figure 3-22. Effect of Increasing Vertical Offset

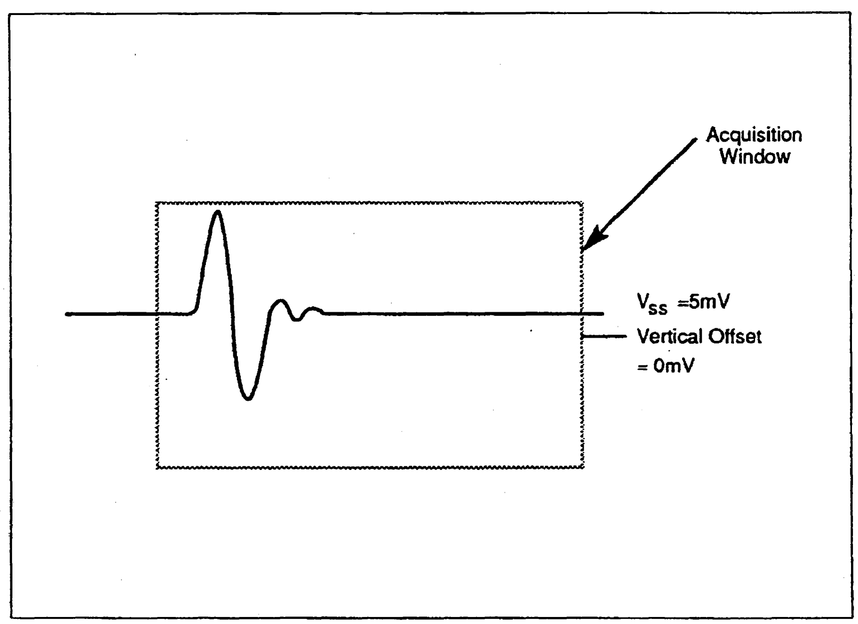


Figure 3-23. Effect of Decreasing Vertical Offset

Horizontal Size, Resolution, and Position

The horizontal size of the acquisition window determines the amount of the waveform captured along the time axis. The larger the size, the more of the waveform that can be captured. The waveform recorder's *Time Window* function of the acquisition mode controls the horizontal size.

The Time Window function sets the writing speed of the CRT's write gun, which determines the amount of the signal written on the target. The faster the writing speed, the smaller the time window, and the shorter the horizontal axis of the window (Figure 3-24). A slow-moving signal requires a time window longer than a fast-moving signal. The time window can be set from 5 ns to 100 µs.

Once the signal has been written, the scanning resolution is determined by the number of sample intervals to digitize. The waveform recorder's *Record Length* function of the trigger mode controls this parameter. Record lengths are 256, 512, or 1024 sample points. Increasing the sample points increases the number of digitized intervals along the time axis.

The horizontal positioning of the acquisition window is dependent on the trigger event. The *Trigger Delay* function of the Trigger mode controls this parameter.

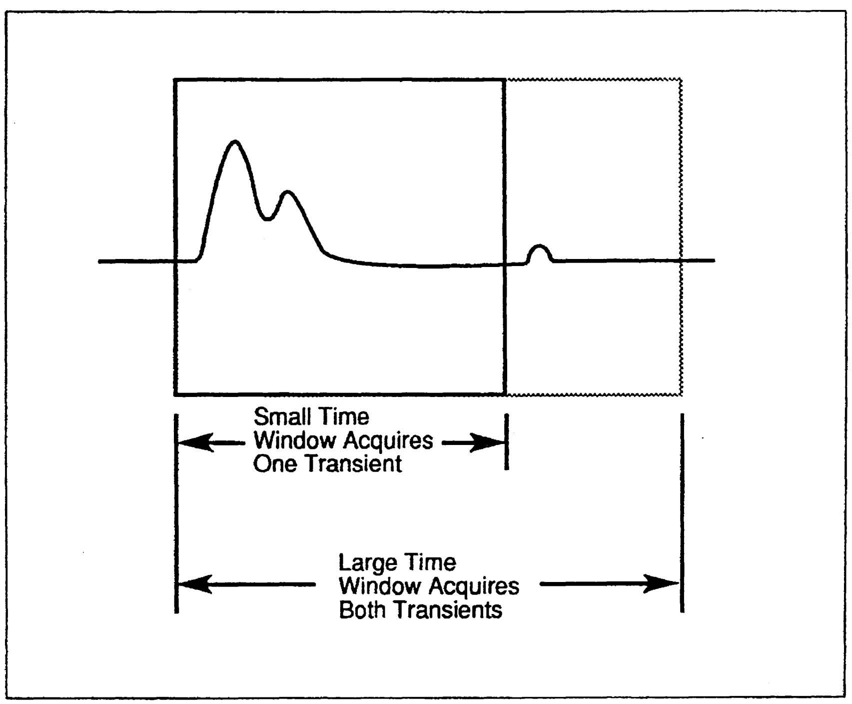


Figure 3-24 Effect of Time Window on Horizontal Size

Horizontal Size, Resolution, and Position (cont)

The trigger event occurs at a point in time, t_0, where the trigger signal reaches a specified voltage level or a specified percentage of the selected vertical range. If the signal to be captured occurs after the trigger event, an amount of trigger delay (Figure 3-25) is necessary to hold off waveform recording until the delay time has expired. SCD delay setting can be from 0 to 500% the size of the time window.

The SCD write gun's sweep subsystem contains 45 ns of delay. If an input signal is simultaneously applied to the vertical deflection and internal trigger subsystems, waveform data would be recorded approximately 45 ns after trigger. To offset the sweep delay, the SCD1000 has an internal 47.5 ns delay in the vertical deflection signal path. This results in approximately 2.5 ns of pre-trigger information being recorded with internally triggered signals. For example, if a waveform is recorded in a 5 ns time window with a 0 trigger delay setting, one-half of the waveform record will include information prior to the trigger event. This applies only to internally triggering, which is available only on the SCD1000.

To capture a desired waveform event using external triggering, an external delay must be added prior to the SCD signal input. If a delay is not introduced, waveform recording will start 45 ns after the trigger event.

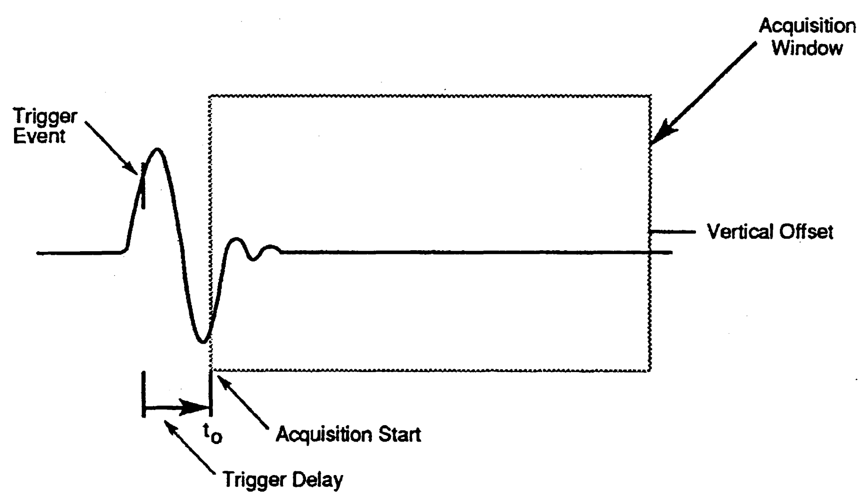


Figure 3-25 Effect of Trigger Delay on Horizontal Position.

Multiple Record Acquisition

Up to 16 records can sequentially be filled using the Auto Advance Acquire mode. This acquisition mode causes the waveform recorder to fill a beginning record and repeat the acquisition sequence for each record to be filled, up to 16 records. The first record is called the start record and is set by the *Sta Rec* function of the Acquisition mode. The number of records filled is set by the *N Rec* function of the Acquisition mode. Records 1, 2, 3, and 4 are stored in non-volatile memory.

While a signal is being scanned and digitized, other input signals are ignored. After the signal data has been stored, the waveform recorder is reset and waits for the next trigger event to occur. Figure 3-26 illustrates Auto Advance acquisition concepts.

Averaging

Up to 1024 averages can be done using the Average Acquire Mode. This acquisition mode causes the waveform recorder to perform the set number of averages as one acquire. The number of averages is set with the N Avg function which is visible when the Acquire mode is set to Average. While averaging is in process, the display is updated about every five seconds.

Timestamping

Each record is stamped with the time of day the signal was acquired. A date/time clock in the SCD waveform recorder provides the time. The date/time clock is set using the Utility mode or over the GPIB. The time clock's resolution is 10 ms.

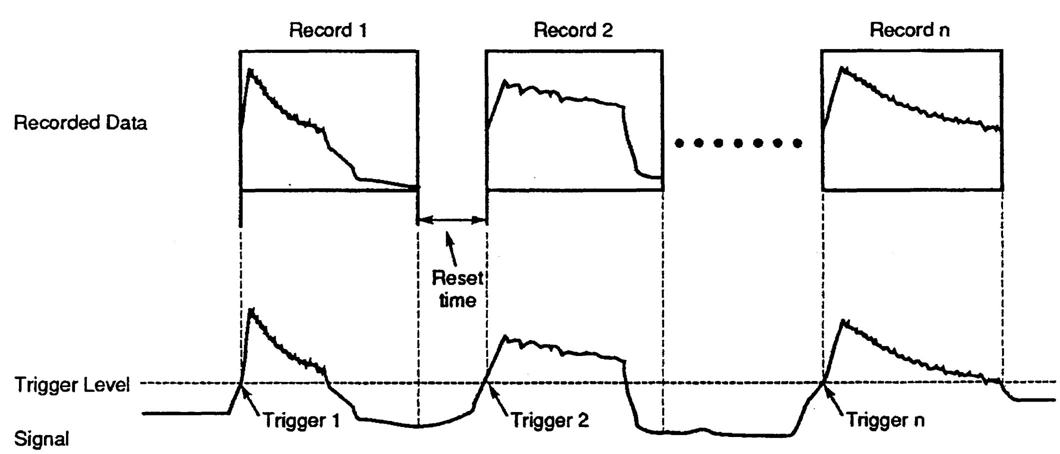


Figure 3-26. Auto Advance Acquisitions

Display Process

Like the acquisition process, the display process can be illustrated as a window in which appears all or a portion of the acquired signal stored in the record. The simplest display process consists of one record displayed on the Display Unit in a display *window*. Up to four windows can be displayed at one time, but each window can contain only one record. The number of windows displayed is selected using the display mode's *N Window* function. All windows can display the same waveform, portions of the same waveform, or all or portions of different waveforms. The record displayed is selected using the display mode's *Wx Rec* function (x indicates the currently selected window). The user defines what portion of the waveform is seen by setting the expansion functions of the display mode. Expansion functions allow the user to "zoom" in on the waveform to see more detail.

Expansion functions include the expansion factors and the expansion point. The horizontal and vertical expansion factors determine how much of a waveform is displayed. The expansion point determines what part of the waveform is displayed.

Vertical expansion factors are 1, 2, or 4 (SCD1000 only). Horizontal expansion factors are 1 and 2. An expansion factor of 1 displays the entire record in the window. Only records with 1024-sample record length can be expanded horizontally. The default expansion factor is 1. Expansion factors are selected using the display mode's *Wx VExp* (vertical expansion) and *Wx HExp* (horizontal expansion). The expansion point is selected using the display mode's *Wx ExpPt* function. (The x indicates the currently selected window to be expanded.)

An expansion point is selected by activating the Wx ExpPt function of the display mode, and turning the knob. An expansion point indicator (a small box) moves across the waveform as the knob is turned. The sample point on which the expansion indicator rests is displayed in the display mode menu label and next to the knob. The Δtime from the trigger to the expansion point indicator is displayed in the message/measurements zone. Expansion takes place when the vertical or horizontal expansion factor function key is activated and the knob turned to select the desired expansion factor.

Figure 3-27 illustrates vertical expansion. Figure 3-28 illustrates horizontal expansion.

If more than one window is displayed and horizontal expansion is selected, all waveforms can be expanded at the same time (aligned) or independently expanded. The display mode's *HExpMode* function is used to select *Aligned* or *Independent* horizontal expansion.

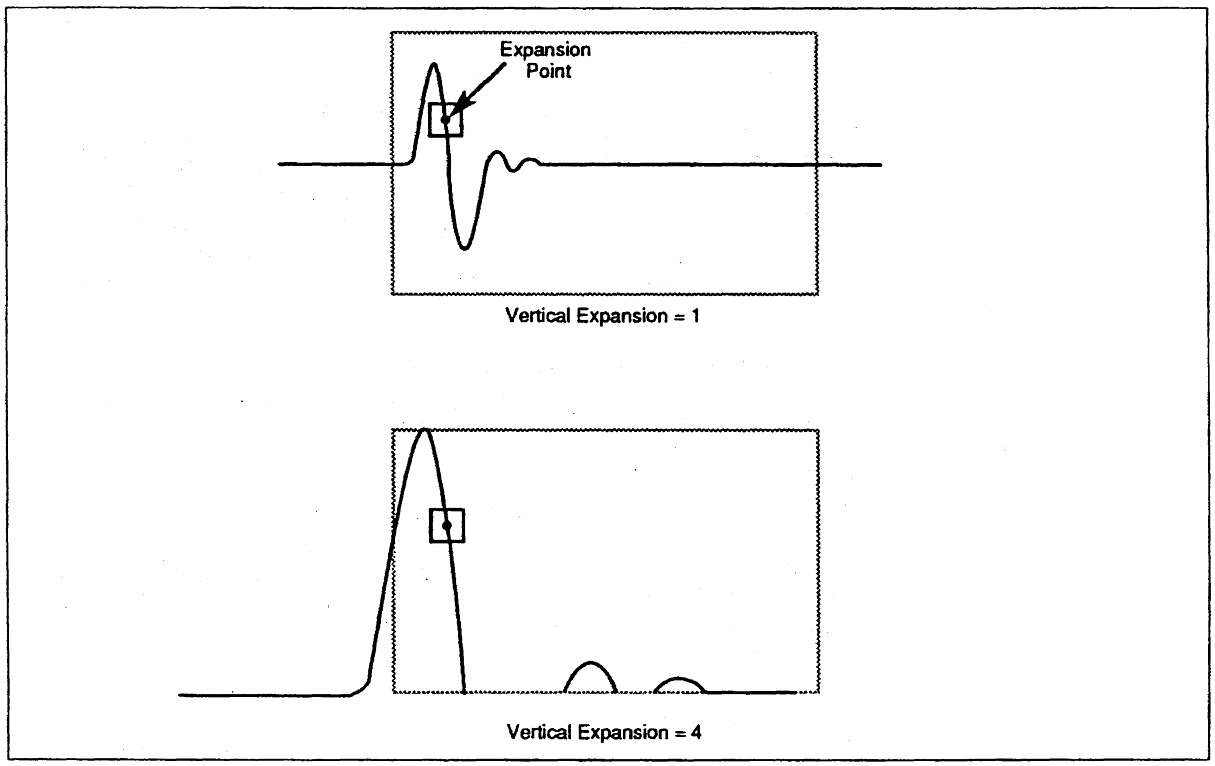


Figure 3-27 Effect of Vertical Expansion on Display

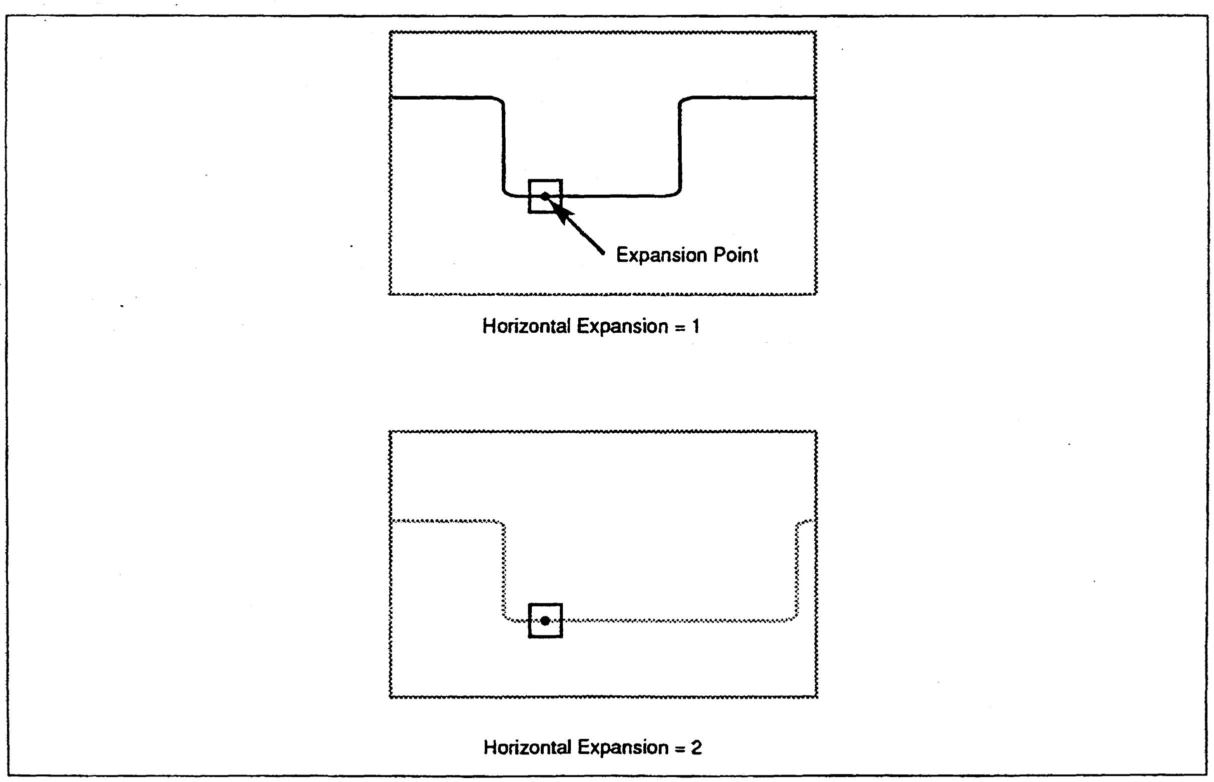


Figure 3-28. Effect of Horizontal Expansion on Display

GPIB Data Transmission

The acquired waveform data can be transmitted over the GPIB to a computer for analysis, plotting, graphing, storage, etc. To transmit the acquired data, the data must be requested from a bus controller.

The following characteristics of data transmission may be defined before data transmission (see Section 6C of this manual for detailed descriptions of each of the GPIB commands associated with data transfer):

- number of records to be transferred
- starting record to be transferred
- starting point in the selected record(s)
- number of points in the records to be transferred
- type of data to be transferred: linear array data (LINARRAY? command), reference array data (REFARRAY? command), or centroided data (CURVE? command)

GPIB Port

The GPIB port uses an 8-bit-parallel, byte-serial binary data format which has a maximum transmission rate of 500 Kbytes/sec for data transmission. See Section 6B of this manual for more information about the GPIB port.

Number Of Records

The SCD waveform recorders can transfer multiple consecutive records (up to 16) in one data transfer. The number of records to be transferred is selected using the DATA CNTRECORD command. A selection of 0 records causes all 16 records to be transferred. See Section 6C of this manual for detailed information about the DATA CNTRECORD command.

Starting Record

The first record to be transferred in a data transfer is selected using the DATA STRECORD command. Once a transfer is initiated, data will be transferred starting with the specified start record and ending when the specified number of records has been transferred. Records are transmitted consecutively; it is not possible to transfer non-consecutive records in a single data transmission. See Section 6C of this manual for detailed information about the DATA STRECORD command.

Starting Point

The SCD waveform recorders can transfer all or only specified portions of a data record. Specifying a starting point other than the beginning of a record is done using the DATA START command. A starting point within the limits of 1 to the record length may be specified. If multiple records are transferred, each record transmission will begin at the same starting point in each record. See Section 6C of this manual for detailed information about the DATA START command.

Number Of Points

Once a starting point for data transmission has been selected, the number of data points to be transferred may also be selected using the DATA COUNT command. If 0 is selected, the entire record will be transferred. If multiple records are transferred, the same number of points will be transferred for each record. See Section 6C of this manual for detailed information about the DATA COUNT command.

Waveform Preamble Information

The waveform preamble contains scaling, encoding, timestamp, and other information to be used by the controller in re-constructing the acquired waveforms from their data. The WFMPRE? query command causes the waveform recorder to transmit all available preamble information. See Section 6C of this manual for a detailed description of this commands.

Initiation of Data Transfer

Once all of the data transmission parameters have been specified, the data transfer can be initiated using the CURVE? query. Once initiated, data will be transferred in the specified manner. See Section 6C of this manual for detailed information about the CURVE query.

Partial Data Transfer

If a transfer is not completed (i.e. the controller does not read all data), further GPIB activity is prevented. Sending any command or query will return normal GPIB operation.

INSTRUMENT FUNCTION REFERENCE

The remainder of this section provides reference information for SCD waveform recorder modes and functions.

Tables 3-1 through 3-7 summarize all the modes and functions described on the following pages. The tables list all modes and functions(function name and function key label), the range of functional settings, the factory default setting, and whether the setting is affected by the function key or knob. Function key names are shown as they appear on the Display Unit (limited to eight characters). An "x" in a key label indicates the channel or window that the function affects. For example, *Wx Rec* is a function key that assigns a record to the currently selected window (selected by another function key). The currently selected window number (1, 2, 3, or 4) replaces the x in the key label.

Some functions are dependent on the waveform recorder's model: SCD1000 or SCD5000. Model dependencies are noted in the tables and the descriptions.
Since only seven function keys can be active at one time, modes with more than seven functions have more than one level of function key labels. These additional levels are accessed by pressing the *NextMenu* function key (the bottom function key). The NextMenu label is displayed only when additional levels are available. The following tables indicate the different levels of functions provided (if any) in each mode.

In this functional reference, functions are described according to the mode in which they appear. Vertical mode functions are explained first, followed by Acquisition functions, Trigger functions, Display functions, Cursor functions, Save/Recall functions, and Utility functions. Each function is described with various important aspects of the function. A brief description of each function of the mode is provided prior to the detailed descriptions of each function.

Changing a function setting while an acquisition is in process stops the acquisition, selects the new function setting, and restarts the acquisition system. For example, if the waveform recorder is in the "Running" acquisition state, after the function setting is changed, the waveform recorder returns to the Running state, continuously acquiring data. If AutoAdvance acquisition mode is selected, HoldNext is on, and the waveform recorder state is "Running", after a change to the function setting, the AutoAdvance acquisition is restarted; the waveform recorder starts storing data into the specified start record.

For each function, the following information (if applicable) is provided:

Function Name lists the descriptive title of the function. A representation of the mode menu is shown with the appropriate mode key highlighted.
If the function is dependent on the waveform recorder model (SCD1000 or SCD5000), it is noted in the function name.

Key Presses indicates the sequence of keys to be pressed to arrive at the desired function. The **Selector** column next to the key presses indicates the control (function key just pressed or the knob) that further defines the value of the selection.

Description provides a detailed description of the function.

Values includes all available settings for the function. If the value is numeric, the numeric range is provided. The factory setting is also listed, showing the value assumed when the instrument is initialized to the factory settings.

Interactions lists any functions that are affected by or affect the function being described.

GPIB Command lists the command or commands that perform the equivalent function over the GPIB. Not all GPIB functions are available on the Display Unit. (Furthermore, the Display Unit may provide capabilities that are not available over the GPIB.)

Only the long form of the GPIB command is given here. Most commands have an abbreviated form that can be used instead. For more information regarding GPIB commands listed in this reference section, see Section 6C of this manual.

TABLE 3-1
VERTICAL FUNCTIONS

Function	Label	Selector	Selections	Factory Setting
Vertical Mode (SCD 1000 only)	VertMode	Function Key	Ch A; Ch B; Add,	Ch A
Channel Select (SCD 1000 only)	Chan Sel	Function Key	Ch A; Ch B	Ch A
Range (SCD 1000 Only)	Range	Knob	100 mV to 10 V	1 V
Offset (Volts)	Offset	Knob	SCD 1000: ±(2.5 x Range) SCD 5000: ±4.5 V	0 V
Offset (%)	Offset	Knob	SCD 1000: ±250% of Range SCD 5000: ±80% of Range	NA
Coupling (SCD 1000 Only)	Coup	Function Key	AC; DC; OFF	DC
Channel Invert (SCD 1000 Only)	Invert	Function Key	Off or On	Off

TABLE 3-2
ACQUISITION FUNCTIONS

Function	Label	Selector	Selections	Factory Setting
Mode	Mode	Function Key	Normal, Auto Adv Average	Normal
Time Window	TimeWin	Knob	5 ns to 100 µs	1 ms
Record Length	Length	Knob	256; 512; 1024	512
Start Record	Sta Rec	Knob	1 to 16	1
Number of Records Acquired (normal acquire mode)	N Rec	Knob	1 to 16	1
Number of Averages Acquired (average acquire mode)	N Avg	Knob	1 to 1024	16
Hold Next	HoldNext	Function Key	Off or On	Off
Next Menu				
Use Geometry Correction	Geometry	Function Key	Off or On	On (SCD5000) Off (SCD1000)
Set Geometry Correction	Set Geom	Function Key	Running or stopped	Stopped

TABLE 3-3
TRIGGER FUNCTIONS

Function	Label	Selector	Selections	Factory Setting
Mode	TrigMode	Function Key,	Normal or Auto	Auto
Source	Source	Function Key	SCD 1000: Ch A; Ch B; Add; External; SCD 5000: External or Cal	SCD 1000: Ch A; SCD 1000: Ch A; SCD 5000: EXT
Level (Internal/Volts)	TrigLvl	Knob	±(Vertical Range/2) + Offset	0 V
Level (Internal/%)	TrigLvl	Knob	±100%	0 %
Level (External)	TrigLvl	Knob	SCD 1000: ±0.5 V SCD 5000: ±1.0 V	0 V
Slope	Slope	Function Key	+ or -	+
Coupling (SCD 1000 Only)	TrigCoup	Function Key	AC or DC,	DC
Delay	TrigDly	Knob	0 to 5 times the time window (% or seconds)	0 %

TABLE 3-4
DISPLAY FUNCTIONS

Function	Label	Selector	Selections	Factory Setting
Number of Window	N Window	Function Key	1; 2; 4	1
Window Select	Wind Sel	Function Key	1; 2; 3; 4	1
Record Selection for Selected Window	Wx Rec	Knob	0 to 16	1
Horizontal/Vertical Expansion Point	WxExpPt	Knob	0 to (Record Length-1)	0
Vertical Expansion Factor	Wx VExp	Knob	1 to 4	1
Horizontal Expansion Mode	HExpMode	Function Key	Independent or Aligned	Independent
Horizontal Expansion Factor	Wx HExp	Knob	1 or 2 (1024 point waveform only)	1

TABLE 3-5
CURSOR FUNCTIONS

Function	Label	Selector	Selections	Factory Setting
Cursors On/Off	Cursors	Function Key	On or Off	On
Cursor 1 Window	Curs1Loc	Function Key	Any displayed window (1 to 4)	Win 1
Cursor 2 Window	Curs2Loc	Function Key	Any displayed window (1 to 4)	Win 1
Cursor 1 Position	Curs 1	Knob	0 to (Record Length - 1)	0
Cursor 2 Position	Curs 2	Knob	0 to (Record Length - 1)	0

TABLE 3-6
SAVE/RECALL FUNCTIONS

Function	Label	Selector	Selections	Factory Setting
Save Settings Selection	SaveSel	Knob	1 to 10	1
Save Current Settings	Save Set	None	None	None
Recall Settings Selection	Rcl Set	Knob	1 to 10	1
Recall Settings	Rcl Set	None	None	None
Recall Status Messages	Rcl Stat	Function Key	Stat 1 to Stat 10	Stat 1
Initialize Digitizer	Init	Function Key	None	None
Secure Digitizer	Secure	Function Key	None	None

TABLE 3-7
UTILITY FUNCTIONS

Function	Label	Selector	Selections	Factory Setting
Target Threshold	Thresh	Knob	0 to 63	0
Time Window	Timewin	Knob	5 µs to 100 µs	1 ms
CRT Beam Intensity	Inten	Knob	0 % to 100 %	Set by time window
CRT Beam Focus	Focus	Knob	0 % to 100 %	Set by time window
Set target Reference Data	Set Ref	Function Key	None	None
Trigger Delay	Trig Dly	Function Key	0% to 500%	0%
Next Menu				
Calibration Mode Selection	Cal Mode	Function Key	System; Vertical; Horizontal; Trigger; CRT, Geometry	System
Initiate Calibration	Cal	Function Key	None	None
View Settings	View	Function Key	ID; Acquire; Display	ID
Beeper On/Off	Beeper	Function Key	On or Off	On
Knob Beeper On/Off	KnobBeep	Knob	On or Off	On
Debug Mode	Debug	Function Key	On or Off	Off
Next Menu				
Instrument Self Test	Inst Test	Function Key	Stopped; running	Stopped
Processor Board Test	MPU Test	Function Key	Stopped; running	Stopped
Front Panel Test	FP Test	Function Key	Stopped; running	Stopped
Acquisition System Test	Acq Test	Function Key	Stopped; running	Stopped

TABLE 3-7 (CONT)
UTILITY FUNCTIONS

Function	Label	Selector	Selections	Factory Setting
Next Menu				
Set timestamp year	Year	Knob	1989 - 2010	year of calibration
Set timestamp month	Month	Knob	1 - 12	month
Set timestamp day	Day	Knob	1 - 31	day (PDT)
Set timestamp hour	Hour	Knob	0 - 23	hour
Set timestamp minute	Minute	Knob	0 - 59	minute
Enter timestamp info into NV RAM	Enter	Function Key	N/A	N/A
Next Menu				
Channel Calibration Signals (SCD 1000)	Ch A Cal Ch B Cal	Function Key	Time; Ampl into 0; Ampl into 450; Off	Off
Calibrator Output Signal (SCD 5000)	Cal Out	Function Key	Time; Ampl into 0; Ampl into 450; Off	Off
External Calibrator Signal (SCD1000)	Ext Cal	Function Key	Time; Amplitude	Time
Calibrator Signal Amplitude	CalAmpl	Knob	SCD 1000: 0 V to ±2.5 V; SCD 5000: ±2.5 V	+2.5 V
Calibrator Signal Period	CalTime	Knob	4 ns to 8 ms	0.8 ms

VERTICAL FUNCTIONS

Vertical Functions affect the active acquisition channel and the input signal conditioning for the channel. These functions are selected by pressing the *Vertical* mode key. Vertical selections are (with function key labels in parentheses):

Vertical Mode (VertMode): (SCD1000 only.) Selects the active channel(s) (Ch A, Ch B, or Add) for an acquisition. Either of the two input channels can be selected, or the algebraic sum of the two inputs can be selected.

Channel Select (Chan Sel): (SCD1000 only) Selects the channel for which signal conditioning parameters are to be adjusted (range offset, coupling, and invert). These parameters can be independently set for each acquisition channel. When a channel is selected, the channel indicator (A or B) appears in other menu labels.

Vertical Range (Range x): Sets the full-scale input range for the selected channel. (SCD5000 range is fixed at 5 volts.)

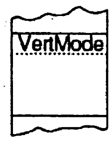
Vertical Offset (Offset x): Sets a DC offset for the selected channel. Offset can be specified in terms of volts or percent of the full-scale range.

Vertical Coupling (Coup x): (SCD1000 only.) Selects the input coupling (DC, AC, or OFF) to the input amplifiers. DC selects the waveform recorder's entire bandwidth limit. (SCD5000 coupling is fixed at DC.) AC coupling attenuates signal components below 1 kHz. OFF effectively provides an open circuit (500 k Ω) to the input signal path.

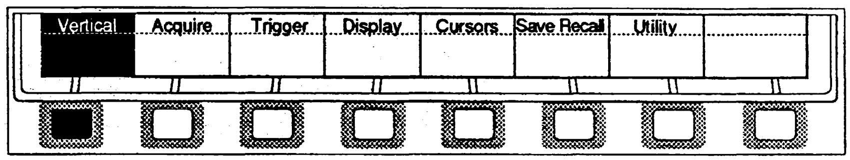
Invert Signal (Invert): (SCD1000 only.) Inverts the signal from the selected input channel. If Vertical Mode is set to ADD, the Invert function can be used to obtain the difference between two signals.

VERTICAL MODE (SCD1000 ONLY)

Key Presses



Mode Key	Function Key	Function adjusted by
Vertical	VertMode	Function Key



Description

The Vertical Mode function selects the input channel(s) to be used for acquisition. Either of the input channels, or the algebraic sum of both channels, can be selected.

Values

Choices	Init Value
Ch A Ch B Add	Ch A

Interactions

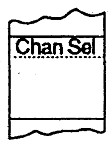
None

GPIB Command

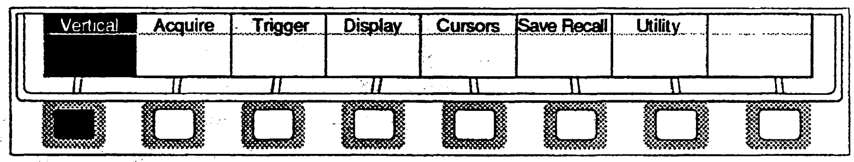
VMODE {CHA|CHB|ADD}
VMODE?

VERTICAL CHANNEL SELECT (SCD1000 ONLY)

Key Presses



Mode Key	Function Key	Function adjusted by
Vertical	Chan Sel	Function Key



Description

The Vertical Channel Select function selects the channel on which vertical parameters are to be changed: range, offset, coupling, and signal invert. Each of these functions can independently be set on each acquisition channel.

As this function key is pressed to select the next channel, the menu label of each of the vertical parameters (range, offset, coupling, and invert) displays the current settings for the selected channel. The label also indicates the channel for which the settings are made.

Whether or not the channel selected with Chan Sel function key is being used for acquisition, parameters for the selected channel can be adjusted. This allows setup of input parameters prior to selecting a channel for acquisition. It also allows setting signal conditioning parameters of an input signal that is not acquired but is being used as a trigger source.

Values

Choices	Init Value
Ch A Ch B	Ch A

Interactions

None

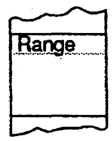
GPIB Command

No direct equivalent. The vertical channel is specified together with one of the other vertical functions (Range, Offset, Offset Type, Coupling, or Invert) as follows:

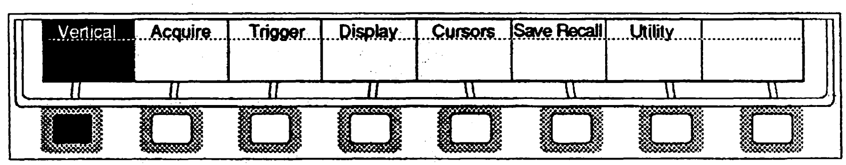
CH<x> {RANGE|OFFSET|TYPEOFFSET|COUPLING|}:<NRx>
CH? {RANGE|OFFSET|TYPEOFFSET|COUPLING|}:
CH<x>?
CH?

VERTICAL RANGE

Key Presses



Mode Key	Function Key	Function adjusted by
Vertical	Range	Knob



Description

The Vertical Range function sets the full-scale (peak-to-peak) dynamic range of the vertical acquisition window. Range is set only for the channel selected with the Vertical Channel Selection function. Vertical range values are adjusted with the variable knob. (Vertical range for the SCD5000 is fixed at 5 volts peak-to-peak.)

When no mode is active, the vertical range is displayed in the waveform vertical status information to the left of the waveform zone.

Values

Ranges SCD 1000 only	Init Value
100 mV	1 V for both channels
200 mV	
500 mV	
1 V	
2 V	
5 V	
10 V	

Interactions

The Vertical Range selection affects the following other functions:

Vertical Offset
The offset is coerced to the closest valid setting if the current setting is invalid for the selected range. For example, if the offset is set to +5 volts for a 10 volt range and the range is changed to 500 mV, the offset is automatically set to +1.25 V.

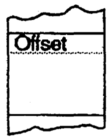
Trigger Level
If the trigger source is the channel being changed and the trigger level is set in volts, the trigger level is automatically recalculated, adjusted, and the trigger level readout changed to the appropriate value.

GPIB Command

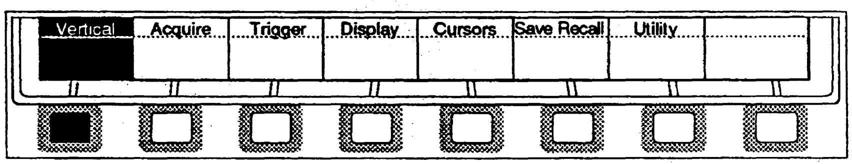
CH<x> RANGE
CH<x>? RANGE

VERTICAL OFFSET

Key Presses



Mode Key	Function Key	Function adjusted by
Vertical	Offset	Knob



Description

The Vertical Offset function adjusts the vertical position of the acquisition window. The offset value corresponds to the voltage value at the center of the acquisition window. Increasing the offset moves the acquisition window upward; decreasing the offset moves the acquisition window downward. When offset is *increased*, the resultant waveform appears to move *downward* (and vice versa); this is because the window is being positioned, not the waveform.

Offset units are selected with the Units key (% or volts). Offset value is adjusted with the variable knob. Knob resolution is selectable as Coarse or Fine.

Values

The offset values differ between the SCD1000 and SCD5000.

Offset Parameter	SCD1000	SCD5000
Max. Negative Offset (Volts)	-2.5 x Range	-4.5 V
Max. Positive Offset (Volts)	+2.5 x Range	+4.5 V
Resolution (Volts)	5% of Range (both Coarse and Fine)	5% of Range (both Coarse and Fine)
Max. Negative Offset (%)	-250% of Range	-80% of Range
Max. Positive Offset (%)	+250% of Range	+80% of Range
Resolution	5% of Range (both Coarse and Fine)	5% of Range (both Coarse and Fine)
Initialized Value	0 V	0 V

VERTICAL OFFSET (CONT)

Interactions

The Vertical Offset selection affects the following other functions:

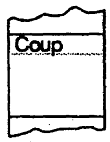
Trigger Level
If the trigger source is the channel being changed and the trigger level is set in volts, the trigger level is automatically recalculated, adjusted, and the trigger level readout changed to the appropriate value.

GPIB Command

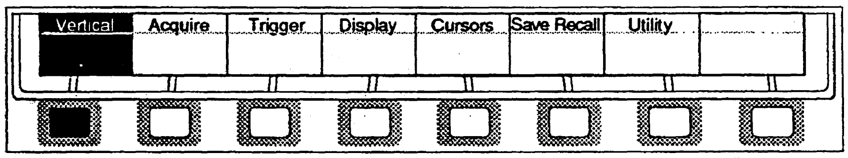
CH<x> OFFSET: <NRx>
CH<x>? OFFSET
CH<x> TYPEOFFSET: {VOLTS|PERCENT}
CH<x>? TYPEOFFSET

VERTICAL COUPLING (SCD1000 ONLY)

Key Presses



Mode Key	Function Key	Function adjusted by
Vertical	Coup	Function Key



Description

The Vertical Coupling function selects how the input signal is coupled to the input amplifiers. The selections are AC, DC, and OFF. DC couples all signal components within the waveform recorder's bandwidth. AC couples all components from 1 kHz to the waveform recorder's upper bandwidth limit. OFF disconnects the input from the signal, providing an effective open circuit to the input signal (≥500 k Ω input impedance) and grounding the input amplifiers.

Values

Choices	Init Value
AC DC OFF	DC

Interactions

None

Calibration

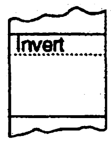
When an internal calibration signal is used as the channel input, the input coupling is set to OFF. If the input coupling is changed from OFF, the calibration signal is turned off.

GPIB Command

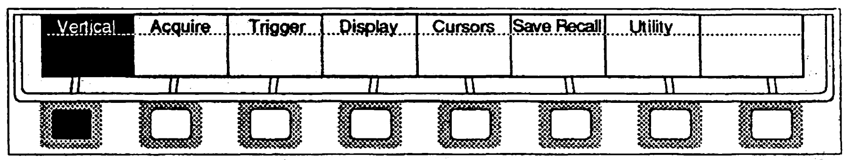
CH<x> COUPLING: {AC|DC|OFF}
CH<x>? COUPLING

VERTICAL CHANNEL INVERT (SCD1000 ONLY)

Key Presses



Mode Key	Function Key	Function adjusted by
Vertical	Invert	Knob



Description

The Vertical Channel Invert function inverts the signal to the input amplifiers and trigger circuitry (if the signal is also the trigger source). If the vertical mode is set to Add and one of the channels is inverted, the resulting input signal will be the difference between the two signals.

Values

Choices	Init Value
Off On	Off

Interactions

None

GPIB Command

CH<x> INVERT: {ON|OFF}
CH<x>? INVERT

ACQUISITION FUNCTIONS

Acquisition functions control how the input signal is acquired and stored. These functions are selected by pressing the *Acquire* mode key. The acquisition selections are (with menu abbreviations in parentheses):

Acquisition Mode (Acq Mode): Selects the type of acquisition (Normal, Auto Advance, or Average). In normal mode, a single record is acquired and stored into the specified start record. In Auto Advance mode, up to 16 records can be acquired. In Average mode 1 to 1024 averages can be done as an acquire.

Time Window (TimeWin): Selects the duration of the acquisition window from 5 ns to 100 μs. This parameter controls the sweep speed of the CRT write gun.

Acquisition Record Length (Length): Sets the record length of the record(s) to be filled.

Start Record (Sta Rec): Selects the first record to be filled (Auto Advance acquisition mode) or selects the only record to be filled for the current acquisition(s) (Normal acquisition mode).

Number of Acquisition Records (N Rec): Sets the number of records to acquire when the Acquisition Mode is set to Auto Advance. This function is only available when the acquisition mode is Auto Advance.

Number of Averages (N Avg): Sets the number of averages to acquire when the acquisition mode is Average. This function is available when the acquisition mode is Average.

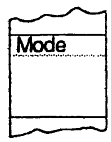
Acquisition Hold Next (HoldNext): When On, sets the waveform recorder to stop acquiring data after filling the current record (in Normal acquisition mode) or the final record (in Auto Advance acquisition mode). When Off, the waveform recorder continuously acquires data until manually stopped, or until no trigger events are detected.

Use Geometry Correction (Geom). When on, centroided waveforms will be processed to remove distortions produced by non-linearities in the scan converter CRT. When off, the distortions will remain uncorrected. See Acquisition Concepts, Geometry Correction for more information.

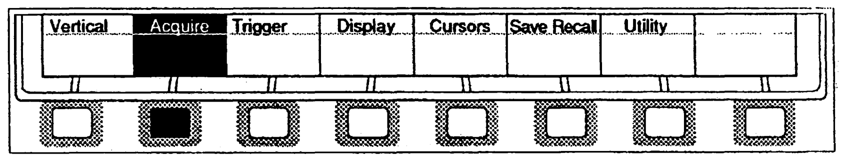
Set Geometry Correction (Set Geom). When run, a series of acquisitions will be done to map the distortion due to the scan converter CRT. The map is used to reduce vertical non-linearity when Geometry Correction is on. See Acquisition Concepts, Geometry Correction for more information.

ACQUISITION MODE

Key Presses



Mode Key	Function Key	Function adjusted by
Acquire	Mode	Function Key



Description

The Acquisition Mode function determines whether one or many records will be acquired. The selections are Normal and Auto Advance.

In Normal mode, acquired data is stored in the specified start record. If Hold Next is off, the waveform recorder continuously acquires data and stores it into the specified start record. Any data in the record is over-written for each acquisition. This continues until the acquisition process is manually stopped (using the Display Unit key), no more triggers occur, or stopped via a GPIB command. If Hold Next is on, the waveform recorder fills the specified start record and stops acquisition.

In Auto Advance mode, multiple acquisitions of the input signal can be done, filling up to 16 records. Records are filled starting with the specified start record through the specified number of records to be filled. If Hold Next is off, the waveform recorder continuously acquires data and stores it into the specified record(s). Any data in the record(s) is over-written for each acquisition. This continues until the acquisition process is manually stopped, stopped via a GPIB command, or no more triggers occur. If Hold Next is on, the waveform recorder fills the specified record(s) and stops acquisition.

In Auto Advance mode, if the number of records to be filled causes the waveform recorder to advance beyond record 16, record 1 is filled next with subsequent records filled, if necessary.

In Average mode, the input signal is averaged the number of times set by N Avg. While averaging, the display is updated every five seconds. Curve queries will not be answered until the averaging is complete. Changing any setting while an averaged acquire is in progress will restart the average.

The time the waveform recorder takes to acquire data and recycle for the next acquisition depends on the record length, type of signal and intensity of the waveform on the target. This recycle time determines how many acquisitions can be accomplished per second. With the Display turned off (GPIB command: DISPLAY OFF), for 256 sample records, the recycle time is 250 ms (or 4 Hz); for 512 sample records, the recycle time is 480 ms (or 2 Hz); for 1024 sample records, the recycle time is 700 ms (or 1.1 Hz). With the fast waveform capture option, (Option 1P), the capture rate increases to 10 Hz for 512 point waveforms.

Values

Choices	Init Value
Normal Auto Advance Average	Normal

Interactions

The Acquisition Mode selection affects the following other functions:

Number of Records to Advance (N Rec)

Number of Records to Average (N Avg)

The N Rec function key label appears only when Auto-Advance mode is selected.

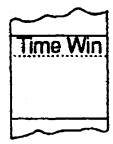
The N Avg function key label appears only when Average mode is selected.

GPIB Command

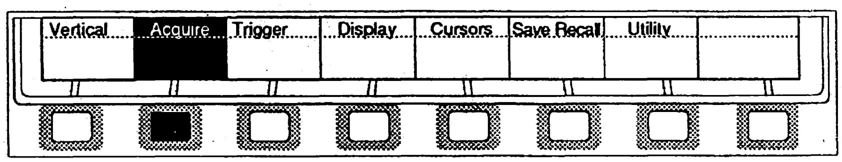
ACQUIRE MODE: {NORMAL|ADVANCE|AVERAGE}
ACQUIRE? MODE

ACQUISITION TIME WINDOW

Key Presses



Mode Key	Function Key	Function adjusted by
Acquire	TimeWin	Knob



Description

The Time Window function sets the duration of the acquisition. The quality of the waveform written onto the CRT is affected by the time window setting and the CRT settings (intensity and focus). See UTILITY FUNCTIONS later in this reference section and see SCD ACQUISITION CONCEPTS earlier in this section.

The time window value is adjusted with the knob.

Values

Choices	Init Value
5 ns	1 µs
10 ns	
20 ns	
50 ns	
100 ns	
200 ns	
500 ns	
1 µs	
2 µs	
5 µs	
10 µs	
20 µs	
50 µs	
100 µs	

Interactions

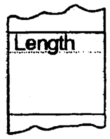
None

GPIB Command

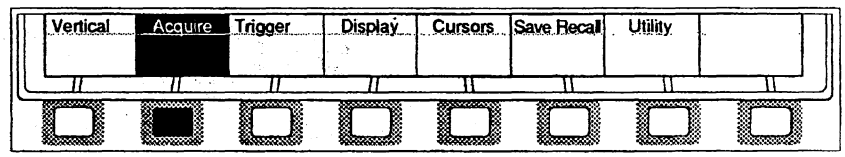
ACQUIRE TIME:<NRx>
ACQUIRE? TIME

ACQUISITION RECORD LENGTH

Key Presses



Mode Key	Function Key	Function adjusted by
Acquire	Length	Knob



Description

The Record Length function sets the record length of all records to be filled in the next acquisition. Record length can be 256, 512, or 1024 sample points. The value is adjusted with the knob.

Since the waveform zone's width is 512 pixels, 512-sample waveforms are horizontally mapped 1 display pixel to 1 waveform sample. 256-sample waveforms are mapped 1 waveform sample to every other pixel. Only one half of the display pixels along the horizontal axis are illuminated. 1024-sample waveforms are mapped 2 display pixels on the same vertical column per 2 adjacent waveform samples. The mapping uses a min-max algorithm with two pixels in one column connected by a line. Because the 1024-sample record contains twice as many samples as available pixels, only this size record can be horizontally expanded (2 times).

Values

Choices	Init Value
256 512 1024	512

Interactions

The record length affects the following parameters:

Cursors

Expansion Point
The expansion point and cursor position settings are affected by the selected record length. If these settings are currently set outside the new record length, the settings will be coerced to a value within the record length for the next acquisition cycle. The following relationship is maintained for the acquisition cycle after the change in the record length:

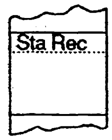
1 ≤ parameter setting ≤ record length

GPIB Command

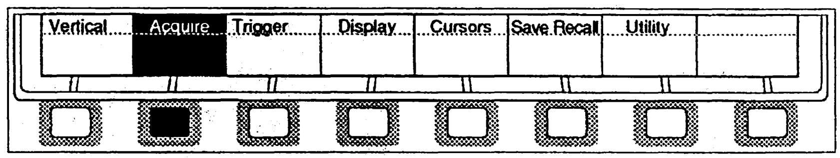
ACQUIRE LENGTH:<NRx>
ACQUIRE? LENGTH

ACQUISITION START RECORD

Key Presses



Mode Key	Function Key	Function adjusted by
Acquire	Sta Rec	Knob



Description

The Start Record function selects the only record to be filled (for Normal acquisition mode) or the first record to be filled (for Auto Advance acquisition mode). The start record can be from record 1 to record 16. The setting is selected with the knob.

Records 1, 2, 3 and 4 are stored in non-volatile memory and will be present across power-downs.

If Auto Advance acquisition mode is used, and the start record and number of records are set such that record 16 is filled, the next record to be filled will be record 1. Further acquisitions will fill subsequent records until the specified number of records are filled.

Values

Min	Max	Init Value
1	16	1

Interactions

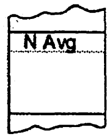
None

GPIB Command

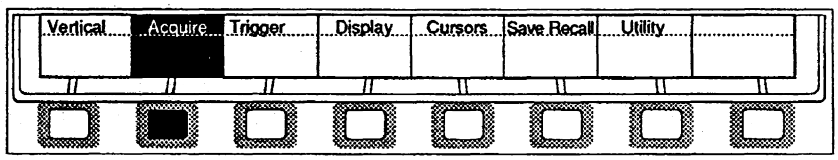
ACQUIRE START:<NRx>
ACQUIRE? START

NUMBER OF RECORDS TO AVERAGE

Key Presses



Mode Key	Function Key	Function adjusted by
Acquire	N Avg	Knob



Description

The Number of Records to Average function sets the number of averages to be performed when the Acquisition Mode is set to Average. The setting can be from 1 to 1024.

The value is adjusted with the variable knob.

The menu label is displayed only when the acquisition mode is set to Average.

Values

Min	Max	Init Value
1	1024	16

Interactions

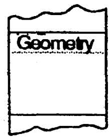
None

GPIB Command

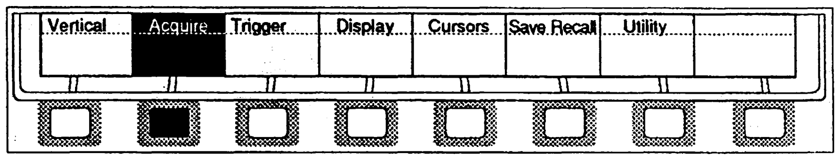
ACQUIRE AVERAGE: <NRx>
ACQUIRE? AVERAGE

GEOMETRY CORRECTION

Key Presses



Mode Key	Function Key	Function adjusted by
Acquire	Geometry	Function Key



Description

Geometry correction processes centroided waveforms to remove distortions produced by non-linearities in the scan converter CRT.

When off, the distortions will remain uncorrected.

See Acquisition Concepts, Geometry Correction for more information.

Values

Choices	Init Value
On Off	Off (SCD1000) On (SCD5000)

Interactions

None

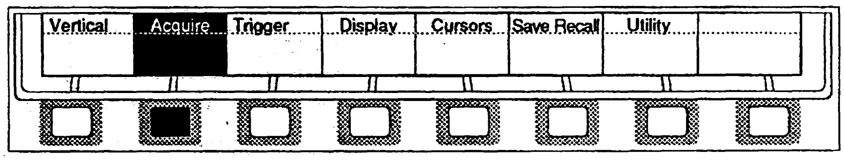
GPIB Command

ACQUIRE GEOMETRY: {ON|OFF|RUN}
ACQUIRE? GEOMETRY

SET GEOMETRY CORRECTION

Key Presses

Mode Key	Function Key	Function adjusted by
Acquire	Set Geom	Function Key



Description

When run, a series of acquisitions will be done to map the distortion due to the scan converter CRT. The map is used to reduce vertical non-linearity when Geometry Correction is on.

See Acquisition Concepts, Geometry Correction.

Values

Choices	Init Value
Running Stopped	Stopped

Interactions

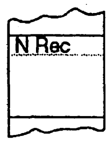
None

GPIB Command

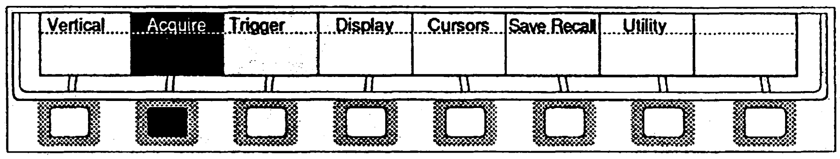
ACQUIRE GEOMETRY: {ON|OFF|RUN}
ACQUIRE? GEOMETRY

NUMBER OF RECORDS TO ACQUIRE

Key Presses



Mode Key	Function Key	Function adjusted by
Acquire	N Rec	Knob



Description

The Number of Records to Acquire function sets the number of records to acquire when the Acquisition Mode is set to Auto Advance. The setting can be from 1 to 16.

The value is adjusted with the variable knob.

The menu label is displayed only when the acquisition mode is set to Auto Advance. If the number of records to acquire and the start record settings are such that record 16 is filled, the next record to be filled will be record 1. Further acquisitions will fill subsequent records until the specified number of records are filled.

Values

Min	Max	Init Value
1	16	1

Interactions

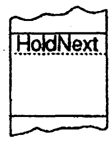
None

GPIB Command

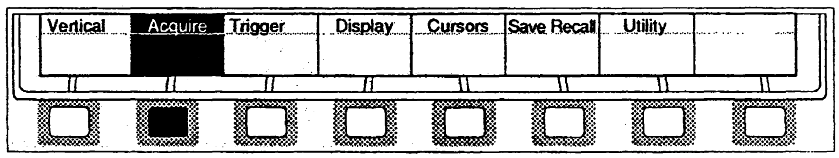
ACQUIRE NRECORD: <NRx>
ACQUIRE? NRECORD

ACQUISITION HOLD NEXT

Keypresses



Mode Key	Function Key	Function adjusted by
Acquire	HoldNext	Function Key



Description

The Hold Next function turns the Hold Next state OFF and ON. When Hold Next is on, the waveform recorder stops acquiring data after the final record is filled. Triggers are accepted until the waveform recorder fills all required records (whether one record, as in Normal acquisition mode, or several records as in Auto Advance acquisition mode). Once all required records are filled, additional trigger events are ignored until the acquisition process is again initiated.

When Hold Next is off, the waveform recorder continuously acquires data until the acquisition is manually stopped, stopped by a GPIB command, or trigger events are no longer detected.

When an acquisition is running with Hold Next turned ON, the acquisition status label displays *HoldNext*, and the HoldNext function key label displays *On*. When the acquisition has finished, the acquisition status label displays *Stopped*. The HoldNext function label continues to display the Hold Next selection (*On*).

Values

Choices	Init Value
On Off	Off

Interactions

None

GPIB Command

ACQUIRE STATE: {STOP|RUN|HLDNXT}
ACQUIRE? STATE
HOLDNEXT:{ON|OFF}

NOTE

To enable the HoldNext function from the GPIB, the ACQUIRE STATE:HLDNXT command and the HOLDNEXT:ON command must be sent to the waveform recorder.

TRIGGER FUNCTIONS

The Trigger Functions control when the acquisition begins. These functions are selected by pressing the *Trigger* mode key. The selections are (with menu abbreviations in parentheses):

Trigger Mode (TrigMode): Selects the trigger mode as Normal or Auto. Auto trigger mode is typically used while setting up the waveform recorder. In this mode, the waveform recorder triggers either when a trigger event occurs or 360 ms after the start of an acquisition sequence. In Normal mode, the waveform recorder triggers only when a valid trigger event occurs, the Trigger button on the Display Unit is pressed, or a trigger command is sent over the GPIB.

Trigger Source (Source): Selects the source of the trigger signal. The selections for this function differ between the SCD1000 and the SCD5000. The SCD1000 allows selection of Ch A, Ch B, Add, or an external signal as the trigger source. The SCD5000 allows selection of either an external signal or the Calibrator Time signal as the trigger source. If Option 01, Delay Line option, has been installed in an SCD5000, the trigger can also be internally from the delay-line. In the SCD1000, the vertical mode's Invert function inverts the signal to the trigger circuitry.

Trigger Level (TrigLvl): Sets the signal amplitude at which a trigger will be recognized. Depending on the trigger source and coupling method, the level can be specified in either volts or percentage of the triggering channel's full-scale vertical range. Both positive and negative values can be specified. If the trigger source is from an inverted channel, inversion does not affect the level setting.

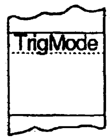
Trigger Slope (Slope): Selects the slope of the waveform to be triggered on. The slope can be rising (plus) or falling (minus). If the trigger source is from an inverted channel, the slope is not affected by the inversion.

Trigger Coupling (TrigCoup): Selects the coupling method of the trigger signal (AC or DC) if internally triggered (SCD 1000 only). Only AC coupling for external triggering is allowed.

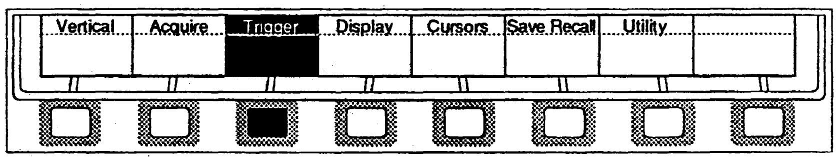
Trigger Delay (TrigDly): Sets the amount of delay from the trigger event to the beginning of waveform data storage. Delay can be as late as 5 times the acquisition time window's setting. Delay can be specified in percentage of the time window or in seconds. If the time window value is changed after a delay is specified, the amount of delay remains the same (as a percentage of the time window), even if the delay is specified in seconds.

TRIGGER MODE

Key Presses



Mode Key	Function Key	Function adjusted by
Trigger	TrigMode	Function Key



Description

The Trigger Mode function determines if the waveform recorder is triggered only by a valid trigger event (Normal) or automatically triggered even if a valid trigger event does not occur (Auto). If Auto is selected, the waveform recorder waits 360 ms until after the start of the acquisition sequence and automatically produces a trigger if no valid trigger event occurs. This mode is useful for setting up the waveform recorder before acquiring input signal data for analysis. If Normal is selected, the waveform recorder triggers only if a valid trigger event occurs.

Values

Choices	Init Value
Normal Auto	Auto

Interactions

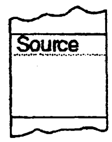
None

GPIB Command

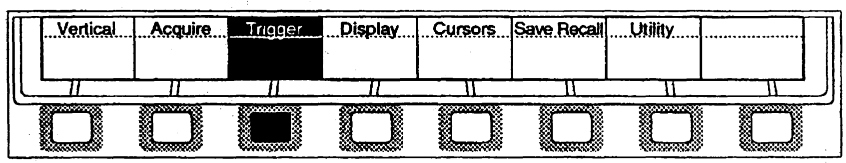
TRIGGER MODE: {AUTO|NORMAL}
TRIGGER? MODE and TRIGGER?

TRIGGER SOURCE

Key Presses



Mode Key	Function Key	Function adjusted by
Trigger	Source	Function Key



Description

The Trigger Source function selects from where the trigger signal is received. For the SCD1000, this setting can be any of the vertical mode settings (Ch A, Ch B, or Add), or from the external trigger input connector. For the SCD5000 this setting can be from the external input connector or from an internal time calibrator signal.

In the SCD1000, if the source is from an internal vertical channel that has been inverted, the trigger signal is also inverted. Inversion affects the signal, but has no affect on trigger slope or level settings.

Values

Model	Choices	Init Value
SCD1000	Ch A Ch B Add External	Ch A
SCD5000	External Call (Time Calibrator Signal)	External

Interactions

The Trigger Source selection interacts with the following other functions:

Trigger Level
As the trigger source is changed, the trigger level readout is adjusted according to the following relationship:
trigger level = trig% * vertical range + offset

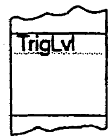
Trigger Level Units
Trigger level units are forced to volts if the source is changed to external.

GPIB Command

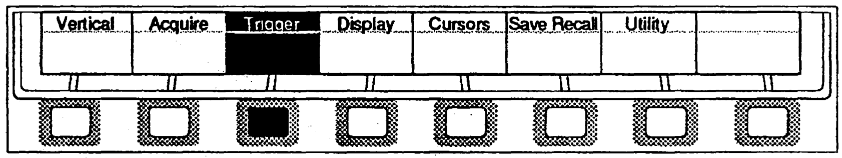
TRIGGER SOURCE: {CHA|CHB|ADD|EXTERNAL} (SCD1000)
TRIGGER SOURCE: {CALIBRATOR|EXTERNAL} (SCD5000)
TRIGGER? SOURCE

TRIGGER LEVEL

Key Presses



Mode Key	Function Key	Function adjusted by
Trigger	TrigLvl	Knob



Description

The Trigger Level function sets the trigger level in either volts or as a percentage of the selected channel's vertical full-scale range. The *Units* key allows selection of the different units. The *Units* key is active only when the source is internal. If the source is external, the trigger level can be specified only as voltage.

The trigger level is adjusted with the variable knob.

Trigger level is determined by the following relationship:
Trigger level = trig% * vertical range + offset

Once the trigger level is set, it remains constant as a percentage of the full-scale acquisition window. If the vertical range or offset (of an internal trigger source) is adjusted, the trigger level is recalculated and the level readout is updated, but the position of the trigger level within the acquisition window does not change.

For example, if trigger level is set to the center of the acquisition window (0%) and the range or offset is changed, the trigger level will remain in the center of the window. The level's position changes only when the trigger level is changed. When the coupling is AC, a "~" (tilde) character is appended to the trigger level readout.

Values

Source	Units*	Min	Max	Init Value
Int	Volts	-(Vertical Range/2 + Offset**)	+(Vertical Range/2 + Offset**)	0 V
Int	%	-100%	+100%	0 %
Ext	Volts only	-0.5 V -1.0 V	+0.5 V (SCD 5000) +1.0 V (SCD 1000)	0 V

*Units are initialized at volts.

* *Offset is included in the calculation only if the coupling is DC for both vertical and trigger modes. Otherwise, Offset is not included.

TRIGGER LEVEL (CONT)

Interactions

Trigger Level is affected by adjustment of the following other functions:

Trigger Source
If the trigger source is changed from internal to external, the level units will automatically change to volts.

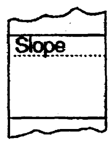
Vertical Channel Parameters
If the vertical range or vertical offset is changed, the trigger level voltage readout is adjusted, but the actual trigger level % of vertical range remains constant.

GPIB Command

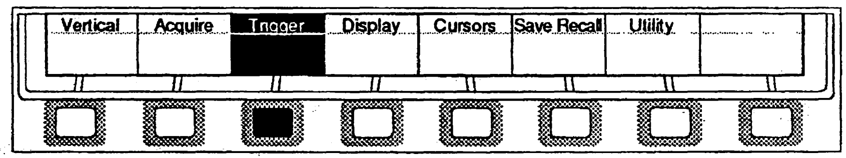
TRIGGER LEVEL: <NRx>
TRIGGER TYPELEVEL: {PERCENT|VOLTS}
TRIGGER? LEVEL
TRIGGER? TYPELEVEL

TRIGGER SLOPE

Key Presses



Mode Key	Function Key	Function adjusted by
Trigger	Slope	Function Key



Description

The Trigger Slope function selects the slope of the signal that triggers an acquisition. Slope can be either a rising edge (+) or falling edge (-). If the trigger source is an inverted internal channel, the slope is not affected by the signal inversion.

Values

Choices	Init Value
+ -	+

Interactions

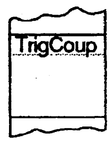
None

GPIB Command

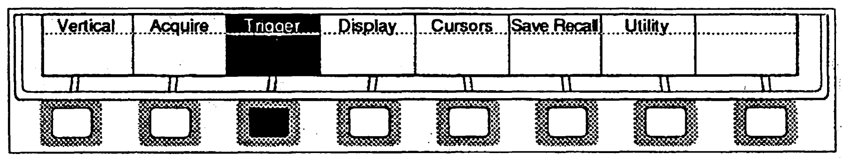
TRIGGER SLOPE: {PLUS|MINUS}
TRIGGER? SLOPE and **TRIGGER?**

TRIGGER COUPLING (SCD1000 ONLY)

Key Presses



Mode Key	Function Key	Function adjusted by
Trigger	TrigCoup	Function Key



Description

The Trigger Coupling function selects how the trigger signal is coupled to the trigger circuitry. The selections are DC and AC. (AC coupling only is allowed when the trigger source is external.) DC coupling allows all signal components within the waveform recorder's bandwidth to be coupled to the trigger circuitry. AC coupling attenuates frequencies below 1 kHz.

Only AC coupling is allowed on the SCD5000.

Values

Choices	Init Value
AC DC	DC

Interactions

The Trigger Coupling selection interacts with other functions as follows:

Trigger Level
If coupling is set to AC, the "~" (tilde) character is appended to the level value readout.

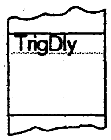
Trigger Source
If the trigger source is changed from internal to external, the coupling automatically changes to AC.

GPIB Command

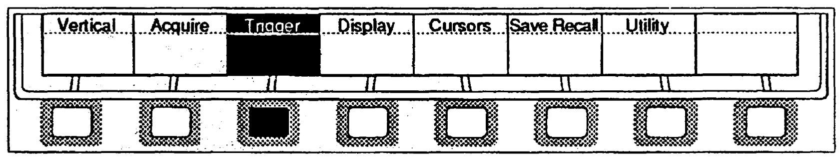
TRIGGER COUPLING: {AC|DC}
TRIGGER? COUPLING and TRIGGER?

TRIGGER DELAY

Key Presses



Mode Key	Function Key	Function adjusted by
Trigger	TrigDly	Knob



Description

The Trigger Delay function sets how long to wait (up to 5 times the time window) after a valid trigger event before writing the signal onto the target. Delay can be specified in % of the time window or seconds. Knob resolution can be Coarse or Fine. Coarse resolution is 10% of the time window, Fine is 0.4%. Resolution is set with the *Resolution* key. The value is set with the knob.

If the time window value is changed after a delay is specified, the amount of delay remains the same (as a percentage of the time window), even if the delay is specified in seconds.

Values

Min	Max	Init Value
0	5 times the Time Window	0%

Interactions

Trigger Position is affected by the following other functions:

Time Window
If the time window value is changed, the delay remains constant as a percentage of the time window, even if specified in seconds.

GPIB Command

TRIGGER POSITION: <NRx>
TRIGGER TYPEPOSITION: {PERCENT|SECOND}
TRIGGER? POSITION
TRIGGER? TYPEPOSITION

DISPLAY FUNCTIONS

Display functions control how the acquired waveform is displayed on the Display Unit. These functions are selected by pressing the *Display* mode key. The display selections are (with menu abbreviations in parentheses):

Number of Windows Displayed (N Window): Selects 1, 2, or 4 windows to be displayed simultaneously in the Waveform Zone.

Window Select (Wind Sel): Selects the active display window for the record select and waveform expansion functions. When a window is selected, the window number (1, 2, 3, or 4) appears in other function key labels.

Record Selection for Current Window (Wx Rec): (x indicates the window selected by the *Wind Sel* key) Selects the record to be displayed in the currently-selected window.

Horizontal/Vertical Expansion Point (WxExpPt): (x indicates the window selected by the *Wind Sel* key) Sets the sample point around which horizontal and vertical expansions occur in the currently-selected window.

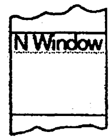
Vertical Expansion Factor (Wx VExp): (x indicates the window selected by the *Wind Sel* key) Sets the vertical expansion factor for the selected window.

Horizontal Expansion Mode (HExpMode): Selects whether horizontal expansion is done for all windows at the same time (Aligned mode) or only upon the selected window (Independent mode).

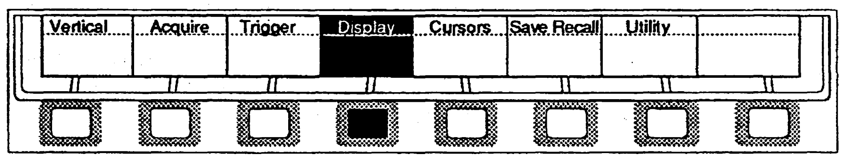
Horizontal Expansion Factor (Wx HExp): (x indicates the window selected by the *Wind Sel* key) Sets the horizontal expansion factor for the selected window.

NUMBER OF WINDOWS DISPLAYED

Key Presses



Mode Key	Function Key	Function adjusted by
Display	N Window	Function Key



Description

The Number of Windows function selects the number of windows to be displayed at one time (1, 2, or 4) in the waveform zone. Each window can display one waveform record and its related data. More than one window can display the same, or portions of the same, record. A window can display a special text window designated record number 0. See RECORD SELECTION FOR SELECTED WINDOW later in this Display Function reference. If a window has been displayed and then is removed from the screen, the current parameters remain defined. If the window is again displayed, it is displayed with the same parameters.

The entire vertical display axis is 256 pixels. As the waveform zone is divided, the number of pixels per window changes. One window is 256 pixels high. Two windows are each 128 pixels high. Four windows are each 64 pixels high.

The number of windows (along with the vertical expansion factor) affects the ratio of sample points to display pixels (number of waveform sample points displayed per one display pixel). The ratios (at a vertical expansion factor of 1 are as follows: one window = 8:1; two windows = 16:1; four windows = 32:1. As vertical expansion is changed, the ratio changes as described in VERTICAL EXPANSION FACTOR later in this reference.

The horizontal display axis is 512 pixels. The number of windows does not affect waveform display on this axis. However, the record length does affect how data is displayed. See Acquisition Record Length earlier in this functional reference.

Values

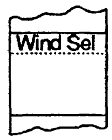
Choices	Init Value
1 2 4	1

NUMBER OF WINDOWS DISPLAYED (CONT)

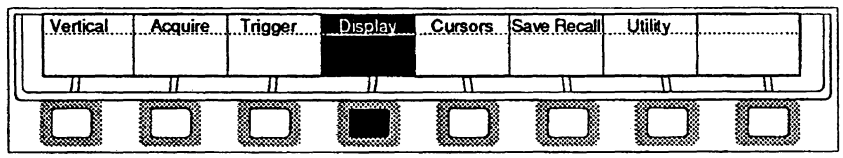
Interactions	The number of windows affects the displayed resolution of the vertical waveform data as explained above.
GPIB Command	NWIN {1|2|4} NWIN?

WINDOW SELECT

Key Presses



Mode Key	Function Key	Function adjusted by
Display	Wind Sel	Function Key



Description

The Window Select function selects one of the four windows in order to change its record selection, horizontal/vertical expansion point, vertical expansion factor, and horizontal expansion factor. When a window is selected, the window number appears in other display function key labels.

Window selection is limited to the number of windows currently displayed.

Values

Choices	Init Value
1	1
2	
3	
4	

Interactions

Window selection affects the following parameters:

Display Parameters
The selected window affects record selection, vertical/horizontal expansion point, and the vertical and horizontal expansion factors for the currently selected window. The setting displayed in the key label of each of these parameters changes to indicate the current setting for the selected window.

The selected window is affected by the following parameters:

Number of Windows
Window selection is limited to the number of windows currently displayed. If one window is displayed, the only window selection is 1. If two windows are displayed, window selection can be 1 or 2. If four windows are displayed, window selection can be 1, 2, 3, or 4.

WINDOW SELECT (CONT)

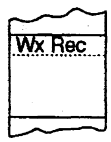
GPIB Command

No direct equivalent. The active window selection is part of other display function GPIB commands.

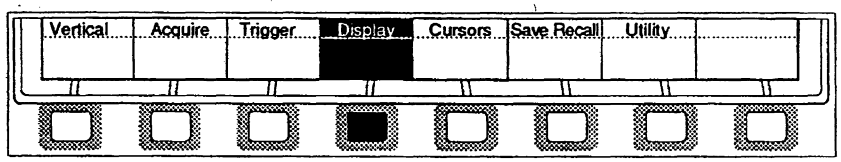
See **WIN<ui> CHANNEL:{RECORD:|EXPNT:|VEXPND:|HEXPND:}**
WIN<ui> RECORD:<NRx>
WIN<ui> EXPNT: <NRx>
WIN<ui> VEXPND:<NRx>
WIN<ui> HEXPND:<NRx>
WIN<ui>?
WIN?

RECORD SELECTION FOR SELECTED WINDOW

Key Presses



Mode Key	Function Key	Function adjusted by
Display	Wx Rec	Knob



Description

The Record Selection function displays a record in the currently selected window. Records 0 to 16 can be selected. Records 1 to 16 are the waveform records; record 0 is a special empty record in which waveform data cannot be stored. (Record 0 is not selectable from the acquisition functions menu.)

Text only can be written anywhere on the Display Unit using the GPIB TEXT command. The text appears over any waveform data currently displayed. By selecting record 0, text can displayed without waveform data.

The function is adjusted with the variable knob.

Values

Min	Max	Init Value
0	16	1

Interactions

Record selection is affected by the following parameters:

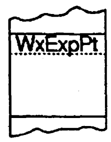
Window Select
As the currently selected window is changed, the record selection readout is automatically updated to indicate the record assigned to the window.

GPIB Command

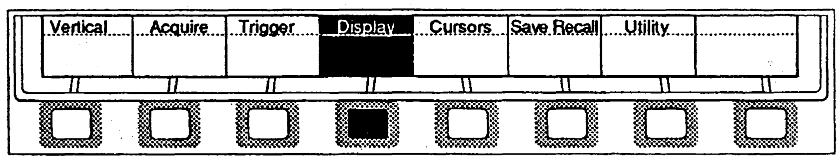
WIN<ui> RECORD:<NRx>
WIN<ui>? RECORD

HORIZONTAL/VERTICAL EXPANSION POINT

Key Presses



Mode Key	Function Key	Function adjusted by
Display	WxExpPt	Knob



Description

The Expansion Point function selects the sample point in the record of the currently selected window around which vertical and horizontal expansions occur. An expansion point cursor ("x" surrounded by a box) indicates the current expansion point. As the waveform is expanded, the cursor remains in the same position on the display.

When the Display mode is activated or when an expansion function is activated, the message/measurements zone displays the time from the trigger point to the current expansion point and the voltage from the ground reference to the current expansion point. The measurements remain until another message/measurements indicator is selected (such as cursors or status messages).

Positioning the expansion point beyond the left, right, top, or bottom display boundary results in the waveform being scrolled in the appropriate direction by 75% of the screen's height or width (if possible).

The setting is adjusted with the variable knob. The RESOLUTION key selects the number of sample points the knob moves the expansion point cursor.

Values

Min	Max	Init Value
0	Record Length - 1	Point 0

Interactions

The expansion point setting is affected by the following parameters:

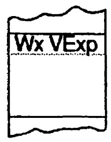
Record Length
The maximum expansion point setting is limited to the record length.

GPIB Command

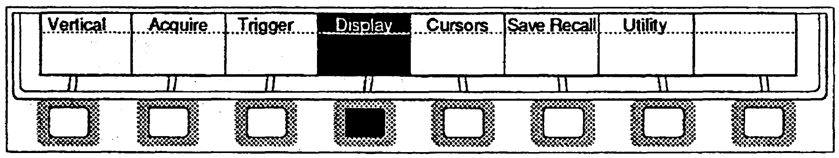
WIN<ui> EXPNT: <NRx>
WIN<ui>? EXPNT

VERTICAL EXPANSION FACTOR

Key Presses



Mode Key	Function Key	Function adjusted by
Display	Wx VExp	Knob



Description

The Vertical Expansion factor sets the expansion factor along the vertical axis. Vertical expansion factors are 1, 2, and 4. An expansion factor of 1 displays the entire waveform. Vertical expansion is allowed on all record lengths.

The expansion factor is adjusted with the variable knob.

Values

Min	Max	Init Value
1	4	1

Interactions

Apparent vertical expansion is affected by the following parameters:

Number of Windows

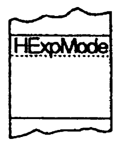
The apparent vertical expansion is affected by the number of windows displayed as listed in the table above.

GPIB Command

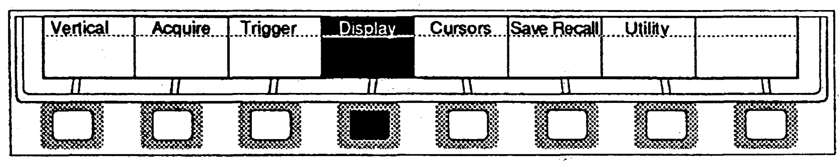
WIN<ui> VEXPND: <NRx>
WIN<ui>? VEXPND

HORIZONTAL EXPANSION MODE

Key Presses



Mode Key	Function Key	Function adjusted by
Display	HExpMode	Function Key



Description

The Horizontal Expansion Mode function controls how expansion is accomplished when more than one window is displayed. **Independent** mode expands each window independently of the others. In **Aligned** mode, all windows are expanded according to the expansion point and horizontal expansion factor of the currently selected window. If Aligned is selected and the selected window is changed, the expansion factors of the newly selected window are used, and expansion is re-executed.

Values

Choices	Init Value
Independent Aligned	Independent

Interactions

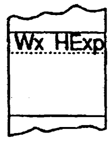
None

GPIB Command

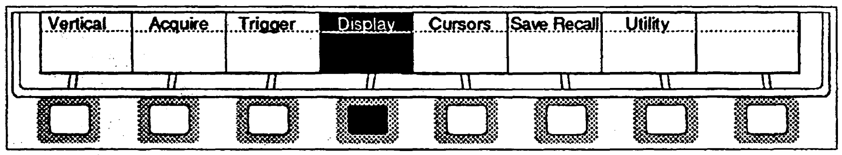
HEXPMD {ALIGNED|INDEP}
HEXPMD?

HORIZONTAL EXPANSION FACTOR

Key Presses



Mode Key	Function Key	Function adjusted by
Display	Wx HExp	Knob



Description

The Horizontal Expansion Factor sets the expansion along the horizontal axis of the selected window. Expansion factors are 1 and 2. A factor of 1 displays the entire waveform length in the window. Only record lengths of 1024 can be expanded horizontally. Changing the record length from 1024 to 512 or 256 forces horizontal expansion to 1.

The horizontal expansion factor is adjusted with the variable knob.

Values

Min	Max	Init Value
1	2	1

Interactions

The horizontal expansion factor is affected by the following parameters:

Record Length
Only record lengths of 1024 can be expanded. This is because the ratio of record length to number of pixels along the horizontal axis is equal to or less than 1:1 at other record lengths. Changing the record length from 1024 to 512 or 256 forces horizontal expansion to 1.

Expansion Mode
If the expansion mode is Aligned, the currently selected window determines the expansion factor for all other windows. If the expansion factor is 2, any windows with record lengths less than 1024 are not expanded. If the currently selected window's record length is less than 1024, the expansion factor is forced to 1 and no expansion takes place, even if other windows contain a record length of 1024.

GPIB Command

WIN<ui> HEXPND: <NRx>
WIN<ui>? HEXPND

CURSOR FUNCTIONS

Cursor functions control the placement of Cursor 1 and Cursor 2. These functions are selected using the *Cursor* mode key. The cursor selections are (with menu abbreviations in parentheses):

Cursors ON/OFF (Cursors): Turns the cursors ON and OFF. The cursors must be on to move them and to make measurements.

Cursor 1 Window Location (Curs1Loc): Selects the window in which Cursor 1 will appear.

Cursor 2 Window Location (Curs2Loc): Selects the window in which Cursor 2 will appear.

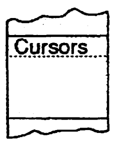
Cursor 1 Position (Cursor 1): Positions Cursor 1 on a sample point in the selected window.

Cursor 2 Position (Cursor 2): Positions Cursor 2 on a sample point in the selected window.

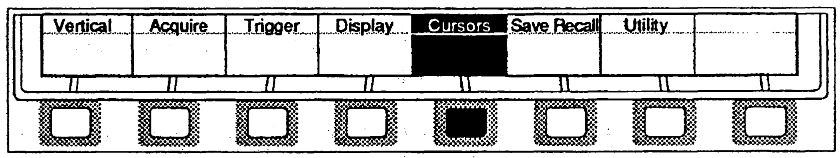
Unit (Units Key): Selects units of Δtime measurements as Hertz or seconds.

CURSORS ON/OFF

Key Presses



Mode Key	Function Key	Function adjusted by
Cursors	Cursors	Function Key



Description

The Cursors function turns the cursors ON or OFF. Cursors are indicated on the waveform and in the record bar as the symbols "v" (Cursor 1) and "^" (Cursor 2). The cursors allow time, Δtime, voltage, and Δvoltage measurements.

Delta measurements are made by measuring from the beginning of the record to each cursor and calculating the difference between the values: (Curs 1 Location - record start) - (Curs 2 Location - record start). To obtain meaningful measurement data cursors should be placed in records with similar acquisition settings.

Measurement information is displayed in the message/measurements zone above the waveform zone.

Measurement information is first displayed when the Cursors mode key is activated and the cursors are turned on. (The cursors must be turned on to display cursor positions in the menu labels and measurement information in the message/measurements zone.) The cursor measurement information is removed from the message/measurements zone if another function that uses this zone, such as expansion point, is activated. The cursor information returns when a cursor function (including rotating the knob to move a cursor) is used (if the cursors are on).

Turning the cursors off removes the measurements from the message/measurement zone and removes the cursor symbols from the waveform display and the record bar indicator. Cursor position and window location are still displayed in the key labels. These parameters can be changed, but measurement information and the cursor symbols are not displayed.

If a waveform on which cursors are placed is expanded and the cursors are no longer visible, the cursor position readout in the menu label and the cursor measurement information is still displayed.

CURSORS ON/OFF (CONT)

Values

Function	Choices	Init Value
Cursors	On Off	On
Units	Second Hertz	Seconds

Interactions

The Cursors On/Off function affects the following parameters:

Measurement Information
Turning cursors on or off add or remove the measurement information in the message/measurements zone and the cursor symbols in the waveform zone. Cursors can still be manipulated, but measurement information is not displayed when cursors are off.

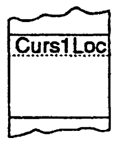
Debug Mode
The cursor measurements take precedence over debug information, therefore cursors must be off when the GPIB Debug function (of the Utility mode) is turned on.

GPIB Command

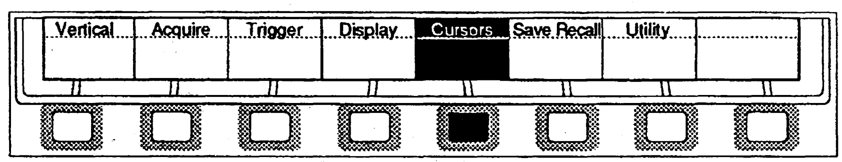
CURSORS {ON|OFF}
CURSORS?

CURSOR 1 WINDOW LOCATION

Key Presses



Mode Key	Function Key	Function adjusted by
Cursors	Curs1Loc	Function Key



Description

The Cursor 1 Window Location selects the window in which Cursor 1 will appear. Only one of the windows currently displayed can be selected.

Both Cursors can be placed in the same window.

Values

Choices	Init Value
Win 1 Win 2 Win 3 Win 4	Win 1

Interactions

Cursor 1 Location is affected by the following parameters:

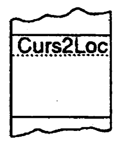
Number of Windows
If a window in which a cursor is located is removed, the cursor readout becomes undefined.

GPIB Command

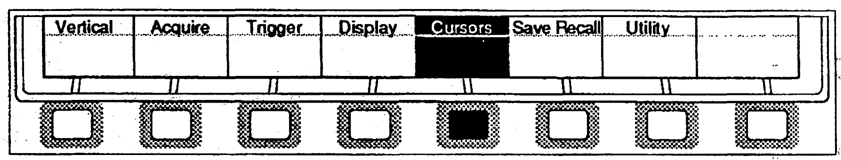
CRS1 LOCTN: WIN<ui>
CRS1? LOCN

CURSOR 2 WINDOW LOCATION

Key Presses



Mode Key	Function Key	Function adjusted by
Cursors	Curs2Loc	Function Key



Description

The Cursor 2 Window Location selects the window in which Cursor 2 will appear. Only one of the windows currently displayed can be selected.

Both Cursors can be placed in the same window.

Values

Choices	Init Value
Win 1 Win 2 Win 3 Win 4	Win 1

Interactions

Cursor 2 Location is affected by the following parameters:

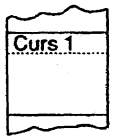
Number of Windows
If a window in which a cursor is located is removed, the cursor readout becomes undefined.

GPIB Command

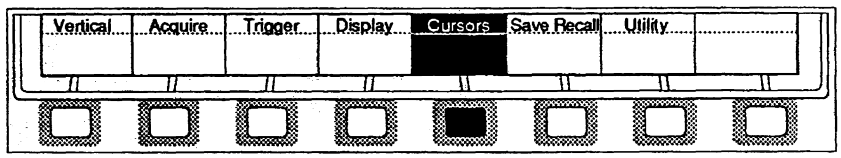
CRS2 LOCTN: WIN<ui>
CRS2? LOCN

CURSOR 1 POSITION

Key Presses



Mode Key	Function Key	Function adjusted by
Cursors	Curs 1	Knob



Description

The Cursor 1 Location function positions Cursor 1 on a sample point of the record in the selected window. The cursor position value is adjusted with the variable knob.

The *Units* and *Resolution* keys can be used to select the Δtime units and the step size of cursor movement.

Values

Min	Max	Init Value
0	Record Length-1	0

Interactions

Cursor 1 Position is affected by the following parameters:

Record Length
The cursor position is limited to the number of points in the record.

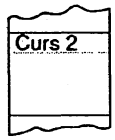
Number of Windows
If a window in which a cursor is located is removed, the cursor readout becomes undefined.

GPIB Command

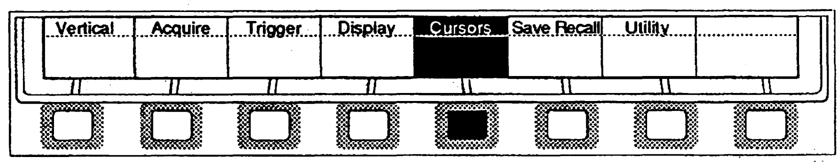
CRS1 XPOINT: <NRx>
CRSD TYPETIME: {HZ|SECOND}
CRS1? XPOINT
CRSD? TYPETIME
CRS1? XTIME
CRS1? YCOORD
CRS1?
CRS?
CRSD? T
CRSD? V
CRSD?

CURSOR 2 POSITION

Key Presses



Mode Key	Function Key	Function adjusted by
Cursors	Curs 2	Knob



Description

The Cursor 2 Location function positions Cursor 2 on a sample point of the record in the selected window. The cursor position value is adjusted with the variable knob.

The *Units* and *Resolution* keys can be used to select the Δ time units and the step size of cursor movement.

Values

Min	Max	Init Value
0	Record Length-1	0

Interactions

Cursor 2 Position is affected by the following parameters:

Record Length
The cursor position is limited to the number of points in the record.

Number of Windows
If a window in which a cursor is located is removed, the cursor readout becomes undefined.

GPIB Command

CRS2 XPOINT: <NRx>
CRSD TYPETIME: {HZ|SECOND}
CRS2? XPOINT
CRSD? TYPETIME
CRS2? XTIME
CRS2? YCOORD
CRS2?
CRS?
CRSD? T
CRSD? V
CRSD?

SAVE/RECALL FUNCTIONS

Save/Recall functions control non-volatile storage and retrieval of instrument settings and display of status messages. The waveform recorder can also be "secured" from the Save/Recall function menu. These functions are selected by pressing the *Save/Recall* mode key. The selections are (with menu abbreviations in parentheses):

Save Settings Selection (Save Sel): Selects a storage location (1 to 10) where the current settings will be saved.

Save Current Settings (Save Set): Saves all current settable parameters in the location specified by the Save Settings Selection function.

Recall Settings Selection (Rcl Sel): Selects a storage location (1 to 10) from which to recall saved settings.

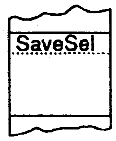
Recall Settings (Rcl Set): Recalls settable parameters from the location specified with the Recall Settings Selection function.

Recall Status Messages (Rcl Stat): Recalls any one of the last ten status messages for display in the message/measurements zone.

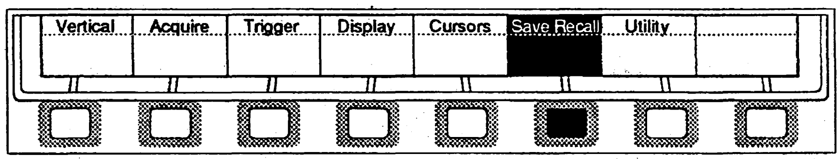
Secure Instrument (Secure): Initializes all instrument settings and clears all waveform, settings, and status memory. To prevent unwanted erasure of memory, this function requires a double key press, allowing function cancellation before the second press.

SAVE SETTINGS SELECTION

Key Presses



Mode Key	Function Key	Function adjusted by
SaveRecall	SaveSel	Knob



Description

The Save Settings function selects one of the ten memory locations for saving current front panel settings. The location value is selected with the variable knob.

Values

Min	Max	Init Value
1	10	1

Interactions

None

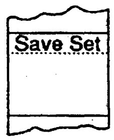
GPIB Command

SAVE <NRx> (see also the **LLSET <bblock>** and **ERASE <NRx>** commands)
SET? (see also the **LLSET?** command)

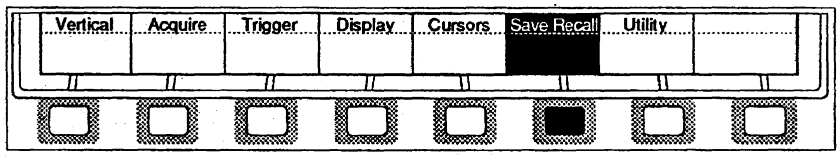
The SAVE <NRx> command also executes the equivalent of the Save Current Settings function. The SET? and LLSET? command queries for all current instrument settings. The GPIB controller can then read them for use at a later time.

SAVE CURRENT SETTINGS

Key Presses



Mode Key	Function Key	Function adjusted by
SaveRecall	Save Set	No Selector



Description

The Save Settings function saves all current settable parameters in the location selected by the Save Settings Selection. The function is executed when selected, and presents no options.

Waveform data is not part of the front panel settings; it is not saved using the SaveRecall functions.

Values

None

Interactions

None

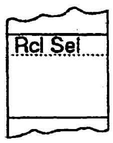
GPIB Command

SAVE <NRx> (see also the **LLSET <bblock>** and **ERASE** <NRx> commands)
SET? (see also the **LLSET?** command)

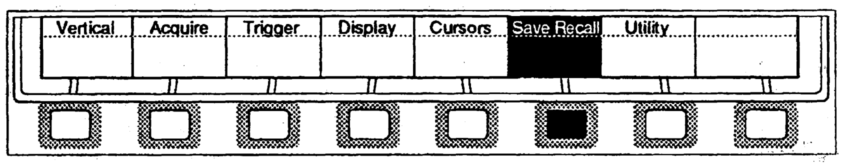
The SAVE <NRx> command also executes the equivalent of the Save Current Settings function. The SET? command queries for all current instrument settings.

RECALL SETTINGS SELECTION

Key Presses



Mode Key	Function Key	Function adjusted by
SaveRecall	Rcl Sel	Knob



Description

The Recall Settings function selects one of the ten memory locations from which to recall current front panel settings. The location value is selected with the variable knob.

CAUTION *Certain waveform recorder functions, such as cursor positions, expansion point, etc., rely on the current contents of acquisition memory for legal boundaries. Under some circumstances, the contents of acquisition memory at the time of recall can force settings to legal boundaries that differ from the saved value. To avoid this, recall the settings, perform the acquisition, then recall the settings again.*

Values

Min	Max	Init Value
1	10	1

Interactions

None

GPIB Command

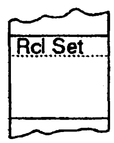
RECALL SAVE <NRx> (see also the **LLSET <bblock>** and **ERASE <NRx>** commands)

SET? (see also the **LLSET?** command)

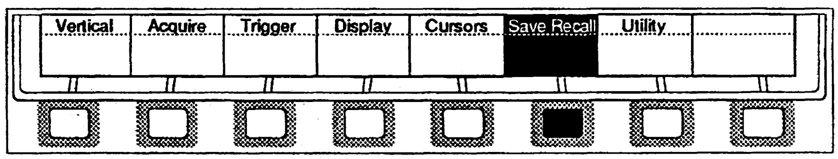
The RECALL <NRx> command also executes the equivalent of the Recall Current Settings function. The SET? command queries for all current instrument settings.

RECALL SETTINGS

Key Presses



Mode Key	Function Key	Function adjusted by
SaveRecall	Rcl Set	No Selector



Description

The Recall Settings function recalls all current settable parameters in the location selected by the Recall Settings Selection. The function is executed when selected, and presents no options.

CAUTION *Certain waveform recorder functions, such as cursor positions, expansion point, etc., rely on the current contents of acquisition memory for legal boundaries. Under some circumstances, the contents of acquisition memory at the time of recall can force settings to legal boundaries that differ from the saved value. To avoid this, recall the settings, perform the acquisition, then recall the settings again.*

Values

None

Interactions

None

GPIB Command

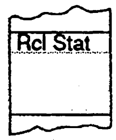
RECALL <NRx> (see also the **LLSET <bblock>** and **ERASE <NRx>** commands)

SET? (see also the **LLSET?** command)

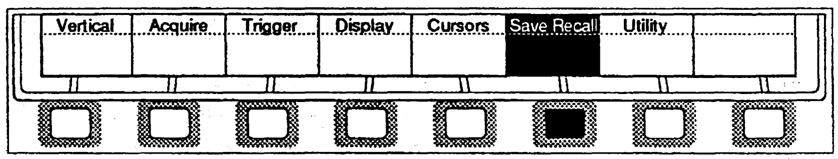
The RECALL <NRx> command also executes the equivalent of the Recall Current Settings function. The SET? command queries for all current instrument settings.

RECALL STATUS MESSAGES

Key Presses



Mode Key	Function Key	Function adjusted by
SaveRecall	Rcl Stat	Function Key



Description

The Recall Status Messages function recalls any of the last ten status messages for display in the message/measurements zone. Only one message can be displayed at a time.

The status messages are part of the waveform recorder firmware. The messages are the same messages reported over the GPIB when an event is reported to the GPIB controller. See Section 6D for a list of event codes.

If Debug mode is turned on, the last 10 status messages saved include any GPIB traffic information to this instrument.

Values

Choices	Init Value
Stat 1 (Current)	Stat 1 (Current)
Stat 2	
Stat 3	
Stat 4	
Stat 5	
Stat 6	
Stat 7	
Stat 8	
Stat 9	
Stat 10	

Interactions

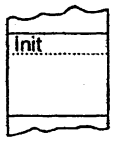
None

GPIB Command

None

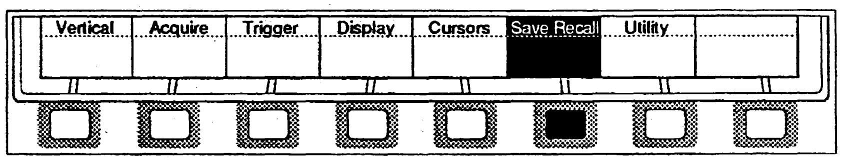
INITIALIZE

Key Presses



Mode Key	Function Key	Press any mode key
SaveRecall	Init	to initialize a mode

Mode Key	Function Key	Press Init to initialize
SaveRecall	Init	the entire instrrument, including GPIB



Description

The Initialize function initializes any mode or the entire instrument to the factory settings stored in ROM. Pressing a mode key after pressing *Init* initializes the selected mode. Pressing the Init key twice initializes all waveform recorder parameters, including GPIB parameters. To prevent unwanted initialization of the entire instrument, the Init key must be pressed twice to execute complete waveform recorder initialization. Pressing the *Cancel* key before pressing Init a second time cancels the operation.

Tables C-17 and C-18 in Section 6 list the factory default settings assumed upon initialization.

Values

None

Interactions

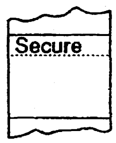
If a mode key is pressed after Init is pressed, Init affects all mode parameters. If Init is pressed twice, Init affects all waveform recorder parameters.

GPIB Command

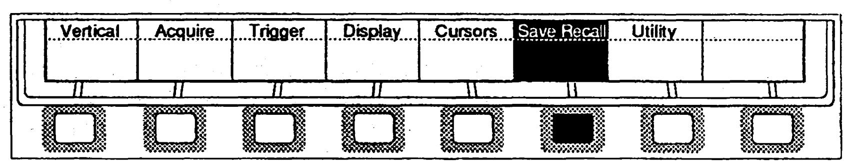
INIT PANEL
INIT GPIB
INIT

SECURE

Key Presses



Mode Key	Function Key	
SaveRecall	Secure	Secure



Description

The Secure function sets all instrument parameters to their factory settings and erases all stored settings, waveforms, and status memory.

To prevent unwanted erasure of data and settings, the Secure function must be pressed a second time before this function is executed. The *Cancel* function key is pressed to cancel the operation.

Values

Choices	Init Value
Secure Cancel	N/A

Interactions

This function affects all settable parameters and waveform memory in the waveform recorder.

GPIB Command

SAFEGUARD SECURE

UTILITY FUNCTIONS

Utility functions control beam-writing parameters, test functions, date/time clock setting functions, and SCD calibrator functions. These functions are selected by pressing the *Utility* mode key. Because of the numerous selections, the functions are divided into four menus. A *NextMenu* key selects the next menu in the sequence. When the last menu in the sequence is displayed, pressing NextMenu selects the first menu in the sequence. The following list describes the menus in the order they appear after initializing the Utility mode or the entire instrument, or after the instrument has been secured (using the Secure key in the SaveRecall mode). The selections are (with menu abbreviations in parentheses):

Utility Menu 1

This menu allows setting up the CRT for signal capture. When Utility Menu1 is selected, the Display Unit displays the target image (linear array) for the last acquired waveform. Centroiding is not done. If GPIB SETREF OFF has been sent to the SCD, the reference arry data is not subtracted from the raw target data; any target aberrations will be seen.

Using a signal identical to or similar to the one to be captured, the write gun's beam intensity can be properly set for recording. If the SCD is not properly set up, "linear array overflow" can occur. This condition results in a "checkerboard" pattern being displayed as the waveform is written on the display. See SCD Scanning Setup and Acquiring Data earlier in this section for more information on how to properly set up the SCD waveform recorders.

Display Threshold (Thresh): Sets the threshold above which any object written on the target is displayed as the target image. The Display Threshold setting is only valid when this Utility function menu is displayed. See Acquiring Data earlier in this section.

CRT Intensity (Intens): Sets the intensity for the write gun. This setting is similar to an oscilloscope's CRT intensity setting. This value should be set prior to capturing a signal. CRT Intensity settings are individually maintained for each window size.

NOTE

For an accurate waveform capture, it is important to adjust the intensity setting prior to capturing the final waveform. Adjustment should be done at the time window and delay settings used for final capture and with an identical or similar waveform that will be the final captured waveform. See Acquiring Data earlier in this section for instructions on how to set up this parameter.

CRT Focus (Focus): Sets the focus for the write gun. Focus normally does not need adjustment. This setting is similar to an oscilloscope's CRT focus setting. CRT focus settings are individually maintained for each window size.

Acquisition Time Window (TimeWin): Same as acquisition time window setting. This function is provided in this menu to select the time window to be used for final waveform capture. See **ACQUISITION FUNCTIONS** in this reference section.

Utility Menu 1 (cont)

Trigger Delay (TrigDly): Same as trigger delay setting. This function is provided in this menu to select the trigger delay to be used for final waveform capture. See TRIGGER FUNCTIONS in this reference section.

Set Target Reference Data (Set Ref): Analyzes the target for aberrations. This data is used as a target reference when digitizing waveforms. The aberrations are subtracted from waveform data before the data is stored in the linear array. See **SCD ACQUISITION CONCEPTS** earlier in this section.

Utility Menu 2

Calibration Mode Selection (Cal Mode): Selects one or all of the SCD subsystems to automatically calibrate. The subsystems are: System, Horizontal, Vertical, CRT, and Trigger. The CRT calibration process requires an input signal and provides on-display instructions in the message/measurements zone. System calibration does not include CRT calibration.

Initiate Calibration (Cal): Starts automatic calibration of the system or selected subsystem. The state of the calibration operation is displayed in the menu label.

View Settings of All or Selected Areas (View): Displays various system and mode information. There are three view displays: ID, Acquire, and Display.

Beeper ON/OFF (Beeper): Turns ON and OFF the audio feedback for button presses.

Knob Beeper ON/OFF (KnobBeep): Turns ON and OFF audio feedback for knob clicks.

Debug Mode (Debug): Turns ON and OFF the Debug mode. When Debug is ON, all commands received at the GPIB port for this waveform recorder are displayed in the screen. Cursors must be turned off to use the Debug mode.

Select Next Menu (Next Menu): Advances to the next menu in the sequence. This function appears in all utility menus.

Utility Menu 3

Instrument Tests (Inst Test, MPU Test, FP Test, Acq Test): Executes self tests of the entire waveform recorder, the processor subsystem, the Display Unit, and the acquisition subsystem.

Utility Menu 4

Date/Time Functions (Year, Month, Day, Hour, Minute): Set the waveform recorder's date/time clock. After each parameter is set, pressing *Enter* sets the date/time clock. The date/time clock is used to determine waveform acquisition time, which is stored with the waveform data (timestamp).

Enter Date/Time Values (Enter): Enters the currently selected date/time values into the waveform recorder's date/time clock.

Utility Menu 5 (SCD1000 Only)

Channel A Calibrator Signal (Ch A Cal): Connects the internal calibrator signal to Channel A and selects the signal type (time, amplitude into 0 ohms, amplitude into 450 ohms, or off).

Channel B Calibrator Signal (Ch B Cal): Connects the internal calibrator signal to Channel B and selects the signal type (time, amplitude into 0 ohms, amplitude into 450 ohms, or off).

External Calibrator (Ext Cal): Connects the calibrator signal to the CAL OUT connector on the SCD1000 rear panel.

Calibrator Signal Amplitude (CalAmpl): Sets the calibrator signal's amplitude.

Calibrator Signal Period (CalTime): Sets the calibrator signal's period.

Utility Menu 5 (SCD5000 Only)

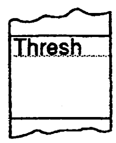
Calibrator Signal (Cal Out): Selects the type of signal connected to the CAL OUT connector on the front panel: time, amplitude into 0 ohms, or amplitude into 450 ohms.

Calibrator Signal Amplitude (CalAmpl): Sets the calibrator signal's amplitude.

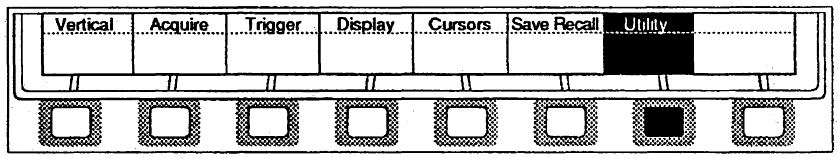
Calibrator Signal Period (CalTime): Sets the calibrator signal's period.

DISPLAY THRESHOLD

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	Thresh	Function Key



Description

The Threshold function sets the display threshold value, above which data from the CRT will be visible on the Display Unit. The value is adjusted with the knob. This setting is usually set to 0 during normal operation.

A setting of 63 is used for critical adjustment of intensity. See Acquiring Data earlier in this section.

Values

Min	Max	Init
0	63	0

Interactions

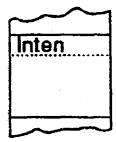
None

GPIB Command

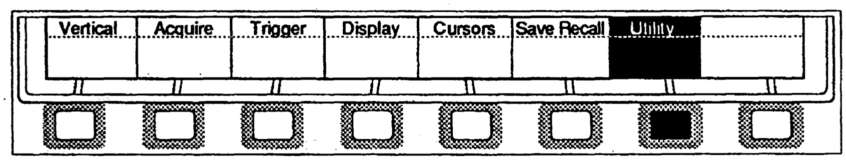
None

CRT BEAM INTENSITY

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	Inten	Function Key



Description

The Intensity function sets the CRT's write gun intensity (like an oscilloscope's intensity) for the current time window setting. The intensity affects the quality of the waveform written onto the target and thus the digitized waveform. Beam intensity varies over the beam's sweep rates. Therefore, intensity should be set for a specific time window and checked (and changed if necessary) for other time window settings.

The value is set with the knob.

Values

Min	Max
0%	100%

Interactions

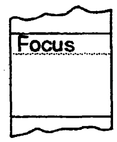
The setting of Intensity affects the quality of the waveform to be digitized.

GPIB Command

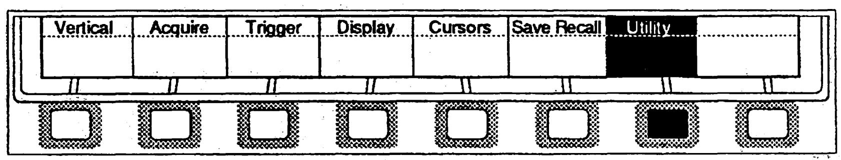
INTENSITY <NRx>
INTENSITY?

CRT BEAM FOCUS

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	Focus	Knob



Description

The Focus function sets the crt's write gun focus on the target (like an oscilloscope's focus adjustment) for the current time window setting. Focus is set at the factory and should not need to be changed. See Acquiring Data earlier in this section.

The focus affects the quality of the waveform written onto the target and thus the digitized waveform.

The value is set with the knob.

Values

Min	Max
0%	100%

Interactions

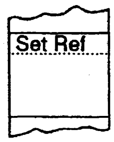
The setting of focus affects the quality of the digitized waveform.

GPIB Command

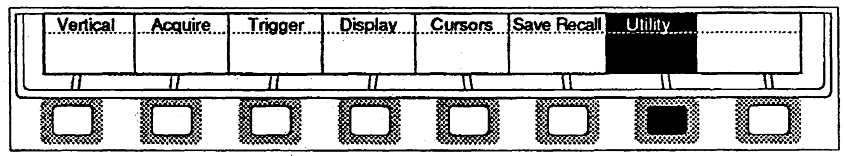
FOCUS <NRx>
FOCUS?

SET REFERENCE DATA

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	Set Ref	Function Key



Description

The Target Reference function digitizes a blank target, analyzing it for aberrations. These aberrations stored in memory (reference array) and are subtracted from actual digitized waveform data before being stored in the linear array.

Values

None

Interactions

The result of the reference data affects the digitized waveform data.

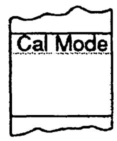
GPIB Command

SERFEF RUN. The contents of the reference array can be transmitted over the GPIB using the **REFARRAY?** command. Use RAW REF ARRAY to view reference array data while in Utility Menu 1.

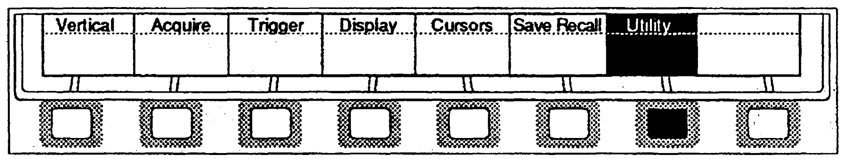
The **SETREF ON/OFF** command allows turning a reference array correction on and off.

CALIBRATION MODE SELECTION

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	Cal Mode	Function Key



Description

The Cal Mode function selects calibration of the entire waveform recorder or a subsystem. Calibration is controlled through system software. It is performed to establish a functional reference. The vertical, horizontal, CRT, and trigger subsystems can be calibrated. Results and messages related to calibration are displayed in the message/measurements zone.

The CRT calibration requires input of an external signal, therefore it is not included in the system calibration. During CRT calibration, a message appears instructing the user to connect a calibration signal (approximately 1 MHz @ 3 V p-p for SCD 5000; 1 MHz @ 80 mV p-p for SCD 1000) to the input connector.

The SCD 5000 requires connecting the CAL OUT to the signal input for any cal mode other than CRT.

Internal calibration does not replace periodic calibration performed by a qualified calibration technician or metrology laboratory.

Values

Choices	Init Value
System Vertical Horizontal Trigger CRT	System

Interactions

None

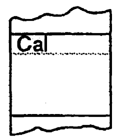
GPIB Command

CALIBRATE {HORIZONTAL|VERTICAL|TRIGGER|CRT|ALL}
CALIBRATE? (see also the **CCONSTANT? <ui>**, **CCONSTANT?**, and **CCDATE?** commands)

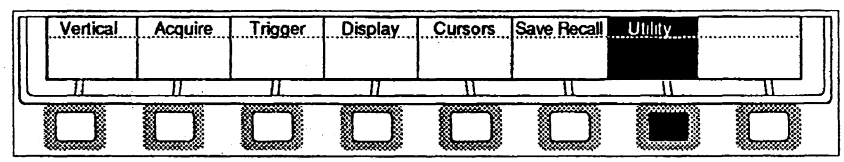
The GPIB CALIBRATE command also executes the equivalent of the Initiate Calibration function.

INITIATE CALIBRATION

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	Cal	Function Key



Description

The Initiate Calibration function starts the calibration process specified with the Calibration Mode Selection. The function is executed when selected, and presents no options.

Once initiated, calibration runs to completion. GPIB activity is suspended and the display is shut off until calibration is complete.

Values

None

Interactions

None

GPIB Command

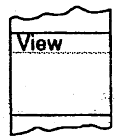
CALIBRATE {TIME|TRIGGER|VERT|ALL}
CALIBRATE? (see also the **CCONSTANT?<ui>**, **CCONSTANT?**, and **CCDATE?** commands)

NOTE

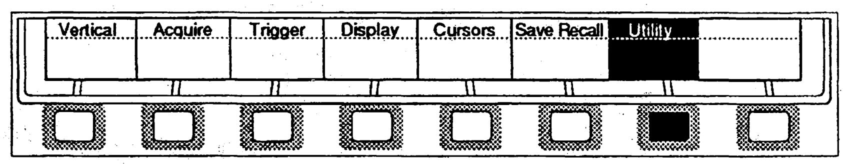
The GPIB CALIBRATE command also executes the equivalent of the Calibrate Mode Selection function.

VIEW SETTINGS OF ALL OR SELECTED AREAS

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	View	Function Key



Description

The View function displays system and mode information. It enables the user to view the entire instrument's settings at a glance. The function is forced off when the Utility mode is exited.

There are three view selections: ID, Acquire, and Display.

The **ID** selection displays the front panel and instrument version number, instrument options, GPIB address, termination, SRQ status, SRQ Mask, Event Code, calibration date, optional interface parameters, and instrument serial number. Figure 3-29 illustrates the ID view.

The **Acquire** and **Display** choices allow all the current settings of the Acquire and Display modes to be viewed. These views are illustrated in Figure 3-30 and Figure 3-31.

Values

Choices	Init Value
ID Acquire Display Off	ID

Interactions

None

GPIB Command

No direct equivalent. This function performs the equivalent of the GPIB SET?, EVENT?, ID?, RQS?, SRQMASK, OPTION?, and CCDATE commands.

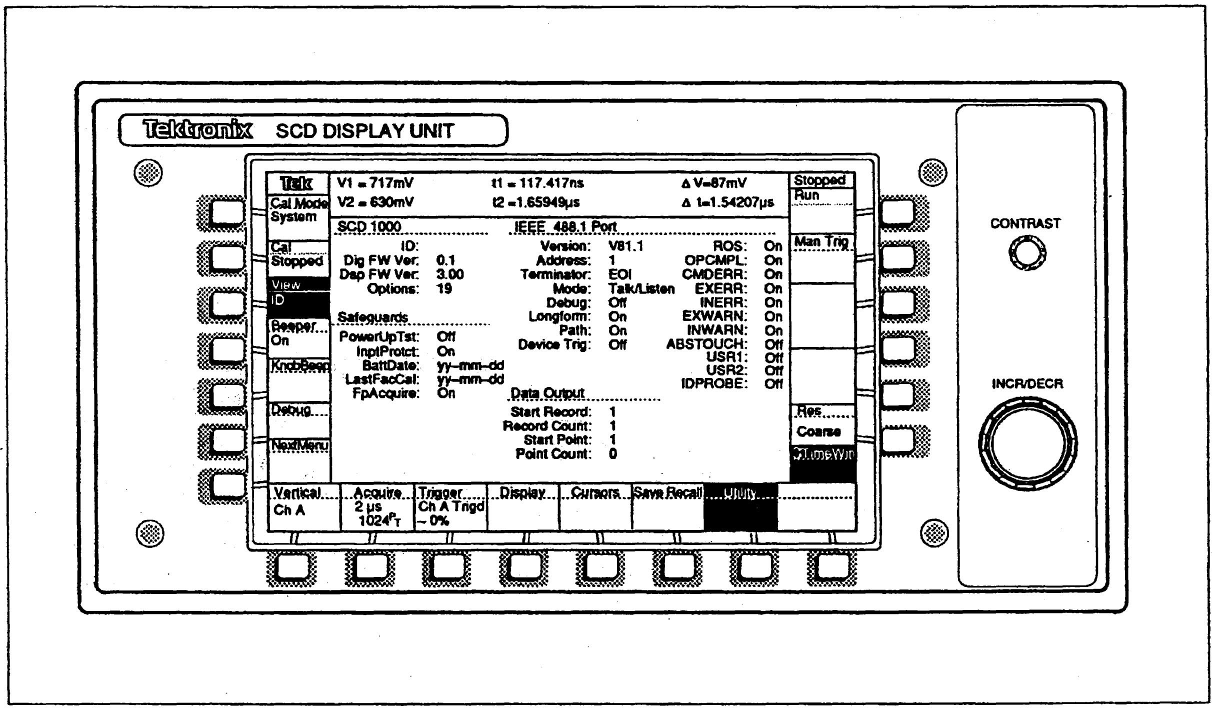


Figure 3-29. ID View

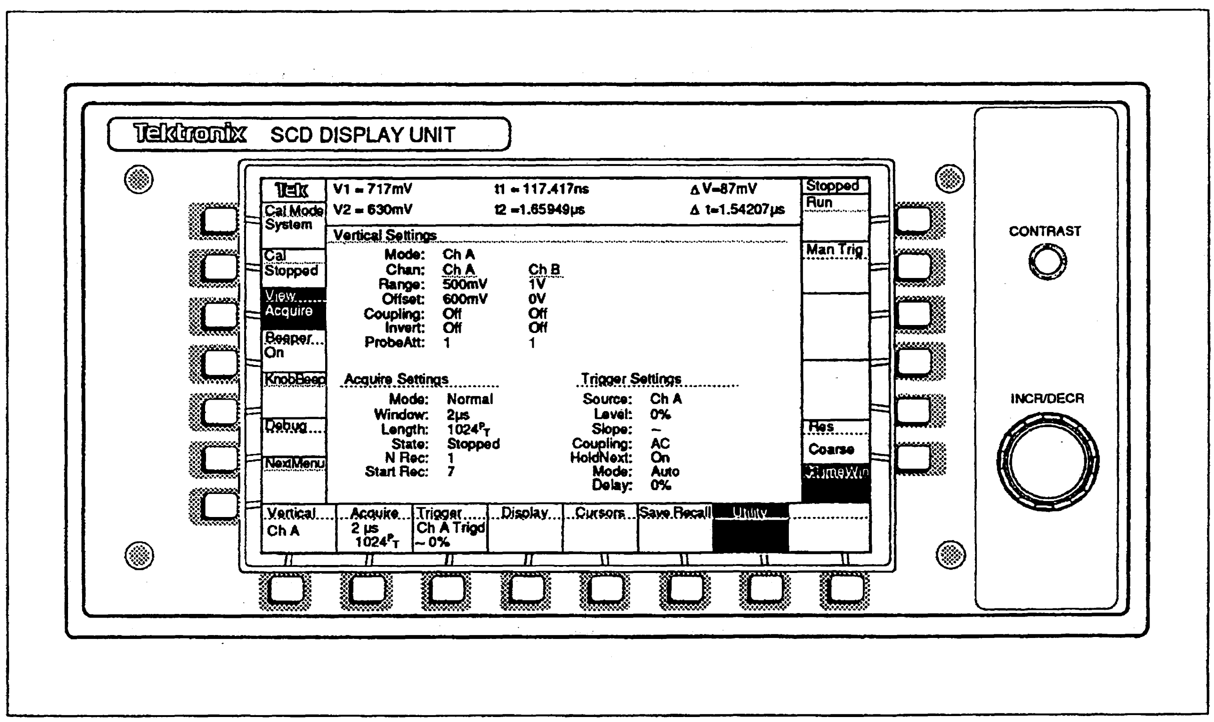


Figure 3-30. Acquire View

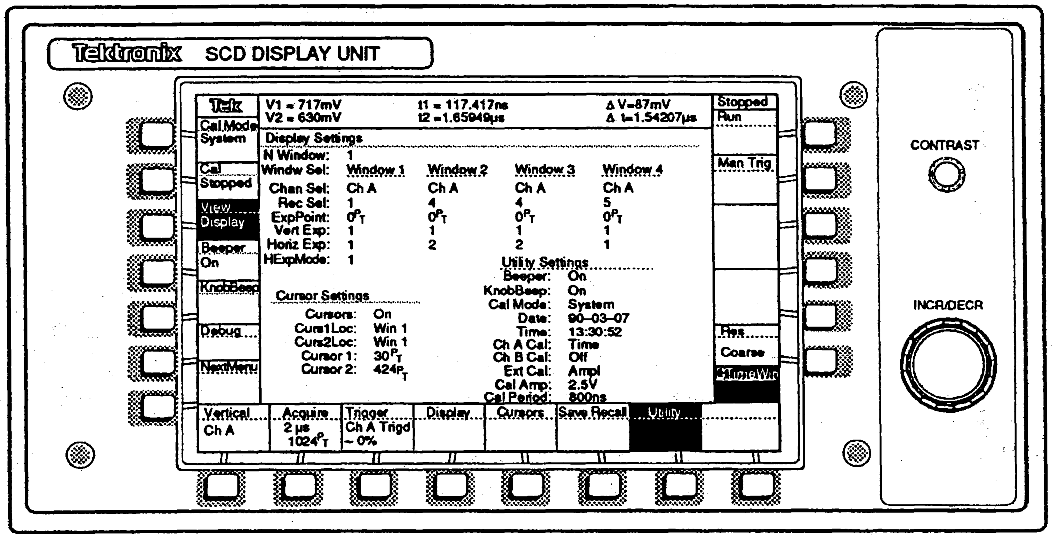
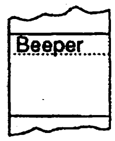


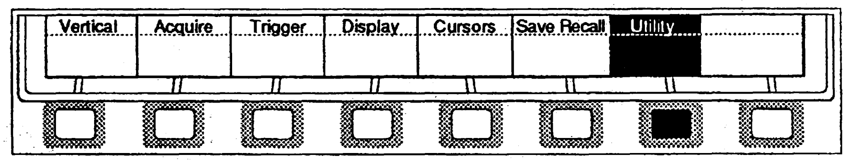
Figure 3-31. Display View

BEEPER ON/OFF

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	Beeper	Function Key



Description

The Beeper function turns the button beeper ON or OFF. The button beeper provides audio feedback for button presses.

Values

Choices	Init Value
On Off	On

Interactions

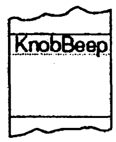
None

GPIB Command

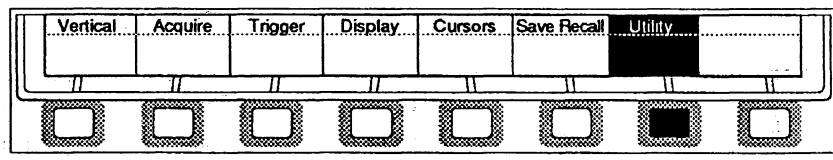
BELL BUTTON: {ON|OFF}
BELL? BUTTON
BELL?

KNOB BEEPER ON/OFF

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	KnobBeep	Function Key



Description

The Knob Beeper function turns the knob beeper ON or OFF. The knob beeper provides audio feedback for variable knob actions.

Values

Choices	Init Value
On Off	On

Interactions

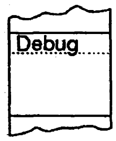
None

GPIB Command

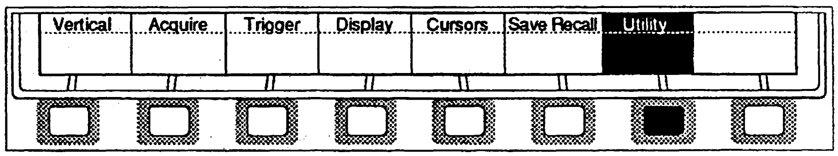
BELL KNOB: {ON|OFF}
BELL? KNOB
BELL?

DEBUG MODE

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	Debug	Knob



Description

The Debug function initiates or cancels the Debug mode. In Debug mode, all commands and errors being received at the GPIB port for this waveform recorder are displayed on the screen in the message area.

The Debug function is useful when developing instrument control programs over the GPIB. The display shows all commands, control characters, and errors, making program debugging easier.

Values

Choices	Init Value
On Off	Off

Interactions

The Debug mode is affected by the following parameters:

Cursors
Cursors must be off to view the debug display, because cursor measurments override the debug mode display.

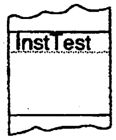
GPIB
When Debug is on, GPIB operation is slowed and binary data is not shown.

GPIB Command

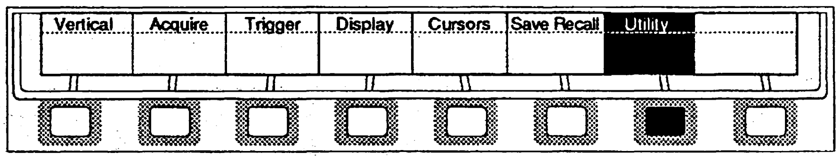
DEBUG GPIB: {ON|OFF}
DEBUG?

INSTRUMENT SELF-TEST

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	InstTest	Function Key



Description

The Instrument Test function initiates a self-test of the entire waveform recorder. When the test is executing, the status indicates such (i.e., "Running"). The test results are displayed in the message/measurements area.

The function is executed when selected, with no options presented.

If power is turned off during self-test, settings are returned to the factory default.

Values

None

Interactions

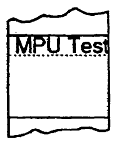
None

GPIB Command

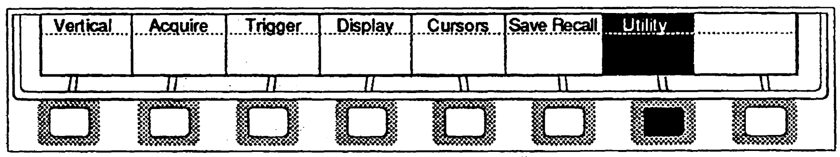
TEST SYS: [ALL] **(see also TEST LOOP: command)**
TEST? SYS
TEST?
DIAG? (see also **TEST VERBOSE:** command)

PROCESSOR SELF-TEST

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	MPU Test	Function Key



Description

The MPU Test function initiates a self-test of the processor board subsystem. When the test is executing, the status indicates such (i.e., "Running"). The test results are displayed in the message/measurements area.

The function is executed when selected, with no options presented.

For information on testing specific components and assemblies of the processor subsystem, refer to the **TEST NUM: <NRx>** command description in Section 2 and Section 6 of this manual.

Values

None

Interactions

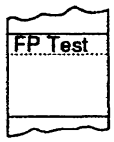
None

GPIB Command

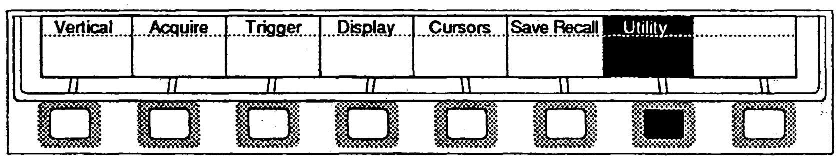
TEST SYS: PROSYS (see also the **TEST LOOP:** and **TEST NUM: <NRx>** commands)
TEST? SYS
TEST?
DIAG? (see also **TEST VERBOSE:** command)

FRONT PANEL SELF-TEST

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	FP Test	Function Key



Description

The FP Test function initiates a self-test of the Display Unit. When the test is executing, the status indicates such (i.e., "Running"). The test results are displayed in the message/measurements area.

The function is executed when selected, with no options presented.

For information on testing specific components and assemblies of the acquisition memory subsystem, refer to the **TEST NUM: <NRx>** command description in Section 2 and Section 6 of this manual.

Values

None

Interactions

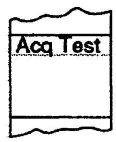
None

GPIB Command

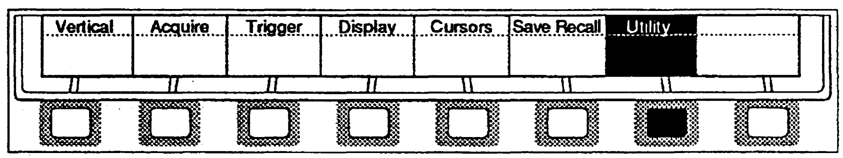
TEST SYS: FP (see also the **TEST LOOP:** and **TEST NUM: <NRx>** commands)
TEST? FP
TEST?
DIAG? (see also the **TEST VERBOSE:** command)

ACQUISITION SELF-TEST

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	Acq Test	Function Key



Description

The Acquisition Test function initiates a self-test of the acquisition subsystem. When the test is executing, the status indicates such (i.e., "Running"). The test results are displayed in the message/measurements area.

The function is executed when selected, with no options presented.

For information on testing specific components and assemblies of the acquisition subsystem, refer to the **TEST NUM: <NRx>** command description in Section 2 and Section 6 of this manual.

Values

None

Interactions

None

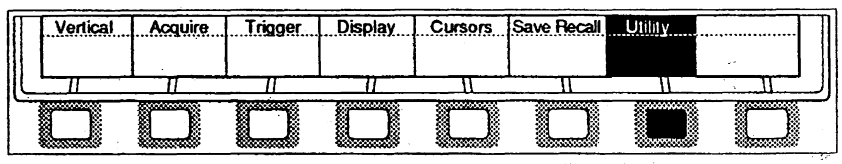
GPIB Command

TEST SYS: ACQSYS (see also the **TEST LOOP:** and **TEST NUM:** commands)
TEST? SYS
TEST?
DIAG? (see also the **TEST VERBOSE:** command)
See Section 6C of this manual for more information about these commands.

DATE/TIME FUNCTIONS

Key Presses

Mode Key	Function Key
Utility	year, month, day, hour, minute, Enter



Description

The Date/Time functions set the waveform recorder's date/time clock. The date/time clock is used to determine waveform acquisition time. These settings are selected with the knob. When the date/time settings are correct, the Enter key sets the current values into the date/time clock.

The date/time clock is set to the shipping date when it leaves the factory.

Values

Parameter	Min	Max
Year	1989	2010
Month	1	12
Day	1	31
Hour	0	23
Minute	0	59

Interactions

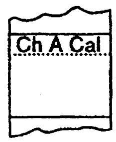
None

GPIB Command

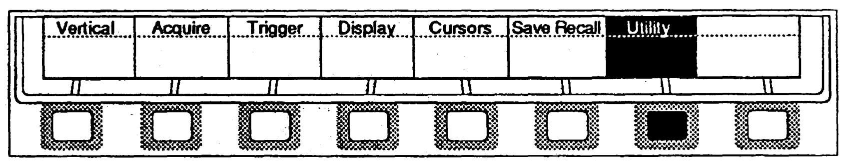
CLOCK DATE:<qstring>
CLOCK TIME:<qstring>
CLOCK? DATE
CLOCK? TIME
CLOCK?

CHANNEL CALIBRATION SIGNALS (SCD1000)

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	Ch A Cal Ch B Cal	Function Key



Description

The Channel Calibration function selects the signal that is internally connected to the channel inputs (Ch A Cal connects the calibrator to channel A; Ch B Cal connects the calibrator to channel B). The calibrator can be one of three types: Time, Amplitude from 0 Ω, or Amplitude from 450 Ω. The calibrator can also be turned off.
If the calibrator is Time, the period can be set with the *CalTime* function (described later in this functional reference). If the signal is amplitude (DC voltage level), the amplitude can be set with the *CalAmpl* function (described later in this functional reference).

If a calibrator signal is selected, the trigger source is automatically set to internal. If the trigger source is set to external, the calibrator is automatically turned off.

Values

Choices	Init
Time Ampl from 0Ω Ampl from 450 Ω Off	Off

Interactions

The calibrator affects and is affected by the following parameters:

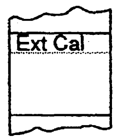
Trigger Source
If a calibrator signal is selected, the trigger source is automatically set to internal. If the trigger source is set to external, the calibrator is automatically turned off.

GPIB Command

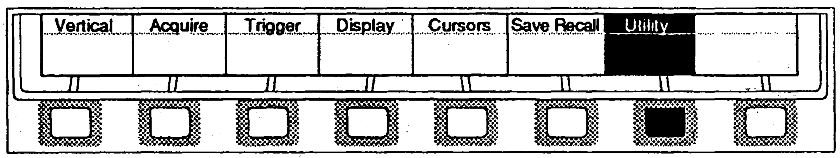
CALOUT CH{A|B}:{TIME|AMPL|AMPL450|OFF}
CALIBRATOR {AMPLITUDE|TIME}<NRx>
CALOUT? CH{A|B}
CALOUT?
CALIBRATOR? {AMPLITUDE|TIME}
CALIBRATOR?

EXTERNAL CALIBRATOR SIGNAL

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	Ext Cal	Function Key



Description

The External Calibrator function connects the internal calibrator signal to the CAL OUT connector and selects the type of calibrator signal: time or amplitude.

If the calibrator is Time, the period can be set with the *CalTime* function (described later in this functional reference). If the signal is amplitude (DC voltage level), the amplitude can be set with the *CalAmpl* function (described later in this functional reference).

When Ext Cal is selected, both channels A and B are turned off.

Values

Choices	Init
Time Amplitude	Time

Interactions

The External Calibrator function affects the following function:

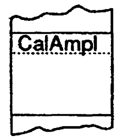
Vertical Mode
When External Calibrator is selected, both channels are turned off.

GPIB Command

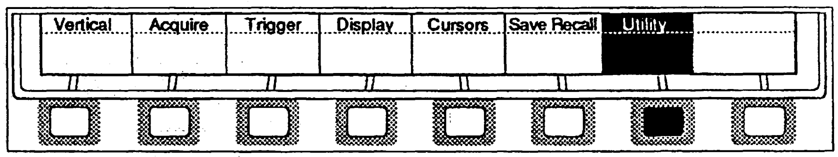
CALOUT EXTERNAL:{TIME|AMPL}
CALIBRATOR {AMPLITUDE|TIME}:<NRx>
CALOUT? EXTERNAL
CALOUT?
CALIBRATOR? {AMPLITUDE|TIME}
CALIBRATOR?

CALIBRATOR SIGNAL AMPLITUDE

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	CalAmpl	Knob



Description

The Calibrator Signal Amplitude function sets the DC level of the calibrator signal.

Values

Choices SCD1000	Init
-2.5V,+2.5V	+2.5V
-2.0V,+2.0V	
-0.8V,+0.8V	
-0.4V,+0.4V	
-0.2V,+0.2V	
-0.080V,+0.080V	
-0.040V, +0.040V	
0 V	

Choices SCD5000	Init
-4.0V,+4.0V	+2.0V
-3.0V,+3.0V	
-2.0V,+2.0V	
-1.0V,+1.0V	
-0.5V,+0.5V	
0V	

Interactions

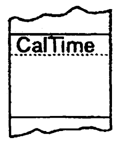
None

GPIB Command

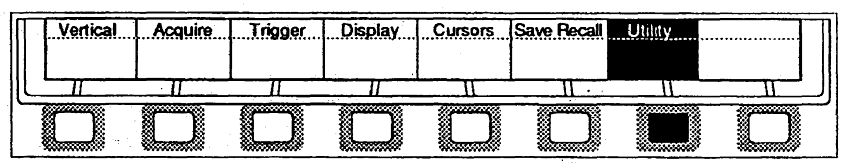
CALIBRATOR AMPLITUDE:<NRx>
CALIBRATOR? AMPLITUDE
CALIBRATOR?

CALIBRATOR SIGNAL PERIOD

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	CalTime	Knob



Description

The Calibrator Signal Period function sets the period of the calibrator signal. The amplitude is automatically set to 800 mV with a 600 mV offset.

Values

Min	Max	Step Sequence	Init
4 ns	80 µs	4, 8, 16, 40	0.8 µs

Interactions

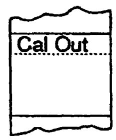
None

GPIB Command

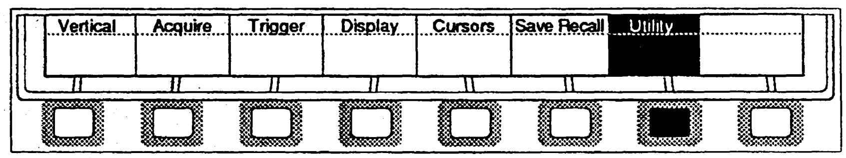
CALIBRATOR TIME:<NRx>
CALIBRATOR? TIME
CALIBRATOR?

CALIBRATOR OUT SIGNAL (SCD5000)

Key Presses



Mode Key	Function Key	Function adjusted by
Utility	Cal Out	Function Key



Description

The Calibrator Out function selects the signal that is connected to the CAL OUT connector on the front panel. The calibrator can be either amplitude or time. The SCD5000 requires a cable to be connected from the CAL OUT connector to the INPUT connector.

If the calibrator is Time, the period can be set with the *CalTime* function (described later in this functional reference). If the signal is amplitude, the DC level can be set with the *CalAmpl* function (described later in this functional reference).

Values

Choices	Init
Time Ampl	Ampl

Interactions

None

GPIB Command

CALOUT EXTERNAL:{TIME|AMPL}
CALIBRATOR {AMPLITUDE|TIME}<NRx>
CALOUT? EXTERNAL
CALOUT?
CALIBRATOR? {AMPLITUDE|TIME}
CALIBRATOR?

SPECIFICATIONS

- Performance Conditions
- Electrical Specifications and Characteristics
- Physical Characteristics
- Environmental Characteristics

PERFORMANCE CONDITIONS

This specification applies when the following conditions are true:

- the instrument is verified at an ambient temperature between +20° C and +30° C
- the instrument has been running for at least 20 minutes (minimum warm-up period)

Specifications

Specifications are verifyable qualitative or quantitative limits that define the measurement capabilities of the instrument.

For environmental specifications, test result is highly dependent on the procedure used. For verfication of environment performance, refer to the listed government/ industry documents for test methods. Tektronix internal verification procedures and in some cases more stringent requirement for performance, are contained in the listed standards. Tektronix standards may be provided upon request.

Under MIL-T-28800D, the instrument is classified as Type III, Class 3, Style F. Only these requirements from MIL-T-28800D listed in these specifications apply. Non-operating specification means the principle power switch on the rear panel is off, or the power cord is disconnected.

Characteristics

Characteristics qualitatively or quantitatively describe the typical behavior or operation of the instrument.

ELECTRICAL SPECIFICATIONS AND CHARACTERISTICS

TABLE 4-1
ELECTRICAL SPECIFICATIONS

Feature	Specification
VERTICAL SYSTEM (SCD1000)	
Input Range	100 mV to 10V full scale in a 1, 2, 5, sequence
Δ Volts Accuracy (1 KHz or lower) 10% to 90% full scale signal; within ±5° C of calibration temperature	±1% + 0.0003 x range
0° to 50° C; calibrated at 20° to 30° C	±2.5% + 0.005 x range
Low-frequency Linearity	1% full-scale or less of compression or expansion for a 25% of full-scale, center-of-range signal when offset is anywhere within the full-scale range.
Offset Range Resolution Accuracy	 ±2.5 X input range 0.05 x input range (101 steps) ±(2.0% + 0.02 x input range)
Frequency Response (HF -3dB) 0 to 35° C	 At least 71% of 10 MHz gain @ 1 GHz
Channel Isolation test on 100 mV range with other channel driven 0.8 x full-scale on 1 V range. Ration=Ampl. (driven channel)/Ampl. (undriven channel)	At least 40:1 DC to 1 GHz
Common Mode Rejection Ratio full-scale sinewave signal on each channel For same range and coupling	At least 20:1 DC to 50 MHz
Ch A and CH B RMS Noise (Referred to input) ADD (without INVERT on)	0.0030 x range 0.006 x range

TABLE 4-1 (CONT)
ELECTRICAL SPECIFICATIONS

Feature	Specification
VERTICAL SYSTEM (SCD5000)	
Δ Volts Accuracy (1 KHz or lower) 10% to 90% full-scale signal	±2% of range
Low Frequency Linearity	2% full-scale or less of compression or expansion for a 25% of full-scale, center-of-range signal when offset is anywhere within the full-scale range.
Offset Accuracy	 ±(2% +0 0.02 x input range)
Frequency Response (HF -3dB)	At least 71% of 10 MHz gain @ 4.5 GHz
HORIZONTAL SYSTEM	
Window Range	5 ns to 100 µs in a 1, 2, 5 sequence
Accuracy 10 to 90% of time window	 2% within 5° C of temperature when internal calibration was performed 5% (over 0° to 40° C) when internal calibration is performed between 20° and 30° C
TRIGGER SYSTEM	
Sensitivity (Sinewave) Channel A or B inputs (SCD1000)	 0.05 x range, DC to 250 MHz 0.15 x range, 250 MHz to 1 GHz
Sensitivity (Pulse) 0.5 ns Half Amplitude Duration pulse External input (SCD5000)	 150 mV p-p

TABLE 4-1 (CONT)
ELECTRICAL SPECIFICATIONS

Feature	Specification
CALIBRATOR	
Voltage	
Range (SCD1000)	±2.5, ±2.0, ±0.8, ±0.4, ±0.2, ±0.08, ±0.04, 0 V DC
Range (SCD5000)	±4.0, ±3.0, ±2.0, ±1.0, ±0.5, 0 V DC
Accuracy	
Absolute	±(0.1% + 1mV)
Δ (Delta), ±100% of range	±0.2%
Timing	
Accuracy	0.1%
CRT OPERATING PARAMETERS	
Writing Speed	
SCD1000 conditions: Writes a sine wave of at least 1 GHz in a single sweep	70% full-scale
SCD5000 conditions: Writes a sine wave of at least 4.5 GHz in a single sweep	20% full-scale
Geometry (Geometry correction off) 10% to 90% of range. 10% to 90% of window	
SCD1000	4% of range
SCD 5000	5% of range

TABLE 4-2
ELECTRICAL CHARACTERISTICS

Feature	Characteristic
VERTICAL SYSTEM (SCD1000)	
Low Frequency Limit (-3dB) AC Coupled	1 KHz or less from 50 Ω source
Step Response 0.5 x range with centered signal, t_r ≤120 ps Risetime	≤0.35 ns calculated from BW (0.35/BW)
Input Characteristics	
Maximum Input Voltage (AC or DC Coupled)	5 V_{rms} (0.5 W) or 0.25 W-sec. Pulses not exceeding 25 V peak.
Maximum Input Voltage AC Coupled)	±100 V (DC + peak AC)
Input Protection Disconnect Threshold	5 V_{rms} DC to 100 MHz, typical
Input Resistance Power-off & Disconnect	500 KΩ ±10%
DC Coupling	Within ±5° C of Calibration Temperature
100 mV to 10 V	50 Ω ±0.23 Ω
AC Coupling	50 Ω ±1Ω in series with nominally 2.2 µF
VSWR 100 mV Range	<1.45:1 10 MHz to 1 GHz
200 mV to 10 V	<1.25:1 10 MHz to 1 GHz
Input Bias Current 0 V offset, 100 mV range	≤10 µA
0 to 50° C, Calibrated at 20° to 30° C	≤50 µA
Delay Line	Permits acquiring the trigger event when channel A or B is selected as the trigger source
Delay Match Between Channels same range and coupling	100 ps

TABLE 4-2 (CONT)
ELECTRICAL CHARACTERISTICS

Feature	Characteristic
VERTICAL SYSTEM (SCD5000)	
Input Range	5 V full-scale
Offset Range	±4 V (±8 V with Option 01)
Resolution	0.05 x input range (33 steps)
Input Characteristics	Maximum input voltage 50 Vrms (0.5W) or 0.25 W-sec. Pulses not to exceed 70 V peak
Input Resistance	50Ω ±0.5 Ω
VSWR	≤1.5:1 for frequencies ≤ 3.5 GHz
HORIZONTAL SYSTEM	
Gate Output (BNC connector) Output Voltage	2.4 to 5 V high level, 0 to 0.5 V low level
Polarity	Low during sweep
Output Drive	Source 500 µA into 2 V, sink 100 mA
Double Sweep Range	10 ns to 200 ns in the 1, 2, 5 sequence
Delay Time Between Sweeps	≤700 ns
Sweep start delay (SCD5000)	≤ 50 ns

TABLE 4-2 (CONT)
ELECTRICAL CHARACTERISTICS

Feature	Characteristic
TRIGGER SYSTEM	
External Input	50 mV, 20 KHz to 50 MHz 150 mV, 50 MHz to 500 MHz 250 mV, 500 MHz to 1 GHz
Jitter 500 mV p-p square wave, ristetime ≥1ns	30 ps or less @ 1 GHz
Trigger Level Range SCD 1000 CHA, CHB or ADD (AC) CHA, CHB or ADD (DC)	 ±vertical range ±(vertical range/2) + offset
External Input	±1.0 V
SCD5000 External Input Internal Input (Option 01)	 ±0.5 V ±5 V
Resolution (201 steps) SCD1000 CHA, CHB, or ADD (AC) CHA, CHB, or ADD (DC) External Input	 0.01 vertical range 0.005 vertical range 10 mV
SCD5000 External Input Internal Input (Option 01)	 5 mV 50 mV
Accuracy CHA, CHB, or ADD External Input	 ±(2% + 0.05 x vertical range) ±(10% + 50 mV)

TABLE 4-2 (CONT)
ELECTRICAL CHARACTERISTICS

Feature	Characteristic
TRIGGER SYSTEM (CONT)	
Slope	Positive or negative
Coupling Channel A or B (SCD1000)	DC or AC (Triggering sensitivity is reduced below 2 KHz when AC coupled.)
External Input	AC
Internal Input (SCD5000)	AC
External Trigger Input Maximum Safe Input	DC component: 100 V DC
SCD1000	AC component: 0.2 watt average, 25 V peak (3 V_{rms})
SCD5000	AC component: 0.5 watt average, 25 V peak (5 V_{rms})
Input Impedance	Nominally 0.1 µf in series with 50 Ω ±5%
Delay (when operated within 5° C of temperature where internal calibration was last performed) Accuracy	±(3% of time window + 1 ns)
Range	0 to 500 % of the acquire time window
Resolution	≥2000 steps
DIGITIZER SYSTEM	
Vertical Resolution	9 bits of raw data from linear array query (GPIB command); 11 bits of centroided data
Horizontal Resolution	256, 512, or 1024 points
Maximum Acquisition Recycle Rate display off, repeat mode on.	4 Acquisitions/second for 256 point waveforms 2 Acquisitions/second for 512 point waveforms 1 Acquisition/second for 1024 point waveforms

TABLE 4-2 (CONT)
ELECTRICAL CHARACTERISTICS

Feature	Characteristic
CALIBRATOR	
Timing Amplitude (SCD1000)	At least 100 mV p-p into 50 Ω, reduced to 50 mV p-p at 4 ns period
Amplitude (SCD5000)	≥2 V p-p into 50 Ω; 80 ns to 8 µs period
Period	4 ns to 80 µs in 4, 8, 16, 40 sequence
Offset SCD1000	600 ±100 mV
SCD5000	1 V ±500 mV
VIDEO OUTPUT	
Type	640 x 400 pixel resolution, compatible with TTL input of Multi-sync video monitors.
AUXILIARY INPUTS AND OUTPUTS	
Rear Panel IEEE-488 Connector type	24-pin female connector located on rear panel. Meets specification IEEE-488-1978.
POWER	
AC Line Power Voltage	Selected by rear panel switch 90 to 132 Vrms 180 to 250 Vrms
Line Frequency	48 to 440 Hz
Power Consumption	<350
Line Current	5.5 amps maximum at 90 V, 50 Hz line
Fuse Rating	115 V operation: 8A, 250 VAC. normal blow 230 V operation: 4 A, 250 VAC, normal blow
Low Voltage Power Supplies Long Term Tolerance	Includes variation caused by: load (25% to 75%), temperature (+20° C to +30° C) line, initial setting, 1 year drift.

TABLE 4-3
PHYSICAL CHARACTERISTICS

Feature	Characteristic
Dimensions Height	178 mm (7 inches)
Width	483 mm (19 inches)
Depth	762 mm (30 inches)
Weight Net	24.5 Kg (SCD1000 51 lbs; SCD5000 57 lbs..)
Shipping	31.75 Kg (70 lbs.)
Cooling Type	forced air circulation
Airflow	Internal airflow is approximately 100 CFM at fan voltage (8 V). Airflow direction is intake from sides, exhaust at rear, and is not reversible. Air flow is regulated, based on internal temperature of the power supply.
Clearance Rear	Sides: 51 mm (2 inches) 25 mm (1 inch)
Top and rear	3 mm (0.125 inch)

TABLE 4-4
ENVIRONMENTAL SPECIFICATIONS

Feature	Specification
Temperature Operating & Non-operating	Meets MIL-T-28800D class 7
Operating	+5° C to +40° C
Non-operating	-20° C to +60° C
Humidity Operating & Non-operating	Meets MIL-T-28800D type III, class 5
Operating	30% to 85% relative humidity, non-condensing
Non-operating	20% to 90% relative humidity, non-condensing
Altitude Operating & Non-operating	Exceeds MIL-T-28800D type III, class 5
Operating	4.5 Km (15,000 ft.) maximum
Non-operating	15 Km (50,000 ft.) maximum
Vibration Operating	Meets MIL-T-28800D type III, class 5; tested per paragraph 4.5.5.3.1
Operating	0.015 in. p-p, 10 to 55 Hz sinewave; total test time is 75 minutes.
Shock Non-operating	Meets MIL-T-28800D type III, class 5; tested per paragraph 4.5.5.4.1
Non-operating	30 gs (1/2 sine), 11 ms duration, 3 shocks in each direction along 3 major axes, 18 total shocks.
Bench Handling Operating	Meets MIL-T-28800D type III, class 5; tested per paragraph 4.5.5.4.3
Operating	Withstands 12 drops from 10 cm (4") or 45°
Packaged Product Vibration	Meets ASTM D999-75, method A, paragraph 3.1g (NSTA Proj. 1A-B-1).
Shock	Meets ASTM D775-61, method 1, paragraph 5 (NSTA Proj. 1A-B-2)

TABLE 4-3
ENVIRONMENTAL SPECIFICATIONS

Feature	Specification
Electrostatic Immunity No disruption or degradation of performance	15 KV, 500 pF capacitor discharged in series with 100 Ω resistor.
Electromagnetic Compatibility U.S.	Within limits of FCC Regulation, Part 15, Subpart J, class A. In compliance with MIL-STD-461B, CE01 Part 2, narrowband CE03 Part 4; CE07 Part 2; CS01 Part2 CS02 Part 2; CS06 Part 5; limited to 300 V RE01 Parts 5 & 6; RE02 Part 2; RS02 Part 2 RS03 Part 2, limited to 1 GHz when tested per MIL-STD-462 test procedures
Germany	Complies with acceptance criteria of VDE 0871/6.78 class B.

OPTIONS

- Option Overview
- Detailed Description

OPTION OVERVIEW

The SCD family has several orderable options. They are listed in Tables 5-1 through 5-3. Some of these options are field installable using a Tektronix Field Upgrade Kit available from Tektronix.

TABLE 5-1
SCD DIGITIZER POWER OPTIONS

Option Name	Description
A1	Universal European 220 V,, 16 A,, 50 Hz
A2	United Kingdom 240 V,, 13 A,, 50 Hz
A3	Australian 240 V,, 15 A,, 60 Hz
A4	North American 240 V,, 15A,, 60 Hz
A5	Switzerland 220 V,, 10 A,, 50 Hz

TABLE 5-2
SCD1000 DIGITIZER OPTIONS

Option Name	Description
1E	Tek Type II Probe Interface Input Connectors
1P	Fast Waveform Capture increases waveform captures from one to ten 512 point waveforms per second.
2E	SMA-type input connectors
2F	HSDO 16-bit data output & battery backed-up linear array (see Section 6 for information on HSDO).
94	Traceable Calibration
M4	Two-year extended warranty (beyond factory warranty) with one factory calibration the first year and two factory calibrations in each of the second and third years.
20	Delete LCD Display Unit

TABLE 5-3
SCD5000 DIGITIZER OPTIONS

Option Name	Description
01	Delay Line and Internal Trigger Pickoff
1P	Fast Waveform Capture increases waveform captures from one to ten 512 point waveforms per second.
2E	SMA-type input connectors
2F	HSDO 16-bit data output & battery backed-up linear array (see Section 6 for information on HSDO).
94	Traceable Calibration
M4	Two-year extended warranty (beyond factory warranty) with one factory calibration the first year and two factory calibrations in each of the second and third years.
20	Delete LCD Display Unit

DETAILED DESCRIPTION

Options A1 - A5

The SCD digitizers are shipped with a detachable power cord as ordered by the customer. Descriptive information about the international power cords is provided in Section 2, Preparation for Use. Table 5-4 lists the Tektronix part number for the available power cords.

TABLE 5-4
POWER CORD OPTIONS

Option	Description	Tektronix Part Number
A1	Universal Euro Power Cord (2.5 m)	161-0066-09
A2	UK Power Cord (2.5 m)	161-0066-10
A3	Australian Power Cord (2.5 m)	161-0066-11
A4	North American Power Cord (2.5 m)	161-0066-12
A5	Switzerland Power Cord (2.5 m)	161-0154-00

INTERFACING GUIDE

- A - Introduction
- B - GPIB Introduction
- C - GPIB Command Set
- D - Status & Event Reporting
- E - Programming Examples
- F - Alternate Interfaces
- G - ASCII & GPIB Code Chart

INTRODUCTION

OVERVIEW

The SCD1000 and SCD5000 are high-speed, transient digitizers based on CRT scan conversion.

Both SCD digitizers have an input impedance of 50 Ω with programmable input settings. Table A-1 lists the features of each system.

TABLE A-1
SCD1000/SCD5000 CHARACTERISTICS

Characteristic	SCD1000	SCD5000
Impedance	50 Ω	50 Ω
Input BW	DC to 1 GHz	DC to 4.5 GHz
# Input Channels	2	1
Input Range	10 mV to 10 V	5 V
Input Offset	±2.5 x full-scale range	±2.0 x full-scale range
Input Coupling	AC,DC,OFF	DC Only
Trigger Source	Any input channel external input	External or internal calibrator or signal
Trigger Coupling	AC or DC (Internal only)	AC Only

Instrument Control

Instrument functions of the SCD are controlled through either the IEEE-488.1 interface or through the front panel Display Unit (DU). When the interface is used, a controller (PEP 301, HP 200/300, etc.) programs the SCD and receives information through a set of SCD commands. When the display unit is used, front panel controls provide

- instrument set up
- display of waveforms
- waveform measurements (cursors)
- output to a hard copy unit

Input Channels

The SCD1000 includes two input channels. The SCD5000 has only one input channel. In the SCD1000, different vertical modes allow acquisition from either of the channels (CHA or CHB) or allows the algebraic addition of the channels (ADD). The number of channels used for acquisition affects other parameters such as the data statement.

Other programmable input parameters include full-scale range (SCD1000 only), offset, coupling, and signal inversion (SCD1000 only).

In the SCD1000, the input range for each channel can be set from 100 mV to 10 V full scale. SCD5000 input range is fixed at 5 volts. Programmable offset values range from 250 mV to 25 V.

In the SCD1000, signals can be AC or DC coupled or disconnected from the input. In the SCD5000, the input signal is DC coupled. Input impedance is 50 ohms in both instruments.

Acquisition Sequence & Acquisition Process

An acquisition sequence starts when the digitizer recognizes a trigger event defined by the trigger parameters or when auto-triggering is initiated. After recognizing the trigger event, the SCD reads the target and digitizes the data on the target, storing the data in a data record. An acquisition sequence is finished when the record is filled.

An acquisition process is the filling of all required records. If more than one record must be filled to complete an acquisition process, records are consecutively filled from the specified start record through the specified number of records set by the acquisition system commands, or to the maximum available records.

Acquisition System

The acquisition system controls the sweep mode, time window, acquisition mode, record length, and acquisition state.

Time Window. The time window programs the acquisition duration. Time window settings are from 5 ns to 100 μs.

Acquisition Modes. The acquisition mode programs the number of records acquired during an acquisition process. NORMAL acquisition mode always fills only the programmed start record per acquisition process. Depending on trigger parameters, subsequent acquisitions may occur, but for each acquisition process, only the programmed start record is filled. In ADVANCE mode, the digitizer fills a specified number of records to complete an acquisition process. Acquisition processes may be repeated due to trigger settings, but each acquisition process fills only the number of specified records. In ADVANCE mode, each record is stamped with a time identifying when the acquisition began. AVERAGE acquisition mode allows 1 to 1024 averages to be performed to increase the signal-to-noise ratio.
The maximum number of available records for acquisition is 16.
Records 1, 2, 3, and 4 use non-volatile memory for storage and will retain data across power downs.

Record Length. Record length can be programmed to 256, 512, or 1024 data points.

Acquisition State. The acquisition state controls the starting and stopping of the acquisition process. RUN and STOP immediately affect the acquisition process. RUN continuously acquires data. HOLDNXT completes one *acquisition process* before stopping the digitizer. The completion of the current acquisition process depends on the recognition of enough trigger events and may include the filling of one or more records depending on the acquisition mode (NORMAL or ADVANCE).

Triggering

The trigger system defines the parameters of the trigger event. The trigger event is defined by its source, level, and slope. Level can be defined in either volts or percent. The position of the time window relative to the trigger event can be set using a trigger delay setting.

The SCD can also be triggered from the **Manual Trig** button on the Display Unit and from the IEEE-488 interface using the MTRIG command.

Mode: AUTO trigger mode automatically triggers the digitizer approximately 360 ms after the start of an acquisition sequence, if a trigger event has not already occurred. NORMAL trigger mode allows the digitizer to trigger only with the recognition of a trigger event as defined by the trigger parameters.

Source: In the SCD1000, the trigger source can be from one of the channels, the sum of the channels, or from the external trigger input on the front panel of the SCD. In the SCD5000, the source can be either the external input connector or the internal time calibration source.

Level: With an internal trigger source, the trigger level can be set in the range of ± Vertical Range (CHA, CHB, or Add (AC) - SCD1000), ± (Vertical Range / 2) (CHA, CHB, or Add (DC) - SCD 1000), or ±5 V (SCD5000). Level for an internal source can be specified in either percent of the full-scale range or voltage.

Although the trigger level can be specified in volts, the trigger level is internally expressed as a percentage of the full-scale range plus offset (Level=Trig% * Range + Offset). This is done so that once the level is set, changing range and offset does not affect the relative trigger level.

Specifying the level over the maximum allowable value causes the SCD to coerce the level to the maximum allowable level. With an external trigger source, the trigger must be specified as a voltage level in the range of ±6.25 volts.

Trigger (cont)

Slope: Trigger slope can be positive (PLUS) or negative (MINUS).

Coupling: In the SCD1000, trigger coupling can be AC or DC. DC coupling passes all components of the signal to the trigger circuits. AC coupling blocks all DC components and attenuates frequencies below 2 KHz. In the SCD5000, the trigger signal is AC coupled only.

Delay: The time window can be delayed relative to the trigger event up to five times the length of the time window. See Figure A-1.

Trigger delay can be expressed in percentage of the record or seconds.

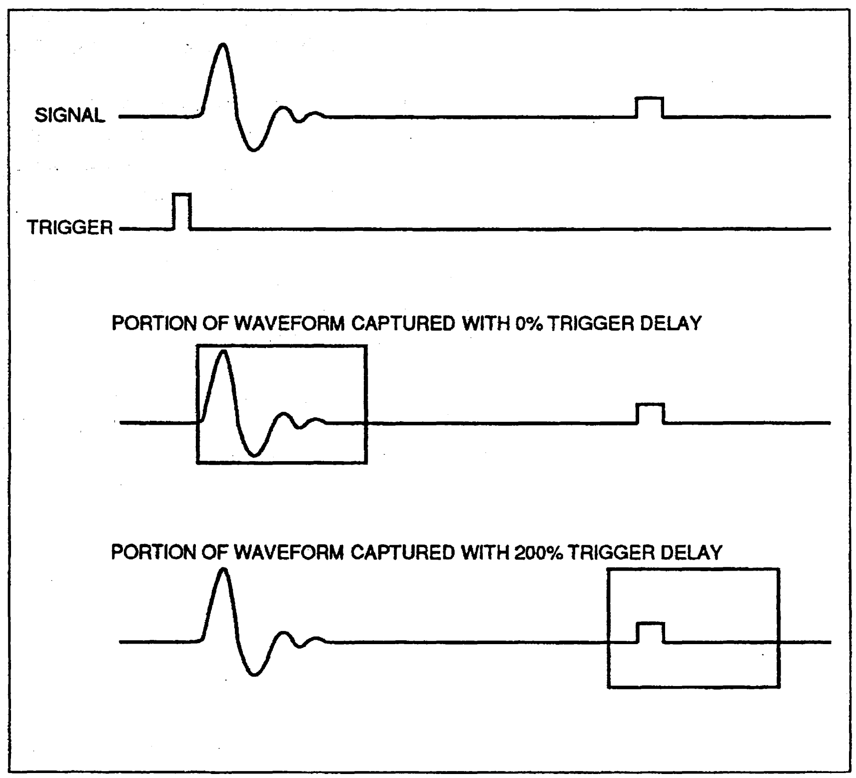


Figure A-1. Trigger Delay.

Internal Calibration & Diagnostics

An internal calibration function provides

- vertical channel amplitude and offset adjustments
- trigger level and delay adjustments
- window size adjustment
- CRT adjustments
- CRT geometry correction

Internal calibration, which is only executed at user request, is initiated from the Display Unit or over the GPIB using the CALIBRATE commands.

Self-tests can be run for the acquisition and processor subsystems, as well as for the front panel. TEST commands allow entire subsystems or portions of a subsystem to be tested one time or several times (LOOP). The test results can be displayed as PASS/FAIL or PASS/FAIL and include a descriptive string.

Factory Settings

An initialization function returns the digitizer's settings to *factory settings* stored in ROM. These factory settings cannot be changed, but are useful to place the instrument in a known state. The settings (see Table C-8) are a good starting point to begin instrument set-up.

As the SCD is used, all instrument settings are saved in non-volatile RAM at power-down so that the digitizer powers up with the same settings that were selected when it was turned off.

Initialization to factory settings can be limited to just GPIB-related functions or just instrument functions, or both the GPIB and instrument functions can be reset to their factory settings. See the INIT command in Table C-8.

Display Unit

The Display Unit (DU) is a control and display device (Figure A-2). In addition to a high-resolution, 640 x 400 pixel liquid crystal display (LCD) panel, the DU contains dedicated control keys, programmable soft keys, and a variable knob.

Depending on the display mode (waveform or menu), the LCD panel displays either waveforms and status information or waveforms and SCD menus. Programmable soft keys change functions according to menu labels to allow control of instrument settings, display modes, cursor positioning, and other functions. The variable knob allows easy adjustment of numeric values of functions.

The Display Unit can operate simultaneously with the GPIB interface functions.

Menu System

Figure A-3 shows the DU displaying menus. The DU displays three types of menus: mode menus, function menus, and an auxiliary menu. Mode menus are displayed along the bottom of the screen and allow selection of function menus for different systems of the digitizer, such as Trigger, Vertical, Cursors, etc. Function menus appear along the left side of the display and allow changing values for each of the parameters associated with a system, such as trigger system Level, Position, Coupling, etc. The auxiliary menu appears at the right side of the display and labels the associated soft keys for various functions. User-defined key labels and the variable knob's last setting are part of the auxiliary menu.

Button presses can be emulated or queried over the GPIB using the ABSTOUCH command. See Table C-8 for more information.

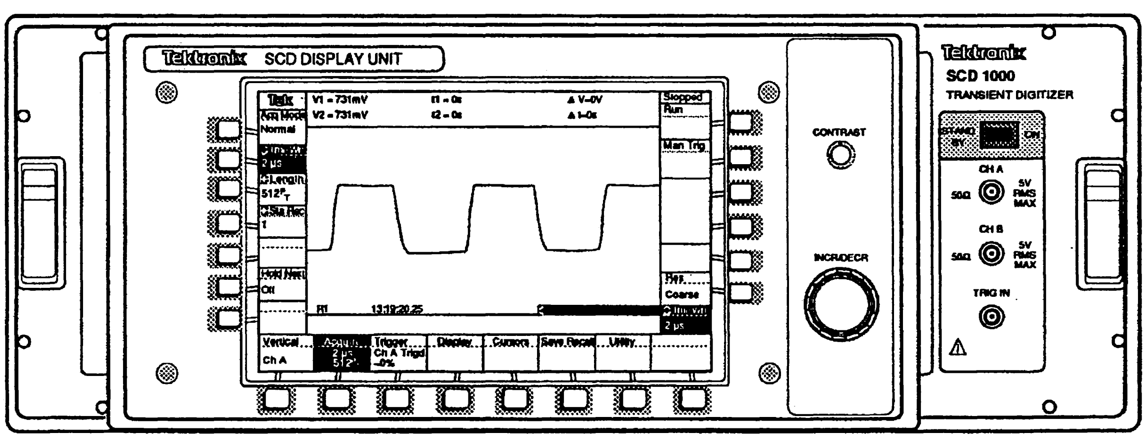


Figure A-2. SCD Display Unit

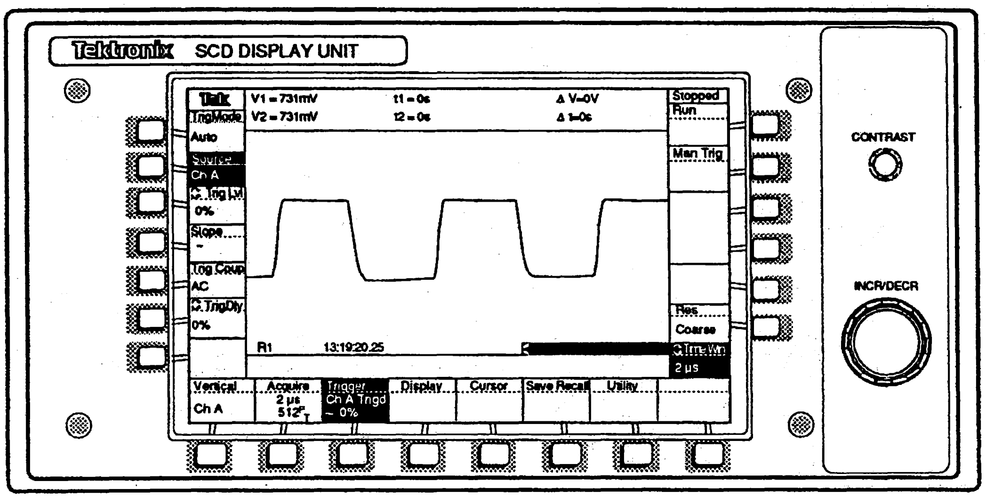


Figure A-3. Display Unit showing Menus

Window System

Through soft key selections, the LCD panel can be divided into one, two, or four separate display windows. (This is not affected by, nor does it affect, the vertical mode setting.) Any record from any selected channel can be displayed in any window. Figure A-4 is an example of a four-window display with waveforms.

When a waveform is displayed, each window contains the following information:

- the digitized waveform
- the record number
- cursors (if selected)
- a ground potential indicator (if in range)
- a time stamp indicating the time the acquisition began
- a reference bar, indicating the relative portion of the record that can be seen in the display

The status information displayed next to each window (when no menu is selected) includes

- channel number from which the waveform was acquired
- vertical full-scale range setting
- vertical offset setting
- vertical expansion (zoom) setting

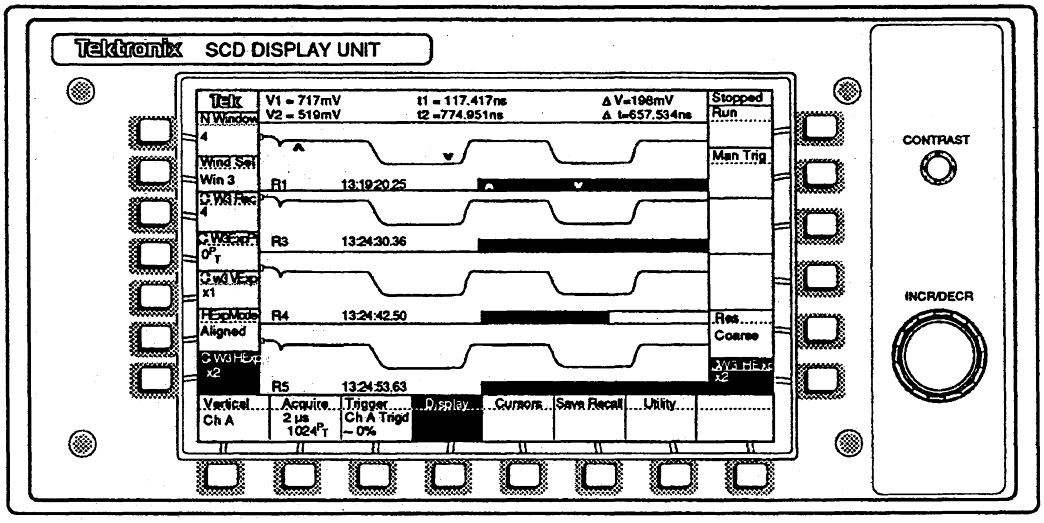


Figure A-4. Four window display

Vertical & Horizontal Expansion (Zoom)

Vertical and horizontal expansion functions display a selectable portion of the waveform in the entire window. Expansion allows individual data points of a record to be seen and increases vertical visual resolution to see discrete digitized levels.

Windows can be individually expanded or aligned with a selected window.

A 1024 point record can be horizontally expanded by a factor of x2. Records with 256 or 512 data points are shown at x1 only. The display window's horizontal axis is 512 data points. At X1, the entire record is displayed in the window.

Vertical expansion factors are x1, x2, and x4. At x1, the entire vertical range of the acquired waveform is displayed. The acquired vertical resolution of a waveform is 2048 levels (11 bits). However, the displayed vertical resolution of a waveform depends on the number of windows in the display: 256 points for one window, 128 points/window for two windows, 64 points/window for four windows.

Cursor Measurements

The SCD provides two cursors that can be placed in any one or two windows. Using the cursors, absolute and differential measurements of voltage and time can be made (frequency measurements are obtained by inverting the time measurements). Absolute measurements are referenced to ground for voltage and the trigger event for time. Differential measurements (Δt, Δv, and Δf) are made between the two cursors.

NOTE

Other messages can be displayed in the cursor readout zone. These messages will overwrite cursor information. The cursor information is automatically updated when the user adjusts the cursor position with the variable knob.

NOTE

Cursor measurement is improved when Acquire state is set to stopped.

Debug Mode

A debug mode displays IEEE-488.1 bus traffic on the Display Unit. Only bus traffic for the digitizer is displayed; other device traffic is not displayed. Besides display of bus traffic, debug features include:

- display of error codes where they occur in the bus transactions
- scrolling of the status area
- display of control and other special characters

NOTE

Turn the cursors off when using Debug mode. If the cursors are turned on, the cursor results will overwrite the debug information. This information can be retrieved, however, by using the Recall Stat utility function.

SCD SETUP SWITCHES

This section describes the parameters to consider when setting up the SCD. The following information does not include pinouts and other IEEE-488.1 bus data. For more information on IEEE-488.1, see Section B.

Setup switches are located on the SCD's rear panel (Figure A-5) select the digitizer's IEEE-488.1 (GPIB) bus and instrument settings.

GPIB Address

GPIB switches 1 through 5 set the bus address from 0 to 30. Each switch is a binary value: 1, 2, 4, 8, and 16.

NOTE

Each instrument on the bus must have a unique address.

GPIB Message Terminator

GPIB switch 6 selects the message terminator as either EOI or EOI/LF. Section B describes the message terminator.

The factory setting is EOI.

NOTE

The SCD will also accept EOI only as a message terminator when the switch is set to EOI/LF; this function is explained in more detail in Section B. If the controller accepts EOI as the terminator, the switch should be set to EOI.

Option

GPIB switch 7 is used in conjunction with MPU board switches 2 and 3 in order to select from optional modes which are available (see Table A-2). Note that switch 7 is not labelled on the rear panel of the instrument.

Dump Continuous Mode. The instrument can be placed in Dump Continuous Mode by setting instrument switch 7 to ON, MPU switch 2 to ON, and MPU switch 3 to OFF. Setting instrument switch 7 to OFF will remove the instrument from this mode.

Auto Record Mode. The instrument can be placed in Auto Record Mode by setting instrument switch 7 to ON, MPU switch 2 to OFF, and MPU switch 3 to ON. Setting instrument switch 7 to OFF will remove the instrument from this mode.
Other combinations of MPU switches 2 and 3 are available, but are reserved for future use.

NOTE
Refer changing the MPU board switches to qualified service personnel.

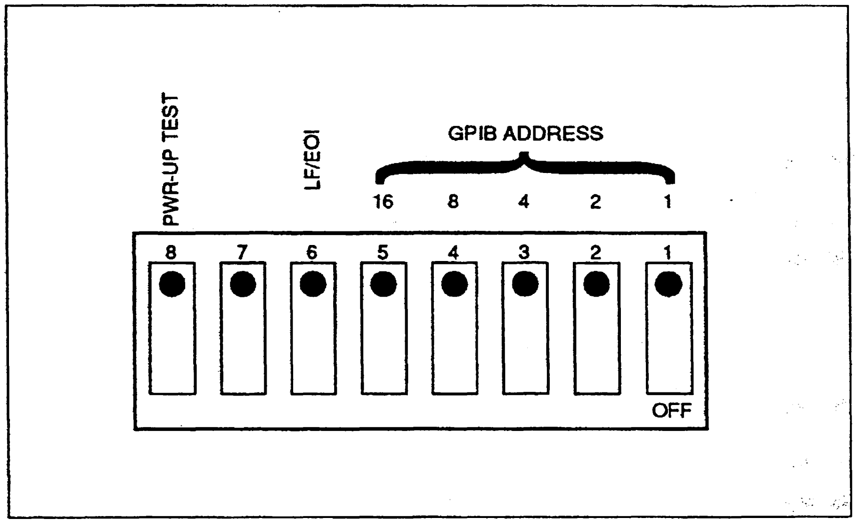


Figure A-5. SCD1000/SCD5000 GPIB and Instrument switches

TABLE A-2
OPTIONAL MODE SWITCHING

	Switch and Location		
Function	GPIB switch 7 on rear panel	Switch 2 on MPU board	Switch 3 on MPU board
Dump continuous mode	On	On	Off
Auto Record mode	On	Off	On

Power-Up Test Bypass

Instrument switch 8 determines whether or not the digitizer performs a self-test upon power-up. When OFF, the digitizer bypasses the self-test (the SAFEGUARD PUPTST command is ignored). When ON, the SAFEGUARD PUPTST command determines whether or not the digitizer performs a self-test upon power up. See Table C-12.

Factory setting is ON.

GPIB INTRODUCTION

INTRODUCTION

This section introduces IEEE 488.1 programming concepts including syntax, command processing conventions, interface messages, and SCD programming examples. This section describes both device-dependent functions (SCD functions) and interface functions (low-level IEEE-488.1 functions).

The IEEE-488.1 interface (GPIB) is based on the IEEE Standard 488.1-1987 *Digital Interface for Programmable Instrumentation*. This specification defines mechanical, electrical, and functional interface elements that enable data transfer between compatible devices. The SCD digitizer adheres to this standard.

The IEEE-488.1 uses a bit-parallel, byte-serial binary data format with a maximum transmission rate of 500 Kbytes/s. The interface allows connection of as many as 15 devices (including the controller) in a linear, star, or combined configuration. The total GPIB transmission cabling should not exceed 2 meters per device.

IEEE-488.1 devices include instruments that communicate bi-directionally (talk and listen) and uni-directionally (listen only or talk only). Each device on the bus has its own unique address and must be addressed and placed in a talk or listen mode before the controller can communicate with it.

COMMAND PROCESSING CONVENTIONS

Several command processing conventions affect the way programs are written. SCD command processing conventions are described in this section.

Upper & Lower Case

The digitizer ignores the case of alphabetical text that is input. Thus, `rqs ON` and `RQS ON` are identical. The digitizer always returns upper case only to the IEEE-488.1 port. Therefore, query responses always return as upper case characters.

Abbreviations & Minimum

Any command word in a command line can be abbreviated to a minimum ambiguity and be properly interpreted by the digitizer. For example, TRIGGER, TRIGGE, TRIGG, TRIG, and TRI are identical commands because each of the abbreviated forms includes the command's minimum ambiguity (TRI).

The minimum ambiguity for each command word is defined in the command set tables (Section C).

Quotes

Double quotes can be used inside a quoted string argument by entering the quotes twice. For example, `"Press ""User1"" Key"` causes `Press "User1" Key` to be sent to the digitizer.

White Space

White space is any CR, space, LF, or TAB character. The digitizer always ignores white space. If the terminator switch is set to EOI/LF (line-feed termination), line-feeds will not be interpreted as white space if properly placed in the message. The line-feed (LF) character is recognized as such anywhere but inside of a quoted string. There, line-feed is ignored.

Message Terminators

A message terminator indicates the end of an IEEE-488.1 message. Using the switch on the rear panel, the SCD can be set to recognize messages terminated by either EOI or EOI/LF (line feed).

When EOI is the terminator, any data byte on the bus when EOI is asserted is recognized as the end of a message. EOI only is made for controllers that want to avoid the overhead of the 2 extra bytes (CR + LF).

When EOI/LF is the terminator, either the LF (line-feed) character properly placed in a message, or any data byte on the bus simultaneously with EOI asserted, is recognized as the end of an input (to the SCD) message. The *digitizer* will not terminate on only a LF character embedded in binary data transfers or in quoted strings.

When EOI/LF is the terminator, the SCD transmits a Carriage Return character followed by Line Feed (LF) and simultaneously asserts EOI to terminate an *output* message. If the controller supports EOI, the terminator switch should be set to EOI (not EOI/LF). This eliminates any unwanted terminations if the binary waveform data sent to the controller contains line-feed characters.

Depending on placement, the LF character may be intepreted as white space as described above.

Longforms & Shortforms (LONGFORM command)

The LONGFORM command controls the number of characters the digitizer returns to the controller as a result of a query command.

When LONGFORM is OFF,

- the digitizer returns the abbreviated form of command elements (for example, `TRI COUP:AC` or `CURS OFF`)
- responses to `ALLEV?` and `EVENT?` queries are limited to the abbreviated form of the message and the event code (for example, `EVE 121`).

When LONGFORM is ON,

- the digitizer returns the complete spelling of the command element (for example, `TRIGGER COUPLING:AC` or `CURSORS OFF`)
- responses to `ALLEV?` and `EVENT?` queries include the complete spelling of the command, the event code, and a quoted string describing the event code (for example, `EVENT 155,"Invalid string input"`)

The PATH command (described below) also affects digitizer responses. The LONGFORM command is described in Table C-8.

Removing Command Echoes in Responses (PATH command)

The PATH command controls whether or not the digitizer includes in its response the query command it received from the controller. When PATH is ON, the command is included with the response. For example, CHA RANGE:.5 is returned when PATH is ON. When PATH is OFF, the query command is not included. The example just given is shortened to .5 when PATH is OFF.

COMMAND SYNTAX

There are two types of SCD commands: set commands and query commands. These types are described below, but their syntactical forms differ slightly as described here.

IEEE-488.1 set command syntax consists of headers, links, arguments, and delimiters. Set commands have the following syntactical form:

<header><space delimiter ( )><optional link><colon delimiter (:)><optional argument>

For example: `TRIGGER SOURCE:CHA`

Some SCD set commands do not include a link. A few set commands have neither link nor argument.

Query commands have a similar form except that the header includes a query indicator a question mark (?) and does not include an argument or the colon delimiter. Some SCD query commands do not include a link.

Query commands have the following syntactical form:

<header><?><space delimiter><optional link>

For example: `TRIGGER? SOURCE`

Set & Query Commands

SCD commands can either be set commands or query commands. Syntax for set and query commands differ slightly as described above.

Set Commands

Set commands instruct the instrument to do something, such as set up a parameter, start a process, etc. Set commands can be of three types: set with link, set without link, set with neither link nor argument. Here are some examples of all three of these types of set commands:

```
CALIBRATE TRIGGER (set without link)
TRIGGER COUPLING:AC (set with link)
NTRIG (set with neither link nor argument)
```

Query Commands

Query commands instruct the instrument to prepare to transfer instrument or other settings or waveform data to the controller. Once a query command has been sent, the device is talk addressed to allow transfer of data from the digitizer's output buffer to the IEEE-488.1 bus.

Query Commands (cont)

Most query commands are derived from set commands; they allow checking the current setting of a parameter set by a set command. Query commands are similar in appearance to set commands except for a question mark added to the header (ACQUIRE?). Queries may or may not have a link; these commands never have an argument, therefore the colon delimiter separating link and argument is not legal. Here are some examples of query commands:

```
EVENT?
TRIGGER? COUPLING
```

Queries can be general or specific. A general query requests settings or data for many links. In the query

```
CHA?
```

the digitizer returns all of the settings of channel A (SCD1000 only).

A specific query requests settings or data for one link. In the query

```
REPSET? NREPEAT
```

only the setting of `NREPEAT` will be returned to the digitizer if it is talk addressed before another command is sent.

Out of Phase Query

Several queries can be concatenated into one command line as explained later in this section. If a query (single or multiple queries) is sent to the digitizer and the instrument is not talk addressed before another query or command is sent to the same device, the first query is disregarded, and the response to it is cleared. The data requested by a second query is sent as usual, if the digitizer is subsequently talk addressed. In order to get the information from the digitizer, it must be talk addressed after the query is sent.

Oversized Query Response

Some general query commands may produce a response that is too big for the digitizer's output buffers. If all of this data is not talked out of the instrument, the front panel of the digitizer will stop functioning, which makes the instrument appear to hang. The front panel will resume normal operation when the remaining data is transmitted.

Set-Only & Query-Only Commands

Some commands are query-only or set-only. For example, the EVENT? query has no corresponding set command. The ERASE <NRx> command has no corresponding query.

There may be times when a query-only command will be sent to the digitizer in a set command. This is most likely to occur when the results of a query are stored external to the digitizer and are later returned to the digitizer in a corresponding set command. An example of this is the ID? query. In response to a ID? query, the digitizer will return a string which includes the ID? query response. When this string is returned to the digitizer as a set command, a command error is generated. Some query-only commands cause the instrument to generate an error when returned as a set command; others don't. The command set in section C of this manual indicates which query-only commands will generate an error when sent to the instrument as a set command.

Headers

A header identifies a set of commands that affect a category of functions of the instrument, such as TRIGGER settings, ACQUIRE settings, or TEST functions. In the commands,

```
CHA RANGE:.5
TRIGGER SOURCE:CHA
```

`CHA` and `TRIGGER` are headers.

The simplest SCD command consists of just a header, for example,

```
MTRIG
```

Links

A link further specifies a particular parameter of a category of functions that are identified by a header. In the command,

```
CHA OFFSET:.5
```

`OFFSET` is an SCD link specifying a particular parameter of channel 1. Links are separated from the header by a space delimiter (ASCII 32) or a tab character (ASCII 11).
Many commands have links; however, some do not have links, such as

```
PATH OFF (command without link)
```

Arguments

An argument sets the state or value of a parameter specified by a link or header. Most commands require arguments. However, some commands do not have arguments. The argument is separated from the link or header by a colon delimiter (:). An argument can be

- a symbol to set a parameter's state
- a numeric to set a parameter's value
- a quoted string to specify a string of characters

Character String Arguments

In the command

```
DISPLAY ON
```

the argument `ON` is a symbol that turns on the optional Display Unit. Notice that this command has no link.

Numeric Arguments

In the command

```
CHA OFFSET:.5
```

the numeric value .5 sets the offset of channel A.
The SCD accepts the following numeric arguments:

- signed integer
- unsigned integer (unsigned numbers are always interpreted as positive)
- floating point value with no exponent
- floating point value with an exponent

Although the digitizer can receive any of these numeric expressions as a numeric argument, numeric responses from the digitizer follow certain numeric conventions. The convention used depends on the command. Some responses are unsigned integers; some are floating point values with an exponent. The command set tables in Section C identify the numeric convention used for each appropriate command.

Quoted Strings Arguments

In the commmand

```
USER1 "Grp Exec","Trig"
```

the quoted strings `Grp Exec` and `Trig` label one of the user-definable keys on the Display Unit.

Quoted strings can be delimited by double quotes (").

Quotes can be used inside the string by entering the quotes twice. For example, `"Press ""User1"" Key"` causes `Press "User1" Key` to be displayed.

Delimiters

Colon (:) – separates a link from its following argument.

Comma (,) – separates an argument from the next link in a command line, or it separates multiple links for some commands. The comma is used to include more than one link in a command line in order to set several parameters of a single header. For example, to change several trigger parameters in one command string:

```
TRIGGER COUPLING:AC,MODE:AUTO,SLOPE:PLUS.
```

To separate multiple arguments in a single command:

```
ABSTOUCH 0,8
```

Delimiters (cont)

Semicolon (;) – separates a group of links and arguments of one header from the next header in a command line. The semicolon is used to include more than one header in a command line. For example: `VMODE ADD;CHA RANGE:100E-3,OFFSET:.5, TYPEOFFSET:VOLTS;CHB RANGE:1,OFFSET:.5,TYPEOFFSET:VOLTS.`

Concatenation of Commands

Multiple set and query commands can be sent in the same command line if properly delimited. (See Delimiters above.) For example, the following command lines

```
VMODE ADD <EOI>
CHA RANGE:100E-3,TYPEOFFSET:VOLTS,OFFSET:-1.25 <EOI>
CHB RANGE:200E-3,TYPEOFFSET:VOLTS,OFFSET:-1.50 <EOI>
ACQUIRE STATE:HLDNXT <EOI>
```

could be concatenated into one command line such as

```
VMODE ADD;CHA RANGE:1.00E-3,TYPEOFFSET:VOLTS, OFFSET:-
1.25;CHB RANGE:100E-3,TYPEOFFSET:VOLTS, OFFSET:-1.50;AC-
QUIRE STATE:HLDNXT<EOI>
```

Talked With Nothing to Say (TWNTS)

If a response is requested of the digitizer without it first having been queried, it responds with a TWNTS message while asserting the EOI line. The message is one byte long with the value FF <EOI> in EOI mode and FF CR LF <EOI> in LF/EOI mode.

TWNTS will not occur if the digitizer is currently acquiring.

INTERFACE MESSAGES

Interface messages are low-level commands generated by the GPIB interface software in the controller or composed according to the IEEE-488.1 standard. Unlike instrument commands, interface messages cannot be sent as character strings.

The following descriptions are provided as an overview of how these GPIB messages relate to the SCD. All of these messages appear on the bus with the attention line (ATN) asserted. For complete descriptions of the interface messages and resultant interface states, see ANSI/IEEE Standard 488.1-1987.

The SCD supports the IEEE-488.1 interface functions as follows:

- Acceptor Handshake (AH1)
- Controller (C0)
- Device Clear (DC1)
- Device Trigger (DT1)
- Tri-state Bus (E2)
- Listener (L4)
- Parallel Poll (PP0)
- Remote/Local (RL0 however, the SCD generally follows the state transitions of remote and local instrument control; see Local Lockout below)
- Service Request (SR1)
- Source Handshake (SH1)
- Talker (T6)

Listen Address (LA) & Talk

Listen Address (LA) messages condition the SCD to receive commands. Talk Address (TA) messages condition the SCD to respond to queries and serial polls. The SCD receives its Listen Address when the data on the bus equals decimal 32 plus the address set on the SCD's rear panel address switches. The SCD receives its Talk Address when the data on the bus equals decimal 64 plus the address set on the SCD's rear panel address switches. For example, if the SCD is set to address 20 on the dip switch, then the listen address is 32+20=52 and the talk address is 64+20=84.

Local Lockout (LLO)

Remote With Lockout State (RWLS) inhibits front panel operation, which prevents the front panel controls from affecting the SCD. While in this state, the front panel LOCK (red) and GPIB (yellow) LEDs are on. These LEDs will only show if there is no front panel attached to the instrument.

The SCD powers on in the local state (LOCS). RWLS can be acheived by asserting REN, listen addressing the box, and sending the LLO (Local Lockout) message. The front panel controls can also be turned off by sending the FPANEL OFF command (see Table C-13).

Unlisten (UNL) & Untalk (UNT)

The Unlisten (UNL) message is equivalent to talk address decimal 31, so the address sent is 32+31=63. The UNL message cancels the LA message. The Untalk (UNT) message is equivalent to listen address decimal 31, so the address sent is 64+31=95. The UNT message cancels the TA message. The Untalk and Unlisten commands are universal commands. All instruments on the bus stop talking and listening when the controller sends UNT and UNL messages.

Device Clear (DCL)

The Device Clear (DCL) message initializes communication between the SCD and the controller. In response to DCL, the digitizer clears input and output messages as well as unexecuted control settings. Errors and events waiting to be reported are cleared, except for the power-on event. The SRQ message is cleared, unless SRQ is true from a power-on condition.

Interface Clear (IFC)

Interface Clear (IFC) is a signal line of the IEEE-488.1 cable. When IFC is asserted, both the Talk and Listen functions are placed in an idle state. This produces the same effects as receiving both the Untalk and Unlisten comands. IFC resets the interface only and does not affect any instrument functions. The input and output buffers are not cleared.

Selected Device Clear (SDC)

Selected Device Clear (SDC) performs the same function as DCL, but requires the instrument to have been listen-addressed (more than one instrument can be simultaneously addressed and thus affected by SDC). This function allows the controller to perform a device clear on selected instruments. When the SCD receives an SDC, it executes a Device Clear (explained above).

Serial Poll Enable (SPE) & Serial Poll Disable (SPD)

The Serial Poll Enable (SPE) message causes the SCD to transmit its serial-poll status byte when it is talk-addressed. The Serial Poll Disable (SPD) message returns the digitizer to normal operation. If SRQ was asserted, it is cleared when the digitizer is polled.

Parallel Poll

The SCD does not support parallel polling commands.

Group Execute Trigger (GET)

The SCD supports the Group Execute Trigger (GET) function. In the SCD, the DT command (Table C-8) enables the SCD to recognize the GET command and enter one of the acquisition states (STOP, RUN, or HOLDNXT). Get requires the device to be a listener. When GET is received after DT is received, the digitizer enters the set acquisition state. This capability allows many instruments to be synchronized by having them wait for the GET command before executing their instructions. A multiple digitizer system can use the GET command to acquire many channels at the same time.

Device Trigger (DT)

Device Trigger programs the digitizer's response to the GET message. The DT command allows the user to program the digitizer to enter one of the three acquisition states upon receiving GET.

DEVICE-DEPENDENT PROGRAMMING

High-level programming languages, such as BASIC, C, and Pascal, are used to create programs that send GPIB messages to devices and receive data and responses from the devices. Statements in these languages usually contain three parts:

- •input/output keyword (such as `PRINT` or `READ`)
- •IEEE-488.1 logical unit designator, which may be an address or a name (such as `20` or `DIG`)
- •instrument command or response formed by a character string or string-variable designator (such as `CHA RANGE:2`)

Generic Programming Language

Because the SCD can be controlled by several different computer types, a "generic" computer language is used in the following examples to replace language constructs from other languages that provide input, output, and other statements. Table B-1 lists the generic language constructs used in the examples.

TABLE B-1
GENERIC LANGUAGE CONSTRUCTS FOR EXAMPLES

GENERIC CONSTRUCT	DESCRIPTION
Sendstring @address	Send ASCII string to device at @address
Readstring @address	Read ASCII string from device at @address
Readintarray @address	Read binary-encoded integer array values,most significant bit first from device at @address.
Serial poll (address,statusb)	Perform a serial poll to read status byte from device requesting service. Device address is obtained during poll.
Dim	Allocate space for arrays or strings. For example: Dim Integer Intwfm(1024)
While/Wend	While command for looping requirements.
Writedisk	Save data to disk.
@Screen	Replaces @address in command. Use to output to the computer monitor.
@Variablename	Replaces @address in command. Used as a variable to identify an address.

In the following example, the SCD is set to address 20.

All examples assume that proper configuration and declaration to the GPIB port and device have been done prior to these statements. The examples show proper command syntax.

Output Statement Examples

Output statements send commands and other data to the digitizer. The following examples show several commands used to set up the vertical inputs of the SCD, set up the trigger system, and begin an acquisition. Any SCD commands may replace the ones following the generic output statement. (The following commands are written for an SCD1000 and could be concatenated as explained earlier.)

```
Sendstring @20: "VMODE ADD;CHA RANGE:100E-3"
Sendstring @20: "CHB RANGE:200E-3"
Sendstring @20: "TRIGGER MODE:NORMAL,SOURCE:CHA"
Sendstring @20: "ACQUIRE STATE:HLDNXT"
```

Input Statement Examples

Input statements allow the controller to receive waveform data and other information from the digitizer into arrarys or variables. In the following examples, variables and arrays have been dimensioned large enough to hold the expected data

```
Readstring @20: SETTINGS$

Readintarray @20: Intwfm(i)
```

Query Command & Response Examples

Query and input operations may be specified by separate statements, or, if the controller permits, a prompting input statement can perform both functions. The following example queries for and then acquires the channel 1 settings of the device at address 20 (SET$ has been dimensioned as a string variable large enough to accommodate all data coming from the device).

```
Sendstring @20:"CHA?"
Readstring @20:SET$
```

In this operation, the controller addresses the device as a listener and sends the query command, "CHA?", over the bus. The controller then reassigns the instrument to be a talker and receives the characters into the target variable SET$. The variable then contains the channel 1 information, which can be displayed on the console:

```
Sendstring @Screen: SET$

CHA RANGE:2.0E+0,OFFSET:0,TYPEOFFSET:PERCENT,COUPLING:DC
```

Instrument Settings Transfer

Setup parameters can be copied to the controller using the SET? query command. The settings can be saved in a pre-defined string variable and then written to a disk file. Once saved in the controller, the SCD settings can be modified at a later time and returned to the digitizer. The entire setup is described in ASCII characters, as defined in the command tables of Section C.

Instrument Settings Transfer (cont)

The following example shows how to dimension a string variable to receive the current digitizer settings, modify them, and then send them back to the digitizer.

```
DIM SET$ (600)
Sendstring @20:"SET?"
Readstring @20:SET$
.
commands that may modify the settings in SET$
.
Sendstring @20: SET$
```

Handling Service Request (SRQ) & Event Codes

The most recent RQS command (see Table C-7) determines whether the digitizer asserts the SRQ control line of the bus when either an error or a change in status occurs. The RQS command is always set to ON at power-up.

If the controller is configured and programmed appropriately, an asserted SRQ line interrupts its normal program flow. To service the interrupt, the controller polls each device on the bus. In response to being polled, the interrupting device returns a status byte, which reveals the type of event that occurred. The interrupting device then clears the SRQ line.

If another SRQ is pending, either from the same or another instrument on the GPIB, the SRQ line will be re-asserted. The SRQ line is re-asserted each time an SRQ needs to be handled. If the controller does not respond to the SRQ, the instrument continues to operate and communicate normally, even though the condition that caused the SRQ may invalidate an operation such as a measurement, setting, or acquisition.

After reading a status byte, the program may request more information about the event by sending the EVENT? query command. The device returns a number (and a descriptive string if the digitizer is programmed to do so) that identifies the specific event. Section D defines the various status bytes, event codes, and errors.

The following example shows how to read the status byte and obtain the event code after SRQ has been asserted. (The device address is obtained during the poll routine and stored in the variable, DEV.) The status byte and associated event code are then displayed on the controller's screen. The variables for device address (DEV) and status byte (STATUSB) are integer. However, because the LONGFORM command is set to ON, a string is returned with every event query, which is stored in the string variable, EVENT$. (See descriptions of these commands in Section A.)

```
Serialpoll: (DEV,STATUS)
Sendstring @DEV: "LONGFORM ON;PATH ON"
Sendstring @DEV:"EVENT?"
Readstring @DEV:EVENT$
Sendstring @Screen: "SRQ from ";DEV;", status= ";STATUS;
EVENT$
```

Handling Service Request (SRQ) & Event Codes (cont)

Sending an SRQMASK USRx:ON command (where x=1 or 2) to the SCD allows an SRQ to be generated when the appropriate user button on the Display Unit is pressed. (Each of the user buttons can be labeled. See Section C for the appropriate commands.) The SCD sends unique status byte and event code values to signify when a user button is pressed. These values can be used to control program flow by waiting for the operator to press a user button before performing other actions, such as acquiring a waveform or making a cursor measurement.

In addition, SRQMASK ABSTOUCH:ON allows any key on the Display Unit to generate an SRQ. See Table C-7 for information on the SRQMASK command.

DEVICE DEPENDENT COMMAND SET LISTING

Table B-2 alphabetically lists all the SCD commands described in Section C. In the table, spelling of headers, links, and arguments is done with both uppercase and lowercase characters. Uppercase characters indicate the minimum ambiguity of each command. The entire spelling (longform) is in uppercase and lowercase. Other conventions follow those of the tables in Section C.

See Section C for descriptions of each of these commands.

Command Set Table Format Conventions

The following format conventions are used in the command set tables:

Items included in brackets ([...]) are optional items.
<x> represents an alphacharacter
<NR1> represents a signed integer.
<NR2> represents a floating point number with no exponent
<NR3> represents a floating point number with exponent
<NRx> represents an <NR1>, <NR2>, or <NR3>
<ui> represents an unsigned integer with no leading space
<qstring> represents a quoted string ("xxxxx" or 'xxxxx')
<bblock> represents a Tek Codes & Formats Binary Block

Spelling for headers, links, and arguments is done with uppercase and lowercase characters; however, the command's minimum ambiguity appears in uppercase characters (for example, TRI) while the longform includes both uppercase and lowercase characters (for example, TRIgger).

Each table's Description column includes a brief description, numeric limits (where appropriate), factory settings (where appropriate), an example of the query or command, and, for queries, an example of the SCD response.

Factory settings are the values programmed in the SCD when first shipped from the factory. Subsequent programming of the SCD causes values to be changed. These values are saved in memory when the unit is turned off. The digitizer powers on with the saved settings; the SCD does not return to the factory settings each time it is turned on. See Factory Settings in Section A and the INIT command in Table C-8 for more information.

All example responses are representative of the results when the PATH and LONGFORM commands are ON.

Commands are sorted in order of typical importance with queries following commands. For example, in Table C-7 all SRQMASK commands are listed followed by all SRQMASK? queries.

TABLE B-2
ALPHABETICAL COMMAND SET LISTING

Header	Link	Argument	Reference Section C
ABStouch?			Table C-8
ABStouch		<NRx>,<NRx>	Table C-8
ABStouch		CLEar	Table C-8
Acquire	AVErage:	<NRx>	Table C-3
ACQuire	LENgth:	<NRx>	Table C-3
ACQuire	MODe:	NORmal	Table C-3
		ADVance	
		AVErage	
ACQuire	NRECord:	<NRx>	Table C-3
ACQuire	HLDnxt	ON	Table C-3
		OFF	
ACQuire	STARt	<NRx>	Table C-3
ACQuire	STATe:	STOp	Table C-3
		RUN	
		HLDnxt	
ACQuire	TIME:	<NRx>	Table C-3
ACQuire?			Table C-3
ACQuire?	HLDnxt		Table C-3
ACQuire?	LASt		Table C-3
ACQuire?	LENgth		Table C-3
ACQuire?	MODe		Table C-3
ACQuire?	NRECord		Table C-3
ACQuire?	STARt		Table C-3
ACQuire?	STATe		Table C-3
ACQuire?	TIME		Table C-3
ACQuire?	AVErage		Table C-3
ALLEv?			Table C-8
BELl	BUTton:	ON	Table C-13
		OFF	
BELl	KNOb:	ON	Table C-13
		OFF	
BELl	RINg		Table C-13
BELl?			Table C-13
BELl?	BUTton		Table C-13
BELl?	KNOb		Table C-13

TABLE B-2 (CONT)
ALPHABETICAL COMMAND SET LISTING

Header	Link	Argument	Reference Section C
CALIBRATE		[ALL]	Table C-14
		CRT	Table C-14
		HORizontal	Table C-14
		TRigger	Table C-14
		VERTical	Table C-14
		GEOmetry	Table C-14
CALIBRATE?			Table C-14
CALOut		OFF	Table C-16
		ON	
CALOut?	CH<x>	TIME	Table C-16
CALOut?	CH<x>	AMPL	Table C-16
CALOut?	CH<x>	AMPL4[50]	Table C-16
CALOut?	CH<x>	OFF	Table C-16
CALOut?	EXTernal	TIME	Table C-16
CALOut?	EXTernal	AMPL	Table C-16
CALIBRATOr	AMPLitude:	<NRx>	Table C-14
CALIBRATOr	TIME:	<NRx>	Table C-14
CALIBRATOr?			Table C-14
CALIBRATOr?	AMPLitude		Table C-14
CALIBRATOr?	TIME		Table C-14
CDAte?			Table C-14
CCOnstant?	<ui>		Table C-14
CH<x>	COUPling:	AC (SCD1000)	Table C-2
		DC	
		OFF (SCD1000)	
CH<x>	INVert:	OFF (SCD1000)	Table C-2
		ON (SCD1000)	
CH<x>	OFFSet:	<NRx>	Table C-2
CH<x>	RANge: (SCD1000)	<NRx>	Table C-2
CH<x>	TYPEOffset:	PERcent	Table C-2
		VOLts	
CH<x>?			Table C-2
CH<x>?	COUPling		Table C-2
CH<x>?	INVert (SCD1000)		Table C-2
CH<x>?	OFFSet		Table C-2
CH<x>?	RANge (SCD1000)		Table C-2
CH<x>?	TYPEOffset		Table C-2
CH<x>?	PROBe (Option 1E)		Table C-2
CH?			Table C-2

TABLE B-2 (CONT)
ALPHABETICAL COMMAND SET LISTING

Header	Link	Argument	Reference Section C
CLOck	DATE:	<qstring>	Table C-16
CLOck	TIME:	<qstring>	Table C-16
CLOck?	DATE		Table C-16
CLOck?	TIME		Table C-16
CLOck?			Table C-16
CRS?			Table C-9
CRS1	LOCTn:	WIN<ui>	Table C-9
CRS2			
CRS1	XPOint:	<NRx>	Table C-9
CRS2			
CRS1?	LOCTn		Table C-9
CRS2?			
CRS1?	XTIMe		Table C-9
CRS2?			
CRS1?	XPOint		Table C-9
CRS2?			
CRS1?	YCOord		Table C-9
CRS2?			
CRS1?			Table C-9
CRS2?			
CRSD	TYPETime:	HZ	Table C-9
		SECond	
CRSD?			Table C-9
CRSD?	T		Table C-9
CRSD?	TYPETime		Table C-9
CRSD?	Y		Table C-9
CURSors		ON	Table C-9
		OFF	
CURSors?			Table C-9
CURVe?			Table C-6
DATA	CNTrecord:	<NRx>	Table C-6
DATA	COUNt:	<NRx>	Table C-6
DATA	STARt:	<NRx>	Table C-6
DATA	STREcord:	<NRx>	Table C-6
DATA?			Table C-6
DATA?	CNTrecord		Table C-6
DATA?	COUNt		Table C-6
DATA?	STARt		Table C-6
DATA?	STREcord		Table C-6

TABLE B-2 (CONT)
ALPHABETICAL COMMAND SET LISTING

Header	Link	Argument	Reference Section C
DEBug	GPIb:	ON OFF	Table C-8
DEBug?	[GPIb]		Table C-8
DIAg?			Table C-14
DISplay		ON OFF	Table C-12
DISplay?			Table C-12
DT		RUN STOp HLDnxt OFF	Table C-8
DT?			Table C-8
ERAse		<NRx>	Table C-10
EVEnt?			Table C-7
EVQty?			Table C-7
FOCus FOCus?		<NRx>	Table C-16 Table C-16
FPAnel		ON OFF	Table C-13
FPAnel?			Table C-13
HELp?			Table C-8
HEXPMd		ALIgned INDep	Table C-12
HEXPMd?			Table C-12
HSDO	STATe	OFF ALL VALid	Table C-20
	MODe	1 2	Table C-20
	DUMp	OFF CONTinuous	Table C-20
	FORmat	BYTE WORd	Table C-20

TABLE B-2 (CONT)
ALPHABETICAL COMMAND SET LISTING

Header	Link	Argument	Reference Section C
HSDO?	STATe MODe DUMp LENgth FORmat		Table C-16 Table C-16 Table C-16 Table C-16 Table C-16
ID?			Table C-8
INIt		PANel GPIb [ALL]	Table C-8
INTEnsity INTEnsity?		<NRx>	Table C-16 Table C-16
LINArray?			Table C-6
LLSet?		<bblock>	Table C-10
LONgform LONgform?		ON OFF	Table C-8 Table C-8
MTRig			Table C-4
NWIn NWIn?		1 2 4	Table C-12 Table C-12
OPTion?			Table C-8
PATh PATh?		ON OFF	Table C-8 Table C-8
RAW RAW?		LINArray REFArray	Table C-15 Table C-15
RECAll		<NRx>	Table C-10
REFArray?			Table C-6
REFList?			Table C-17

TABLE B-2 (CONT)
ALPHABETICAL COMMAND SET LISTING

Header	Link	Argument	Reference Section C
REPEat?			Table C-6
REPSet REPSet? REPSet?	NREPEat: NREPEat	<NRx>	Table C-6 Table C-6 Table C-6
RQS RQS?		ON OFF	Table C-7 Table C-7
SAFeguard SAFeguard SAFeguard SAFeguard? SAFeguard? SAFeguard?	 PROTect: PUPtst: PROTect PUPtst	SECURE ON OFF ON OFF	Table C-11 Table C-11 Table C-11 Table C-11 Table C-11 Table C-11
SAVE		<NRx>	Table C-10
SET?			Table C-10
SETRef SETRef?		OFF ON RUN	Table C-17 Table C-17
SRQmask SRQmask SRQmask SRQmask SRQmask SRQmask SRQmask	ABStouch: CMDerr: EXERr: EXWarn: INErr: INWarn: OPCmpl:	ON OFF ON OFF ON OFF ON OFF ON OFF ON OFF ON OFF	Table C-7 Table C-7 Table C-7 Table C-7 Table C-7 Table C-7 Table C-7

TABLE B-2 (CONT)
ALPHABETICAL COMMAND SET LISTING

Header	Link	Argument	Reference Section C
SRQmask	USR1:	ON OFF	Table C-7
SRQmask	USR2:	ON OFF	Table C-7
SRQmask?			Table C-7
SRQmask?	ABStouch		Table C-7
SRQmask?	CMDerr		Table C-7
SRQmask?	EXERr		Table C-7
SRQmask?	EXWarn		Table C-7
SRQmask?	INErr		Table C-7
SRQmask?	INWarn		Table C-7
SRQmask?	OPCmpl		Table C-7
SRQmask?	USR1 USR2		Table C-7
TESt	LOOp:	ON OFF	Table C-14
TESt	NUM:	<NRx>	Table C-14
TESt	SYS:	ALL MPU FP DIG	Table C-14
TESt	VERBose:	ON OFF	Table C-14
TESt?			Table C-14
TESt?	LOOp		Table C-14
TESt?	NUM		Table C-14
TESt?	SYS		Table C-14
TESt?	VERBose		Table C-14
TEXt	CHAR:	<NRx>	Table C-12
TEXt	CLEar:	<NRx>	Table C-12
TEXt	LINE:	<NRx>	Table C-12
TEXt	STRIng:	<qstring>	Table C-12
TIMESt?			Table C-6
TRIgger	COUPling:	AC DC (SCD1000)	Table C-4
TRIgger	DELay:	<NRx>	Table C-4
TRIgger	LEVel:	<NRx>	Table C-4
TRIgger	MODe:	AUTo NORmal	Table C-4
TRIgger	SLOpe:	PLUs MINus	Table C-4

TABLE B-2 (CONT)
ALPHABETICAL COMMAND SET LISTING

Header	Link	Argument	Reference Section C
TRIgger	SOUrce:	CHA (SCD1000) CHB (SCD1000) ADD (SCD1000) EXTernal INTernal (SCD5000 Opt01) CALIBRATOR (SCD5000)	Table C-4
TRIgger	TYPEDelay:	PERcent SECond	Table C-4
TRIgger	TYPELevel:	PERcent VOLts	Table C-4
TRIgger?			Table C-4
TRIgger?	COUPling		Table C-4
TRIgger?	DELay		Table C-4
TRIgger?	LEVel		Table C-4
TRIgger?	MODe		Table C-4
TRIgger?	SLOpe		Table C-4
TRIgger?	SOUrce		Table C-4
TRIgger?	TYPEDelay		Table C-4
TRIgger?	TYPELevel		Table C-4
UID		<qstring>	Table C-8
UID?			Table C-8
USER1 USER2		<qstring1><qstring2>	Table C-8
USER1? USER2?			Table C-8
VERSion?			Table C-7
VMOde		CHA (SCD1000) CHB (SCD1000) ADD (SCD1000)	Table C-1
VMOde?			Table C-1
VIDeo		ON OFF	Table C-14
WAVfrm?			Table C-5
WFMpre?			Table C-5
WFMpre?	BIT/nr		Table C-5
WFMpre?	BN.fmt		Table C-5
WFMpre?	BYT/nr		Table C-5
WFMpre?	CRVchk		Table C-5
WFMpre?	ENCdg		Table C-5
WFMpre?	NR.pt		Table C-5

TABLE B-2 (CONT)
ALPHABETICAL COMMAND SET LISTING

Header	Link	Argument	Reference Section C
WFMpre?	PT.Fmt		Table C-5
WFMpre?	PT.Off		Table C-5
WFMpre?	WFId		Table C-5
WFMpre?	XINcr		Table C-5
WFMpre?	XUNit		Table C-5
WFMpre?	XZEro		Table C-5
WFMpre?	YMUlt		Table C-5
WFMpre?	YOFf		Table C-5
WFMpre?	YUNit		Table C-5
WFMpre?	YZEro		Table C-5
WFTx		DL	Table C-5
		IL	
		TCF	
WFTx?			Table C-5
WIN<ui>	EXPnt:	<NRx>	Table C-12
WIN<ui>	HEXPNd:	<NRx>	Table C-12
WIN<ui>	RECOrd:	<NRx>	Table C-12
WIN<ui>	VEXpnd:	<NRx>	Table C-12
WIN<ui>?			Table C-12
WIN<ui>?	EXPnt		Table C-12
WIN<ui>?	HEXPNd		Table C-12
WIN<ui>?	RECOrd		Table C-12
WIN<ui>?	VEXpnd		Table C-12
WIN?			Table C-12

GPIB COMMAND SET

INTRODUCTION

This section lists the GPIB commands for the SCD1000/SCD5000. Command syntax and other general information about the IEEE-488.1 interface are provided in Section B. This section includes commands for the vertical system, arm and trigger systems, and acquisition parameters. Commands that affect data and waveforms, status and events, waveform preamble, and diagnostics and calibration are also listed, as well as GPIB-related commands, and other instrument commands. Other tables list initialization values and value limits.

Command Table Summary

The following tables are in this section.

VERTICAL COMMANDS

In the Vertical commands, <x> can be A, or B (for the SCD1000 only); <x> is NULL for SCD5000.

TABLE C-1
VERTICAL MODE COMMANDS

Header	Link	Argument	Description
VMOde		CHA CHB ADD	SCD1000 Only. Selects input source from either channel or the algebraic sum of both. Factory setting: CHA Example: VMODE ADD
VMOde?			SCD1000 only. Queries for input channel selection. Example: VMODE? Response: VMODE CHA

TABLE C-2
VERTICAL CHANNEL COMMANDS

Header	Link	Argument	Description
CH<x>	RANge:	<NRx>	SCD1000 only. Sets specified channel full scale range. The valid settings are 100 mV,200 mV,500 mV,1 V,2 V,5 V,10 V (1X probe attenuation). Limits: 100 mV to 10 V (1X probe attenuation) Factory setting: 1 V Example: CHA RANGE:200E-3
	OFFSet:	<NRx>	Sets the specified channel input offset to <NRx>. Limits: SCD1000: ±250 mV to ±25 V (1X probe attenuation); SCD5000: ±4 V Factory setting: 0 Example: CHA OFFSET:1.25 (SCD1000) Example: CH OFFSET:1.25 (SCD5000)
	TYPEOffset:	PERcent VOLts	Sets the specified channel input offset unit to PERcent of full-scale range or VOLts. Factory setting: VOLTS Example: CHA TYPEOFFSET:PERCENT
	COUPling:	AC (SCD1000) DC OFF(SCD1000)	SCD1000: Sets the specified channel coupling to AC,DC,or OFF (input disconnected from signal). SCD5000: DC coupling only. Factory setting: AC Example: CHA COUPLING:AC
	INVert:	ON OFF	SCD1000 only. Inverts the signal from the specified channel (x). Factory setting: OFF Example: CHB INVERT:ON

TABLE C-2 (CONT)
VERTICAL CHANNEL COMMANDS

Header	Link	Argument	Description
CH<x>?	RANge		Queries for the channel's full scale range setting. SCD1000 responds with it's range setting; SCD5000 responds with a range of 5 Volts. Example: `CHA? RANGE` Response: `CHA RANGE:200.E-3` (SCD1000) Response: `CH RANGE:5.0` (SCD5000)
	OFFSet		Queries for the channel's offset. The response is a floating point number with an exponent. Example: `CHB? OFFSET` Response: `CHB OFFSET:100.E-3`
	TYPEOffset		Queries for the channel's input offset units. Example: `CHA? TYPEOFFSET` Response: `CHA TYPEOFFSET:VOLTS`
	COUPling		Queries for the channel's input coupling setting. SCD1000 responds with AC,DC,or OFF. SCD5000 responds with DC only. Example: `CHA? COUPLING` Response: `CHA COUPLING:AC`
	INVert		SCD1000 only. Queries for the channels signal invert setting. Example: `CHB? INVERT` Response: `CHB INVERT:OFF`
	PROBe (Option 1E)		Queries for the channel's probe value. Returns the Level (I or II) of probe attached to the channel and a string of information generated by the probe. If no probe is attached,the return value is: "NOT IN STALLED." Example: `CHA? PROB` Response: `CHA PROBE:"NOT INSTALLED."`
CH<x>?			Queries for all settings for the specified channel: COUPlin ,RANge,TYPEOffset,OFFSet, INVert.,and PROBe Example: `CHB?` Response: `CHB COUPLING:AC,RANGE:200.E-3, TYPEOFFSET: PERCENT,OFFSET:10.E-1, INVERT:OFF,PROBE:"NOT INSTALLED."`

TABLE C-2 (CONT)
VERTICAL CHANNEL COMMANDS

Header	Link	Argument	Description
CH?			Queries for all settings of all channels: COUPling,RANge,TYPEOffset,OFFSet,and INVert. Example: CH? Response: CHA COUPLING:AC,RANGE:200.E-3, TYPEOFFSET:PERCENT,OFFSET:10.E-1, INVERT:ON,PROBE: "NOT INSTALLED";CHB COUPLING:DC,RANGE:500E-3,TYPEOFFSET:VOLTS,OFFSET:1.E0, INVERT:ON,PROBE: "NOT INSTALLED"

ACQUIRE COMMANDS

TABLE C-3
ACQUIRE COMMANDS

Header	Link	Argument	Description
ACQuire	MODe:	NORmal ADVance AVErage	Sets the acquisition mode. NORmal fills only the record specified by the STArt command. ADVance fills a specified number of consecutive records set by NRECord starting with record specified by the STArt command. AVErage averages a number of acquisitions set by ACQuire:AVErage. The result is placed in the record specified by the STArt command. See also Acquisition Sequence and Acquisition Process in Section A. Factory setting: NORMAL Example: `ACQUIRE MODE:ADVANCE`
	STATe:	STOp RUN HLDnxt	Controls the acquisition state. STOP immediately stops the acquisition sequence. RUN starts the acquisition sequence and causes the digitizer to perform as many acquisitions as possible. HLDNXT completes one acquisition process and then stops. See Acquisition Sequence and Acquisition Process in Section A for more information. At the end of each acquisition process an operation complete (OPC) SRQ is generated.
	TIME:	<NRx>	Sets the time window duration. Limits: 5 ns to 100 µs Factory setting: 1E-6 (1 µs) Example: `ACQUIRE TIME:10E-9`
	LENgth:	256 512 1024	Selects the record length in sample points of all records. See Acquisition System in Section A. Limits: 256, 512, 1024. Factory setting: 512 Example: `ACQUIRE LENGTH:256`
	NRECord:	<NRx>	Sets the number of consecutive records to fill in ADVANCE mode. Limits: 1 to 16. Factory setting: 1 Example: `ACQUIRE NRECORD:4`
	STARt:	<NRx>	Selects the record where the next acquisition starts. Records 1, 2, 3 and 4 are stored in non-volatile memory. Limits: 1 to 16. Factory setting: 1 Example: `ACQUIRE START:2`
	HLDnxt	ON OFF	Turns on or off holdnext acquisition mode. ACQUIRE STATE must be set to HLDNXT. Factory setting: OFF Example: `ACQUIRE HLDNXT:ON`

TABLE C-3 (CONT)
ACQUIRE COMMANDS

<table>
<tr><th>Header</th><th>Link</th><th>Argument</th><th>Description</th></tr>
<tr><td>ACQuire</td><td>AVErage</td><td><NRx></td><td>Sets the number of averages to perform in AVERAGE mode.
Limits: 1 to 1024
Factory setting: 16
<table>
<tr><th>Number of Averages</th><th>Resolution of Curve Data</th></tr>
<tr><td>1-3</td><td>11 bits</td></tr>
<tr><td>4-15</td><td>12 bits</td></tr>
<tr><td>16-98</td><td>13 bits</td></tr>
<tr><td>99-1024</td><td>14 bits</td></tr>
</table></td></tr>
<tr><td>ACQuire?</td><td>MODe</td><td></td><td>Queries for the acquisition mode (NORMAL, ADVANCE or AVERAGE).
Example: ACQUIRE? MODE
Response: ACQUIRE MODE:ADVANCE</td></tr>
<tr><td></td><td>STATe</td><td></td><td>Queries for the state of the acquisition process (STOP, RUN,or HLDNXT).
Example: ACQUIRE? STATE
Response: ACQUIRE STATE:HLDNXT</td></tr>
<tr><td></td><td>TIME</td><td></td><td>Queries for the time window setting.
Example: ACQUIRE? TIME
Response: ACQUIRE TIME:5.E-9</td></tr>
<tr><td></td><td>LASt</td><td></td><td>Query only. Queries for the number of the last valid record. Only completed records are valid.
Example: ACQUIRE? LAST
Response: ACQUIRE LAST: 6</td></tr>
<tr><td></td><td>LENgth</td><td></td><td>Queries for the record length in sample points.
Example: ACQUIRE? LENGTH
Response: ACQUIRE LENGTH:1024</td></tr>
<tr><td></td><td>NRECord</td><td></td><td>Queries for the number of records to acquire when in ADVance mode.
Example: ACQUIRE? NRECORD
Response: ACQUIRE NRECORD:8</td></tr>
<tr><td></td><td>STARt</td><td></td><td>Queries for the first record to be filled.
Example: ACQUIRE? START
Response: ACQUIRE START:2</td></tr>
</table>

TABLE C-3 (CONT)
ACQUIRE COMMANDS

Header	Link	Argument	Description
ACQuire?	HLDnxt		Queries for the state (ON or OFF) of the holdnext acquisition mode. Example: `ACQUIRE? HLDNXT` Response: `ACQUIRE HLDNXT:OFF`
	AVErage		Queries for the number of acquisitions to average when in the Average mode. Example: `ACQUIRE? AVERAGE` Response: `ACQUIRE AVERAGE:16`
ACQuire?			Queries for all the acquisition settings: STATe,HLDnxt,TIMe,LENgth,MODe,NRECord,STArt,and LASt. Example: `ACQUIRE?` Response: `ACQUIRE STATE:STOP,HLDNXT:OFF,TIME:5.E-9, LENGTH:512,MODE:ADVANCE,NRECORD:8, START:2`

TRIGGER COMMANDS

TABLE C-4
TRIGGER COMMANDS

Header	Link	Argument	Description
MTRig			Set only. Immediately triggers the digitizer. Example: MTRIG (This command has no argument.)
TRIgger	MODe:	AUTo NORmal	Selects trigger mode. In AUTO mode,triggering occurs when the trigger event is detected or 360 ms after the start of acquisition sequence,whichever comes first. In Normal mode,only a proper trigger event can trigger the digitizer. Factory setting: AUTO Example: TRIGGER MODE: NORMAL
	COUPling:	AC DC (SCD1000 only)	SCD1000: Sets trigger signal coupling to AC,or DC (AC attenuates signal components <1 K Hz). SCD5000: AC coupling only. Factory setting: AC Example: TRIGGER COUPLING:DC
	LEVel:	<NRx>	Sets trigger level to the value specified by <NRx>. Units specified by TYPELEVEL command (% or volts). See Section A for more information on triggering. Limits: SCD1000: AC Coupling: ±100% of vertical range; DC Coupling: ±50% of vertical range; SCD5000: ±50% of vertical range (AC Coupling only) Factory setting: 0.0 volts Example: TRIGGER LEVEL:25 (Trigger level is set to 25% of full-scale range if the typelevel is set to percent.)
	TYPELevel:	PERcent VOLts	Sets the units of trigger level to percent of full scale range or to volts. PERcent allowed only for internal trigger sources. External source forces TYPELevel to VOLts. See also TRIGGER LEVEL command and Triggering in Section A. Factory setting: VOLTS Example: TRIGGER TYPELEVEL:PERCENT
	DELay:	<NRx>	Positions the time window relative to the trigger event. Trigger delay can be specified in terms of percent of the record length or seconds. See Triggering in Section A. Limits: 0 to 5 times the record length. Factory setting: 0 Example: TRIGGER POSITION:50 (Delay is 50%.)
	TYPEDelay:	PERcent SECond	Sets the unit of trigger delay to percent or seconds. See also TRIGGER POSITION command. Factory setting: SECOND Example: TRIGGER TYPEDELAY:PERCENT

TABLE C-4 (CONT)
TRIGGER COMMANDS

Header	Link	Argument	Description
Trigger	SLOpe:	PLUs MINus	Sets trigger slope to positive (PLUS) or negative (MINUS) edge triggering. Factory setting: PLUS Example: TRIGGER SLOPE:MINUS
	SOUrce:	CHA (SCD1000) CHB (SCD1000) ADD (SCD1000) EXTernal INTernal (SCD5000 Opt 01) INTERNAL CALIBRATOR (SCD 5000)	Sets trigger source to channel A, B, the algebraic sum of A and B,or the external input. SCD5000: Sets the trigger source to the external input or the internal time calibrator signal. SCD5000 Option 01 sets the trigger source to the external input or the internal triggger pickoff. Factory setting: SCD1000: CHA; SCD5000: EXTERNAL Example: TRIGGER SOURCE:CHB
TRIgger?	MODe		Queries for the setting of the trigger mode (AUTO or NORMAL). Example: TRIGGER? MODE Response: TRIGGER MODE: AUTO
	COUPling		Queries for the setting of the trigger coupling: SCD1000: AC or DC; SCD5000: AC only. Example: TRIGGER? COUPLING Response: TRIGGER COUPLING:AC
	LEVel		Queries for the setting of the trigger level. Example: TRIGGER? LEVEL Response: TRIGGER LEVEL:125.E-3
	TYPELevel		Queries for unit of the trigger level (PERCENT or VOLTS). Example: TRIGGER? TYPELEVEL Response: TRIGGER TYPELEVEL:PERCENT
	DELay		Queries for the setting of the trigger delay. Example: TRIGGER? DELAY Response: TRIGGER DELAY:150 (Delay is 150 percent.)
	TYPEDelay		Queries for unit of the trigger delay (PERCENT or SECOND). Example: TRIGGER? TYPEDELAY Response: TRIGGER TYPEDELAY:SECOND
	SLOpe		Queries for the setting of the trigger slope (PLUS or MINUS). Example: TRIGGER? SLOPE Response: TRIGGER SLOPE:MINUS

TABLE C-4 (CONT)
TRIGGER COMMANDS

Header	Link	Argument	Description
Trigger?	SOUrce		Queries for the setting of trigger source: SCD1000: CHA,CHB,ADD,or EXTERNAL: SCD5000: EXTERNAL, INTERNAL (Option 01), or CALIBRATOR. Example: `TRIGGER? SOURCE` Response: `TRIGGER SOURCE:EXTERNAL`
TRIgger?			Queries for all trigger settings: SOUrce,TYPELevel,LEVel,TYPEDelay,DELlay,SLOpe,COUPling, and MODe. Example: `TRIGGER?` Response: `TRIGGER SOURCE:CHB,TYPELEVEL:PERCENT,LEVEL:40, TYPEDELAY:PERCENT,DELAY:50,SLOPE:PLUS, COUPLING:AC,MODE:AUTO`

WAVEFORM PREAMBLE COMMANDS

The waveform preamble contains scaling, encoding and other information that the controller can use to reconstruct the waveform from the data. Some of the data in the query are values set by the DATA command parameters and other commands. See Table C-6 for DATA commands.

TABLE C-5
WAVEFORM PREAMBLE COMMANDS

Header	Link	Argument	Description
WFMpre?	BIT/nr		Query only. Queries for the number of bits per binary waveform data point (the sample point). This value is either 9 or 11 bits Example: WFMPRE? BIT/NR Response: WFMPRE BIT/NR:11
	BN.fmt		Query only. Queries for the Tek Codes & Formats binary number format. This value is always RI (right justified). Example: WFMPRE? BN.FMT Response: WFMPRE BN.FMT:RI
	BYT/nr		Query only. Queries for the number of bytes per binary waveform data point (sample point). This value is always 2 bytes per sample point. Example: WFMPRE? BYT/NR Response: WFMPRE BYT/NR:2
	CRVchk		Query only. Queries for the checksum (NONE,NULL,or CHKSM0) that is appended to the binary waveform data stream. NONE is returned when WFTX is IL. NULL is returned when WFTX is DL. CHKSM0 is returned when WFTx is TCF. See WFTx command in this table. Example: WFMPRE? CRVCHK Response: WFMPRE CRVCHK:NULL
	ENCdg		Query only. Queries for the encoding of the binary waveform data stream sent from the digitizer. This value is always BINARY. Example: WFMPRE? ENCDG Response: WFMPRE ENCDG:BINARY
	NR.pt		Query only. Queries for the number of points in the waveform to be transmitted. This value is set by the DATA COUNT and DATA CNTRECORD commands (see Table C-6). Response is a signed integer. Example: WFMPRE? NR.PT Response: WFMPRE NR.PT:512
	PT.Fmt		Query only. Queries for the point format of the binary waveform data. This value is always "Y" meaning that the byte defines the amplitude of the waveform at each sample interval. Example: WFMPRE? PT.FMT Response: WFMPRE PT.FMT:Y

TABLE C-5 (CONT)
WAVEFORM PREAMBLE COMMANDS

Header	Link	Argument	Description
WFMpre?	PT.Off		Query only. Queries for the number of sample points between the trigger point and the first point being transmitted. This value is affected by the DATA START and TRIGGER POSITION com mands. Example: `WFMPREE? PTOFF` Response: `WFMPRE PTOFF:127`
	WFId		Query only. Queries for the waveform identification string. The response is a quoted string indicating the channel number,record number,date and time of acquisition,and the number of missing data points on the centroided waveform ("Ch# REC# date time xx"). If more than one record is being sent,only the beginning record number is indicated. Example: `WFMPRE? WFID` Response: `WFMPRE WFID:"CHA 4 89-12-15 23:14:22.62 54"`
	XINcr		Query only. Queries for the sample interval of the waveform.The response is a floating point number with an exponent. This value is set by the ACQUIRE TIME command. Example: `WFMPRE? XINCR` Response: `WFMPRE XINCR:50.E-9`
	XUNit		Query only. Queries for the horizontal unit of measure for the waveform. This value is always SECONDS. Example: `WFMPRE? XUNIT` Response: `WFMPRE XUNIT:SECONDS`
	XZEro		Query only. Queries for the horizontal offset of the waveform data. The response is <NR3>. Example: `WFMPRE? XZERO` Response: `WFMPRE XZERO:100.E-3`
	YMUlt		Query only. Queries for the vertical scale factor (multiplier in volts) of the waveform data. This number is any of the full-scale vertical range settings divided by 512 or 2048 (the current vertical resolu tion). The response is a floating point number with an exponent. Example: `WFMPRE? YMULT` Response: `WFMPRE YMULT:3.91.E-3`
	YUNit		Query only. Queries for the vertical unit of measure for the wave form. This value is always VOLTS. Example: `WFMPRE? YUNIT` Response: `WFMPRE YUNIT:VOLTS`

TABLE C-5 (CONT)
WAVEFORM PREAMBLE COMMANDS

Header	Link	Argument	Description
WFMpre?	YZEro		Query only. Queries for the vertical offset of the waveform. This value is set by the CH<x> OFFSET command. The response is a floating point number with an exponent. Example: `WFMPRE? YZERO` Response: `WFMPRE YZERO:100.E-3`
	YOFf		Query only. Queries for the center value of the waveform data. Example: `WFMPRE? YOFF` Response: `WFMPRE YOFF:127`
WFMpre?			Query only. Queries for all WFMPRE data. Example: `WFMPRE?` Response: `WFMPRE WFID:"CH1 7 89-09-22 07:24:33 25",ENCDG:BINARY,NR.PT:512,PT.FMT:Y,XINCR: 5.E-9,PTOFF:64,XZERO:0, XUNIT:SECONDS,YMULT:3.91.E-3,YZERO:100.E-3,YOFF:127,YUNIT:VOLTS,BYT/NR:1,BN.FMT:RI, BIT/NR:8,CRVCHK:NULL`
WFTx		DL IL TCF	Sets the waveform transfer format. DL = Definite Length Binary Block. IL = Indefinite Length Binary Block. TCF = Tek Codes and Formats. See Section E for more information on transfer formats. Factory setting: DL Example: `WFTX IL`
WFTx?			Queries for the waveform transfer format (DL,IL,or TCF). Example: `WFTX?` Response: `WFTX TCF`

DATA & WAVEFORM COMMANDS

The CURVE? query causes the SCD to transmit waveform data to the controller. The amount of data that is sent is defined by the DATA command parameters (DATA statement). See Table C-5 earlier in this section.

TABLE C-6
DATA & WAVEFORM COMMANDS

Header	Link	Argument	Description
CURVe?			Query only. Sends the SCD's binary waveform data to the GPIB port. The data sent is specified by the DATA command parameters. Example: `CURVE?` The response to CURVE? depends on the transmission format (WFTx commands) and the DATA statement. See Table C-5 for the WFTx command. Note: Data which was interpolated rather than recorded is flagged by setting the 15th bit in the data word (Data would be of the pattern: 4xxxH).
DATA	CNTrecord:	<NRx>	Sets the number of records to be transferred. The first record is set by the DATA STREcord command. Limits: 1 to 16 Factory setting: 1 Example: `DATA CNTRECORD:4`
	COUNt:	<NRx>	Sets the number of points in the curve to be transferred (the starting point is included in the transfer). If COUNT:0 is specified,the entire record is transmitted. Limits: 0 to record length Factory setting: 0 Example: `DATA COUNT:128`
	STARt:	<NRx>	Sets the starting point in the selected record where transferred waveform data starts. Limits: 1 to record length. Factory setting: 1 Example: `DATA START:64`
	STREcord:	<NRx>	Selects the first record to be transferred. Limits: 1 to 16 Factory setting: 1 Example: `DATA STRECORD:10`
DATA?	CNTrecord		Queries for the number of records to include in a waveform transfer. Example: `DATA? CNTRECORD` Response: `DATA CNTRECORD:16`

TABLE C-6 (CONT)
DATA & WAVEFORM COMMANDS

Header	Link	Argument	Description
DATA?	COUNt		Queries for the number of points to include in a waveform data transfer. Example: DATA? COUNT Response: DATA COUNT:1024
	STARt		Queries for the data transfer starting point in the selected record. Example: DATA? START Response: DATA START:64
	STREcord		Queries for first record to include in a waveform transfer. Example: DATA? STRECORD Response: DATA STRECORD:1
DATA?			Queries for all settings of the data command for all channels: CNTrecord,COUNt,STARt and STREcord. Example: DATA? Response: DATA CNTRECORD:0,COUNT:1024,START:1,STRECORD:1
REPSet	NREPEat:	<NRx>	Sets the SCD to execute repeat mode acquisition and transfer mode. In this mode, the SCD is set to capture the number of records defined using NRECORD command and automatically transfer the waveform data to a waiting GPIB controller. The controlller does not need to query for the waveform data transfer using the CURVE? query. If <NRx> = 0, the process is repeated indefinitely until the SCD is listen addressed with any command. At that time, the process is terminated. Limits: 0 to (2^{32}-1) Factory setting: 1 Example: REPSET NREPEAT:10
REPSet?	NREPEat		Queries for the number of times to execute the repeat cycle. Example: REPSET? NREPEAT Response: REPSET NREPEAT:12
REPSet?			Queries for the number of times to execute the repeat cycles. Example: REPSET? Response: REPSET NREPEAT:10
REPEat?			Query Only. Starts repeat cycle set up by the REPSet command. The SCD repeatedly (according to values set by REPSet com mand) acquires and then transmits binary waveform data to the controller. (Any command from the bus or front panel aborts the REPEat process.) The data sent is specified by the DATA com mand parameters. Example: REPEAT? The response to this command is the waveform data acquired and transmitted to the controller. Transmission format is specified by the WFTX command (see Table C-5).

TABLE C-6 (CONT)
DATA & WAVEFORM COMMANDS

Header	Link	Argument	Description
LINArray?			Query only. Sends the raw,uncentroided waveform data to the GPIB port. Only DL format is allowed. The WFTx setting is ignored (see WFTx command in Table C-5). Refer to Table E-1 for data format. Example: LINARRAY? Response: LINARRAY *517584 <data>...{null checksum}
REFArray?			Query only. Sends the grey scale pixel map of the traget to the GPIB. This array is used in the digitizer to remove target irregularities. Only DL format is allowed. The WFTx setting is ignored (see WFTx command in Table C-5). Refer to Table E-1 for data format. Example: REFARRAY? Response: REFARRAY *6524289 <data>...{null checksum}
TIMESt?	<ui>		Query only. Queries for the date/time stamp of the specified record. The value of the time stamp is the date and time of the trigger event in yy-mm-dd hh:mm:ss.ss format. Example: TIMEST? 12 Response: TIMEST 12:"89-12-15 12:42:33.61"
TIMESt?			Query only. Queries for the time stamps of all acquired records. The value of the time stamp is the date and time of each trigger event,in yy-mm-dd hh:mm:ss.ss format. Example: TIMEST? Response: TIMEST? 1:"89-12-15 12:42:53.42:,2:"89-12-15 13:22:54.22", 3:"89-12-15 16:22:33.23", 4:"89-12-15 18:22:34.76", 5:"....".... to 16 records.
WAVfrm?			Query only. Sends the waveform preamble and waveform data to the GPIB port. The transmitted data depends on the DATA statement and the WFTx command. This query is equivalent to sending a WFMPRE? query followed by a CURVE? query. See Table C-5 for the WFMPRE? query and WFTx commands. Example: WAVFRM? Response: See WFMPRE? query in Table C-5 and CURVE? query at the beginning of this table.

STATUS & EVENT COMMANDS

The following commands are used to control and report the details of operating status to the controller. Details on status bytes and event codes can be found in Section D.

TABLE C-7
STATUS & EVENT COMMANDS

Header	Link	Argument	Description
ALLEv?			Query only. Queries the SCD for all event codes. If the LONGFORM command is ON,the event code is followed by a quoted string describing the event code. If OFF,only the event code is sent. To return all event codes,either the RQS OFF command must first be sent or all events must have been serially polled. If RQS is ON,only the most recent event code will be returned followed by an error. See RQS command below. See also Section D for more information on the event codes. Example: ALLEV? Response: ALLEV 156,"Unknown symbol",157,"Syntax error"(RQS is OFF.)
EVEnt?			Query only. Queries the SCD for the most recent event code. If the LONGFORM command is set to ON,the event code is followed by a quoted string describing the event code. If LONGFORM is OFF,only the event code is sent. If RQS is ON,an event code will be returned only if a serial poll has been performed before request ing the event code. If RQS is OFF,a serial poll is not necessary prior to requesting the event code. However,corresponding status bytes are lost when consecutive event codes are requested. See the RQS command later in this table. See also Section D for information on status bytes and event codes. Example: EVENT? Response: EVENT 455,"Self test completed suc cessfully"
EVQty?			Query only. Queries the SCD for how many events are waiting to be queried (up to a maximum of 20). The response is a signed integer. Example: EVQTY? Response: EVQTY 3
ID?			Query only. Queries the SCD for information about the digitizer. The response includes the firmware version numbers for the digitizer and Display Unit. Example: ID? Response: IID "TEK/SCD1000,V81.1,DIG/1.0,DSY/ 3.00"

TABLE C-7 (CONT)
STATUS & EVENT COMMANDS

Header	Link	Argument	Description
RQS		ON OFF	Enables or disables the digitizer's ability to assert the SRQ line when an event occurs or a condition changes. ON enables; OFF disables. When OFF,the digitizer does not request service from the controller. The controller must poll the digitizer to determine if it needs to be serviced. See also SRQMask command in this table and Section D for more details. Factory setting: ON Example: `RQS OFF`
RQS?			Queries for the RQS status. Example: `RQS?` Response: `RQS ON`
SRQmask	ABStouch:	ON OFF	Enables (ON) or disables (OFF) SRQ assertion as the result of a front panel change,either by the ABStouch command or button pushes. See also the ABStouch command in Table C-8. Factory setting: OFF Example: `SRQMASK ABSTOUCH:OFF`
	CMDerr: EXERr: EXWarn: INErr: INWarn: OPCmpl: USR1: USR2:	ON OFF	Enables or disables the ability of the SCD to assert SRQ on each of these status conditions. See Section D for more information on errors,warnings,user,and operation complete conditions. Factory settings: CMDerr: ON,EXErr: ON,EXWarn: ON,INERr: ON,INWarn: ON,OPCmpl: ON,USR1: OFF,USR2: OFF Example: `SRQMASK CMDERR:ON,EXERR:ON, EXWARN:ON, INERR:ON, INWARN:ON,OPCMPL:ON, USR1:OFF,USR2:OFF`
SRQmask?	ABStouch CMDerr EXERr EXWarn INErr INWarn OPCmpl USR1 USR2		Queries for the states (ON or OFF) of the individual SRQMask set tings. See Section D for more information on errors,warnings,user,and operation complete conditions. Example: `SRQMASK? ABSTOUCH` Response: `SRQMASK ABSTOUCH:ON.`
SRQmask?			Queries for the states (ON or OFF) of all SRQ masks. See Section D for more information on errors,warnings,user,and operation complete conditions. Example: `SRQMASK?` Response: `SRQMASK ABSTOUCH:OFF,CMDERR:ON,EXERR:ON, EXWARN:ON, INERR:ON, INWARN:ON, OPCMPL:ON,USR1:OFF,USR2:OFF`

TABLE C-7 (CONT)
STATUS & EVENT COMMANDS

Header	Link	Argument	Description
UID		<qstring>	Assigns an identifying name to the device. The name must be a quoted string no longer than ten characters (for example,"MSTRSCD"). Set at factory to instrument serial number. Example: `UID "DIG_2"`
UID?			Queries for the instrument's ID string. The response is a ten-character quoted string. Example: `UID?` Response: `UID "B010101"`
OPTion?			Query only. Queries for the options installed in the digitizer. Possibilities are OPT 1E: TEK type II probe OPT 2E: SMA input connectors OPT 1P: Fast wfm capture OPT 2F: HSDO & battery backed-up linear array OPT 01: Delay line (SCD5000 only) Example: `OPTION?` Response: `OPTION "01 Delay line"`
VERSion?			Query only. SCD sends firmware version number. Response is <digitizer firmware version #>,<display firmware version #>. Example: `VERSION?` Response: `VERSION "DIG FW*1.0 DSY FW*3.00"`

GPIB RELATED COMMANDS

TABLE C-8
GPIB RELATED COMMANDS

Header	Link	Argument	Description
ABStouch		<NRx>,<NRx>	Emulates a touch to a front-panel button or a "click" of the variable knob designated by the coordinates <NRx> and <NRx>. Figure C-1 identifies the coordinates possible with the SCD Display Unit. These coordinates are stored in a buffer (ABSTOUCH buffer). The last 20 ABSTOUCH commands and front panel button presses are stored. ABStouch coordinates from the front panel are not stored if RWLS is active. Factory setting: None Example: `ABSTOUCH 0,8`
		CLEar	Clears the coordinates in the ABSTOUCH buffer. The ABSTOUCH buffer is always cleared at power-up. Example: `ABSTOUCH CLEAR`
ABStouch?			Queries for the coordinates in the ABSTOUCH buffer. The response is two signed integers indicating the touch area. See Figure C-1 for touch area coordinates. If the ABSTOUCH buffer is empty,the response is -1,-1 Example: `ABSTOUCH?` Response: `ABSTOUCH 2,8`

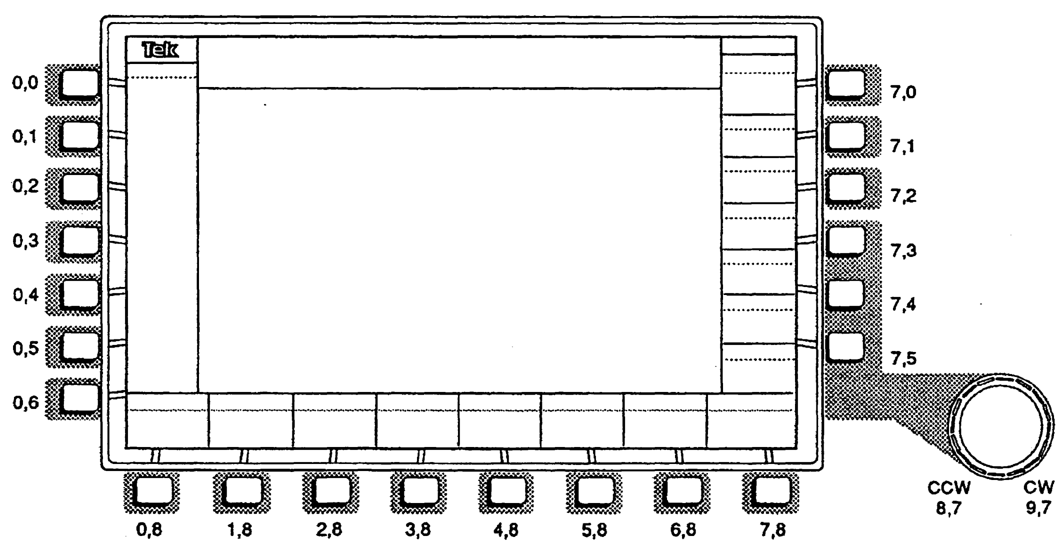


Figure C-1. Front Panel Coordinates for ABSTOUCH

TABLE C-8 (CONT)
GPIB RELATED COMMANDS

Header	Link	Argument	Description
DEBug	GPIb:	ON OFF	Sets the state of GPIB debugging. When ON,the IEEE-488.1 bus traffic to the SCD is displayed on the Display Unit. See Debug Mode in Section A. Factory setting: OFF Example: DEBUG GPIB:ON
DEBug?	GPIb		Queries for the state (OFF or ON) of GPIB debugging. Example: DEBUG? GPIB Response: DEBUG ON
DT		RUN STOp HLDnxt OFF	Sets the acquistion state the SCD enters when the next GET is re ceived. See Table C-3 (ACQUIRE STATE command) for more information on these settings. Factory setting: OFF Example: DT RUN
DT?			Queries for the group execute trigger acquisition state. Example: DT? Response: DT RUN
HELp?			Queries for list of all SCD command headers. Example: HELP?
INIt		PANel GPIb [ALL]	Set only. Resets settings to factory settings for instrument (PANEL),IEEE-488.1 (GPIB),or both (ALL). See Tables C-19 and C-18 for factory settings of PANEL and GPIB. An OPC SRQ is generated when PANel or GPIb is sent. Example: INIT ALL
LONgform		ON OFF	Controls number of characters reported to controller. When ON,complete spelling of headers,links,and arguments are reported. (Affected by PATH command.) Responses to EVENT? and ALLEV? queries include event numbers and quoted string descrip tion of event. number(s). When OFF,headers,links,and arguments are abbreviated to minimum ambiguity. Responses to EVENT? and ALLEV? queries are limited to event number(s). Factory setting: ON Example: LONGFORM ON
LONgform?			Queries for the setting (OFF or ON) of the LONGFORM command. Example: LONGFORM? Response: LONGFORM ON
PATh		ON OFF	Sets the type of response to queries. When ON,the header and link are returned with the argument (for example, CHA OFFSET:10). When OFF,only the arguments are returned to the query (for example,10). Factory setting: ON Example: PATH OFF

TABLE C-8 (CONT)
GPIB RELATED COMMANDS

Header	Link	Argument	Description
PATh?			Queries for the state (ON or OFF) of the path setting. Example: `PATH?` Respnse: `PATH ON`
USER1 USER2		<qstring1>, <qstring2>	Labels the Display Unit's front panel USER buttons with <qstring1> on line 1 and <qstring2> on line 2. The strings can be up to eight characters each. Factory setting: "","" Example: `USER1"Group","Trig"`
USER1? USER2?			Queries the specified front panel USER button for its labels. The response is a set of two quoted strings (<qstring>) containing the labels for each line. Pressing either user button causes a USER SRQ to be generated if the USER SRQ is unmasked. Example: `USER1?` Response: `USER1 "Send","Wavefrm"`

CURSOR COMMANDS

TABLE C-9
CURSOR COMMANDS

Header	Link	Argument	Description
CRS1 CRS2	LOCTn:	WIN<ui>	Places the specified cursor in the window specified by <ui>. Limits: <ui> can be from 1 to 4. Factory setting: Cursor 1: Window 1; Cursor 2: Window 1 Example: `CRS1 LOCTN:WIN1`
	XPOint:	<NRx>	Places the specified cursor at sample point location <NRx>. Limits: <NRx> can be from 0 to (Record Length - 1) Factory setting: Cursor 1: point 0; Cursor 2: point 0 Example: `CRS1 XPOINT:127`
CRS1? CRS2?	LOCTn		Queries for the window number in which the specified cursor is located. Example: `CRS2? LOCTN` Response: `CRS2 LOCTN:WIN4`
	XTIMe		Query only. Queries for the time in seconds of the selected cursor. The response is a floating point number with an exponent. Example: `CRS1? XTIME` Response: `CRS1 XTIME:112.E-3`
	XPOint		Queries for the sample point of the specified cursor. The response is an integer. Example: `CRS2? XPOINT` Response: `CRS2 XPOINT:365`
	YCOord		Query only. Queries for the amplitude (in volts) of the specified cursor. The response is a floating point number with an exponent. Example: `CRS1? YCOORD` Response: `CRS1 YCOORD:65.E-2`
CRS1? CRS2?			Queries for the settings of each of the above cursor commands: LOCTn, XPOint, XTIMe, and YCOord. Example: `CRS1?` Response: `CRS1 LOCTN:WIN2,XPOINT:123,XTIME:` `65.E-9,YCOORD:2.57.E-6`

CRS?			Queries for all settings of both cursors.
			Example: `CRS?`
			Response: `CRS1 LOCTN:WIN2,XPOINT:123,XTIME:`
			`65.E-9,YCOORD:2.57.E-6;`
			`CRS2 LOCTN:WIN2,XPOINT:158,XTIME:83.E-`
			`9,YCOORD:1.07.E-6`

TABLE C-9 (CONT)
CURSOR COMMANDS

Header	Link	Argument	Description
CRSD	TYPETime:	HZ SECond	Sets the unit of Δt measurements to hertz or seconds. Measure ments between cursor 1 and cursor 2 are displayed in the selected unit. Factory setting: SECOND. Example: `CRSD TYPETIME:SECOND`
CRSD?	TYPETime		Queries for the units of Δt measurements. Example: `CRSD? TYPETIME` Response: `CRSD TYPETIME:HZ`
	T		Query only. Queries for the Δt measurement value in seconds. Δt is he time difference between the locations of cursor 2 and cursor 1. The response is a floating point number with an exponent. Example: `CRSD? T` Response: `CRSD T:122.E-9`
	Y		Query only. Queries for the Δy measurement value in volts. Δy is the voltage difference between the locations of cursor 2 and cursor 1. The response is a floating point number with an exponent. Example: `CRSD? Y` Response: `CRSD Y:12.5.E-3`
CRSD?			Queries for the typetime value and the Dt and Dy measurement values. Example: `CRSD?` Response: `CRSD TYPETIME:SECOND,T:14.3.E-9,Y:1.54.E-6`
CURSors		ON OFF	Turns ON or OFF the display of the cursors. Factory setting: ON Example: `CURSORS ON`
CURSors?			Query for the state (ON or OFF) of the cursor display. Example: `CURSORS?` Response: `CURSORS ON`

SAVE/RECALL SETTINGS COMMANDS

TABLE C-10
SAVE/RECALL SETTINGS COMMANDS

Header	Link	Argument	Description
LLSet?			Queries for the contents of the LLSET binary block. The format is <&><data><&><data><&><data>...<EOI>. The LLSET binary block contains all of the digitizer settings. The user may store the results of an LLSET? query and return them to the digitizer at a later time to restore the digitizer to the state it was in when the LLSET? query was executed.
		<bblock>	This command contains no header. It's argument is a binary block which was generated by an LLSET? query and stored external to the instrument.. This binary block specifies the settings for the instrument. LLSET sets up the digitizer quicker than using an ASCII string generated by querying all settings and resending it. However,the settings should also be saved as an ASCII string because the <bblock> may become obsolete if the SCD firmware version is changed.
RECAll		<NRx>	Recalls the instrument settings stored in a non-volatile RAM area specified by <NRx>. (The settings are stored in non-volatile RAM using the SAVE command as described below.) An OPC SRQ is generated upon completion. Limits: <NRx> ranges from 1 to 10. Factory setting: None Example: `RECALL 1`
SAVE		<NRx>	Stores the current instrument settings in the location in non-volatile memory specified by <NRx>. Settings can be recalled using the RECALL command. An OPC SRQ is generated upon completion. Limits: <NRx> ranges from 1 to 10. Factory setting: None Example: `SAVE 1`
SET?			Queries for all current instrument settings. Example: `SET?` Response: `H1 RANGE:1,OFFSET:10.....`
ERAse		<NRx>	Clears the saved settings located in <NRx>. Factory setting: None Example: `ERASE 2`

INSTRUMENT/DATA PROTECTION COMMANDS

Some of the following commands are over-ridden by instrument switch settings. See Section A for descriptions of these switches.The command descriptions below include how the switch affects the command.

TABLE C-11
INSTRUMENT /DATA PROTECTION COMMANDS

Header	Link	Argument	Description
SAFEGuard	PROTect: (SCD1000 only)	ON OFF	When ON, the digitizer automatically disconnects the inputs when it detects an overvoltage condition. When OFF, the inputs are not protected.However, a service request can be issued if an overvolt age condition is detected. **Operation of the instrument with Protect = OFF will damage the instrument if an input overvoltage condition occurs.** Factory setting: ON Example: `SAFEGUARD PROTECT:OFF`
	PUPtst:	ON OFF	When ON and instrument switch #8 is OFF,the digitizers executs a self-test at power-up. When OFF and instrument switch #8 is OFF,the digitizer does not execute a self-test. Factory setting: ON. Example: `SAFEGUARD PUPTST:OFF`
		SECURE	Set only.Erases all memory data and resets all parameters to their factory settings.Diagnostics are run (if enabled). POWER ON and SETTINGS LOST SRQs are generated. Example: `SAFEGUARD SECURE`
SAFEguard?	PROTect (SCD1000 only)		Queries for the input protection setting (OFF or ON). Example: `SAFEGUARD? PROTECT` Response: `SAFEGUARD PROTECT:ON`
	PUPtst		Queries for the power-up self-test setting (OFF or ON). Example: `SAFEGUARD? PUPTST` Response: `SAFEGUARD PUPTST`
SAFEguard?			Queries for state of all SAFEguard settings. Example: `SAFEGUARD?` Response: `SAFEGUARD PROTECT:ON,PUPTST:OFF`

DISPLAY COMMANDS

TABLE C-12
DISPLAY COMMANDS

Header	Link	Argument	Description
DISplay		ON OFF	Turns ON or OFF the Display Unit. (The SCD executes faster when the display is OFF.) Factory setting: ON Example: DISPLAY OFF
DISplay?			Queries for the state of the Display Unit. Example: DISPLAY? Response: DISPLAY OFF
NWIn		1 2 4	Selects the number of windows for displaying waveforms. 1,2,or 4 windows can be displayed at the same time. Factory setting: 1 Example: NWIN 4
NWIn?			Queries for the number of displayed windows (1,2,or 4). Example: NWIN? Response: NWIN 4
HEXPMd		ALIgned INDep	Selects whether expansion occurs for all windows at the same time by the same expansion setting (ALIgned) or for only the selected window (INDep). Factory setting: ALIGNED Example: HEXPMD INDEP
HEXPMd?			Queries for the horizontal expansion mode (ALIGNED or INDEP). Example: HEXPMD? Response: HEXPMD INDEP
TEXt	STRIng:	<qstring>	Set only. Writes the text string (<qstring>) at the location specified by TEXT CHAR and TEXT LINE commands. Text is only allowed in waveform areas. Table C-21 lists the TEXT command character set. Record 0 may be used to display text only. Limits: 16 rows x 64 cols. Rows are divided evenly among the number of displayed windows. See Figure C-2. Factory setting: "" Example: TEXT STRING:"Trig position -25%."
	CHAR:	<NRx>	Set only. Specifies the starting column for the TEXT STRIng command. Limits: 1 to 64 Factory setting: 1 Example: TEXT CHAR:10

TABLE C-12 (CONT)
DISPLAY COMMANDS

Header	Link	Argument	Description
TEXt	LINE:	<NRx>	Set only. Specifies the starting line number for the TEXT STRIng command. Note: Record bar lines cannot be used for displaying text. Limits: 1 to 16. Rows are divided evenly among displayed windows. See Figure C-2. Factory setting: 1 Example: `TEXT LINE:6`
	CLEar:	<NRx>	Set only. Clears the text on line <NRx> of the display. If <NRx> is 0,all lines are cleared. Factory setting: None Example: `TEXT CLEAR:2`

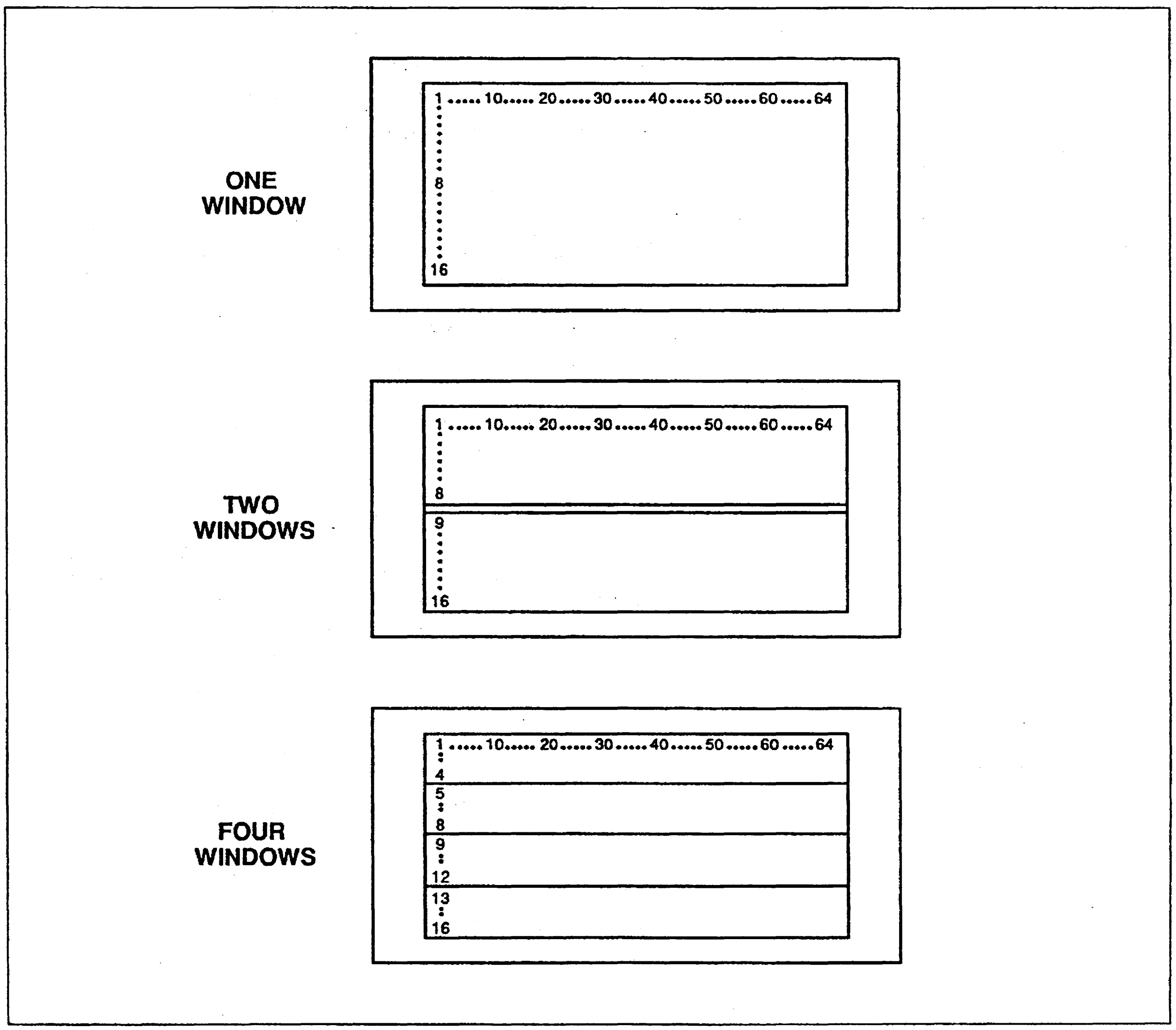


Figure C-2. Text Areas

TABLE C-12 (CONT)
DISPLAY COMMANDS

Header	Link	Argument	Description
WIN<ui>	EXPnt:	<NRx>	Selects point of waveform around which expansion takes place. Limits: 0 to (Record Length - 1) Factory setting: 0 Example: `WIN1 EXPNT:38`
	HEXPNd:	<NRx>	The horizontal expansion factor can be set to 2 to expand a 1024 data point record. Otherwise HEXPNd equals 1. Limits: 1 or 2 Factory setting: 1 Example: `WIN2 HEXPND:2`
	RECOrd:	<NRx>	Displays waveform data from record <NRx> in window <ui>. Factory setting: Win1: 1; Win2: 1; Win3:1; Win4: 1 Example: `WIN4 RECORD:24`
	VEXpnd:	<NRx>	Vertically expands window <ui> by <NRx>. <NRx> can be 1, 2, or 4. If <NRx> is 1,the entire vertical range is displayed. Factory setting: 1 Example: `WIN4 VEXPND:2`
WIN<x>?	EXPnt		Queries for window <ui>'s expansion point. The response is a signed integer. Example: `WIN3? EXPNT` Response: `WIN3 EXPNT:116`
	HEXPNd		Queries for horizontal expansion value of window <ui>. The response is a signed integer: 1, 2, 4, or 8. Example: `WIN4? HEXPND` Response: `WIN4 HEXPND:4`
	RECOrd		Queries for the record from which window <ui> displays its data. The response is a signed integer. Example: `WIN2? RECORD` Response: `WIN2 RECORD:12`
	VEXpnd		Queries for the vertical expansion value of window <ui>. The response is a signed integer. Example: `WIN4? VEXPND` Response: `WIN4 VEXPND:2`

TABLE C-12 (CONT)
DISPLAY COMMANDS

Header	Link	Argument	Description
WIN<ui>?			Queries for all the settings (EXPnt,HEXPNd,RECOrd,VEXpnd) of window <ui>. Example: WIN1? Response: WIN1 EXPNT:129,HEXPND:8,RECORD:2,VEXPND:2
WIN?			Queries for all the settings (EXPnt, HEXPNd, RECOrd,V EXpnd) of all the windows (1, 2, 3, 4). Example: WIN? Response: WIN1 EXPNT:129,HEXPND:1,RECORD:2,VEXPND:2; WIN2 EXPNT:332,HEXPND:2,RECORD:7,VEXPND:4;WIN3 EXPNT:129,HEXPND:1,RECORD:2,VEXPND:2;WIN4 EXPNT:332,HEXPND:1,RECORD:7,VEXPND:4

FRONT PANEL COMMANDS

TABLE C-13
FRONT PANEL COMMANDS

Header	Link	Argument	Description
BELl	BUTton:	ON OFF	Turns sound for button clicks ON or OFF. Factory setting: ON Example: `BELL BUTTON: OFF`
	KNOb:	ON OFF	Turns sound for knob clicks ON or OFF. Factory setting: ON Example: `BELL KNOB: ON`
		RINg	Sounds a beep. Example: `BELL RING`
BELl?	BUTton		Queries for the setting (ON or OFF) of the button sound. Example: `BELL? BUTTON` Response: `BELL BUTTON:OFF`
	KNOb		Queries for the setting (ON or OFF) of the knob sound. Example: `BELL? KNOB` Response: `BELL KNOB:OFF`
BELl?			Queries for the settings of both the knob and button sounds. Example: `BELL?` Response: `BELL BUTTON:ON,KNOB:ON`
FPAnel		ON OFF	When ON,front panel changes from the knob and buttons are allowed. When OFF,the front panel is locked out as in RWLS.
FPAnel?			Queries for the state (OFF or ON) of the FPANEL command. Example: `FPANEL?` Response: `FPANEL OFF`

DIAGNOSTICS & CALIBRATION COMMANDS

Diagnostics allow checking of several SCD subsystems. Calibration provides internal calibration of digitizer circuits. Calibration should be run whenever the values from the SCD are suspect, or whenever the operating environment of the SCD changes. Calibration should not be run within the first 20 minutes after power-up.

TABLE C-14
DIAGNOSTICS & CALIBRATION COMMANDS

Header	Link	Argument	Description
DIAg?			Query only. Queries for results of the last diagnostics executed,which can be either power-up self-test or tests set up by TEST command. Response is PASSED,FAILED,or BYPASSED. If TEST VERBOSE is ON (see below),an ASCII string is also reported describing the test result. Example: DIAG? Response: DIAG PASSED
TESt	LOOp:	ON OFF	Sets test looping. When ON,the selected tests are repeated until any GPIB command is issued. When OFF,the tests are done only once. (Must be enabled by an internal jumper.) Factory setting: OFF Example: TEST LOOP:ON
	ERRStp	ON OFF	Starts test looping. When ON,the selected tests are repeated until an error is detected or a GPIB command is issued. Factory Setting: OFF Example: TEST ERRS:ON
	NUM:	<NRx>	Runs only the test specified by (<NRx>) as referenced in Table C-15. Factory setting: 1 Example: TEST NUM:3
	SYS:	MPU	Runs tests associated with the acquisition system only. See Table C-15 for more information.
		FP	Runs tests associated with the front panel only. See Table C-15 for more information.
		DIG	Runs tests associated with the processor board only. See Table C-15 for more information.
		ALL	Runs all tests,and generates an operation complete (OPC) SRQ when done. Factory setting: ALL Example: TEST SYS:FPASYS

TABLE C-14 (CONT)
DIAGNOSTICS & CALIBRATION COMMANDS

Header	Link	Argument	Description
TESt	VERBose:	ON OFF	Sets DIAG? response format. If ON,an ASCII string of up to 130 characters describes the results of the first test that failed,or the last test executed if no failures were detected. If OFF,the response to queries on test results is abbreviated to PASSED or FAILED. Factory setting: OFF Example: `TEST VERBOSE:OFF`
TESt?	LOOp		Queries for the state of test looping. See TEST LOOP earlier. Example: `TEST? LOOP` Response: `TEST LOOP:OFF`
	NUM		Queries for the number of the test to be run (see Table C-15). The response is an unsigned integer. See TEST NUM command earlier. Example: `TEST? NUM` Response: `TEST NUM:3`
	SYS		Queries for the group of tests to be run. The response indicates which subsystem is checked: acquisition (MPU),front panel (FP),processor board (DIG),or ALL. See TEST SYS earlier. Example: `TEST? SYS` Response: `TEST SYS:FP`
	VERBose		Queries for state (OFF or ON) of test verbosity. See TEST VERBOSE earlier. Example: `TEST? VERBOSE` Response: `TEST VERBOSE:OFF`
TESt?			Queries for all test settings: LOOp,NUM,SYS,and VERBose. Example: `TEST?` Response: `TEST LOOP:OFF,NUM:1,SYS:FP,VERBOSE:OFF`
VIDeo		ON OFF	When ON,target video can be viewed in realtime using an external monitor (factory service switch and internal jumper must also be set). Set to OFF at power-up. (Intended for calibration use only.) Factory setting: OFF Example: `VIDEO ON`
VIDeo?			Queries for the setting of the video command. Example: `VIDEO?` Response: `VIDEO OFF`

TABLE C-14 (CONT)
DIAGNOSTICS & CALIBRATION COMMANDS

Header	Link	Argument	Description
CALIBRATE		HORizontal VERTical TRIgger CRT GEOmetry [ALL]	Performs internal calibration of horizontal circuitry. Performs internal calibration of vertical circuitry. Performs internal calibration of trigger circuitry. Performs internal calibration to align CRT tilt and intensity. Performs internal calibration to create the correction table to improve vertical linearity. Performs internal calibration of horizontal,vertical,and trigger circuitry. Each calibrate function generates an operation complete (OPC) SRQ when done. Example: `CAL TRIGGER`
CALIBRATE?			Queries for self-calibration status. The response is a quoted string that identifies the sections that failed or passed. Example: `CALIBRATE?` Response: `CALIBRATE "PASSED"`
CALOut	EXTernal	TIME AMPL	Connects the time calibrator signal to the external cal connector. In the SCD1000 both channels A & B are forced to OFF. Connects the amplitude calibrator signal to the external cal connector. In the SCD 1000 both channels A & B are forced to OFF. Factory setting: `TIME` (SCD10000),`AMPL` (SCD 5000) Example: `CALOUT EXTERNAL:AMPL`
CALOut	CH[A|B]:	 TIME AMPL AMPL4[50] OFF	SCD1000 only. Connects the time calibrator signal to the channel [A|B] input. Channel [A|B] vertical coupling is forced to OFF. Calout External is forced to Amplitude and the alternate calout channel is forced to OFF. Connects the 50 Ω amplitude calibrator signal to the channel [A|B] input. Channel [A|B] vertical coupling is forced to OFF. Calout External is forced to Time and the alternate calout channel is forced to OFF. Connects the 50 Ω amplitude calibrator signal to the channel [A|B] input. Channel [A|B] vertical coupling is forced to OFF. Calout External is forced to Time and the alternate calout channel is forced to OFF. Disconnects calibrator signals from the channel [A|B] input. Factory setting: OFF Example: `CALO CHA:TIME`

TABLE C-14 (CONT)
DIAGNOSTICS & CALIBRATION COMMANDS

Header	Link	Argument	Description
CALIBRATOr	AMPLitude:	<NRx>	Sets the calibrator signal amplitude. Limits: SCD1000: 0 VDC,±40 mVDC,±80 mVDC,±0.2 VDC,±0.4 VDC,±0.8 VDC,±2 VDC,and ±2.5 VDC; SCD5000: 0 VDC,±0.5 VDC,±1.0 VDC,±2.0 VDC,±3.0 VDC,and ±4.0 VDC. Factory setting: 2.5 (SCD1000),2.0 (SCD5000) Example: `CALIBRATOR AMPLITUDE:2`
	TIME	<NRx>	Sets the calibration signal time period. Limits: 4E-9 to 80E-6 Factory setting: 800E-9 Example: `CALIBRATOR TIME:4E-9`
CALIBRATOr?	AMPLitude		Queries for the calibrator signal amplitude. Example: `CALIBRATOR? AMPLITUDE` Response: `CALIBRATOR AMPLITUDE:2.5`
	TIME		Queries for the calibrator signal time period. Example: `CALIBRATOR? TIME` Response: `CALIBRATOR TIME:800.E-9`
CALIBRATOr?			Queries for all settings of the calibrator signal: amplitude and time period. Example: `CALIBRATOR?` Response: `CALIBRATOR AMPLITUDE:1.0,TIME:8.E-6`
CCOnstant?	<ui>		Queries for the calibration constant specified by <ui>. Example: `CCONSTANT? <33>` Response: `CCONSTANT 33:1234`
CDAte?			Queries for the date when the last calibration was performed. The response is a quoted string. The format is yy-mm-dd. Example: `CDATE?` Response: `CDATE "89-09-24"`

UTILITY COMMANDS

TABLE C-15
UTILITY COMMANDS

Header	Link	Argument	Description
CLOck	DATE:	<qstring>	Sets the date of the internal clock in yy-mm-dd format. Factory setting: Current date Example: `CLOCK DATE:"89-12-23"`
	TIME:	<qstring>	Sets the time of the internal clock in hh:mm:ss format. The time should be set in 24-hour format. Factory setting: Current time Example: `CLOCK TIME:"14:25:12"`
CLOck?	DATE		Queries for the date. Response is a quoted string in yy-mm-dd format. Example: `CLOCK? DATE` Response: `CLOCK DATE:"89-12-21"`
	TIME		Queries for the time. Response is a quoted string in hh:mm:ss format. Example: `CLOCK TIME` Response: `CLOCK TIME:"15:23:33"`
CLOck?			Queries for the time and date. Example: `CLOCK?` Response: `CLOCK DATE:"89-12-22",TIME:"22:12:34"`
FOCus		<NRx>	Adjusts the write gun's focus. Affects only the current time window. Limits: 0 to 100% Factory setting: 50 Example: `FOCUS 25`
FOCus?			Queries for the current focus setting (0 to 100%). Example: `FOCUS?` Response: `FOCUS 32`
INTEnsity		<NRx>	Adjusts the write gun's beam intensity. Affects only the current time window. Limits: 0 to 100% Factory setting: Depends on the time window Example: `INTENSITY 34`
INTEnsity?			Queries for the intensity setting (0 to 100%). Example: `INTENSITY?` Response: `INSTENSITY 34`

TABLE C-15 (CONT)
UTILITY COMMANDS

Header	Link	Argument	Description
RAW			The RAW command selects what will be seen on the display when the target image is selected. To set the display to view the target image over GPIB the following procedure should be used: 1. Save the current settings: SAVE 9. 2. INIT the instrument: INI. 3. Recall the saved settings: REC 9. 4. Use the ABStouch command to select the Utility Mode menu: ABS 6,8. (The target image is seen on the LCD display when Utility Mode menu containing the CRT settings is selected.)
		LINArray	Selects the waveform stored in the linear array when viewing the target image.
		REFArray	Selects the reference array defect map when viewing the target image.

HIGH SPEED DATA OUTPUT (HSDO) COMMANDS

The High Speed Data Output (HSDO) is an alternate interface to the GPIB for transmitting wavceform data. HSDO commands affect only the binary waveform data. Waveform proable data and response to queries are always transmitted over the IEEE488-1 bus. The binary waveform data is specified by the DATA statement. See Table C-6 for DATA commands. See Table C-5 for WAVEFORM PREAMBLE commands.

TABLE C-16
HSDO COMMANDS

Header	Link	Argument	Description
HSDo	STATe	OFF	The redirection of the "Linarray?" and "Curve?" queries to the HSDO port is off; normal GPIB output occurs.
		ALL	The redirection of the "Linarray?" and "Curve?" queries to the HSDO port is on. All 256 kbytes of the Linarray will be sent to the HSDO port instead of the GPIB.
		VALid	This is the same as the "ALL" option except that only valid ac quired data will be sent for the "Linarray?" query. Any unrecorded sections of the linear array will not be transmitted. Note: the size of the linear array data is not setable and varies with each acquisition.
	MODe	1	Use Handshake protocol for transmitting data out of the HSDO port. Each data byte is handshaked between the digitizer and the receiving controller.
		2	Use Synchronous protocol for transmitting data out of the HSDO port. When an enabling signal is received by the digitizer, it sends the data out with a clock to the receiving controller.
	DUMp	OFF	Continous output of linear array data is OFF.
		CONTinuous	Linear array data is repeatedly output continuously to the HSDO port. This function is also invoked by setting a combination of the dip switches on the rear panel and the processor board. See Section A, Introduction, for information on setting the switches.
	FORmat	BYTE	Data sent out the HSDO port is sent one byte at a time. Data is transmitted in the low HSDO byte with the MSB first.
		WORd	Data sent out the HSDO port is sent one work at a time.
HSDO?	STATe		Queries for the State of HSDO redirect.
	MODe		Queries for the Mode of HSDO redirect.
	DUMp		Queries for the setting of the HSDO Dump command.
	LENgth		Query Only. The length in bytes of the valid data in the linear array.
	FORmat		Queries for the HSDO data format.

REFERENCE ARRAY CORRECTION COMMANDS

TABLE C-17
REFERENCE ARRAY CORRECTION COMMANDS

Header	Link	Argument	Description
SETRef		OFF	Turns off Reference Array correction.
		ON	Turns on Reference Array correction.
		RUN	Runs Reference Array correction cycles. Reference array correction cycles are run to record accumulated target defect data. A more detailed description of reference array correction is given in the SCD1000/SCD5000 Operator's Manual. Any further input on the front panel or the GPIB will abort the correction cycle.
SETRef?			Queries for the state of Reference Array correction.
REFList?			Query only. Returns the reference array defects coordinate list. This is a list of the locations on the target where defects were detected during the reference array correction cycles. The format of the defects coordinate list is:REFLIST{min_x, min_y, max_x, max_y}....

TABLE C-18
TEST LIST FOR THE TEST COMMAND

Number	Name	Subsystem	Description
1	Real Time Clock	MPU	Verifies that tick interrupts occur at the correct rate.
2	GPIB	MPU	Verifies the GPIB interface.
3	Bus Error	MPU	Verifies the bus error detect logic.
4	Timer	MPU	Verifies that the timer interrupts at the correct rate.
5	ROM0 Part Number	MPU	Retrieves the part number from the ROM header.
6	ROM1 Part Number	MPU	Retrieves the part number from the ROM header.
7	ROM2 Part Number	MPU	Retrieves the part number from the ROM header.
9	Display Unit ROM Part Number	MPU	Retrieves the part number from the display unit ROM.
10	NVRAM	MPU	Verifies that NVRAM works correctly.
11	Video	FP	Verifies video RAM/LCD display.
12	Button	FP	Exercises knobs and buttons.
13	Front Panel Communication	FP	Verifies communication between the front panel 68705 CPU and the 68010 MPU.
14	Digital Acquisition With Memory Test	DIG	Verifies digital acquisition hardware and memory (refer ence & linear array).
15	Digital Acquisition Without Memory Test	DIG	Same test as 14 without the memory test.
16	Serial Bus	DIG	Verifies communications over the serial bus to the analog, read, and write boards.

INSTRUMENT FACTORY SETTINGS & ARGUMENT LIMITS

TABLE C-19
INSTRUMENT FACTORY SETTINGS & LIMITS

Header	Link	Factory Settings	Limits (N/A = Not Applicable)
VMOde		CHA	SCD1000 only.
CH<x>	RANge	1	100E-3 to 10 (probe attenuation = x1)
CH<x>	OFFSet	0	±1 to ±100
CH<x>	TYPEOffset	VOLTS	N/A
CH<x>	COUPling	AC	AC & OFF allowed only on SCD 1000.
CH<x>	INVert	OFF	SCD1000 only.
TRIgger	COUPling	AC	DC coupling allowed only on SCD1000.
TRIgger	MODE	AUTO	N/A
TRIgger	LEVel	0.0	Internal source: ±0.625*full-scale voltage range; External source: ±6.25 volts
TRIgger	TYPELevel	VOLTS	N/A
TRIgger	DELay	0	0 to 5 times record length
TRIgger	TYPEDelay	SECOND	N/A
TRIgger	SLOpe	PLUS	N/A
TRIgger	SOUrce	EXTERNAL (SCD5000)/ CHA (SCD1000)	N/A
ACQuire	MODe	NORMAL	N/A
ACQuire	STATe	STOP	N/A
ACQuire	TIME	1E-6 (1 µs)	5E-9 to 100E-6 (5 ns to 100 µs)
ACQuire	LENgth	512	256, 512, or 1024.
ACQuire	NRECord	1	1 to 16
ACQuire	STARt	1	1 to 16
ACQuire	HLDnxt	OFF	N/A
ACQuire	DBLsweep	OFF	N/A
CRS1	LOCTn	WIN1	1≤LOCTn≤4
CRS1	XPOint	0	0 ≤ XPOint≤ (RL-1)
CRS2	LOCTn	WIN1	1≤LOCTn≤4
CRS2	XPOint	0	0 ≤ XPOint≤ (RL-1)
CRSD	TYPETime	SECOND	N/A
CURSors		ON	N/A
HEXPMd		ALIGNED	N/A
NWIn		1	1, 2, or 4

TABLE C-19 (CONT)
INSTRUMENT FACTORY SETTINGS & LIMITS

Header	Link	Factory Settings	Limits (N/A = Not Applicable)
WIN<ui>	EXPnt	0	0 to (Record Length - 1)
WIN<ui>	HEXPNd	1	1, 2, 4, or 8
WIN<ui>	RECOrd	All windows: 1	1 ≤ RECOrd ≤ nNRECord
WIN<ui>	VEXpnd	1	1, 2, or 4 (SCD1000)
SAVe		1	1 to 10
RECAll		1	1 to 10
VIEW		OFF	Accessible from Display Unit only

IEEE 488.1 FACTORY SETTINGS & ARGUMENT LIMITS

TABLE C-20
IEEE-488.1 FACTORY SETTINGS & ARGUMENT LIMITS

Header	Link	Factory Settings	Limits (N/A = Not Applicable)
BELl	BUTton	ON	N/A
BELl	KNOb	ON	N/A
DATA	CNTrecord	1	1 ≤ CNTrecord ≤ (Number of Records)
DATA	COUnt	0	0 ≤ COUnt ≤ (Record Length-STArt)
DATA	STArt	1	1 ≤ STArt ≤ Record Length
DATA	STRecord	1	1 ≤ STRecord ≤ NRECord
DEBug	GPIb	OFF	N/A
DISplay		ON (Only if Display Unit is present)	N/A
DT		OFF	N/A
FPAnel		ON (Only if Display Unit is present)	N/A
LONgform		ON	N/A
PATh		ON	N/A
REPSet	NREPEat	1	0 ≤ NREPeat ≤ $(2^{32}-1)$ (0 = infinite repeat.)
RQS		ON	N/A
SAFeguard	PROTect	ON	SCD1000 only
SAFeguard	PUPtst	ON	Affected by rear panel switch #8.
SRQmask	ABStouch	OFF	N/A
SRQmask	CMDerr	ON	N/A
SRQmask	EXErr	ON	N/A
SRQmask	EXWarn	ON	N/A
SRQmask	INErr	ON	N/A
SRQmask	INWarn	ON	N/A
SRQmask	OPCmpl	ON	N/A
SRQmask	USR1	OFF	N/A
SRQmask	USR2	OFF	N/A
TESt	LOOp	OFF	N/A
TESt	NUM	1	1≤NUM≤42
TESt	SYS	ALL	N/A
TESt	VERBose	OFF	N/A

TABLE C-20 (CONT)
IEEE-488.1 FACTORY SETTINGS & ARGUMENT LIMITS

Header	Link	Factory Settings	Limits (N/A = Not Applicable)
TEXt	STRIng	"" (null string)	N/A
TEXt	CHAR	1	1≤CHAR≤64
TEXt	CLEar	N/A	0≤<NRx>≤16
TEXt	LINE	1	1≤LINe≤16
USER1		"","" null string,null string	≤8 characters for each string
USER2		"","" null string,null string	≤8 characters for each string
WFTx		DL	N/A

TABLE C-21
TEXT COMMAND CHARACTER SET

Decimal	Binary	Character
0	00000000	NU
1	00000001	SH
2	00000010	SX
3	00000011	EX
4	00000100	ET
5	00000101	EQ
6	00000110	AK
7	00000111	BL
8	00001000	BS
9	00001001	HT
10	00001010	LF
11	00001011	VT
12	00001100	FF
13	00001101	CR
14	00001110	SO
15	00001111	SI
16	00010000	DL
17	00010001	D1
18	00010010	D2
19	00010011	D3
20	00010100	D4
21	00010101	NK

Decimal	Binary	Character
22	00010110	SY
23	00010111	EB
24	00011000	CN
25	00011001	EM
26	00011010	SB
27	00011011	EC
28	00011100	FS
29	00011101	GS
30	00011110	RS
31	00011111	US
32	00100000	<space>
33	00100001	!
34	00100010	"
35	00100011	#
36	00100100	$
37	00100101	%
38	00100110	&
39	00100111	'
40	00101000	(
40	00101001	)
42	00101010	*
43	00101011	+
44	00101100	,
45	00101101	-
46	00101110	.
47	00101111	/
48	00110000	0
49	00110001	1
50	00110010	2
51	00110011	3
52	00110100	4
53	00110101	5
54	00110110	6
55	00110111	7
56	00111000	8

TABLE C-21 (CONT)
TEXT COMMAND CHARACTER SET

Decimal	Binary	Character
57	00111001	9
58	00111010	:
59	00111011	;
60	00111100	<
61	00111101	=
62	00111110	>
63	00111111	?
64	01000000	@
65	01000001	A
66	01000010	B
67	01000011	C
68	01000100	D
69	01000101	E
70	01000110	F
71	01000111	G
72	01001000	H
73	01001001	I
74	01001010	J
75	01001011	K
76	01001100	L
77	01001101	M
78	01001110	N
79	01001111	O
80	01010000	P
81	01010001	Q
82	01010010	R
83	01010011	S
84	01010100	T
85	01010101	U
86	01010110	V
87	01010111	W
88	01011000	X
89	01011001	Y
90	01011010	Z
91	01011011	[
92	01011100	\
93	01011101	]
94	01011110	^
95	01011111	‘
96	01100000	_
97	01100001	a
98	01100010	b
99	01100011	c
100	01100100	d
101	01100101	e

Decimal	Binary	Character
102	01100110	f
103	01100111	g
104	01101000	h
105	01101001	i
106	01101010	j
107	01101011	k
108	01101100	l
109	01101101	m
110	01101110	n
111	01101111	o
112	01110000	p
113	01110001	q
114	01110010	r
115	01110011	s
116	01110100	t
117	01110101	u
118	01110110	v
119	01110111	w
120	01111000	x
121	01111001	y
122	01111010	z
123	01111011	{
124	01111100	|
125	01111101	}
126	01111110	~
127	01111111	<shaded box>
128	10000000	Ä
129	10000001	ä
130	10000010	Ö
131	10000011	ö
132	10000100	Ü
133	10000101	ü
134	10000110	à
135	10000111	é
136	10001000	á
137	10001001	è
138	10001010	Å
139	10001011	å
140	10001100	Æ
141	10001101	æ
142	10001110	ç
143	10001111	ß
144	10010000	Ñ
145	10010001	ñ
146	10010010	¿

TABLE C-21 (CONT)
TEXT COMMAND CHARACTER SET

Decimal	Binary	Character
147	10010011	i
148	10010100	A <tilde>
149	10010101	a <tilde>
150	10010110	A <'>
151	10010111	O <tilde>
152	10011000	o <tilde>
153	10011001	E <'>
154	10011010	Ø
155	10011011	ø
156	10011100	Œ
157	10011101	œ
158	10011110	Ç
159	10011111	∞
160	10100000	<smiling face>
161	10100001	°
162	10100010	<ground symbol>
163	10100011	<smiling face>
164	10100100	<db symbol>
165	10100101	B
		W
		L
166	10100110	H
		Z
167	10100111	R
		A
		D
168	10101000	D
		E
		G
169	10101001	<smiling face>
170	10101010	<smiling face>
171	10101011	<arrows>
172	10101100	<smiling face>
173	10101101	<rising edge symbol>
174	10101110	P
		T
175	10101111	N
		U
176	10110000	^{1}
177	10110001	^{2}
178	10110010	^{3}
179	10110011	^{4}
180	10110100	^{5}
181	10110101	^{6}
182	10110110	^{7}
183	10110111	^{8}
184	10111000	^{9}
185	10111001	^{0}
186	10111010	<smiling face>
187	10111011	<smiling face>
188	10111100	<smiling face>
189	10111101	<falling edge symbol>
190	10111110	<smiling face>
191	10111111	<smiling face>
192	11000000	Π
193	11000001	α
194	11000010	γ
195	11000011	δ
196	11000100	Δ
197	11000101	ε
198	11000110	φ
199	11000111	Γ
200	11001000	Θ
201	11001001	ι
202	11001010	ψ
203	11001011	κ
204	11001100	λ
205	11001101	μ
206	11001110	η
207	11001111	Ω
208	11010000	π
209	11010001	θ
210	11010010	ρ
211	11010011	Σ
212	11010100	τ
213	11010101	υ
214	11010110	ν
215	11010111	ω
216	11011000	χ
217	11011001	ξ
218	11011010	ζ
219	11011011	Φ
220	11011100	Λ
221	11011101	Ψ
222	11011110	σ
223	11011111	Ξ
224	11100000	Ø
225	11100001	≠
226	11100010	Æ
227	11100011	¨

TABLE C-21 (CONT)
TEXT COMMAND CHARACTER SET

Decimal	Binary	Character
228	11100100	Ú
229	11100101	Π
230	11100110	∞
231	11100111	+
232	11101000	¬
233	11101001	±
234	11101010	≠
235	11101011	≤
236	11101100	≥
237	11101101	©
238	11101110	®
239	11101111	≈
240	11110000	—
241	11110001	<left half of T in Tek>
242	11110010	<right half of T/left half of e in Tek>
243	11110011	<right half of e/left third of k in Tek>
244	11110100	<middle third of k in Tek>
245	11110101	<right third of k in Tek>
246	11110110	
247	11110111	
248	11111000	
249	11111001	
250	11111010	
251	11111011	
252	11111100	
253	11111101	
254	11111110	
255	11111111	

STATUS & EVENT REPORTING

INTRODUCTION

This section describes the status and event system of the SCD. A general description of the system and concepts is provided along with tables of status bytes and event codes.

If the RQS ON command has been sent, the SCD can request service from the controller by asserting the SRQ control line. In response, the controller performs a serial poll, reading a *status byte* from each device on the IEEE-488.1 bus. The status byte indicates the current condition of each device. If the device requested service, a bit of the status byte is set.

The status byte also generally indicates the reason for requesting service. More information on the request is indicated by an event code, which the controller can query using the EVENT? query command (all event codes can be queried by sending the ALLEV? query command). The information obtained from the event codes can be used during program execution and is also helpful during program development and troubleshooting.

Through this process, involving serial polls, status bytes, and event codes, the SCD can report operating status to the controller. For more information on the status and event query commands, see Table C-7.

STATUS BYTES

The SCD status byte bit assignments are shown in Figure D-1.

8	7	6	5	4	3	2	1
Always 0	SRQ Bit	Abnormal/ Normal	Busy/ Not Busy	Status Bit 4	Status Bit 3	Status Bit 2	Status Bit 1

Figure D-1. Status Byte Bit Assignments

Bit 7 (SRQ Bit) is set to 1 when the digitizer requests service (referred to by "S" in Table D-1). The controller reads this bit during a serial poll to determine the requesting device. When RQS is ON, the digitizer sets this bit and asserts the SRQ line. When RQS is OFF, the digitizer clears this bit and does not assert the SRQ line. The controller must then poll the SCD and read the four status bits to determine if the SCD needs to be serviced. The RQS bit also affects how event codes can be read from the digitizer. See **Reading the Event Codes** later in this section.

Bit 6 (Abnormal/Normal) is set to 1 when the status is abnormal. The bit is set to 0 when the status is normal. Abnormal states include errors and warnings generated during processing. Normal states include power-on, operation complete, and user requests. See Table D-1.

Bit 5 (Busy/Not Busy) is set to 1 when the digitizer is busy. It is set to 0 when the digitizer is not busy. The digitizer is busy when internal processing makes it unavailable to the controller, or when an acquisition is in progress.

Bits 4 through 1 (System Status) generally indicates a reason for requesting service.
Table D-1 lists the status byte values and corresponding system states generated by the 8 bits of the status byte. Further information about the condition can be obtained from the event code.

Normal Status Conditions

No Status To Report means there is no event or device dependent status to report.

Power On indicates to the controller that the digitizer has finished its power-up sequence and is ready.

Operation Complete identifies when a task has been completed, such as a repeat sequence.

User Request identifies that a user-programmable button has been pressed.

TABLE D-1.
SCD100/SCD5000 STATUS BYTES

Title	BINARY			DECIMAL			
				SRQ ASSERTED		SRQ UNASSERTED	
	Bit—	8765	4321	Not Busy	Busy	Not Busy	Busy
System Status (Normal):							
No Status To Report		0000	0000	0	16	0	16
Power On		0S0B	0001	65	81	1	17
Operation Complete		0S0B	0010	66	82	2	18
User Request		0S0B	0011	67	83	3	19
System Status (Abnormal):							
Command Error		0S1B	0001	97	113	33	49
Execution Error		0S1B	0010	98	114	34	50
Internal Error		0S1B	0011	99	115	35	51
Execution Warning		0S1B	0101	101	117	37	53
Internal Warning		0S10	0110	70	102	6	38

Abnormal Status Conditions

Command Error indicates that the digitizer could not understand the command it received.

Execution Error indicates that the digitizer recognized the command it received but could not successfully execute it.

Internal Error identifies a functional problem with the digitizer, such as a system failure, etc. The data should be considered suspect and the problem investigated.

Execution Warning indicates that the digitizer was able to understand and execute the command but there was some problem with it, such as an argument that was outside the commands limits.

Internal Warning identifies when the digitizer detects a problem, such as an overvoltage condition, overtemperature condition, calibration failure, etc., but is able to continue operation. The data should be considered suspect and the condition should be investigated.

All of these status conditions generate one or more event codes to further indicate the abnormal status.

EVENT CODES

Event codes are returned with a number from 0 to 999 and a descriptive string (if LONGFORM is ON). The event codes are categorized as shown in Table D-2.

TABLE D-2
EVENT CODE GROUPS

Event Class	Event Code Range
Command Errors	100-199
Execution Errors	200-299
Internal Errors	300-399
System Events	400-499
Execution Warnings	500-599
Internal Warnings	600-699
Device-Dependent Events	700-799
Not Currently Used	800-900

Reading the Event Registers

Status bytes and event codes are generated at the same time; an event code always accompanies a status byte through the event system. However, the event code is not simultaneoulsy read with the status byte. Figure D-2 illustrates how status bytes and event codes are placed on the bus. A *serial poll* places the status byte on the IEEE-488.1 bus and moves the corresponding event code into a polled event code register. An *event query command* places the event code on the bus.

The controller must poll the digitizer and read the status byte to determine if the SCD needs to be serviced. The controller may also query for an event code or for all event codes. However, the RQS command setting affects how the digitizer responds to serial polls and event queries.

With RQS ON, an event code can only be transmitted if its corresponding status byte has first been polled. Thus, consecutive event queries without prior serial polls, or a query for all events, will return a *special event code* identifying that a serial poll must first be done. Depending on the situation, one normal event code may also be returned, but with RQS ON, no more than one event code plus the special event code will be returned.

With RQS OFF, event codes can be consecutively transmitted, or all event codes can be transmitted, without first polling the device. However, since status bytes and event codes travel through the event system together, corresponding status bytes are lost with consecutive event queries or a query for all events. Similarly, consecutive serial polls will cause status bytes to be transmitted, but corresponding event codes will be lost.

Table D-2 lists the results of serial poll/event query combinations for RQS ON and RQS OFF. The / character separates the commands as they occur.

TABLE D-3.
EFFECTS OF RQS ON STATUS BYTES & EVENT CODES

RQS State	Assert SRQ	Serial Poll/ Event?*	Serial Poll Allev?*	No Serial Poll/Event?*	NoSerial Poll/Allev?*	Serial Poll/ Serial Poll*
OFF	NO	Most recent sb followed by corresponding ec	most recent sb, corresponding ec; all other ec's (corresponding sb's are lost)	Most recent sb lost; correspon-ding ec is sent	all sb's lost; ec's sent	most recent sb sent followed by next sb; first ec lost
ON	YES	most recent sb followed by corresponding ec	most recent sb, corresponding ec followed by sec	not allowed; sec returned	not allowed; sec sent	most recent sb sent followed by next sb; first ec lost

* sb=status byte; ec= event code; sec=the special event code described above.

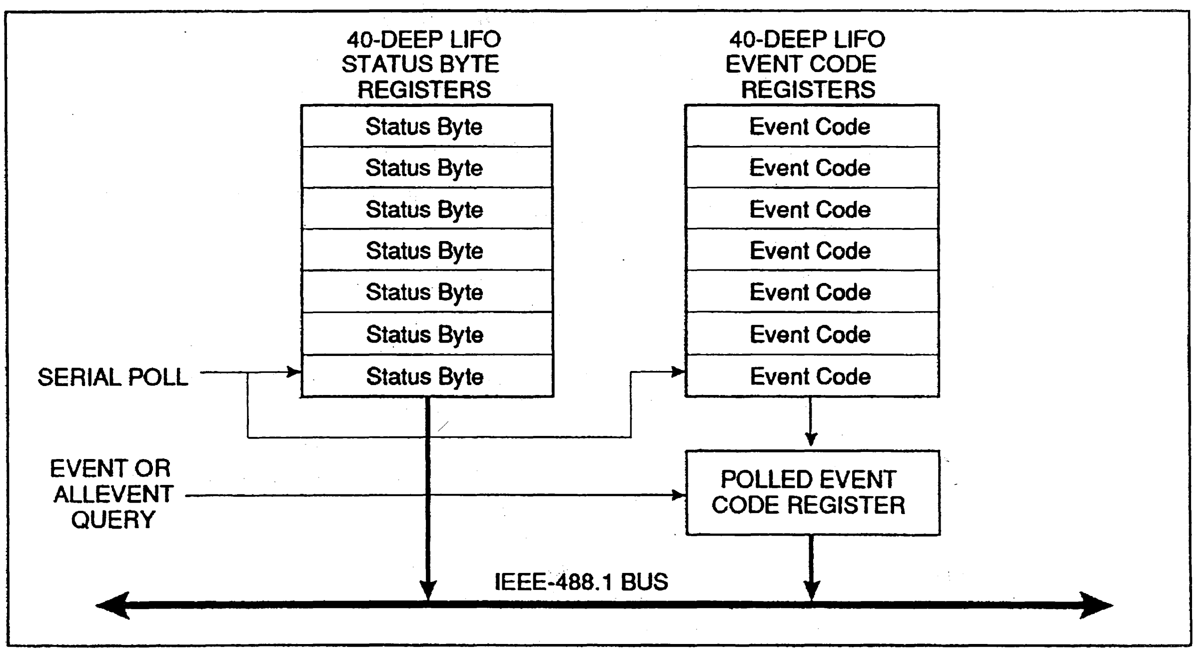


Figure D-2. Status Byte & Event Registers Model.

Event Code Tables

Tables D-4 through D-9 list the SCD event codes and event code description strings for all event groups.

TABLE D-4
COMMAND ERROR EVENT CODES

Event Codes corresponding to Command Error SRQs 97 or 113	
Event Code	**Event Code Description String**
108	Checksum error in binary block transfer
151	Symbol or number too long
152	Invalid or out of range input character
154	Invalid number input (syntax incorrect)
155	Invalid string input
157	Syntax error
160	Too many binary points
162	Numerical overflow
163	Numerical underflow

TABLE D-5
EXECUTION ERROR EVENT CODES

Event Codes corresponding to Execution Error SRQs 98 or 114	
Event Code	**Event Code Description String**
203	I/O buffers full. Untalk query in output buffer prevents instrument from processing new commands
252	Illegal date/time argument
253	Saved setting buffer #<NR1> is empty
255	Window #<NR1> not displayed
256	No data available for selected channel/record in window <NR1>
257	Command disabled by internal switch (see GPIB command set)
260	Too many points for TC&F transfer
261	Calibration constant #<<NR1>> is not valid
268	Acquire status must be running before manually triggering
269	Reference Array Data lost
270	Reference array update aborted, data lost
271	Vertical Geometry constants invalid, reset to zero
272	Setting is illegal with current option configuration

TABLE D-6
INTERNAL ERROR EVENT CODES

Event Codes corresponding to Internal Error SRQs 99 or 115	
Event Code	**Event Code Description String**
350	Self test failure
352	Fast waveform comm. fault; Option has been disabled

TABLE D-7
SYSTEM ERROR EVENT CODES

Event Codes corresponding to System Error SRQs 99 or 115	
Event Code	**Event Code Description String**
400	No status to report
401	Power on initialization complete
403	User requested SRQ #1
451	User requested SRQ #2
452	Front panel input generates SRQ
454	SRQ pending
455	Self test completed successfully
456	<string> calibration passed
458	Selected front panel setting #<NR1> recalled
459	Save in buffer #<NR1> complete
461	RAM has been erased
462	Front-panel initialization is complete
463	GPIB initialization is complete
465	Acquisition done
466	Reference array update completed, <number> defects found

TABLE D-8
EXECUTION WARNING EVENT CODES

Event Codes corresponding to Execution Warning SRQs 101 or 117	
Event Code	**Event Code Description String**
551	<string> argument is out of range
553	Expansion factor on window #<NR1> forced to a power of 2
554	Expansion point aligned on a <NR1> point boundary
555	Input number too large; forced to maximum value
556	Input number too small; forced to minimum value
560	Invalid point count specified for curve transfer
561	Curve data not from same acquire cycle
565	Repeat mode aborted on input
566	Reference array update overflow, <number> defects processed
567	Reference array update in progress, DO NOT power down

TABLE D-9
INTERNAL WARNING EVENT CODES

Event Codes corresponding to Internal Warning SRQs 70 & 102

Event Code	Event Code Description String
655	Input channel <string> overvoltage
656	Target protect, check Z-axis
657	Linear array overflow in record <NR1>
658	Missing data in record <NR1>
660	Calibration failure: <string>
662	Self test bypassed
663	<string> out of range
665	Video mode has timed out
666	Target protect, check horizontal

PROGRAMMING EXAMPLES

INTRODUCTION

This section provides some program examples to show how routines can be used to perform acquisitions, read the waveform preamble information for scaling data, acquire and scale waveform data, and graph the data on a computer terminal. In addition, some background information on waveform transfer formats and data transfers is provided.

The program listings provided in this section are written in BASIC for IBM PC, XT, AT, and 386-compatible microcomputers (such as the Tektronix PEP-301) and HP 200/300 Series computers. IBM-compatibles require the National Instruments™ GPIB Interface Card with drivers and Microsoft QuickBASIC 4.5 HP computers require the HP 200/300 Series BASIC language.

The remainder of this section decribes the integration of the SCD Series into the 7912AD/HB Series systems.

Waveform Data Formats

Each digitized waveform point is represented as an 11-bit number in absolute binary format. Waveform data can be transferred to the controller in one of three different formats (set by the WFTX command): Indefinite Length (IL), Definite Length (DL), and Tek Codes & Formats (TCF).

Transfer format response (LONGFORM and PATH are ON)

WFTxMODE: TCF

CURVE<space>%<b_H><b_L><$data_1$MSB><$data_1$LSB><$data_2$MSB><$data_2$LSB><...$data_n$MSB><...$data_n$LSB><CHKSUM>

data byte count + checksum byte
(2 bytes)

<EOI>

WFTxMODE:DL

CURVE<space>#<#bytes in byte count><bc_1><bc_2><bc_n><$data_1$MSB><$data_1$LSB><$data_2$MSB>

ASCII Digits
'0' to '9'

data byte count +checksum byte (always 0)
ASCII Digits '0' to '9'

<$data_2$LSB><...$data_n$MSB><...$data_n$LSB><0>

<EOI>

WFTxMODE:IL

CURVE<space>#<0><$data_1$MSB><$data_1$LSB><$data_2$MSB><$data_2$LSB><...$data_n$MSB><...$data_n$LSB>

'0' ASCII Digit

<EOI>

Figure E-1. Data Transfer Formats Protocol

Table E-1 illustrates the format of the linear and reference arrays when queried using the LINARRAY? and REFARRAY? commands. The number of data values varies depending on the signal type and intensity level. The number of data values can be up to 128K words (16 bit) of data.

TABLE E-1 - LINEAR & REFERENCE WAVEFORM DATA FORMAT

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	1	0	0	0	0	0	h	h	h	h	h	h	h	h	h	h
	0	v	v	v	v	v	v	v	v	v	d	d	d	d	d	d
	0	v	v	v	v	v	v	v	v	v	d	d	d	d	d	d
									.							
									.							
									.							
	0	v	v	v	v	v	v	v	v	v	d	d	d	d	d	d
	1	0	0	0	0	0	h	h	h	h	h	h	h	h	h	h
	0	v	v	v	v	v	v	v	v	v	d	d	d	d	d	d
	0	v	v	v	v	v	v	v	v	v	d	d	d	d	d	d
									.							
									.							
									.							
	0	v	v	v	v	v	v	v	v	v	d	d	d	d	d	d

Bit15 = 1 indicates a horizontal point where hhhhhhhhhh is a binary number representing the horizontal position. (10 bits: 0..1023)

Bit15 = 0 indicates a vertical position where vvvvvvvvv (9 bits 0..511) is a binary number representing the vertical position and dddddd (6 bits 0..63) represents the charge intensity data.

The data points are not arranged in increasing (or decreasing) vertical order. Each gray scale data pint is paired with its vertical position, The vertical position must be used to correctly place the point.

Waveform Data Transfers

The DATA statement specifies the source, length, and other parameters of the transfer. The DATA statement also provides a means of transferring only a portion of a record.

In order to select a certain record, the record number must be specified in a DATA statement. For example, to acquire data from only record 5, the following DATA statement would be sent to the digitizer:

```
DATA STRECORD:5;DATA CNTRECORD:1;DATA COUNT:0;CURVE?
```

A section of a waveform record can also be selected for transfer by specifying the starting sample point and the number of sample points to be transferred. To transmit 100 samples starting at sample point 32, the following DATA statement would be sent:

```
DATA STRECORD:5;DATA CNTRECORD:1;DATA START:32;DATA
COUNT:100;CURVE?
```

Record numbers and start points begin with 1. If the start/count combination exceeds the record length, a warning SRQ will be issued and the count will be corrected. If COUNT is set to 0, the instrument will transmit the entire record. If the selected records are not from the same acquisition, a warning SRQ will be generated.

The CURVE?, WAVEFRM?, and REPEAT? query commands initiate data transfers. CURVE? transfers only waveform data. WAVEFRM? transfers waveform preamble information first and then waveform data. REPEAT? causes the digitizer to repeat a programmed number of acquisitions and then transfer them to the controller after each acquisition.

Waveform Scaling Algorithms

Scaling of waveform data for graphing and analysis requires scaling data included in the waveform preamble. The scaling data along with the vertical and horizontal data points are used in the following algorithms.

Y = (PV - YOFF) * YMULT + YZERO
X = (PH - PT.OFF) * XINCR + XZERO

NOTE

XZERO is always 0. YOFF is always 127.

Sample WFMPRE? & SET? Transfers

The SCD waveform preamble contains the information needed to convert the binary waveform data from the digitizer into actual vertical and horizontal data for graphing, plotting, and analysis. The preamble information includes:

- the number of points in the waveform
- the vertical scale factor
- the sample interval
- the position of the first data point in the transfer relative to the trigger position
- the vertical offset
- timestamp

The following are typical responses to queries for waveform preamble information (WFMPRE?) and instrument settings (SET?).

SCD1000 Sample WFMPRE? Response

```
WFMPRE WFID:"CHA 1 90-03-09 14:46:04.06 0",ENCDG:BINARY,
NR.PT:512,PT.FMT:Y,XINCR:19.5695E-12,PT.OFF:0,XZERO:0,
XUNIT:SECOND,YMULT:244.260E-6,YZERO:650.0E-3,
YOFF:1024,YUNIT:VOLTS,BYT/NR:2,BN.FMT:RI,BIT/
NR:11,CRVCHK:CHKSUM
```

SCD1000 Sample SET? Response

```
VMODE CHA;RESOLUTION HIGH;ACQUIRE STATE:STOP,HLDNXT:OFF,
TIME:10.E-
9,LENGTH:512,MODE:NORMAL,NRECORD:1,START:1,LAST:1,
DBLSWEEP:OFF;RESOLUTION HIGH;CHA PROBE:"",COUPLING:OFF,
RANGE:500.E-3,TYPEOFFSET:VOLTS,OFFSET:650.E-
3,INVERT:OFF;CHB
PROBE:"",COUPLING:OFF,RANGE:1,TYPEOFFSET:VOLTS,OFFSET:0,INVERT:OFF;TRIGGER
SOURCE:CHA,TYPELEVEL:VOLTS,LEVEL:0,
TYPEDELAY:SECOND,DELAY:0,SLOPE:PLUS,COUPLING:AC,MODE:AUTO;
NWIN 1;HEXPMD ALIGNED;WIN1
EXPNT:0,HEXPND:1,RECORD:1,VEXPND:1; WIN2
EXPNT:0,HEXPND:1,RECORD:1,VEXPND:1;WIN3 EXPNT:0,HEXPND:1,
RECORD:1,VEXPND:1;WIN4
EXPNT:0,HEXPND:1,RECORD:1,VEXPND:1;DCURSORS ON;CRS1
LOCTN:WIN1,XPOINT:0,XTIME:0,YCOORD:751.E-3;CRS2
LOCTN:WIN1,XPOINT:104,XTIME:2.03523E-9,YCOORD:535.E-
3;CRSD TYPETIME:SECOND,T:2.03523E-9,Y:-216.E-3;DATA
CNTRECORD:1,COUNT:0, START:1,STRECORD:1;REPSET
NREPEAT:3;DEBUG GPIB:OFF;RQS ON; SRQMASK
ABSTOUCH:OFF,CMDERR:ON,EXERR:ON,EXWARN:ON,INERR:ON,
INWARN:ON,OPCMPL:ON,USR1:OFF,USR2:OFF;DT OFF;BELL
BUTTON:ON, KNOB:ON;DISPLAY OFF;FPANEL OFF;PATH
ON;LONGFORM ON;USER1 "","";USER2 "","";CALIBRATOR
AMPLITUDE:2.5,TIME:4.E-9;CALOUT
CHA:TIME,CHB:OFF,EXTERNAL:AMPL;SAFEGUARD PROTECT:ON,
PUPTST:OFF
```

IBM QUICK BASIC Example

```
DECLARE SUB GRAPH.WFM (iwfm%(), xi#, numpt!)
DECLARE SUB SWAP.BYTES (test%(), numpt!)
DECLARE FUNCTION MIN% (iwfm%(), MINLOC!)
DECLARE FUNCTION MAX% (iwfm%(), MAXLOC!)
DECLARE SUB GETWFM (dig!, iwfm%(), MODE$, flag!)
DECLARE SUB GETSCALE (dig!, rec!, numpt!, ym#, yz#, yo#, xi#, flag!)
DECLARE FUNCTION GETANS$ (mes$)
DECLARE SUB PRESS.ANY.KEY (mes$)
DECLARE SUB GPIB.WRITE (dig!, mes$, flag!)
DECLARE SUB GPIB.READ (dig!, rd$, flag!)
DECLARE FUNCTION STR2NUM! (SOURCE$, SRCH$)
DECLARE FUNCTION GETNUM% (mes$)
DECLARE FUNCTION NUM2STR$ (NUM!)

' PROGRAM TO ACQUIRE, SCALE & GRAPH A WAVEFORM FROM SCD SERIES
' PROGRAMMABLE WAVEFORM RECORDERS .
'
'SCD ADDRESS IS ASSUMED TO BE ADDRESS 4 (SCD1000 DEFAULT ADDRESS).  THE
'ADDRESS CAN BE CHANGED BY MODIFYING VARIABLE 'PRI%' AT THE BEGINNING OF
'VARIABLE DECLARATIONS.
'
' Three variables are used by the National instruments GPIB driver to
' describe the status of GPIB operations (IBSTA, IBERR, & IBCNT).  The
' COMMON SHARED statement used depends on the version of Quickbasic. If you
' are using Quickbasic 4.0 or less, comment out the QB 4.5 COMMON statement
' and unremark the QB 4.0 or less COMMON statement below.

      COMMON SHARED /NISTATBLK/ IBSTA%, IBERR%, IBCNT%    'Quickbasic 4.5

      'COMMON SHARED IBSTA%, IBERR%, IBCNT%               'Quickbasic 4.0 or less

      COMMON SHARED true, false, flag, ega%, waves.defined
      COMMON SHARED pri%, dig, numpt, ym#, yz#, xi#, key$, id$

      DIM SHARED iwfm(0 TO 1023) AS INTEGER
      DIM SHARED rwfm(0 TO 1023) AS SINGLE


RESTART:
      pri% = 1                        'DEFAULT SCD1000 ADDRESS
      true = 1                        'SET FLAG = TRUE MEANS FLAG=1
      false = 0                       'SET FLAG = FALSE MEANS FLAG=0
      flag = true                     'FLAG USED FOR ERROR HANDLING
      rec = 1                         'Record can be 1 to 16
      ega% = 1                        'SET EGA%=0 FOR CGA TERMINAL
      ver$ = "0.2"                    'software version number
      ega% = 1                        'SET EGA%=0 FOR CGA TERMINAL

      ON ERROR GOTO General.error.handler

      CALL IBFIND("TEKDEV1", dig)     'FIND 'TEKDEV1' IN GPIB.COM
      CALL ibpad(dig, pri%)           'CHANGE PRIMARY ADDRESS
      'CALL SRQ(dig, status%, 1)      'PERFORM A SERIAL POLL ON THE SELECT INST

start:
      CLS
      PRINT " *** SCD Series waveform recorder IIG example program version " +
ver$ + ", written using QB4.5 ***"
```

```
      PRINT : PRINT "SCD waveform recorder address assumed to be" + STR$(pri%)
      CALL PRESS.ANY.KEY("Ready to acquire a waveform from wfm location" +
STR$(rec))
      CALL GETSCALE(dig, rec, numpt, ym*, yz*, yo*, xi*, flag)
      IF numpt > -99 THEN     'selected record is empty
            PRINT "Reading a" + STR$(numpt) + " point waveform"
            MODE$ = "CURVE?"
            CALL GETWFM(dig, iwfm%(), MODE$, flag)

            'The next line is commented out because it isn't used in the
            'example.  Un-remark it to scale 'iwfm%' into a voltage array
            'named 'rwfm'.

            'CALL SCALEWFM(ym*, yz*, yo*, numpt, rwfm(), iwfm%())
      END IF
      CALL GRAPH.WFM(iwfm%(), xi*, numpt)

      ans$ = GETANS("Acquire another waveform")
      IF ans$ = "Y" THEN GOTO start
END

General.error.handler:
      SCREEN 0
      CLS
      PRINT "Unexpected Error *"; ERR
      PRINT
      PRINT "Please try to document the sequence of operations and conditions"
      PRINT "which led to this error.  This information is extremely valuable"
      PRINT "in trying to correct programming problems.  Use the Quickbasic"
      PRINT "manual for an explanation of the error number."
      PRINT
      CALL PRESS.ANY.KEY("To restart the program...")
RESUME RESTART

SUB GETSCALE (dig, rec, numpt, ym*, yz*, yo*, xi*, flag)
' SUB TO QUERY THE MAINFRAME FOR THE VERTICAL & HORIZONTAL SCALE FACTORS
'
      PRINT "Reading scale factors"
      'read number of points
      tmp$ = NUM2STR$(rec)
      mes$ = "WFTX TCF;DATA STRECORD:" + tmp$ + ";wfmpre?"
      wfmpre$ = SPACE$(600)
      CALL GPIB.WRITE(dig, mes$, flag)
      CALL GPIB.READ(dig, wfmpre$, flag)
      IF INSTR(wfmpre$, "None") < 1 THEN
            numpt = STR2NUM(wfmpre$, "NR.PT")
            ym* = STR2NUM(wfmpre$, "YMULT")
            yz* = STR2NUM(wfmpre$, "YZERO")
            yo* = STR2NUM(wfmpre$, "YOFF")
            xi* = STR2NUM(wfmpre$, "XINCR")
      ELSE
            CALL PRESS.ANY.KEY("Selected record:" + STR$(rec) + " is empty")
            numpt = -99 'Set number of points to -99 indicating empty record
      END IF
END SUB

SUB GETWFM (dig, iwfm%(), MODE$, flag)
' READS SCD WAVEFORM INTO INTEGER ARRAY 'IWFM%()'
' VARIABLE MODE$ CONTAINS QUERY FOR WAVEFORM
'
```

```
        HEADER$ = SPACE$(9)
        CHECKSUM$ = SPACE$(1)

        flag = true
        CALL GPIB.WRITE(dig, MODE$, flag)
        IF flag = false THEN GOTO read.curve.error

        CALL GPIB.READ(dig, HEADER$, flag)              ' read CURVE %bc
        IF flag = false THEN GOTO read.curve.error

        cnt% = numpt * 2
        CALL IBRDI(dig, iwfm%(), cnt%)                  ' READ CURVE
        IF IBSTA% < 0 THEN GOTO read.curve.error

        CALL GPIB.READ(dig, CHECKSUM$, flag)            ' read checksum
        IF flag = false THEN GOTO read.curve.error

        CALL SWAP.BYTES(iwfm%(), numpt)         ' swap high and low data bytes
        EXIT SUB
read.curve.error:
        flag = false
        CALL PRESS.ANY.KEY("GPIB error reading waveform, IBSTA=$" + HEX$(IBSTA%) +
", IBERR=" + STR$(IBERR%) + ", IBCNT=" + STR$(IBCNT%))
        IBERR% = 0
END SUB

SUB SWAP.BYTES (test%(), numpt)
' THE SCD SENDS 16 INTEGER DATA MOST SIGNIFICANT BYTE FIRST
' THE IBM PC REQUIRES 16 BIT INTEGER TO BE LEAST SIGNIFICANT BYTE FIRST
' SWAPS HIGH & LOW BYTES OF AN INTEGER NUMBER

        FOR i% = 0 TO numpt - 1
        tempbyte% = test%(i%) AND &HFF00
        IF tempbyte% < 0 THEN
              tempbyte% = ((tempbyte% AND &H7F00) \ 256) OR &H80
        ELSE
              tempbyte% = tempbyte% \ 256
        END IF
        test%(i%) = ((test%(i%) AND &HFF) * 256) + tempbyte%

        'remove interpolated data flag from data point (4000 hex)
        'needed only with B010101 instruments.
        IF test%(i%) >= &H4000 THEN test%(i%) = test%(i%) - &H4000
        NEXT i%
END SUB

SUB SCALEWFM (ym*, yz*, yo*, numpt, wfm(), iwfm%())
'SUB TO SCALE THE INTEGER ARRAY IWFM$() INTO A VOLTAGE ARRAY WFM()
'USING THE YMULITPLIER 'YM!'

        PRINT "Scaling waveform into a voltage array"

        FOR i% = 0 TO numpt - 1
              wfm(i%) = (iwfm%(i%) - yz*) * ym* + yo*
        NEXT i%
END SUB

SUB GRAPH.WFM (iwfm%(), xi*, numpt)
'GRAPHS ACQUIRED INTEGER WAVEFORM ARRAY ONTO PC MONITOR
```

```
        start = 0
        FINISH = numpt - 1
        AMAX% = MAX%(iwfm%(), MAXLOC)
        AMIN% = MIN%(iwfm%(), MINLOC)
        IF ega% THEN
                SCREEN 9: CLS 0
                vpix% = 12'    14
                VIEW (70, 2.5 * vpix%)-(570, 22.5 * vpix%), , 1
        ELSE
                SCREEN 2: CLS 0
                vpix% = 8
                VIEW (70, 2.5 * vpix%)-(570, 22.5 * vpix%), , 1
        END IF
        LOCATE 2, 30
        PRINT "SCD Series WAVEFORM"
        WINDOW (start - 10, AMIN% - (AMIN% / 10))-(FINISH + 10, AMAX% + (AMAX% /
10))
        PSET (start, iwfm%(start))
        FOR i% = start + 1 TO FINISH
                LINE -(i%, iwfm%(i%))
        NEXT i%
        LOCATE 21, 1
        CALL PRESS.ANY.KEY("TO RETURN TO MAIN MENU")
END SUB

SUB GPIB.READ (dig, rd$, flag)
' READS A STRING FROM THE GPIB.  IF AN ERROR OCCURS, AN ERROR MESSAGE IS
' DISPLAYED AND THE VARIABLE 'FLAG' IS SET TO ZERO (FALSE).

        flag = true
        CALL IBRD(dig, rd$)
        IF IBSTA% < 0 THEN
                flag = false
                CALL PRESS.ANY.KEY("GPIB error on read, IBSTA=$" + HEX$(IBSTA%) + ",
IBERR=" + STR$(IBERR%) + ", IBCNT=" + STR$(IBCNT%))
                IBERR% = 0
        ELSE
                flag = true
        END IF
END SUB

SUB GPIB.WRITE (dig, mes$, flag)
' WRITES A STRING FROM THE GPIB.  IF AN ERROR OCCURS, AN ERROR MESSAGE IS
' DISPLAYED AND THE VARIABLE 'FLAG' IS SET TO ZERO (FALSE).

        flag = true
        CALL IBWRT(dig, mes$)
        IF IBSTA% < 0 THEN
                flag = false
                CALL PRESS.ANY.KEY("GPIB error on write, IBSTA=$" + HEX$(IBSTA%) + ",
IBERR=" + STR$(IBERR%) + ", IBCNT=" + STR$(IBCNT%))
                IBERR% = 0
        ELSE
                flag = true
        END IF
END SUB

FUNCTION GETANS$ (mes$)
'FUNCTION TO DISPLAY THE PROMPT IN 'MES$' AND RETURN A 'Y' (YES) OR 'N' (NO)
        ans$ = SPACE$(1)
```

```
AGAIN:
      PRINT : PRINT mes$ + " (Y/N)";
      INPUT ans$
      ans$ = UCASE$(ans$)
      IF ans$ <> "N" AND ans$ <> "Y" THEN GOTO AGAIN
      GETANS$ = ans$
END FUNCTION

FUNCTION GETNUM% (mes$)
'FUNCTION TO DISPLAY THE PROMPT 'MES$' AND RETURN AN INTEGER NUMBER 'GETNUM%'
BADNUM:
      PRINT : PRINT mes$ + ": ";
      INPUT a$
      a$ = a$ + "-99"
      a% = VAL(a$)
      IF a% = -99 THEN GOTO BADNUM
      GETNUM% = a%
END FUNCTION

FUNCTION MAX% (iwfm%(), MAXLOC)
' FIND MAXIMUM VALUE OF AN INTEGER ARRAY AND IT'S LOCATION IN THE ARRAY
      first% = LBOUND(iwfm%)
      last% = UBOUND(iwfm%)
      TMAX% = iwfm%(first%)
      MAXLOC = first%
      FOR i% = first% + 1 TO last%
         IF iwfm%(i%) > TMAX% THEN
            TMAX% = iwfm%(i%)
            MAXLOC = i%
         END IF
      NEXT i%
      MAX% = TMAX%
END FUNCTION

FUNCTION MIN% (iwfm%(), MINLOC)
'FIND MINIMUM VALUE OF AN INTEGER ARRAY AND IT'S LOCATION IN THE ARRAY
      first% = LBOUND(iwfm%)
      last% = UBOUND(iwfm%)
      TMIN% = iwfm%(first%)
      MINLOC = first%
      FOR i% = first% + 1 TO last%
         IF iwfm%(i%) < TMIN% THEN
            TMIN% = iwfm%(i%)
            MINLOC = i%
         END IF
      NEXT i%
      MIN% = TMIN%
END FUNCTION

FUNCTION NUM2STR$ (NUM)
'Remove leading space when number is converted to string

      NUM2STR$ = MID$(STR$(NUM), 2)
END FUNCTION

SUB PRESS.ANY.KEY (mes$)
' PRINT MESSAGE AND WAIT UNTIL ANY KEY IS PRESSED

      PRINT : PRINT mes$
      PRINT "Press <Space Bar> to continue"
```

```
      WHILE INKEY$ > ""      ' flush out pending keystrokes
      WEND
      DO
            key$ = INKEY$
      LOOP UNTIL key$ > ""

END SUB

SUB SRQ (dig, status%, PAUSE%)
' CLEAR SRQ'S FROM MAINFRAME, VERTICAL PLUG-IN, & TIMEBASE PLUG-IN AND
' RETURN THE STATUS BYTES IN VARIABLE 'STATUS%()'.
' STATUS% = SCD SERIES STATUS
' VARIABLE PAUSE% TELLS THIS SUB TO PRINT STATUS AND WAIT FOR USER KEY PRESS


      CALL IBRSP(dig, status%)
      IF IBSTA% < 0 THEN
            flag = false
            CALL PRESS.ANY.KEY("ERROR HANDLING SRQ, IBSTA= $" + HEX$(IBSTA%) + ",
IBERR=" + STR$(IBERR%) + ", IBCNT=" + STR$(IBCNT%))
            IBERR% = 0
      ELSE
            CALL GPIB.WRITE(dig, "EVENT?", flag)
            evt$ = SPACE$(50)
            CALL GPIB.READ(dig, evt$, flag)
      END IF

      IF PAUSE% = 1 THEN
         PRINT
         CALL PRESS.ANY.KEY("SCD Series waveform recorder SRQ:" + STR$(status%) +
", " + evt$)
      END IF
END SUB

FUNCTION STR2NUM (SOURCE$, SRCH$)
' FUNCTION TO RETURN A NUMBER FROM A STRING.  USEFUL FOR PARSING WAVEFORM
' PREAMBLE FOR VALUES

      POSIT% = INSTR(SOURCE$, SRCH$) + LEN(SRCH$) + 1
      tmp$ = MID$(SOURCE$, POSIT%, 15)
      STR2NUM = VAL(tmp$)

END FUNCTION
```

HP Program Listing

```
10   ! SCD SERIES RECORDERS/HP9000 Series 200/300
20   !
30   ! Waveform acquire, scale and graph
40   ! scaled waveform program.
50   !
60   ! Written on 9826 w/ Ver 4.0 BASIC.
70   ! using GPIB port 7.
80   !
90   !  Requires loading the following binary
100  !  files before executing this program:
110  !  LOAD BIN "<FILENAME>"
120  !
130  !  o- IO      Opt 4
140  !  o- GRAPH   Opt 2
150  !  o- MAT     Opt 7
160  !
170  GOSUB Initialize
180  ON INTR 7 CALL Srqhandl
190  ENABLE INTR 7;2
200  CALL Getscale(@Scd,Record,Np,Xi,Pt,Yz,Yo,Ym,Wfmpre$)
210  ALLOCATE INTEGER Iwfm(1:Np)
220  ALLOCATE Wfm(1:Np)
230  CALL Getwfm(@Scd,Cha,Loc,Pt,Np,Iwfm(*))
240  CALL Scalewfm(Np,Ym,Yo,Yz,Wfm(*),Iwfm(*))
250  CALL Graphwfm(Wfm(*),Xi,Np,Pt)
260  GOTO Fini
270 Initialize:  !
280  OPTION BASE 1
290  Addr=1 ! SCD ADDRESS
300  DIM Wfmpre$[600],Wrt$[200]
310  Record=1   !Record location to transfer
320  ABORT 7
330  REMOTE 700+Addr
340  CLEAR 700+Addr
350  ASSIGN @Scd TO 700+Addr;EOL CHR$(13) END
360  OUTPUT @Scd;"LONGFORM ON;PATH ON"
370  RETURN
380 Fini:  END
390  SUB Getscale(@Scd,Record,Np,Xi,Pt,Yz,Yo,Ym,Wfmpre$)
400  REM
410  REM GET SCALE FACTORS FOR WAVEFORM IN CHANNEL CHA, LOCATION LOC
420  REM
430  OUTPUT @Scd;"DATA CNTRECORD:1,START:1,STRECORD:"&VAL$(Record)&";WFMPRE?"
440  PRINT "READING SCALE FACTORS"
450  ENTER @Scd;Wfmpre$
460 Np=FNArg("NR.PT:",Wfmpre$) !  NUMBER OF POINTS IN WAVEFORM
470  Xi=FNArg("XINCR:",Wfmpre$) !  TIME PER POINT
480  Pt=FNArg("PT.OFF:",Wfmpre$) !  AMOUNT OF PRETRIGGER
490  Yz=FNArg("YZERO:",Wfmpre$) !  GROUND REFERENCE
500  Yo=FNArg("YOFF:",Wfmpre$) !  DC OFFSET
510  Ym=FNArg("YMULT:",Wfmpre$) !  VOLTS PER BIT
520  SUBEND
530 SUB Getwfm(@Scd,Cha,Loc,Start,Np,INTEGER Iwfm(*))
```

```
540 REM
550 REM GET A WAVEFORM
560 REM AND RETURN IT IN THE INTEGER ARRAY, IWFM
570 DIM Wrt$[200]
580 DIM Header$[9]
590 DIM Chksum$[1]
600 Wrt$="ACQUIRE STATE:STOP;WFTX TCF"
610 PRINT "READING";Np;"POINT BINARY WAVEFORM"
620 OUTPUT @Scd;Wrt$&";CURVE?"
630 ENTER @Scd USING "#,9A";Cur$
640 ENTER @Scd USING "%,W";Iwfm(*)
650 ENTER @Scd USING "B";Chk !CHECKSUM
660 SEND 7;UNL UNT
670 CLEAR 7
680 SUBEND
690 SUB Scalewfm(Np,Ym,Yo,Yz,Wfm(*),INTEGER Iwfm(*))
700 REM
710 REM SCALE BINARY WAVEFORM STORED IN 'IWFM'
720 REM INTO A VOLTAGE WAVEFORM STORED IN 'WFM'
730 MAT Wfm= Iwfm-(Yo)
740 MAT Wfm= Wfm*(Ym)
750 MAT Wfm= Wfm+(Yz)
760 SUBEND
770 SUB Graphwfm(Wfm(*),Xi,Np,Pt)
780 GINIT
790 GCLEAR
800 GRAPHICS ON
810 Amax=MAX(Wfm(*))
820 Amin=MIN(Wfm(*))
830 Voffset=(Amax-Amin)/20
840 Hoffset=(Np)/5
850 OUTPUT 2;"_K";
860 ! Message between quotes is as follows:
870 ! "<CTRL-BACKSPACE>K"
880 MOVE 40,95
890 LABEL "SCD SERIES WAVEFORM"
900 WINDOW -Hoffset,Np+(Np/10),Amin-(8*Voffset),Amax+(4*Voffset)
910 !
920 ! Draw vertical and horizontal axes
930 !
940 MOVE 0,Amin-Voffset
950 DRAW Np+1,Amin-Voffset
960 DRAW Np+1,Amax+Voffset
970 DRAW 0,Amax+Voffset
980 DRAW 0,Amin-Voffset
990 MOVE 1,Wfm(1)
1000 FOR I=2 TO Np
1010 DRAW I,Wfm(I)
1020 NEXT I
1030 !
1040 ! Print vertical labels, max & min
1050 !
1060 LORG 2
1070 MOVE -Hoffset,Amax+(3*Voffset)
1080 LABEL "Volts"
```

```
1090 MOVE -Hoffset,Amin
1100 LABEL DROUND(Amin,3)
1110 MOVE -Hoffset,Amax
1120 LABEL DROUND(Amax,3)
1130 !
1140 ! Print horizontal labels, 1st & last pnt
1150 !
1160 LORG 5
1170 MOVE 0+(Np/10),Amin-(2*Voffset)
1180 LABEL DROUND(-(Pt)*Xi,4)
1190 LORG 5
1200 MOVE Np-(Np/10),Amin-(2*Voffset)
1210 LABEL DROUND((Np-Pt)*Xi,4)
1220 MOVE Np/2,Amin-(3.5*Voffset)
1230 LABEL "Secs"
1240 MOVE Np/2,Amin-(4.5*Voffset)
1250 LABEL "Press enter to erase screen"
1260 INPUT A$
1270 OUTPUT 2;"_K";
1280 GCLEAR
1290 PRINT "Press RUN to acquire another wfm"
1300 SUBEND
1310  DEF FNArg(Header$,String$)
1320  REM
1330  REM RETURN THE NUMERIC ARGUMENT ASSOCIATED WITH HEADER$ IN STRING$
1340  REM
1350 Ps=POS(String$,Header$)+LEN(Header$)
1360 Tp$=String$[Ps;15]
1370 RETURN VAL(Tp$)
1380 FNEND
1390 SUB Srqhandl
1400 Sb=SPOLL(701)
1410 IF Sb<16 THEN 1460
1420 BEEP
1430 OUTPUT 701;"EVENT?"
1440 ENTER 701;Event$
1450 PRINT "SRQ...Status=";Sb;", ";Event$
1460 ENABLE INTR 7;2
1470 SUBEND
```

INTEGRATING THE SCD SERIES INTO 7912 SERIES SYSTEMS

Introduction

The SCD1000 and SCD5000 are an obvious addition to present 7912AD and 7912HB systems providing significantly enhanced performance. There are many differences between the two products. This document explains functional and command differences using various methods:

- New features available in the SCD Series waveform recorders are listed in Table E-2.
- A comparison of physical characteristics between SCD series and 7912 waveform recorders.
- Common operations such as acquiring waveform data, setting up for single shot acquisition, getting scaling information, etc using examples in both SCD Series commands and 7912 commands are listed in Table E-4.
- 7912, 7A16P/7A29P and 7B90P command comparisons with the SCD Series waveform recorder are listed in Tables E-5, E-6 and E-7.

New Capabilities of SCD Series waveform recorders

There are several new capabilities that you may want to take advantage of. Table E-2 lists the major improvements in both the SCD1000 and SCD5000 waveform recorders.

TABLE E-2
NEW CAPABILITIES AVAILABLE ON SCD SERIES WAVEFORM RECORDERS

Capability	Explanation
Time resolution to 5 picoseconds per point	With the fastest time window of 5 nanoseconds and a record length of 1024 points results in time resolution to 5 picoseconds per point (twice as fine as the 7912 series).
Higher analog bandwidth	The SCD1000 has two amplifiers with 1 GHz bandwidth and the SCD5000 has 4.5 GHz analog bandwidth. Both are greater than the 500/750 MHz available from 7912AD/7912HB.
16 waveform locations	There are 16 volatile waveform locations built into the SCD Series waveform recorder. Each can be accessed individually or used with auto-advance recording. Each waveform location has time & date stamping.
Auto-Advance recording	Auto-advance allows quick capture of repetitive events into up to 16 separate wave form locations. The standard SCD Series waveform recorder captures at a 1 wave form per second rate. With option 1P (fast waveform capture option), the rate is 10 waveforms per second.
Time Stamping of waveform data	Every waveform acquisition is time and date stamped for later comparison. The time is displayed on the display unit. The time and date information is stored in the WFID portion of the waveform preamble (accessed using the WFMPRE? or WFMPRE? WFID commands)
Selectable waveform record lengths	256, 512 or 1024 point waveforms can be selected. Shorter record lengths give faster waveform capture rates. Longer record lengths give better time resolution and longer time windows.
Automatic ground reference	Zero volts (or ground) is automatically captured with each waveform. There is no need to manually calculate the ground as with the 7912.
Detachable display unit	The display unit offers stand-alone flexibility to the SCD Series waveform recorders. It can be attached to either the SCD1000 or SCD5000. Because it is detachable, it can be optioned out if there isn't a need for a display. The display unit allows: • User control of instrument settings • View up to 4 waveforms at one time • Cursor measurements on any two waveforms displayed • Can be used as a computer display with text & special characters and two user definable buttons. • Viewing instrument status information
Choice of input connectors	The standard SCD waveform recorders come with Type N connectors. There are connector options to suit user needs. Both the SCD1000 and SCD5000 offer SMA input connectors as an option. The SCD1000 also offers BNC with Tek Type II probe interface. This interface (as seen on 11K scopes) allows connection and usage of high impedance probes (P6203 or P6204) and optical to electrical converters (P6701 and P6702), including probe power.

TABLE E-2 (CONT)
NEW CAPABILITIES AVAILABLE ON SCD SERIES WAVEFORM RECORDERS

Capability	Explanation
Centroid waveform processing	Instead of only having edges to define the waveform like with the 7912 (and others), each diode in the SCD series waveform recorder contains intensity information (up to 64 levels of intensity). Centroid processing takes the intensity into account when defining the processed waveform. This improves writing rate and gives better vertical resolution (up to 11 bits).
Cursor measurements	Measurements can be made on the display unit using cursors. Cursors give V, ΔV, time, Δtime and frequency.
VGA compatible output display	Allows convenient viewing using a PC style multi-sync monitor or making hardcopies using a VGA video hardcopy unit
10 nonvolatile settings storage	Allows quickly changing instrument setups from the display unit or GPIB.
Settings saved at power down	When the SCD series waveform recorder is turned off, it remembers it's settings at power-up. This means that settings do not need to be setup manually or with the computer.
Beam intensity settings for each time window	There are individual write beam intensity settings for each time window (sweep speed). The intensities are set at the factory. Each can be modified and saved by the user. This eliminates the blooming when changing time windows that occurred on 7912's.
Lower power consumption	The SCD1000 is <300 watts and the SCD5000 is <250 watts. This is at least 60 watts less than a 7912.
Repeat mode acquisition	The SCD series waveform recorder has a command REPset NREPEat:<NRx> that instructs the SCD to capture <NRx> single shot events and after each acquisition, transfer it to a waiting computer. After this command is sent, no other commands must be issued until all waveforms have been sent. This is useful for data logging applications.
Internal calibration	Enhances accuracy of vertical, horizontal, trigger & crt characteristics.
Warranty plus option M4	This option extends the SCD warranty to 3 years and includes all normal calibrations needed in this period (1 cal first year, 2 cals for 2nd & 3rd years).
No secondary addressing	The SCD's do not require secondary addressing. This eases implementation into systems by only requiring a primary address.

Physical characteristics comparison

This section describes differences in physical characteristics between SCD series and 7912 series waveform recorders.

- Same width, depth and height as 7912. The display unit projects approximately 1 inch further than the 7912.
- Less power consumption and better cooling.
- No signal feedthru's as with 7912.
- No RS-170 video signal or X-Y-Z output so there is no need for 620 X-Y-Z monitor or 634 video monitors. The display unit replaces these monitors.
- No vertical and timebase plug-ins required.
- Screw holes in front panel for permanent mounting of SCD recorder into rack
- Type N connectors instead of BNC connectors on 7AxxP plug-ins. There are adaptors for converting Type N into BNC, SMA, GR, etc.
- No probe power connector on front panel. Probe power supplied with option 1E (Tek Type II probe interface) on SCD1000.

SCD Series/7912 Usage Examples

There are acquisition and control operations that are performed by both the 7912 series and the SCD series waveform recorders. This section compares common operations that are performed to set up an instrument, acquire data and scale the binary data into a voltage array.

Because there are a variety of computers and languages available, this document will use a "generic" language for all examples (see Table E-3). This can simplify user implementation because these functions can be duplicated in the native language (or may already be there). The examples assumes that the GPIB is initialized and variables have been previously defined and allocated.

Table E-3 contains common operations performed by both the SCD Series and the 7912 waveform recorders.

TABLE E-3
GENERIC COMPUTER LANGUAGE SUMMARY

Sendstring @4:	Send ASCII string to GPIB address 4.
Readstring @4:	Read ASCII string into string variable.
Readinteger @4:	Read 16 bit integer value, most significant bit first. Useful for reading single integer value.
Readreal @4:	Read real number from GPIB address 4. Useful for reading scale factors and other floating point numbers.
Readintarray @4:	Read 16 bit integer array values, most significant bit first from GPIB address 4. Useful for reading binary waveform data.
Serialpoll @4: (status)	Read status byte from GPIB address 4 and return in variable 'status'.
Readevent @4: (event)	Read event code from GPIB address and return in variable 'event'.
Dim	Allocate space for arrays or strings. For example: Dim Integer Iwfm(1024) Dim Real Wfm(1024) Dim String String$ to 500
While/Wend	While command for looping requirements.
Open @lu "filename: for {read|write}	Open logical unit number (e.g, 2) to use disk file for reading or writing.
Writedisk @2	Save data to disk.
num= Val (str$,start)	Extract a numeric value from string variable 'str$' starting at the position 'start' and put it in variable 'num.'
pos=chrpos(str$,srchstr$,start)	Locate position of substring 'srchstr$" in string 'str$' starting at position 'start'.

TABLE E-4
SCD SERIES/7912 COMMON OPERATIONS

Operation	7912HBOperation	SCD Series Waveform Recorder Operation
Read waveform data into computer	Read integer waveform array using 7912 ATC command. Number of point s always 512 16-bit values. Command sequence: Sendstring @0,0:"MODE DIG;DIG DAT; ATC;READ ATC"	Read integer waveform array using CURVE? command. Number of points is 256, 512 or 1024 16-bit values. Differences: • 16 waveform locations (location 1 is factory set) • 256, 512, or 1024 point waveforms. Set using the ACQUIRE LENGTH command. • Partial waveform transfer. The SCD's can transfer partial waveforms from 1 point to the full record length. Set by DATA START & DATA COUNT commands. Command sequence: Sendstring @4:"DATA CNTRECORD:1; COUNT:0;START:1;STRECORD:1;CURVE? Note: The DATA statement needs only be sent once to get data from the same place.

TABLE E-4 (CONT)
SCD SERIES/7912 COMMON OPERATIONS

Operation	7912HBOperation	SCD Series Waveform Recorder Operation
Read voltage and timing scale factors	Query 7912 mainframe for the volts and and time per division. Read values into real variables. Divide the values to give volts per point and time per point. Command sequence: Sendstring @0,0:".i.VS1?;" Readreal @0,0: voltsdiv Sendstring @0,0: ".i.HS1?;" Readreal @0,0: timediv ! volts per point is the volts/div divided by 64 voltspoint=voltsdiv/64 ! time per point is the time/div divided by 51.2 timepoint=timediv/51.2 ! The next line scales a binary waveform into a voltage array. yzero equals zero unless you have defined where ground is. Voltwfm()=(lwfm() - yzero) * voltspoint	Query for waveform preamble vertical and timing scale factors. Differences: • all necessary scale factors can be read by issuing the WFMPRE? query. • the volts per point and time per point are already calculated. Command sequence: Sendstring@4:"WFMPRE?YMULT" Readreal@4:voltspoint Sendstring@4:"WFMPRE? YZERO" Readreal@4::yzero Sendstring@4:"WFMPRE?XINCR" Readreal@4:timepoint !The next line scales a binary waveform into a voltage array. Voltwfm()=(lwfm() - 1024) * voltspoint + yzero
Set up for single shot acquisition.	Set up 7912 and 7B90P plug in to be ready to acquire a single shot event into one waveform location. Command sequence: ! Set up 7912 for single sweep Sendstring @0,0:".i.MODE; DIG;.i.DIG; SSW" ! Set up 7B90P for single sweep and arm Sendstring @0,1: ".i.MOD; SSW;.i.SSW ;ARM"	Set up SCD waveform recorder to capture single shot event into one record Differences: • single sweep is accomplished using the ACQuire HLDnxt & HLDnxt:ON commands. Command sequence: Sendstring@4:"ACQUire MODe:NORmal; NREcord:1;STArt:1, STAte: HLDnxt; HLDnxt:ON" Note: to reset for single acquisition, only HLDnxt:ON needs to be sent after sending the ACQuire statement.

TABLE E-4 (CONT)
SCD SERIES/7912 COMMON OPERATIONS

Operation	7912HBOperation	SCD Series Waveform Recorder Operation
Set up for single shot acquisition and send data via GPIB a user-specified number of times	Set up 7912 and 7B90P plug in to be ready to acquire a single shot event. After each capture, make waveform data available for read to GPIB controller using REP command. In this example, 50 times. Command sequence: ! Set up 7912 for single sweep Sendstring @0,0:".i.MODE; DIG;.i.DIG; SSW" ! Set up 7B90P for single sweep and arm Sendstring @0,1: ".i.MOD; SSW;.i.SSW; ARM" ! Send 50 waveforms Sendstring @0,0:".i.REP; 50"	Set up SCD waveform recorder to capture single shot event. After each capture, make waveform data available for read to GPIB controller using REPSET NREPEat command. In this example 50 times. Differences: • single sweep is accomplished using the ACQuire HLDnxt command • the 7912 REP command sends unprocessed pointer and vertical data. The SCD REPset NREPEat command returns centroid data. Command sequence: Sendstring@4: "ACQUire MODe:NORmal; NREcord:1;STArt:1,STAte:HLDnxt;REPSet NREPEat 50"

SCD Series/7912 Series Command Comparison

Before discussing command differences, here are a few conventions used throughout tables E-5 through E-7.

- SCD Series commands have a mixture of UPPER case and lower case letters. The UPPER case letters are the minimum required characters. The lower case letters are optional used for readability.
- Numerics are referred to as <NRx>. This can be an integer or floating point number.
- If a command only refers to one instrument (e.g., SCD1000 only) are noted. If not specifically called out, then a command sequence will work on either SCD Series waveform recorders.

TABLE E-5
SCD SERIES /7912 COMMAND COMPARISON

Header	Argument	Description	SCD equivalent commands
MODE	TV	Set instrument to TV mode	No equivalent command; No TV and digital mode in SCDs. They are always in digital mode.
	DIG	Set instrument to digital mode	
DIG	DAT(A)	Digitize data	Use DATA statement to specify which waveform to read and CURVE? statement to initiate the transfer. User ACQuire & HLDNxt commands to initiate an acquisition.
	GRA(T)	Digitize graticule only	No equivalent command; No graticule in SCD Series.
	SSW	Digitize on single sweep trigger	ACQuire STATe:HLDNxt and HLDNxt:ON command.
	DEF,<NR1>	Digitize only defects n times	SETRef RUN GPIB command or pushing the SETREF button in the utility menu will cause the SCD to redefine the reference array.
	SA,<NR1>	Digitize and signa averagel 1 to 64 times	No equivalent command; No signal averaging currently in SCD series recorders.
DT	ON	Wait for GET interface message to digitize	DT command with expanded functionality. Arguments include OFF, RUN, STOP, HLDNXT.
	OFF	Do not wait for GET interface message to digitize	
GRAT	ON	Write only the graticule on the target	No equivalent command; No graticule in SCD Series.
	OFF	Reset graticule-only mode	

TABLE E-5 (CONT)
SCD SERIES /7912 COMMAND COMPARISON

Header	Argument	Description	SCD equivalent commands
XYZ	ON	Enable XYZ outputs to display raw data	No equivalent command; DISPlay ON command turns on waveform display.
	OFF	Disable XYZ outputs	The DISPlay OFF command turns off display.
	RAW	Same as ON argument	Raw target data - Displayed when in UTILITY menu (the level displaying the graticule lines)
	ATC	Enable XYZ outputs to display ATC data	Centroid data - All operational modes except when in UTILITY menu (the level displaying the graticule lines)
	SA	Enable XYZ outputs to display signal-averaged data	No equivalent command in current SCD recorders.
	EDG(E)	Enable XYZ outputs to display edge-determined data	Raw target data - Displayed when in UTILITY menu (the level displaying the graticule lines)
	DEF	Enable XYZ outputs to display defects data	RAW REFArray command specifies the reference array be displayed on display unit.
MAI	<NR1>	Set main intensity from 0 to 1023	INTensity <NRx> command. <NRx>= 0 to 100 in steps of 1
GRI	<NR1>	Set graticule intensity from 0 to 255	No equivalent command; No graticule intensity in SCD Series
FOC	<NR1>	Set focus from 0 to 63	FOCus <NRx> command <NRx>= 0 to 100 in steps of 1
SSW	ARM	Arm single-sweep trigger	Single sweep is accomplished with the ACQuire STATe HLDNxt and HLDnxt commands. When this command is issued, the instrument resets and waits for a trigger. When a trigger occurs, the SCD acquires and enters the hold state.
	DIS	In single-sweep mode, but disarmed	
	NSS	Not in single-sweep mode	
TV	ON	Turn on TV display of scale disarmed	No equivalent command; No TV mode in SCD Series
	OFF	Turn off TV display of scale factors	

TABLE E-5 (CONT)
SCD SERIES /7912 COMMAND COMPARISON

Header	Argument	Description	SCD equivalent commands
REM	ON	Assert SRQ when REMOTE pressed	There are two user definable buttons on the SCD display unit. They are controlled by SRQMask USER1 and SRQMask USER2 commands. Up to 16 lines of text can be displayed on the display unit using the TEXT com mand.
	OFF	Do not assert SRQ when REMOTE is pressed	
OPC	ON	Assert SRQ when operation complete	Operation complete is turned on/off by using the SRQMask OPCmpl command.
	OFF	Do not assert SRQ when operation complete	
DEF	ON	Flag defects in raw vertical data	SETRef ON command turns on the reference array. The reference array) is available for transfer by using the REFARray? command. The size of the reference array can be up to 256K points.
	OFF	Reset defects flags in raw vertical data	SETRef OFF command turns off the reference array.
LOAD	<BINARY BLOCK>	Load defects array from IEEE 488 bus	REFARray? command; The defects array (called the reference array) is available for transfer by using the REFARray? command. The reference array cannot be updated via the GPIB.
ATC		Perform simple ATC on raw vertical data	No equivalent command; The waveform data available from the 16 waveform locations have centroid processing performed automatically. This processing is equivalent to ATC as far as the GPIB is concerned.
INT	<NR1>or NONE	Max. no. of consecutive interpolated data points	No equivalent command.
EDGE		Determine edges of raw waveform	No equivalent command.
TW	<NR1>	Set max. trace width for EDGE from zero to 512	No equivalent command.
RT	<NR1>	Set max. ratio of trace widths for EDGE from 1 to 32767	No equivalent command.
TEST		Self-test data memory	TESt command; A greatly expanded set of extensive diagnostics of several areas within the SCD Series waveform recorder. They include tests for; acquisition system, processor, read & write circuitry, front panel or all.

TABLE E-5 (CONT)
SCD SERIES /7912 COMMAND COMPARISON

Header	Argument	Description	SCD equivalent commands
READ	VER	Transmit vertical data array	No equivalent command.
	PTR	Transmit pointers data array	No equivalent command.
	SC1	Transmit channel 1 scale factors	•CHA? RANge or CHB? RANge (SCD1000 only) com mand for input voltage range. •ACQuire? TIMe command for time window
	SC2	Transmit channel 2 scale factors	•CHA? RANge or CHB? RANge (SCD1000 only) com mand for input voltage range. •ACQuire? TIMe command for time window
	ATC	Transmit average-to-center data	CURVe? command to read centroid waveform data from one of 16 waveform locations. Use the DATA statement to select which waveform.
	SA	Transmit signal-average data	No equivalent command.
	EGD(E)	Transmit edge-determined data	LINARray? command; This is not equivalent because the data up to 256K of raw target data sent in definite length format. Each data value is the intensity (1 to 64) of a linear array at a specific location.
	DEF	Transmit defect data	REFARray? command; This is not equivalent because the data up to 256K of raw target data sent in definite length format. Each data value is the intensity (1 to 64) of the reference array at a specific location.
REP	<NR1>	Repeat DIG DAT/READ PTR, VER sequence 1 or more times	REPSet NREPEat command; Not equivalent because the data sent is centroid data, not unprocessed data. Per forms automatic capture, centroid process and send via GPIB a user specified number of times.
DUMP	RAW	Dump raw data memory area	LINARRAY? command; This is not equivalent because the data up to 256K of raw target data sent in definite length format. Each data value is the intensity (1 to 64) of a linear array at a specific location.
	PR	Dump processed data memory area	No equivalent command.

TABLE E-5 (CONT)
SCD SERIES /7912 COMMAND COMPARISON

Header	Argument	Description	SCD equivalent commands
VS1	<NR3>or NONE	Scale factor for vertical channel 1	CHA? RANge command
VS2	<NR3>or NONE	Scale factor for vertical channel 2	CHA? RANge command
HS1	<NR3>or NONE	Scale factor for horizontal channel 1	ACQuire? TIMe command
HS2	<NR3>or NONE	Scale factor for horizontal channel 2	ACQuire? TIMe command
VU1	<CHARAC-TERS>	Units for vertical channel 1 vertical data.	WFMPRE? YUNit command will return the units of the
VU2	<CHARAC-TERS>	Units for vertical channel 2	WFMPRE? YUNit command will return the units of the vertical data.
HU1	<CHARAC-TERS>	Units for horizontal channel 1	WFMPRE? XUNit command will return the units of the horizontal scaling.
HU2	<CHARAC-TERS>	Units for horizontal channel 2	WFMPRE? XUNit command will return the units of the horizontal scaling.
ERR	<NR1>or NONE	Code for error indicated in last status byte reported	EVEnt? or ALLEV? commands; Return event code giving specifics about SRQ. EVQty? command returns the number of events in buffer.
SRQ	NULL	Service request code (7912HB provides no other response)	SRQMask command sets up various conditions for issuing SRQ's. RQS command turns SRQ capability on or off.
ID?	<CHARAC -TERS>	Identity of instrument	ID? command; Returns the identity of the SCD Series waveform recorder.
SET?	<MESSAGE UNITS>	Setting of programmable functions (header is omitted)	SET? command; Will learn all programmable functions within SCD Series waveform recorder. This string can be returned at any time to set up instrument. The LONgform ON/OFF command reduces the length of the ASCII settings string. There is also LLSET? command for fast binary transfers. The PATh ON|OFF command selects if the header and link are sent. If off, only the argument is sent. There are 10 nonvolatile settings storage locations in the SCD Series waveform recorder. Accessed using SAVe and RECAll commands.

TABLE E-6
SCD SERIES /7A16P & 7A29P COMMAND COMPARISON

Header	Argument	Description	SCD equivalent commands
INP	A	Input is from A connector	VMOde CHA command (SCD1000 only)
	B	Input is from B connector	VMOde CHB command (SCD1000 only) Note: There is also VMODe ADD and CHx INVert for algebraic addition and subtraction of channels A & B (SCD1000 only).
RIN	HI	High (1 MΩ) input impedance is selected	No equivalent command. If using option 1E (Tek type II probe interface) with SCD1000, high impedance probes like the Tektronix P6203 and P6204 can be used.
	LOW	Low (50 Ω) input impedance is selected	No equivalent command. SCD series waveform recorders are 50Ω.
BW	LIM	Limited bandwidth (20 MHz) is selected	No equivalent command; No bandwidth limit.
	FUL	Full bandwidth is selected	
CPL	AC	Input is AC coupled	CHA COUPling:AC or CHB COUPling:AC
	DC	Input is DC coupled	CHA COUPling:DC or CHB COUPling:DC
	GND	Input is grounded	CHA COUPling:OFF or CHB COUPling:OFF
CPL?	OVL	7A29P ONLY- Overload is returned if input is in OVERLOAD condition. (Query only). Returns an error is used in a set command.	No equivalent command
POL	NOR	Amplifier polarity is normal	CHA INVert:OFF or CHB INVert:OFF (SCD1000 only)
	INV	Amplifier polarity is inverted	CHA INVert:ON or CHB INVert:ON (SCD1000 only)
V/D	<NRx>	Volts/Division is set to argument must be a number in the range of 0.01 to 1 in a 1,2,5 sequence. V/D 0 means probe is on IDENTIFY.	CHA RANge:<NRx> or CHB RANge:<NRx> (SCD1000 only) <NRx>= 100E-3 to 10 in 1,2,5 sequence No probe id return value
POS	<NRx>	Vertical position of trace (from center screen) is set to <NRx>; range is -10.22 to +10.24 is 0.02 steps For example; POS 2 corresponds to +2.00 div above center.	CHA OFFSet:<NRx> or CHB OFFSet:<NRx> (SCD1000 only) <NRx>= ±2.5 times vertical range (volts) ±250 % in steps of 1 CHA TYPEOffset:VOLTs|PERcent sets the units for offset

TABLE E-6 (CONT)
SCD SERIES /7A16P & 7A29P COMMAND COMPARISON

Header	Argument	Description	SCD equivalent commands
VAR	OFF	Variable off -- deflection factors are calibrated	No equivalent command
	ON	Variable on -- deflection factors are uncalibrated	
PRB?	X1	1X or unencoded probe is present on selected input	No equivalent command
	X10	10X probe is present on selected input	
	X100	100X probe is present on selected input	
	ID	Returned when probe ID button is pressed	
ID?		Returns the plug-in type; for example TEK/7A29P,V77.1,F1.0	ID? command; Returns the identity of the SCD Series waveform recorder.
SET?	<MESSAGE UNITS>	Setting of programmable functions) (header is omitted	SET? command; Will learn all programmable functions within SCD Series waveform recorder. This string can be returned at any time to set up instrument. The LONGFORM ON/OFF command reduces the length of the ASCII settings string. There is also LLSET? command for fast binary transfers. There are 10 nonvolatile settings storage locations in the SCD Series waveform recorder. Accessed using SAVE and RECALL commands.

TABLE E-7
SCD SERIES /7B90P COMMAND COMPARISON

Header	Argument	Description	SCD equivalent commands
MOD	PPA	Peak-to-Peak auto trigger mode is selected	TRIgger MODe:AUTo command
	NOR	Normal triggering mode is selected	TRIgger MODe:NORmal command
	SSW	Single-Sweep Triggering mode is selected	ACQuire STATe:HLDNxt and HLDNxt:ON commands
CPL	AC	Trigger signal is AC coupled	TRIgger COUPling:AC command
	DC	Trigger signal is DC coupled	TRIgger COUPling:DC command
	LFR	Trigger signal is AC coupled with low frequency rolloff	No equivalent command
	HFR	Trigger signal is AC coupled with high frequency rolloff	No equivalent command
SRC	INT	Trigger source is internal	TRIgger SOUrce command. Choices of source are CHA, CHB and ADD (SCD1000 only). In SCD5000 choices are INT or EXT.
	LIN	Trigger source is the line voltage	No equivalent command
	EXT	Trigger source is external input	TRIgger SOUrce:EXT command.
	E10	Trigger source is external input attenuated by 10	No equivalent command
T/D	<NR3>	Time/Division is set to <NRx>; range is 5E-10 to 5E-1 in 1-2-5 sequence. Query returns <NR3> value.	ACQuire TIMe:<NRx> command. <NRx>= 5 E-9 to 100 E-6 in 1,2,5 sequence. The SCD Series waveform recorder is programmed using time window (total time) rather than time per division. Time window = Time/div * 10
MAG	ON	Sweep magnifier is turned on (10X)	No equivalent command
	OFF	Sweep magnifier is turned off (1X)	
POS	<NR2>	Horizontal position of sweep is set to <NRx>. Range is -6.4 to +6.39 in 0.0125 steps (80 steps/division). Query returns <NR2>	TRIgger DELay:<NRx> command <NRx>= 0 to (5 * time window) (seconds) 0 to 500% (percent) TRIgger TYPEdelay:SECond|PERcent command selects units for setting trigger delay. With zero trigger delay, there is ≈2.5 ns of pretrigger information.

TABLE E-7 (CONT)
SCD SERIES /7B90P COMMAND COMPARISON

Header	Argument	Description	SCD equivalent commands
HOL	<NRx>	Trigger holdoff period is <NRx>; range is 0 to 63 uncalibrated	No equivalent command
EOS	ON	End-of-sweep SRQ signal is enabled	SRQMask OPCmpl:ON command will issue an operation complete SRQ at end of acquisition.
	OFF	End-of-sweep SRQ signal is disabled	
TRI	ON	Trigger light is on (Read-only; TRI? returns TRI ON/OFF)	No equivalent command
	OFF	Trigger light is off (Read-only)	
SSW	ARM	Single sweep is armed. A GET (Group Execute Trigger) IEEE-488 universal command has the same effect.	Single sweep is accomplished with the ACQuire STATe HLDNxt and HLDNXt:ON|OFF commands. When these commands are issued, the instrument resets and waits for a trigger. When a trigger occurs, the SCD acquires and enters the hold state.
	DIS	Single Sweep is disarmed (Read-only; SSW? returns SSW ARM/DIS)	
ID?		Query only; Returns the plug-in type Example Response: Tek/7B90P,V77.1,LLL	ID? command; Returns the identity of the SCD Series waveform recorder.
SET?	<MESSAGE UNITS>	Setting of programmable functions (header is omitted)	SET? command; Will learn all programmable functions within SCD Series waveform recorder. This string can be returned at any time to set up instrument. The LONGFORM ON/OFF command reduces the length of the ASCII settings string. There is also LLSET? command for fast binary transfers. There are 10 nonvolatile settings storage locations in the SCD Series waveform recorder. Accessed using SAVE and RECALL commands.

SECTION F NOT AVAILABLE AT THIS TIME

B7 B6 B5 BITS	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
B4 B3 B2 B1	CONTROL		NUMBERS SYMBOLS		UPPER CASE		LOWER CASE	
0000	0 NUL 0 0	20 DLE 10 16	40 0 SP 20 32	60 16 0 30 48	100 0 @ 40 64	120 16 P 50 80	140 0 ` 60 96	160 16 p 70 112
0001	1 GTL SOH 1 1	21 LLO DC1 11 17	41 1 ! 21 33	61 17 1 31 49	101 51 1 A 41 65	121 17 Q 51 81	141 1 a 61 97	161 17 q 71 113
0010	2 STX 2 2	22 DC2 12 18	42 2 " 22 34	62 18 2 32 50	102 2 B 42 66	212 18 R 52 82	142 2 b 62 98	162 18 r 72 114
0011	3 EXT 3 3	23 DC3 13 19	43 3 # 23 35	63 19 3 33 51	103 3 C 43 67	123 19 S 53 83	143 3 c 63 99	163 19 s 73 115
0100	4 SDC EOT 4 4	24 DCL DC4 14 20	44 4 $ 24 36	64 20 4 34 52	104 4 D 44 68	124 20 T 54 84	144 4 d 64 100	164 20 t 74 116
0101	5 PPC ENQ 5 5	25 PPU NAK 15 21	45 5 % 25 37	65 21 5 35 53	105 5 E 45 69	125 21 U 55 85	145 5 e 65 101	165 21 u 75 117
0110	6 ACK 6 6	26 SYN 16 22	46 6 & 26 38	66 22 6 36 54	106 6 F 46 70	126 22 V 56 86	146 6 f 66 102	166 22 v 76 118
0111	7 BEL 7 7	27 ETB 17 23	47 7 ' 27 39	67 23 7 37 55	107 7 G 47 71	127 23 W 57 87	147 7 g 67 103	167 23 w 77 119
1000	10 GET BS 8 8	30 SPE CAN 18 24	50 8 (28 40	70 24 8 38 56	110 8 H 48 72	130 24 X 58 88	150 8 h 68 104	170 24 x 78 120
1001	11 TCT HT 9 9	31 SPD EM 19 25	51 9) 29 41	71 25 9 39 57	111 9 I 49 73	131 25 Y 59 89	151 9 i 69 105	171 25 y 79 121
1010	12 LF A 10	32 SUB 1A 26	52 10 * 2A 42	72 26 : 3A 58	112 10 J 4A 74	132 26 Z 5A 90	152 10 j 6A 106	172 26 z 7A 122
1011	13 VT B 11	33 ESC 1B 27	53 11 + 2B 43	73 27 ; 3B 59	113 11 K 4B 75	133 27 [5B 91	153 11 k 6B 107	173 27 { 7B 123
1100	14 FF C 12	34 FS 1C 28	54 12 , 2C 44	74 28 < 3C 60	114 12 L 4C 76	134 28 \ 5C 92	154 12 l 6C 108	174 28 | 7C 124
1101	15 CR D 13	35 GS 1D 29	55 13 — 2D 45	75 29 = 3D 61	115 13 M 4D 77	135 29] 5M 93	155 13 m 6D 109	175 29 } 7D 125
1110	16 SO E 14	36 RS 1E 30	56 14 . 2E 46	76 30 > 3E 62	116 14 N 4E 78	136 30 Λ 5R 94	156 14 n 6E 110	176 30 ~ 7E 126
1111	17 SI F 15	37 US 1F 31	57 15 / 2F 47	77 UNL ? 3F 63	117 15 O 4F 79	137 UNT — 5F 95	157 15 o 6F 111	177 DEL (RUBOUT) 7F 127
	ADDRESSED COMMAND	UNIVERSAL COMMANDS	LISTEN ADDRESSES		TALK ADDRESSES		SECONDARY ADDRESSES OR COMMANDS	

KEY

octal	25 PPU	GPIB code
	NAK	ASCII characters
hex	15 21	decimal

REF: ANSI STD X3.4-1977
IEE STD 488-1978
ISO STD 646-1973

Programmer Manual

Tektronix

SCD1000 & 5000
Transient Waveform Recorders

070-7315-02

This document applies for firmware version V1.80.

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

First Printing: September 1992
Revised Printing: November 1992

Instrument Serial Numbers

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

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

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

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

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Introduction

Overview

The SCD1000 and SCD5000 are high-speed, transient digitizers based on CRT scan conversion.

Both SCD digitizers have an input impedance of 50 Ω with programmable input settings. Table 1-1 lists the features of each system.

Table 1-1: SCD1000/SCD5000 Characteristics

Characteristics	SCD1000	SCD5000
Impedance	50 Ω	50 Ω
Input BW	DC to 1 GHz	DC to 4.5 GHz DC to 3.0 GHz with Option 01
# Input Channels	2	1
Input Range	10 mV to 10 V	5 V 10 V with Option 01
Input Offset	±2.5 × full-scale range	±0.8 × full-scale range
Input Coupling	AC,DC,OFF	DC Only
Trigger Source	Any input channel external input	External or internal calibrator signal (Internal trigger pickoff with Option 01)
Trigger Coupling	AC or DC (Internal only)	AC Only DC Only with Option 01

Instrument Control

Instrument functions of the SCD are controlled through either the IEEE−488.1 interface or through the front panel Display Unit (DU). When the interface is used, an IEEE−488 controller programs the SCD and receives information through a set of SCD commands. When the display unit is used, front panel controls provide:

- instrument set up
- display of waveforms
- waveform measurements
- output to a hard copy unit

Input Channels

The SCD1000 includes two input channels. The SCD5000 has only one input channel. In the SCD1000, different vertical modes allow acquisition from either of the channels (CHA or CHB) or allows the algebraic addition of the channels (ADD). The number of channels used for acquisition affects other parameters such as the data statement.

Other programmable input parameters include full-scale range (SCD1000 only), offset, coupling, and signal inversion (SCD1000 only).

In the SCD1000, the input range for each channel can be set from 100 mV to 10 V full scale. Programmable offset values range from 250 mV to 25 V. SCD5000 input range is fixed at 5 volts (10 volts with Option 01).

In the SCD1000, signals can be AC or DC coupled or disconnected from the input. In the SCD5000, the input signal is DC coupled. Input impedance is 50 Ω in both instruments.

Acquisition Sequence and Acquisition Process

An acquisition sequence starts when the digitizer recognizes a trigger event defined by the trigger parameters or when auto-triggering is initiated. After recognizing the trigger event, the SCD writes the event onto the CRT target. The SCD reads the target and digitizes the data on the target, storing the data in a data record. An acquisition sequence is finished when the record is filled.

An acquisition process is the filling of all required records. If more than one record must be filled to complete an acquisition process, records are consecutively filled from the specified start record through the specified number of records set by the acquisition system commands, or to the maximum available records.

Acquisition System

The acquisition system controls the sweep mode, time window, acquisition mode, record length, and acquisition state.

Time Window — The time window programs the acquisition duration. Time window settings are from 5 ns to 100 μs.

Acquisition Modes — The acquisition mode programs the number of records acquired during an acquisition process. NORMAL acquisition mode always fills only the programmed start record per acquisition process. Depending on trigger parameters, subsequent acquisitions may occur, but for each acquisition process, only the programmed start record is filled. In ADVANCE mode, the digitizer fills a specified number of records to complete an acquisition process. Acquisition processes may be repeated due to trigger settings, but each acquisition process fills only the number of specified records. In ADVANCE mode, each record is stamped with a time identifying when the acquisition began. AVERAGE acquisition mode allows 1 to

1024 averages to be performed to increase the signal-to-noise ratio.The maximum number of available records for acquisition is 16. Records 1, 2, 3, and 4 use non-volatile memory for storage and will retain data across power downs.

Record Length — Record length can be programmed to 256, 512, or 1024 data points.

Acquisition State — The acquisition state controls the starting and stopping of the acquisition process. RUN and STOP immediately affect the acquisition process. RUN continuously acquires data. HOLDNXT completes one *acquisition process* before stopping the digitizer. The completion of the current acquisition process depends on the recognition of enough trigger events and may include the filling of one or more records depending on the acquisition mode (NORMAL or ADVANCE).

Triggering

The trigger system defines the parameters of the trigger event. The trigger event is defined by its source, level, and slope. Level can be defined in either volts or percent.The position of the time window relative to the trigger event can be set using a trigger delay setting.

The SCD can also be triggered from the **Manual Trig** button on the Display Unit and from the IEEE−488 interface using the MTRIG command.

Mode — AUTO trigger mode automatically triggers the digitizer approximately 360 ms after the start of an acquisition sequence, if a trigger event has not already occurred. NORMAL trigger mode allows the digitizer to trigger only with the recognition of a trigger event as defined by the trigger parameters.

Source — In the SCD1000, the trigger source can be from one of the channels, the sum of the channels, or from the external trigger input on the front panel of the SCD. In the SCD5000, the source can be either the external input connector or the internal time calibration source. In the SCD5000 with Option 01 installed, the trigger source can be either the external input connector, or the internal trigger pickoff signal.

Level — With an internal trigger source, the trigger level can be set in the range of ±Vertical Range (CHA, CHB, or Add (AC) SCD1000), ±(Vertical Range / 2) (CHA, CHB, or Add (DC) SCD1000), or ±5 V (SCD5000 with Option 01). Level for an internal source can be specified in either percent of the full-scale range or voltage.

Although the trigger level can be specified in volts, the trigger level is internally expressed as a percentage of the full-scale range plus offset (Level=Trig% × Range + Offset). This is done so that once the level is set, changing range and offset does not affect the relative trigger level.

Specifying the level over the maximum allowable value causes the SCD to coerce the level to the maximum allowable level. With an external trigger source, the trigger must be specified as a voltage level in the range of ±1.0 V (SCD1000) or ±0.5 V (SCD5000).

Slope — Trigger slope can be positive (PLUS) or negative (MINUS).

Coupling — In the SCD1000, trigger coupling can be AC or DC. DC coupling passes all components of the signal to the trigger circuits. AC coupling blocks all DC components and attenuates frequencies below 2 kHz. In the SCD5000, the trigger signal is AC coupled only.

Delay — The time window can be delayed relative to the trigger event up to five times the length of the time window. See Figure 1-1. Trigger delay can be expressed in percentage of the record or seconds.

Arm — External arming allows an externally applied signal to enable trigger recognition when the acquisition state is Hold Next or Running. The arming signal is applied to the rear panel Arm In connector. To enable, select External Arm from the Trigger menu or issue the appropriate GPIB command. A trigger will not be recognized until the arming signal (ground or TTL low) is received.

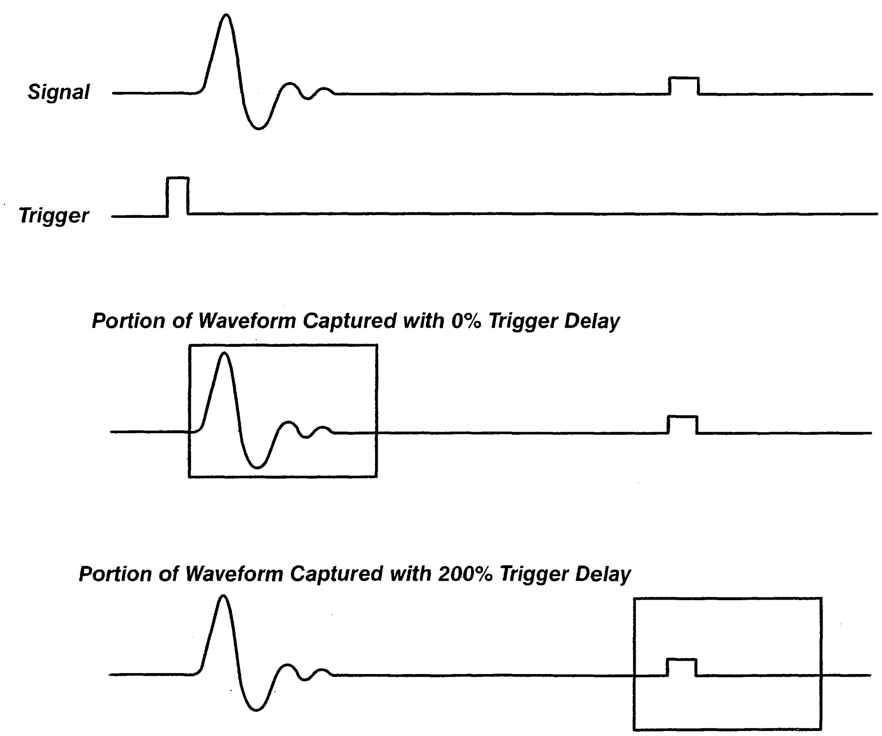

Figure 1-1: Trigger Delay

Internal Calibration & Diagnostics

An internal calibration function provides:

- vertical channel amplitude and offset adjustments
- input impedance bias current adjustment (SCD1000)
- trigger level and delay adjustments
- window size adjustment
- CRT adjustments
- CRT geometry correction

Internal calibration, which is only executed at user request, is initiated from the Display Unit or over the GPIB using the CALIBRATE commands.

Self-tests can be run for the acquisition and processor subsystems, as well as for the front panel. TEST commands allow entire subsystems or portions of a subsystem to be tested one time or several times (LOOP). The test results can be displayed as PASS/FAIL or PASS/FAIL and include a descriptive string. See the Service Manual for a more detailed description of calibration and diagnostics.

Factory Settings

An initialization function returns the digitizer's settings to *factory settings* stored in ROM. These factory settings cannot be changed, but are useful to place the instrument in a known state. The settings (see Table 3-8) are a good starting point to begin instrument set-up.

As the SCD is used, all instrument settings are saved in non-volatile RAM at power-down so that the digitizer powers up with the same settings that were selected when it was turned off.

Initialization to factory settings can be limited to just GPIB-related functions or just instrument functions, or both the GPIB and instrument functions can be reset to their factory settings. See the INIT command in Table 3-8.

Display Unit

The Display Unit (DU) is a control and display device. In addition to a high resolution, 640×400 pixel Liquid Crystal Display (LCD), the DU contains dedicated control keys, programmable soft keys, and a variable knob.

Depending on the display mode (waveform or menu), the LCD panel displays either waveforms and status information or waveforms and SCD menus. Programmable soft keys change functions according to menu labels to allow control of instrument settings, display modes, cursor positioning, and other functions. The variable knob allows easy adjustment of numeric values of functions.

The Display Unit can operate simultaneously with the GPIB interface functions.

Menu System

Figure 1-2 shows the DU displaying menus. The DU displays three types of menus: mode menus, function menus, and an auxiliary menu. Mode menus are displayed along the bottom of the screen and allow selection of function menus for different systems of the digitizer, such as Trigger, Vertical, Cursors, etc. Function menus appear along the left side of the display and allow changing values for each of the parameters associated with a system, such as trigger system Level, Position, Coupling, etc. The auxiliary menu appears at the right side of the display and labels the associated soft keys for various functions. User-defined key labels and the variable knob's last setting are part of the auxiliary menu.

Button presses can be emulated or queried over the GPIB using the ABSTOUCH command. See Table 3-8 for more information.

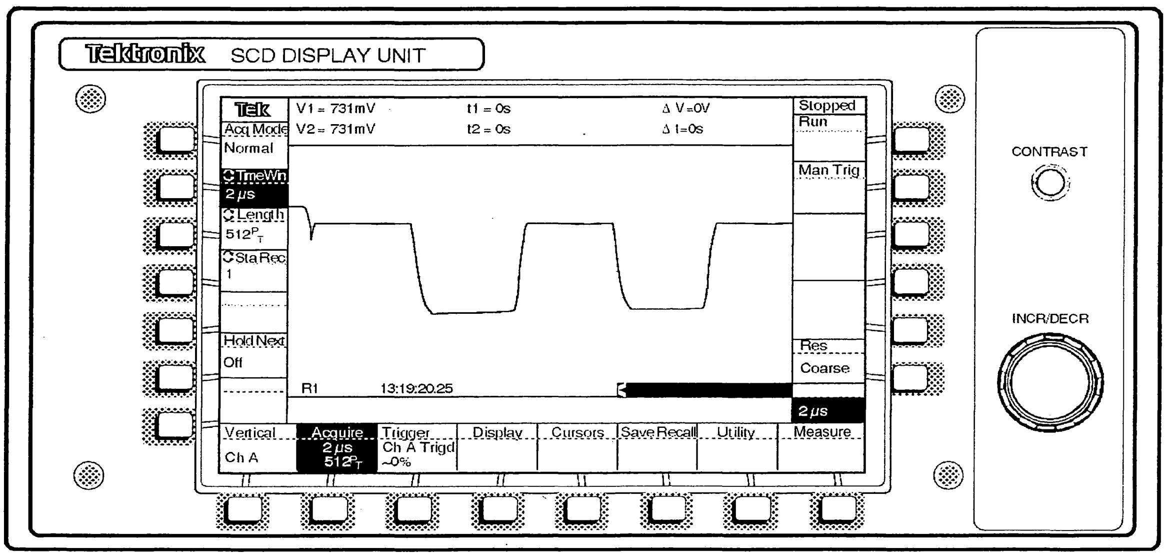

Figure 1-2: Display Unit Showing Menus

Window System

Through soft key selections, the LCD panel can be divided into one, two, or four separate display windows. (This is not affected by, nor does it affect, the vertical mode setting.) Any record from any selected channel can be displayed in any window. Figure 1-3 is an example of a four-window display with waveforms.

When a waveform is displayed, each window contains the following information:

- the digitized waveform
- the record number
- cursors (if selected)
- a ground potential indicator (if in range)
- a time stamp indicating the time the acquisition began
- a reference bar, indicating the relative portion of the record that can be seen in the display

The status information displayed next to each window (when no menu is selected) includes:

- channel number from which the waveform was acquired
- vertical full-scale range setting
- vertical offset setting
- vertical expansion (zoom) setting

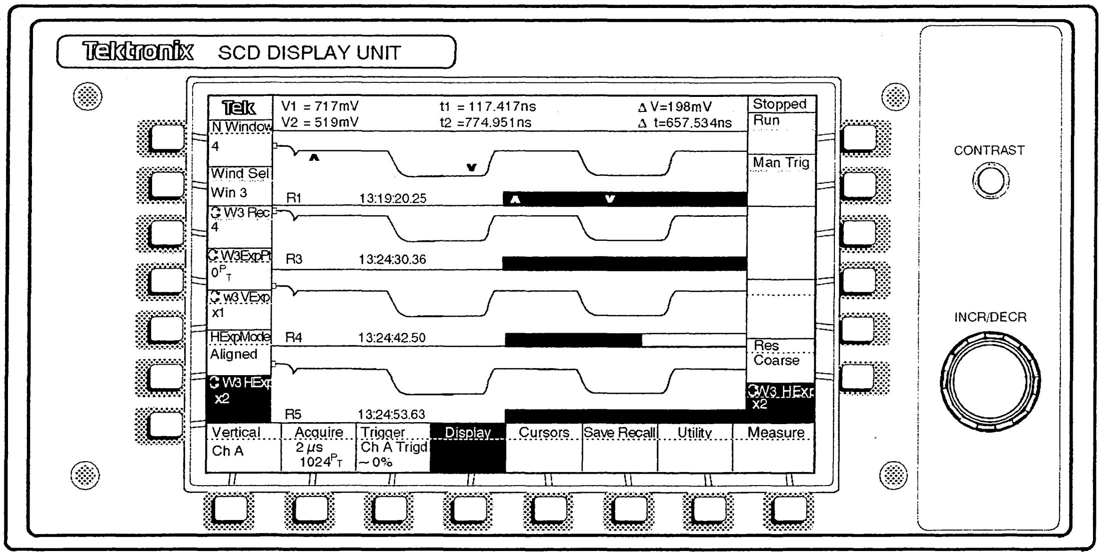

Figure 1-3: Four Window Display

Vertical & Horizontal Expansion (Zoom)

Vertical and horizontal expansion functions display a selectable portion of the waveform in the entire window. Expansion allows individual data points of a record to be seen and increases vertical visual resolution to see discrete digitized levels.

Windows can be individually expanded or aligned with a selected window.

A 1024 point record can be horizontally expanded by a factor of $\times 2$. Records with 256 or 512 data points are shown at $\times 1$ only. The display window's horizontal axis is 512 data points. At $\times 1$, the entire record is displayed in the window.

Vertical expansion factors are $\times 1$, $\times 2$, $\times 4$, $\times 8$, and $\times 16$. At $\times 1$, the entire vertical range of the acquired waveform is displayed. The acquired vertical resolution of a waveform is 2048 levels (11 bits). However, the displayed vertical resolution of a waveform depends on the number of windows in the display: 256 points for one window, 128 points/window for two windows, 64 points/window for four windows.

Cursor Measurements

The SCD provides two cursors that can be placed in any one or two windows. Using the cursors, absolute and differential measurements of voltage and time can be made (frequency measurements are obtained by inverting the time measurements). Absolute measurements are referenced to ground for voltage and the left edge of the window for time. Differential measurements (Δt, Δv, and Δf) are made between the two cursors.

NOTE

Other messages can be displayed in the cursor readout zone. These messages will overwrite cursor information. The cursor information is automatically updated when the user adjusts the cursor position with the variable knob.

Cursor response is improved when Acquire state is set to stopped.

Debug Mode

A debug mode displays IEEE–488.1 bus traffic on the Display Unit. Only bus traffic for the digitizer is displayed; other device traffic is not displayed. Besides display of bus traffic, debug features include:

- display of error codes where they occur in the bus transactions
- scrolling of the status area
- display of control and other special characters

NOTE

Turn the cursors off when using Debug mode. If the cursors are turned on, the cursor results will overwrite the debug information. This information can be retrieved, however, by using the Recall Stat utility function.

SCD Setup Switches

This section describes the parameters to consider when setting up the SCD. The following information does not include pinouts and other IEEE–488.1 bus data. For more information on IEEE–488.1, see Section 2.

Setup switches are located on the SCD's rear panel (Figure 1-4) select the digitizer's IEEE–488.1 (GPIB) bus and instrument settings.

GPIB Address

GPIB switches 4 through 8 set the bus address from 0 to 30. Each switch is a binary value: 1, 2, 4, 8, and 16.

NOTE

Each instrument on the bus must have a unique address.

GPIB Message Terminator

GPIB switch 3 selects the message terminator as either EOI or EOI/LF. Section 2 describes the message terminator.

The factory setting is EOI.

NOTE

The SCD will also accept LF only as a message terminator when the switch is set to EOI/LF; this function is explained in more detail in Section 2. If the controller accepts EOI as the terminator, the switch should be set to EOI.

Option

GPIB switch 2 is used to set the instrument to either talk/listen or talk-only GPIB mode. The talk-only mode is to be used in conjunction with an HPGL plotter. It is also used in conjunction with MPU board switches 2 and 3 in order to select from optional modes which are available (see Table 1-2). Note that switch 2 is labelled Option on the rear panel of the instrument.

Dump Continuous Mode (Option 2F) — The instrument can be placed in Dump Continuous Mode by setting instrument switch 2 to ON, MPU switch 2 to ON, and MPU switch 3 to OFF. Setting instrument switch 2 to OFF will remove the instrument from this mode.

Auto Record Mode — Sets the instrument to "repeat mode" at power up (waveforms are acquired and transmitted immediately). The instrument may be placed in Auto Record Mode by setting instrument switch 2 to ON, MPU switch 2 to OFF, and MPU switch 3 to ON. Setting instrument switch 2 to OFF will remove the instrument from this mode. Other combinations of MPU switches 2 and 3 are available, but are reserved for future use.

NOTE

Refer MPU board switch changes to qualified service personnel.

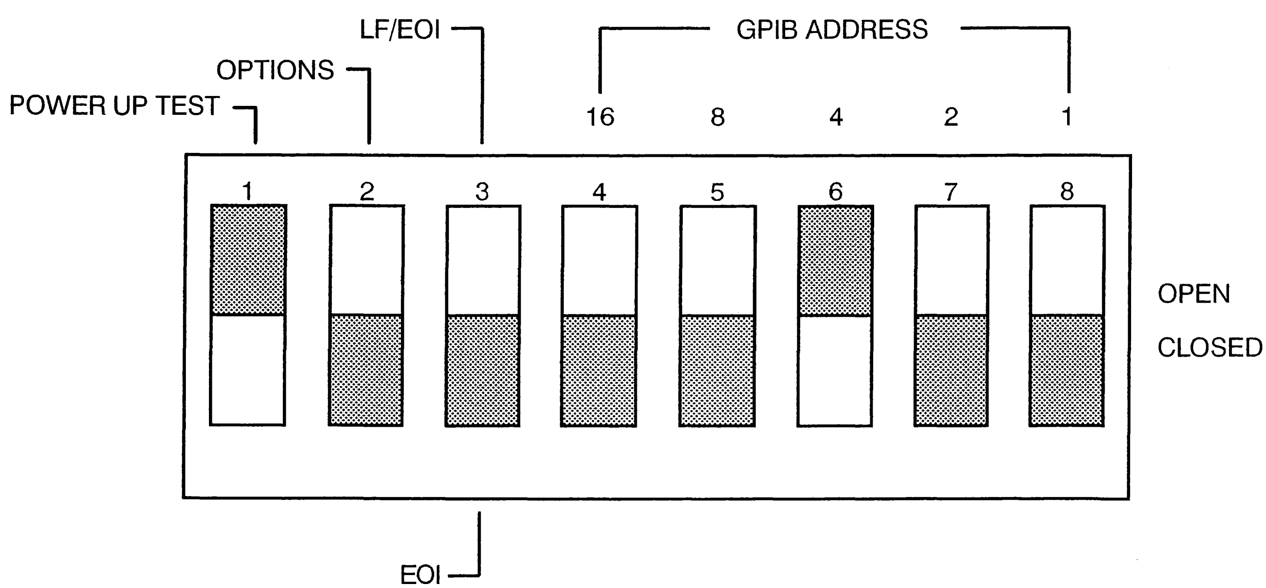

Figure 1-4: SCD1000/SCD5000 GPIB and Instrument Switches

Table 1-2: Optional Mode Switching

	Switch and Location		
Function	GPIB switch 2 on rear panel	Switch 2 on MPU board	Switch 3 on MPU board
Dump Continuous mode (Option 2F)	Open	Open	Closed
Auto Record mode	Open	Closed	Open
GPIB talk-only mode	*Open	*Closed	*Closed

*** Default for standard instrument**

Power Up Test Bypass

Instrument switch 1 determines whether or not the digitizer performs a self-test upon power-up. When OFF, the digitizer bypasses the self-test (the SAFEGUARD PUPTST command is ignored). When ON, the SAFEGUARD PUPTST command determines whether or not the digitizer performs a self-test upon power up. See Table 3-11.

Factory setting is ON.

GPIB Introduction

This section introduces IEEE−488.1 programming concepts including syntax, command processing conventions, interface messages, and SCD programming examples. This section describes both device-dependent functions (SCD functions) and interface functions (low-level IEEE−488.1 functions).

The IEEE−488.1 interface (GPIB) is based on the IEEE Std 488.1−1987 *Digital Interface for Programmable Instrumentation*. This specification defines mechanical, electrical, and functional interface elements that enable data transfer between compatible devices. The SCD digitizer adheres to this standard.

The IEEE−488.1 uses a bit-parallel, byte-serial binary data format with a maximum transmission rate of 500 Kbytes/s. The interface allows connection of as many as 15 devices (including the controller) in a linear, star, or combined configuration. The total GPIB transmission cabling should not exceed 2 meters per device.

IEEE−488.1 devices include instruments that communicate bidirectionally (talk and listen) and unidirectionally (listen only or talk only). Each device on the bus has its own unique address and must be addressed and placed in a talk or listen mode before the controller can communicate with it.

Command Processing Conventions

Several command processing conventions affect the way programs are written. SCD command processing conventions are described in this section.

Upper and Lower Case

The digitizer ignores the case of alphabetical text that is input. Thus, `rqs ON` and `RQS ON` are identical. The digitizer always returns upper case only to the IEEE−488.1 port. Therefore, query responses always return as upper case characters.

Abbreviations and Minimum

Any command word in a command line can be abbreviated to a minimum ambiguity and be properly interpreted by the digitizer. For example, `TRIGGER`, `TRIGGE`, `TRIGG`, `TRIG`, and `TRI` are identical commands because each of the abbreviated forms includes the command's minimum ambiguity (`TRI`).

The minimum ambiguity for each command word is defined in the command set tables (Section 3).

Quotes

Double quotes can be used inside a quoted string argument by entering the quotes twice. For example, `"Press ""User1"" Key"` causes `Press "User1" Key` to be sent to the digitizer.

White Space

White space is any CR, space, LF, or TAB character. The digitizer always ignores white space. If the terminator switch is set to EOI/LF (line-feed termination), line-feeds will not be interpreted as white space if properly placed in the message. The line-feed (LF) character is recognized as such anywhere but inside of a quoted string. There, line-feed is ignored.

Message Terminators

A message terminator indicates the end of an IEEE−488.1 message. Using the switch on the rear panel, the SCD can be set to recognize messages terminated by either EOI or EOI/LF (line feed).

When EOI is the terminator, any data byte on the bus when EOI is asserted is recognized as the end of a message. EOI only is made for controllers that want to avoid the overhead of the 2 extra bytes (CR + LF).

When EOI/LF is the terminator, either the LF (line-feed) character properly placed in a message, or any data byte on the bus simultaneously with EOI asserted, is recognized as the end of an input (to the SCD) message. The digitizer will not terminate on only a LF character embedded in binary data transfers or in quoted strings.

When EOI/LF is the terminator, the SCD transmits a Carriage Return character followed by Line Feed (LF) and simultaneously asserts EOI to terminate an output message. If the controller supports EOI, the terminator switch should be set to EOI (not EOI/LF). This eliminates any unwanted terminations if the binary waveform data sent to the controller contains line-feed characters.

Depending on placement, the LF character may be interpreted as white space as described above.

Longforms and Shortforms (LONGFORM command)

The `LONGFORM` command controls the number of characters the digitizer returns to the controller as a result of a query command.

When `LONGFORM` is `OFF`:

- the digitizer returns the abbreviated form of command elements (for example, `TRI COUP:AC` or `CURS OFF`)
- responses to `ALLEV?` and `EVENT?` queries are limited to the abbreviated form of the message and the event code (for example, `EVE 121`).

When LONGFORM is ON:

- the digitizer returns the complete spelling of the command element (for example, TRIGGER COUPLING:AC or CURSORS OFF)
- responses to ALLEV? and EVENT? queries include the complete spelling of the command, the event code, and a quoted string describing the event code (for example, EVENT 155,"Invalid string input")

The PATH command (described below) also affects digitizer responses. The LONGFORM command is described in Table 3-8.

Removing Command Echoes in Responses (PATH command)

The PATH command controls whether or not the digitizer includes in its response the query command it received from the controller. When PATH is ON, the command is included with the response. For example, CHA RANGE:.5 is returned when PATH is ON. When PATH is OFF, the query command is not included. The example just given is shortened to .5 when PATH is OFF.

Command Syntax

There are two types of SCD commands: set commands and query commands. These types are described below, but their syntactical forms differ slightly as described here.

IEEE–488.1 set command syntax consists of headers, links, arguments, and delimiters. Set commands have the following syntactical form:

```
<header><space delimiter ( )><optional link><colon
delimiter (:)><optional argument>
```

For example: TRIGGER SOURCE:CHA

Some SCD set commands do not include a link. A few set commands have neither link nor argument.

Query commands have a similar form except that the header includes a query indicator a question mark (?) and does not include an argument or the colon delimiter. Some SCD query commands do not include a link.

Query commands have the following syntactical form:

```
<header><?><space delimiter><optional link>
```

For example: TRIGGER? SOURCE

Set and Query Commands

SCD commands can either be set commands or query commands. Syntax for set and query commands differ slightly as described above.

Set Commands

Set commands instruct the instrument to do something, such as set up a parameter, start a process, etc. Set commands can be of three types:

`CALIBRATE TRIGGER` (set without link)

`TRIGGER COUPLING:AC` (set with link)

`MTRIG` (set with neither link nor argument)

Query Commands

Query commands instruct the instrument to prepare to transfer instrument or other settings or waveform data to the controller. Once a query command has been sent, the device is talk addressed to allow transfer of data from the digitizer's output buffer to the IEEE−488.1 bus.

Most query commands are derived from set commands; they allow checking the current setting of a parameter set by a set command. Query commands are similar in appearance to set commands except for a question mark added to the header (`ACQUIRE?`). Queries may or may not have a link; these commands never have an argument, therefore the colon delimiter separating link and argument is not legal. Here are some examples of query commands:

```
EVENT?
```

```
TRIGGER? COUPLING
```

Queries can be general or specific. A general query requests settings or data for many links. In the query

```
CHA?
```

the digitizer returns all of the settings of channel A (SCD1000 only).

A specific query requests settings or data for one link. In the query

```
REPSET? NREPEAT
```

only the setting of `NREPEAT` will be returned to the digitizer if it is talk addressed before another command is sent.

Out of Phase Query

Several queries can be concatenated into one command line as explained later in this section. If a query (single or multiple queries) is sent to the digitizer and the instrument is not talk addressed before another query or command is sent to the same device, the first query is disregarded, and the response to it is cleared. The data requested by a second query is sent as usual, if the digitizer is subsequently talk addressed. In order to get the information from the digitizer, it must be talk addressed after the query is sent.

Oversized Query Response

Some general query commands may produce a response that is too big for the digitizer's output buffers. If all of this data is not talked out of the instrument, the front panel of the digitizer will stop functioning, which makes the instrument appear to lock-up. The front panel will resume normal operation when the remaining data is transmitted.

Set-Only and Query-Only Commands

Some commands are query-only or set-only. For example, the `EVENT?` query has no corresponding set command. The `ERASE <NRx>` command has no corresponding query.

There may be times when a query-only command will be sent to the digitizer in a set command. This is most likely to occur when the results of a query are stored external to the digitizer and are later returned to the digitizer in a corresponding set command. An example of this is the `ID?` query. In response to a `ID?` query, the digitizer will return a string which includes the `ID?` query response. When this string is returned to the digitizer as a set command, a command error is generated. Some query-only commands cause the instrument to generate an error when returned as a set command; others don't. The command set in Section 3 of this manual indicates which query-only commands will generate an error when sent to the instrument as a set command.

Headers

A header identifies a set of commands that affect a category of functions of the instrument, such as `TRIGGER` settings, `ACQUIRE` settings, or `TEST` functions. In the commands:

```
CHA RANGE:.5
TRIGGER SOURCE:CHA
```

`CHA` and `TRIGGER` are headers.

The simplest SCD command consists of just a header, for example:

```
MTRIG
```

Links

A link further specifies a particular parameter of a category of functions that are identified by a header. In the command:

```
CHA OFFSET:.5
```

`OFFSET` is an SCD link specifying a particular parameter of channel 1. Links are separated from the header by a space delimiter (ASCII 32) or a tab character (ASCII 11).

Many commands have links; however, some do not have links, such as:

`PATH OFF` (command without link)

Arguments

An argument sets the state or value of a parameter specified by a link or header. Most commands require arguments. However, some commands do not have arguments. The argument is separated from the link or header by a colon delimiter (:). An argument can be:

- a symbol to set a parameter's state
- a numeric to set a parameter's value
- a quoted string to specify a string of characters

Character String Arguments — In the command

```
DISPLAY ON
```

the argument ON is a symbol that turns on the optional Display Unit. Notice that this command has no link.

Numeric Arguments — In the command

```
CHA OFFSET:.5
```

the numeric value .5 sets the offset of channel A. The SCD accepts the following numeric arguments:

- signed integer
- unsigned integer (unsigned numbers are always interpreted as positive)
- floating point value with no exponent
- floating point value with an exponent

Although the digitizer can receive any of these numeric expressions as a numeric argument, numeric responses from the digitizer follow certain numeric conventions. The convention used depends on the command. Some responses are unsigned integers; some are floating point values with an exponent. The command set tables in Section 3 identify the numeric convention used for each appropriate command.

Quoted Strings Arguments — In the command

```
USER1 "Grp Exec","Trig"
```

the quoted strings `Grp Exec` and `Trig` label one of the user-definable keys on the Display Unit.

Quoted strings can be delimited by double quotes (").

Quotes can be used inside the string by entering the quotes twice. For example, `"Press ""User1"" Key"` causes `Press "User1" Key` to be displayed.

Delimiters

Colon (:) — Separates a link from its following argument.

Comma (,) — Separates an argument from the next link in a command line, or it separates multiple links for some commands. The comma is used to include more than one link in a command line in order to set several parameters of a single header. For example, to change several trigger parameters in one command string:

```
TRIGGER COUPLING:AC,MODE:AUTO,SLOPE:PLUS
```

To separate multiple arguments in a single command:

```
ABSTOUCH 0, 8
```

Semicolon (;) — Separates a group of links and arguments of one header from the next header in a command line. The semicolon is used to include more than one header in a command line. For example: `VMODE ADD;CHA RANGE:100E-3,OFFSET:.5, TYPEOFFSET:VOLTS;CHB RANGE:1,OFFSET:.5,TYPEOFFSET:VOLTS`.

Concatenation of Commands

Multiple set and query commands can be sent in the same command line if properly delimited. (See Delimiters above.) For example, the following command lines

```
VMODE ADD <EOI>

CHA RANGE:100E-3,TYPEOFFSET: VOLTS, OFFSET:-1.25 <EOI>

CHB RANGE: 200E-3,TYPEOFFSET: VOLTS, OFFSET:-1.50
<EOI>

ACQUIRE STATE:HLDNXT <EOI>
```

could be concatenated into one command line such as

```
VMODE ADD;CHA RANGE:1.00E-3,TYPEOFFSET:VOLTS, OFF-
SET:-1.25;  CHB RANGE:100E-3,TYPEOFFSET:VOLTS, OFF-
SET:-1.50;   ACQUIRE STATE:HLDNXT<EOI>
```

Talking With Nothing to Say (TWNTS)

If a response is requested of the digitizer without it first having been queried, it responds with a TWNTS message while asserting the EOI line. The message is one byte long with the value FF <EOI> in EOI mode and FF CR LF <EOI> in LF/EOI mode.

TWNTS will not occur if the digitizer is currently acquiring.

Interface Messages

Interface messages are low-level commands generated by the GPIB interface software in the controller or composed according to the IEEE−488.1 standard. Unlike instrument commands, interface messages cannot be sent as character strings.

The following descriptions are provided as an overview of how these GPIB messages relate to the SCD. All of these messages appear on the bus with the attention line (ATN) asserted. For complete descriptions of the interface messages and resultant interface states, see ANSI/IEEE Std 488.1−1987.

The SCD supports the IEEE−488.1 interface functions as follows:

- Acceptor Handshake (AH1)
- Controller (C0)
- Device Clear (DC1)
- Device Trigger (DT1)
- Tri-state Bus (E2)
- Listener (L4)
- Parallel Poll (PP0)
- Remote/Local (RL0 however, the SCD generally follows the state transitions of remote and local instrument control; see Local Lockout below)
- Service Request (SR1)
- Source Handshake (SH1)
- Talker (T5)

Listen Address (LA) and Talk

Listen Address (LA) messages condition the SCD to receive commands. Talk Address (TA) messages condition the SCD to respond to queries and serial polls. The SCD receives its Listen Address when the data on the bus equals decimal 32 plus the address set on the SCD's rear panel address switches. The SCD receives its Talk Address when the data on the bus equals decimal 64 plus the address set on the SCD's rear panel address switches. For example, if the SCD is set to address 20 on the dip switch, then the listen address is 32+20=52 and the talk address is 64+20=84.

Local Lockout (LLO)

Remote With Lockout State (RWLS) inhibits front panel operation, which prevents the front panel controls from affecting the SCD. While in this state, the front panel LOCK (red) and GPIB (yellow) LEDs are on. These LEDs will only show if there is no front panel attached to the instrument.

The SCD powers on in the local state (LOCS). RWLS can be achieved by asserting REN, listen addressing the box, and sending the LLO (Local Lockout) message. The front panel controls can also be turned off by sending the FPANEL OFF command (see Table 3-13).

Unlisten (UNL) and Untalk (UNT)

The Unlisten (UNL) message is equivalent to talk address decimal 31, so the address sent is 32+31=63. The UNL message cancels the LA message. The Untalk (UNT) message is equivalent to listen address decimal 31, so the address sent is 64+31=95. The UNT message cancels the TA message. The Untalk and Unlisten commands are universal commands. All instruments on the bus stop talking and listening when the controller sends UNT and UNL messages.

Device Clear (DCL)

The Device Clear (DCL) message initializes communication between the SCD and the controller. In response to DCL, the digitizer clears input and output messages as well as unexecuted control settings. Errors and events waiting to be reported are cleared, except for the power-on event. The SRQ message is cleared, unless SRQ is true from a power-on condition.

Interface Clear (IFC)

Interface Clear (IFC) is a signal line of the IEEE−488.1 cable. When IFC is asserted, both the Talk and Listen functions are placed in an idle state. This produces the same effects as receiving both the Untalk and Unlisten commands. IFC resets the interface only and does not affect any instrument functions. The input and output buffers are not cleared.

Selected Device Clear (SDC)

Selected Device Clear (SDC) performs the same function as DCL, but requires the instrument to have been listen-addressed (more than one instrument can be simultaneously addressed and thus affected by SDC). This function allows the controller to perform a device clear on selected instruments. When the SCD receives an SDC, it executes a Device Clear (explained above).

Serial Poll Enable (SPE) and Serial Poll Disable (SPD)

The Serial Poll Enable (SPE) message causes the SCD to transmit its serial-poll status byte when it is talk-addressed. The Serial Poll Disable (SPD) message returns the digitizer to normal operation. If SRQ was asserted, it is cleared when the digitizer is polled.

Parallel Poll

The SCD does not support parallel polling commands.

Group Execute Trigger (GET)

The SCD supports the Group Execute Trigger (GET) function. In the SCD, the DT command (Table 3-8) enables the SCD to recognize the GET command and enter one of the acquisition states (STOP, RUN, or HOLDNXT). Get requires the device to be a listener. When GET is received after DT is received, the digitizer enters the set acquisition state. This capability allows many instruments to be synchronized by having them wait for the GET command before executing their instructions. A multiple digitizer system can use the GET command to acquire many channels at the same time.

Device Trigger (DT)

Device Trigger programs the digitizer's response to the GET message. The DT command allows the user to program the digitizer to enter one of the three acquisition states upon receiving GET.

Device-Dependent Programming

High-level programming languages, such as BASIC, C, and Pascal, are used to create programs that send GPIB messages to devices and receive data and responses from the devices. Statements in these languages usually contain three parts:

- input/output keyword (such as `PRINT` or `READ`)
- IEEE−488.1 logical unit designator, which may be an address or a name (such as `20` or `DIG`)
- instrument command or response formed by a character string or string-variable designator (such as `CHA RANGE:2`)

Generic Programming Language

Because the SCD can be controlled by several different computer types, a "generic" computer language is used in the following examples to replace language constructs from other languages that provide input, output, and other statements. Table 2-1 lists the generic language constructs used in the examples.

Table 2-1: Generic Language Constructs for Examples

Generic Construct	Description
Sendstring @address	Send ASCII string to device at @address
Readstring @address	Read ASCII string from device at @address
Readintarray @address	Read binary-encoded integer array values, most significant bit first from device at @address.
Serial poll (address,statusb)	Perform a serial poll to read status byte from device requesting service. Device address is obtained during poll.
Dim	Allocate space for arrays or strings. For example: Dim Integer Intwfm(1024)
While/Wend	While command for looping requirements.
Writedisk	Save data to disk.
@Screen	Replaces @address in command. Use to output to the computer monitor.
@Variablename	Replaces @address in command. Used as a variable to identify an address.

In the following example, the SCD is set to address 20.

All examples assume that proper configuration and declaration to the GPIB port and device have been done prior to these statements. The examples show proper command syntax.

Output Statement Examples

Output statements send commands and other data to the digitizer. The following examples show several commands used to set up the vertical inputs of the SCD, set up the trigger system, and begin an acquisition. Any SCD commands may replace the ones following the generic output statement. (The following commands are written for an SCD1000 and could be concatenated as explained earlier.)

```
Sendstring @20: "VMODE ADD;CHA RANGE:100E-3"
Sendstring @20: "CHB RANGE:200E-3"
Sendstring @20: "TRIGGER MODE:NORMAL,SOURCE:CHA"
Sendstring @20: "ACQUIRE STATE:HLDNXT"
```

Input Statement Examples

Input statements allow the controller to receive waveform data and other information from the digitizer into arrays or variables. In the following examples, variables and arrays have been dimensioned large enough to hold the expected data

```
Readstring @20: SETTINGS$
Readintarray @20: Intwfm(i)
```

Query Command and Response Examples

Query and input operations may be specified by separate statements, or, if the controller permits, a prompting input statement can perform both functions. The following example queries for and then acquires the channel 1 settings of the device at address 20 (SET$ has been dimensioned as a string variable large enough to accommodate all data coming from the device).

```
Sendstring @20:"CHA?"
Readstring @20:SET$
```

In this operation, the controller addresses the device as a listener and sends the query command, "CHA?", over the bus. The controller then reassigns the instrument to be a talker and receives the characters into the target variable SET$. The variable then contains the channel 1 information, which can be displayed on the console:

```
Sendstring @Screen: SET$
CHA RANGE:2.0E+0,OFFSET:0,TYPEOFFSET:PERCENT,COU-
PLING:DC
```

Instrument Settings Transfer

Setup parameters can be copied to the controller using the SET? query command. The settings can be saved in a pre-defined string variable and then written to a disk file. Once saved in the controller, the SCD settings can be modified at a later time and returned to the digitizer. The entire setup is described in ASCII characters, as defined in the command tables of Section 3.

The following example shows how to dimension a string variable to receive the current digitizer settings, modify them, and then send them back to the digitizer.

```
DIM SET$ (600)
Sendstring @20:"SET?"
Readstring @20:SET$
.
commands that may modify the settings in SET$
.
Sendstring @20: SET$
```

Handling Service Request (SRQ) and Event Codes

The most recent RQS command (see Table 3-7) determines whether the digitizer asserts the SRQ control line of the bus when either an error or a change in status occurs. The RQS command is always set to ON at power-up.

If the controller is configured and programmed appropriately, an asserted SRQ line interrupts its normal program flow. To service the interrupt, the controller polls each device on the bus. In response to being polled, the interrupting device returns a status byte, which reveals the type of event that occurred. The interrupting device then clears the SRQ line.

If another SRQ is pending, either from the same or another instrument on the GPIB, the SRQ line will be re-asserted. The SRQ line is re-asserted each time an SRQ needs to be handled. If the controller does not respond to the SRQ, the instrument continues to operate and communicate normally, even though the condition that caused the SRQ may invalidate an operation such as a measurement, setting, or acquisition.

After reading a status byte, the program may request more information about the event by sending the EVENT? query command. The device returns a number (and a descriptive string if the digitizer is programmed to do so) that identifies the specific event. Section 4 defines the various status bytes, event codes, and errors.

The following example shows how to read the status byte and obtain the event code after SRQ has been asserted. (The device address is obtained during the poll routine and stored in the variable, DEV.) The status byte and associated event code are then displayed on the controller's screen. The variables for device address (DEV) and status byte (STATUSB) are integer. However, because the LONGFORM command is set to ON, a string is returned with every event query, which is stored in the string variable, EVENT$. (See descriptions of these commands in Section 1.)

```
Serialpoll: (DEV,STATUS)
Sendstring @DEV: "LONGFORM ON;PATH ON"
Sendstring @DEV:"EVENT?"
Readstring @DEV:EVENT$
Sendstring @Screen: "SRQ from ";DEV;", status= ";STA-
TUS;
EVENT$
```

Sending an `SRQMASK USRx:ON` command (where x=1 or 2) to the SCD allows an SRQ to be generated when the appropriate user button on the Display Unit is pressed. (Each of the user buttons can be labeled. See Section 3 for the appropriate commands.) The SCD sends unique status byte and event code values to signify when a user button is pressed. These values can be used to control program flow by waiting for the operator to press a user button before performing other actions, such as acquiring a waveform or making a cursor measurement.

In addition, `SRQMASK ABSTOUCH:ON` allows any key on the Display Unit to generate an SRQ. See Table 3-7 for information on the SRQMASK command.

Device Dependent Command Set Listing

Table 2-2 alphabetically lists all the SCD commands described in Section 3. In the table, spelling of headers, links, and arguments is done with both uppercase and lowercase characters. Uppercase characters indicate the minimum ambiguity of each command. The entire spelling (longform) is in uppercase and lowercase. Other conventions follow those of the tables in Section 3.

See Section 3 for descriptions of each of these commands.

Command Set Table Format Conventions

The following format conventions are used in the command set tables:

Items included in brackets ([...]) are optional items.

<x> represents an alphacharacter

<NR1> represents a signed integer.

<NR2> represents a floating point number with no exponent

<NR3> represents a floating point number with an exponent

<NRx> represents an <NR1>, <NR2>, or <NR3>

<ui> represents an unsigned integer with no leading space

<qstring> represents a quoted string ("xxxxx" or 'xxxxx')

<bblock> represents a Tek Codes & Formats Binary Block

Spelling for headers, links, and arguments is done with uppercase and lowercase characters; however, the command's minimum ambiguity appears in uppercase characters (for example, `TRI`) while the longform includes both uppercase and lowercase characters (for example, `TRIgger`).

Each table's Description column includes a brief description, numeric limits (where appropriate), factory settings (where appropriate), an example of the query or command, and, for queries, an example of the SCD response.

Factory settings are the values programmed in the SCD when first shipped from the factory. Subsequent programming of the SCD causes values to be changed. These values are saved in memory when the unit is turned off. The digitizer powers on with the saved settings; the SCD does not return to the factory settings each time it is turned on. See Factory Settings in Section 1 and the INIT command in Table 3-8 for more information.

All example responses are representative of the results when the `PATH` and `LONGFORM` commands are `ON`.

Commands are sorted in order of typical importance with queries following commands. For example, in Table 3-7 all `SRQMASK` commands are listed followed by all `SRQMASK?` queries.

Table 2-2: Alphabetical Command Set Listing

Header	Link	Argument	Reference Section 3
ABStouch		<NRx>,<NRx>	Table 3-8
ABStouch		CLEar	Table 3-8
ABStouch?			Table 3-8
ACQUire	AVErage:	<NRx>	Table 3-3
ACQUire	GEOmetry	ON OFF RUN	Table 3-3
ACQUire	HLDNxt	ON OFF	Table 3-3
ACQUire	LENgth:	<NRx>	Table 3-3
ACQUire	MODe:	NORmal ADVance AVErage	Table 3-3
ACQUire	NRECord:	<NRx>	Table 3-3
ACQUire	STARt	<NRx>	Table 3-3
ACQUire	STATe:	STOP RUN HLDNxt	Table 3-3
ACQUire	TIME:	<NRx>	Table 3-3
ACQUire?			Table 3-3
ACQUire?	AVErage		Table 3-3
ACQUire?	GEOmetry		Table 3-3
ACQUire?	HLDNxt		Table 3-3
ACQUire?	LASt		Table 3-3
ACQUire?	LENgth		Table 3-3
ACQUire?	MODe		Table 3-3
ACQUire?	NRECord		Table 3-3
ACQUire?	STARt		Table 3-3
ACQUire?	STATe		Table 3-3
ACQUire?	TIME		Table 3-3
ALLEv?			Table 3-7
AREA?			Table 3-18

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
AREAZone		DISTal MEAszone MESial PROXimal	Table 3-18
AREAZone?			Table 3-18
ARM		INTERnal EXTernal	Table 3-4
ARM?			Table 3-4
BASE?			Table 3-18
BASEAber?			Table 3-18
BASEMode	METhod:	ABSOlute HISTOGram HISTOMean MINImum	Table 3-18
BASEMode	LEVEl:	<NRx>	Table 3-18
BASEMode?			Table 3-18
BASEMode?	METhod		Table 3-18
BASEMode?	LEVEl		Table 3-18
BASETop?			Table 3-18
BATdate?			Table 3-14
BELl	BUTton:	ON OFF	Table 3-13
BELl	KNOb:	ON OFF	Table 3-13
BELl	RINg		Table 3-13
BELl?			Table 3-13
BELl?	BUTton		Table 3-13
BELl?	KNOb		Table 3-13
CALIBRATE		[ALL] CRT GEOmetry INPut HORizontal TRIgger VERTical	Table 3-14
CALIBRATE?			Table 3-14

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
CALOut	CH<x>	AMPL OFF TIME	Table 3-14
CALOut	EXTernal	AMPL TIME	Table 3-14
CALOut?			Table 3-14
CALOut?	CH<x>		Table 3-14
CALOut?	EXTernal		Table 3-14
CALIBRATOr	AMPLItude:	<NRx>	Table 3-14
CALIBRATOr	TIME:	<NRx>	Table 3-14
CALIBRATOr?			Table 3-14
CALIBRATOr?	AMPLItude		Table 3-14
CALIBRATOr?	TIME		Table 3-14
CCOnstant?	<ui>		Table 3-14
CDAte?			Table 3-14
CH<x>	COUPling:	AC (SCD1000) DC OFF (SCD1000)	Table 3-2
CH<x>	INVert:	OFF (SCD1000) ON (SCD1000)	Table 3-2
CH<x>	OFFSet:	<NRx>	Table 3-2
CH<x>	RANge: (SCD1000)	<NRx>	Table 3-2
CH<x>	TYPEOffset:	PERCent VOLts	Table 3-2
CH<x>?			Table 3-2
CH<x>?	COUPling		Table 3-2
CH<x>?	INVert (SCD1000)		Table 3-2
CH<x>?	OFFSet		Table 3-2
CH<x>?	RANge (SCD1000)		Table 3-2
CH<x>?	TYPEOffset		Table 3-2
CH<x>?	PROBe (Option 1E)		Table 3-2
CH?			Table 3-2

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
CLOck	DATE:	<qstring>	Table 3-15
CLOck	TIME:	<qstring>	Table 3-15
CLOck?			Table 3-15
CLOck?	DATE		Table 3-15
CLOck?	TIME		Table 3-15
CROSS?	DFAll DRIse MAXLoc MFAll MINLoc MPEriod MRIse PFAll PRIse		Table 3-18
CROSS?			Table 3-18
CRS?			Table 3-9
CRS1	LOCTn:	WIN<ui>	Table 3-9
CRS2	LOCTn:	WIN<ui>	Table 3-9
CRS1	XPOint:	<NRx>	Table 3-9
CRS2	XPOint:	<NRx>	Table 3-9
CRS1?			Table 3-9
CRS2?			Table 3-9
CRS1?	LOCTn		Table 3-9
CRS2?	LOCTn		Table 3-9
CRS1?	XTIMe		Table 3-9
CRS2?	XTIMe		Table 3-9
CRS1?	XPOint		Table 3-9
CRS2?	XPOint		Table 3-9
CRS1?	YCOord		Table 3-9
CRS2?	YCOord		Table 3-9
CRSD	TYPETime:	HZ SECond	Table 3-9
CRSD?			Table 3-9

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
CRSD?	T		Table 3-9
CRSD?	TYPETime		Table 3-9
CRSD?	Y		Table 3-9
CRTBkgnd		<NRx>	Table 3-15
CRTBkgnd?			Table 3-15
CURSors		ON OFF	Table 3-9
CURSors?			Table 3-9
CURVe?			Table 3-6
DATA	BYTEOrder:	MSB LSB	Table 3-6
DATA	CNTrecord:	<NRx>	Table 3-6
DATA	COUNt:	<NRx>	Table 3-6
DATA	FLAGbit:	ON OFF	Table 3-6
DATA	STARt:	<NRx>	Table 3-6
DATA	STREcord:	<NRx>	Table 3-6
DATA?			Table 3-6
DATA?	BYTEOrder	MSB LSB	Table 3-6
DATA?	CNTrecord		Table 3-6
DATA?	COUNt		Table 3-6
DATA?	FLAGbit	ON OFF	Table 3-6
DATA?	STARt		Table 3-6
DATA?	STREcord		Table 3-6
DEBug	GPIb:	ON OFF	Table 3-8
DEBug?	[GPIb]		Table 3-8
DIAg?			Table 3-14
DISplay		ON OFF	Table 3-12

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
DISplay?			Table 3-12
DISTAl?			Table 3-18
DISTLevel	PERCent:	<NRx>	Table 3-18
DISTLevel	LEVEl:	<NRx>	Table 3-18
DISTLevel?			Table 3-18
DISTLevel?	PERCent		Table 3-18
DISTLevel?	LEVEl		Table 3-18
DT		RUN STOP HLDNxt OFF	Table 3-8
DT?			Table 3-8
ERAse		<NRx>	Table 3-10
EVEnt?			Table 3-7
EVQty?			Table 3-7
FALL?			Table 3-18
FALLSlew?			Table 3-18
FOCus		<NRx>	Table 3-15
FOCus?			Table 3-15
FPANel		ON OFF	Table 3-13
FPANel?			Table 3-13
FPStat?		<NRx>	Table 3-7
FREquency?			Table 3-18
GEOMArray?			Table 3-6
GRATicule		ON OFF	Table 3-9
GRATicule?			Table 3-9
HELp?			Table 3-8
HEXPMd		ALIgned INDep	Table 3-12
HEXPMd?			Table 3-12

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
ID?			Table 3-7
INIt		PANel GPIb [ALL]	Table 3-8
INTEnsity		<NRx>	Table 3-15
INTEnsity?			Table 3-15
INTERPolate?		<NRx>	Table 3-6
LEVMode		PERCent ABSOlute	Table 3-18
LEVMode?			Table 3-18
LINArray?			Table 3-6
LLSet?		<bblock>	Table 3-10
LONgform		ON OFF	Table 3-8
LONgform?			Table 3-8
MAXImum?			Table 3-18
MEAN?			Table 3-18
MEASUre	FUNction:	ON OFF	Table 3-18
MEASUre	MANmeas		Table 3-18
MEASUre	MEASZone:	CURSors FULl WIN1 WIN2 WIN3 WIN4	Table 3-18
MEASUre	WAVfrm:	<NRx>	Table 3-18
MEASUre	WINDow:	WIN1 WIN2 WIN3 WIN4	Table 3-18
MEASUre?			Table 3-18
MEASUre?	FUNction MEASZone WAVfrm WINDow		Table 3-18

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
MESIal?			Table 3-18
MESLevel	PERCent:	<NRx>	Table 3-18
MESLevel	LEVEl:	<NRx>	Table 3-18
MESLevel?			Table 3-18
MESLevel?	PERCent LEVEl		Table 3-18
MINImum?			Table 3-18
MSList	AREA:	ON OFF	Table 3-18
MSList	BASE:	ON OFF	Table 3-18
MSList	BASEAber:	ON OFF	Table 3-18
MSList	BASETop:	ON OFF	Table 3-18
MSList	DISTAL:	ON OFF	Table 3-18
MSList	FALL:	ON OFF	Table 3-18
MSList	FALLSlew:	ON OFF	Table 3-18
MSList	FREquency:	ON OFF	Table 3-18
MSList	MAXImum:	ON OFF	Table 3-18
MSList	MEAN:	ON OFF	Table 3-18
MSList	MESIal:	ON OFF	Table 3-18
MSList	MINImum:	ON OFF	Table 3-18
MSList	PERIod:	ON OFF	Table 3-18
MSList	PK_pk:	ON OFF	Table 3-18
MSList	PROXImal:	ON OFF	Table 3-18

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
MSList	RISE:	ON OFF	Table 3-18
MSList	RISESlew:	ON OFF	Table 3-18
MSList	RMS:	ON OFF	Table 3-18
MSList	TOP:	ON OFF	Table 3-18
MSList	TOPAber:	ON OFF	Table 3-18
MSList	WIDth:	ON OFF	Table 3-18
MSList	CLEar		Table 3-18
MSList?			Table 3-18
MSList?	AREA		Table 3-18
MSList?	BASE		Table 3-18
MSList?	BASEAber		Table 3-18
MSList?	BASETop		Table 3-18
MSList?	DISTAL		Table 3-18
MSList?	FALL		Table 3-18
MSList?	FALLSlew		Table 3-18
MSList?	FREquency		Table 3-18
MSList?	MAXimum		Table 3-18
MSList?	MEAN		Table 3-18
MSList?	MESIal		Table 3-18
MSList?	MINimum		Table 3-18
MSList?	PERiod		Table 3-18
MSList?	PK_pk		Table 3-18
MSList?	PROXImal		Table 3-18
MSList?	RISE		Table 3-18
MSList?	RISESlew		Table 3-18
MSList?	RMS		Table 3-18

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
MSList?	TOP		Table 3-18
MSList?	TOPAber		Table 3-18
MSList?	WIDth		Table 3-18
MTRig			Table 3-4
NWIn		1 2 4	Table 3-12
NWIn?			Table 3-12
OPTion?			Table 3-7
PATh		ON OFF	Table 3-8
PATh?			Table 3-8
PDAte		ON OFF	Table 3-17
PDAte?			Table 3-17
PERIod?			Table 3-18
PLOT?			Table 3-17
PTItle		<qstring>	Table 3-17
PTItle?			Table 3-17
PK_pk?			Table 3-18
PROXImal?			Table 3-18
PROXLevel	PERCent:	<NRx>	Table 3-18
PROXLevel	LEVEl:	<NRx>	Table 3-18
PROXLevel?			Table 3-18
PROXLevel?	PERCent LEVEl		Table 3-18
RAW		LINArray REFArray	Table 3-15
RAW?			Table 3-15
RECAll		<NRx>	Table 3-10
REFArray?			Table 3-6
REFList?			Table 3-16

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
REPEat?			Table 3-6
REPSet	NREPEat:	<NRx>	Table 3-6
REPSet?			Table 3-6
REPSet?	NREPEat		Table 3-6
RESUlts?			Table 3-18
RESUlts?	AREA		Table 3-18
RESUlts?	BASE		Table 3-18
RESUlts?	BASEAber		Table 3-18
RESUlts?	BASETop		Table 3-18
RESUlts?	DISTAL		Table 3-18
RESUlts?	FALL		Table 3-18
RESUlts?	FALLSlew		Table 3-18
RESUlts?	FREquency		Table 3-18
RESUlts?	MAXImum		Table 3-18
RESUlts?	MEAN		Table 3-18
RESUlts?	MESIal		Table 3-18
RESUlts?	MINImum		Table 3-18
RESUlts?	PERIod		Table 3-18
RESUlts?	PK_pk		Table 3-18
RESUlts?	PROXImal		Table 3-18
RESUlts?	RISE		Table 3-18
RESUlts?	RISESlew		Table 3-18
RESUlts?	RMS		Table 3-18
RESUlts?	TOP		Table 3-18
RESUlts?	TOPAber		Table 3-18
RESUlts?	WIDth		Table 3-18
RISE?			Table 3-18
RISESlew?			Table 3-18
RMS?			Table 3-18

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
RQS		ON OFF	Table 3-7
RQS?			Table 3-7
SAFEguard	ACQProtect	ON OFF	Table 3-11
SAFEguard	LINConvert	<NRX>	Table 3-11
SAFEguard	PROTect:	ON OFF	Table 3-11
SAFEguard	PUPtst:	ON OFF	Table 3-11
SAFEguard	SECURE		Table 3-11
SAFEguard	STOPAcq		Table 3-11
SAFEguard?			Table 3-11
SAFEguard?	ACQProtect		Table 3-11
SAFEguard?	PROTect		Table 3-11
SAFEguard?	PUPtst		Table 3-11
SAVE		<NRx>	Table 3-10
SET?			Table 3-10
SETRef		ON OFF RUN	Table 3-16
SETRef?			Table 3-16
SRQmask	ABSTouch:	ON OFF	Table 3-7
SRQmask	CMDerr:	ON OFF	Table 3-7
SRQmask	EXERr:	ON OFF	Table 3-7
SRQmask	EXWarn:	ON OFF	Table 3-7
SRQmask	INErr:	ON OFF	Table 3-7
SRQmask	INWarn:	ON OFF	Table 3-7

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
SRQmask	OPCmpl:	ON OFF	Table 3-7
SRQmask	USR1:	ON OFF	Table 3-7
SRQmask	USR2:	ON OFF	Table 3-7
SRQmask?			Table 3-7
SRQmask?	ABSTouch		Table 3-7
SRQmask?	CMDerr		Table 3-7
SRQmask?	EXERr		Table 3-7
SRQmask?	EXWarn		Table 3-7
SRQmask?	INErr		Table 3-7
SRQmask?	INWarn		Table 3-7
SRQmask?	OPCmpl		Table 3-7
SRQmask?	USR1		Table 3-7
SRQmask?	USR2		Table 3-7
TESt	LOOp:	ON OFF	Table 3-14
TESt	NUM:	<NRx>	Table 3-14
TESt	SYS:	ALL DIG FP MPU OPTion	Table 3-14
TESt	VERBose:	ON OFF	Table 3-14
TESt?			Table 3-14
TESt?	LOOp		Table 3-14
TESt?	NUM		Table 3-14
TESt?	SYS		Table 3-14
TESt?	VERBose		Table 3-14
TEXt	CHAR:	<NRx>	Table 3-12
TEXt	CLEar:	<NRx>	Table 3-12

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
TEXt	LINE:	<NRx>	Table 3-12
TEXt	STRIng:	<qstring>	Table 3-12
TIMESt?			Table 3-6
TOP?			Table 3-18
TOPAber?			Table 3-18
TOPMode	METhod:	ABSOlute HISTOGram HISTOMean MAXimum	Table 3-18
TOPMode	LEVEl:	<NRx>	Table 3-18
TOPMode?			Table 3-18
TOPMode?	METhod		Table 3-18
TOPMode?	LEVEl		Table 3-18
TRIgger	COUPling:	AC DC	Table 3-4
TRIgger	DELay:	<NRx>	Table 3-4
TRIgger	LEVEl:	<NRx>	Table 3-4
TRIgger	MODe:	AUTo NORmal	Table 3-4
TRIgger	SLOpe:	PLUs MINUs	Table 3-4
TRIgger	SOUrce:	CHA (SCD1000) CHB (SCD1000) ADD (SCD1000) EXTernal INTernal (SCD5000 Opt 01) CALIBRATOR (SCD5000)	Table 3-4
TRIgger	TYPEDelay:	PERCent SECond	Table 3-4
TRIgger	TYPELevel:	PERCent VOLts	Table 3-4
TRIgger?			Table 3-4
TRIgger?	COUPling		Table 3-4
TRIgger?	DELay		Table 3-4
TRIgger?	LEVEl		Table 3-4

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
TRIgger?	MODe		Table 3-4
TRIgger?	SLOpe		Table 3-4
TRIgger?	SOUrce		Table 3-4
TRIgger?	TYPEDelay		Table 3-4
TRIgger?	TYPELevel		Table 3-4
UID		<qstring>	Table 3-7
UID?			Table 3-7
UNIts?			Table 3-18
UNIts?	AREA		Table 3-18
UNIts?	BASE		Table 3-18
UNIts?	BASEAber		Table 3-18
UNIts?	BASETop		Table 3-18
UNIts?	DISTAL		Table 3-18
UNIts?	FALL		Table 3-18
UNIts?	FALLSlew		Table 3-18
UNIts?	FREquency		Table 3-18
UNIts?	MAXImum		Table 3-18
UNIts?	MEAN		Table 3-18
UNIts?	MESIal		Table 3-18
UNIts?	MINImum		Table 3-18
UNIts?	PERIod		Table 3-18
UNIts?	PK_pk		Table 3-18
UNIts?	PROXImal		Table 3-18
UNIts?	RISE		Table 3-18
UNIts?	RISESlew		Table 3-18
UNIts?	RMS		Table 3-18
UNIts?	TOP		Table 3-18
UNIts?	TOPAber		Table 3-18
UNIts?	WIDth		Table 3-18

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
USER1		<qstring1><qstring2>	Table 3-8
USER2		<qstring1><qstring2>	Table 3-8
USER1?			Table 3-8
USER2?			Table 3-8
VERSion?			Table 3-7
VMOde		CHA (SCD1000) CHB (SCD1000) ADD (SCD1000)	Table 3-1
VMOde?			Table 3-1
VIDeo		ON OFF	Table 3-14
VIDeo?			Table 3-14
WAVfrm?			Table 3-6
WFMpre?			Table 3-5
WFMpre?	BIT/nr		Table 3-5
WFMpre?	BN.fmt		Table 3-5
WFMpre?	BYT/nr		Table 3-5
WFMpre?	BYT/or		Table 3-5
WFMpre?	CRVchk		Table 3-5
WFMpre?	ENCdg		Table 3-5
WFMpre?	NR.pt		Table 3-5
WFMpre?	PT.Fmt		Table 3-5
WFMpre?	PT.Off		Table 3-5
WFMpre?	WFId		Table 3-5
WFMpre?	XINcr		Table 3-5
WFMpre?	XUNit		Table 3-5
WFMpre?	XZEro		Table 3-5
WFMpre?	YMUlt		Table 3-5
WFMpre?	YOFf		Table 3-5
WFMpre?	YUNit		Table 3-5

Table 2-2: Alphabetical Command Set Listing (Cont.)

Header	Link	Argument	Reference Section 3
WFMpre?	YZEro		Table 3-5
WFTx		DL IL TCF	Table 3-5
WFTx?			Table 3-5
WIDth?			Table 3-18
WIN<ui>	EXPnt:	<NRx>	Table 3-12
WIN<ui>	HEXPNd:	<NRx>	Table 3-12
WIN<ui>	RECOrd:	<NRx>	Table 3-12
WIN<ui>	VEXpnd:	<NRx>	Table 3-12
WIN<ui>?			Table 3-12
WIN<ui>?	EXPnt		Table 3-12
WIN<ui>?	HEXPNd		Table 3-12
WIN<ui>?	RECOrd		Table 3-12
WIN<ui>?	VEXpnd		Table 3-12
WIN?			Table 3-12

GPIB Command Set

This section lists the GPIB commands for the SCD1000/SCD5000. Command syntax and other general information about the IEEE−488.1 interface are provided in Section 2. This section includes commands for the vertical system, arm and trigger systems, and acquisition parameters. Commands that affect data and waveforms, status and events, waveform preamble, and diagnostics and calibration are also listed, as well as GPIB-related commands, and other instrument commands. Other tables list initialization values and value limits.

Command Table Summary

The following tables are in this section.

Vertical Commands

In the Vertical commands, <x> can be A, or B (for the SCD1000 only); <x> is NULL for SCD5000.

Table 3-1: Vertical Mode Commands

Header	Link	Argument	Description
VMOde		ADD CHA CHB	SCD1000 Only. Selects input source from either channel or the algebraic sum of both. Factory setting: CHA Example: `VMODE ADD`
VMOde?			SCD1000 only. Queries for input channel selection. Example: `VMODE?` Response: `VMODE CHA`

Table 3-2: Vertical Channel Commands

Header	Link	Argument	Description
CH<x>	COUPling:	AC (SCD1000) DC OFF(SCD1000)	SCD1000: Sets the specified channel coupling to AC, DC,or OFF (input disconnected from signal). SCD5000: DC coupling only. Factory setting: AC Example: `CHA COUPLING:AC`
CH<x>	INVert:	ON OFF	SCD1000 only. Inverts the signal from the specified channel (x). Factory setting: OFF Example: `CHB INVERT:ON`
CH<x>	OFFSet:	<NRx>	Sets the specified channel input offset to <NRx>Limits: SCD1000:±250 mV to ±25 V (1X probe attenuation); SCD5000: ±4 V Factory setting: 0 Example: `CHA OFFSET:1.25` (SCD1000) Example: `CH OFFSET:1.25` (SCD5000)
CH<x>	RANge:	<NRx>	SCD1000 only. Sets specified channel full scale range. The valid settings are 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V,10 V (1X probe attenuation). Limits: 100 mV to 10 V (1X probe attenuation) Factory setting: 1 V Example: `CHA RANGE:200E-3`
CH<x>	TYPEOffset:	PERCent VOLts	Sets the specified channel input offset unit to PERCent of full-scale range or VOLts. Factory setting: VOLTS Example: `CHA TYPEOFFSET:PERCENT`

Table 3-2: Vertical Channel Commands (Cont.)

Header	Link	Argument	Description
CH<x>?			Queries for all settings for the specified channel: COUPling, RANge, TYPEOffset, OFFSet, INVert, and PROBe Example: `CHB?` Response: `CHB COUPLING:AC,RANGE:200.E-3, TYPEOFFSET:PERCENT,OFFSET:10.E-1, INVERT:OFF,PROBE:"NOT INSTALLED."`
CH<x>?	COUPling		Queries for the channel's input coupling setting. SCD1000 responds with AC, DC, or OFF. SCD5000 responds with DC only. Example: `CHA? COUPLING` Response: `CHA COUPLING:AC`
CH<x>?	INVert		SCD1000 only. Queries for the channels signal invert setting. Example: `CHB? INVERT` Response: `CHB INVERT:OFF`
CH<x>?	OFFSet		Queries for the channel's offset. The response is a floating point number with an exponent. Example: `CHB? OFFSET` Response: `CHB OFFSET:100.E-3`
CH<x>?	RANge		Queries for the channel's full scale range setting. SCD1000 responds with it's range setting; SCD5000 responds with a range of 5 Volts. Example: `CHA? RANGE` Response: `CHA RANGE:200.E-3` (SCD1000) Response: `CH RANGE:5.0` (SCD5000)
CH<x>?	TYPEOffset		Queries for the channel's input offset units. Example: `CHA? TYPEOFFSET` Response: `CHA TYPEOFFSET:VOLTS`
CH<x>?	PROBe (Option 1E)		Queries for the channel's probe value. Returns the Level (I or II) of probe attached to the channel and a string of information generated by the probe. If no probe is attached, the return value is: "NOT INSTALLED." Example: `CHA? PROB` Response: `CHA PROBE:"NOT INSTALLED,"`
CH?			Queries for all settings of all channels: COUPling, RANge, TYPEOffset, OFFSet, and INVert. Example: `CH?` Response: `CHA COUPLING:AC,RANGE:200.E-3, YPEOFFSET:PERCENT,OFFSET:10.E-1, INVERT:ON,PROBE:"NOT INSTALLED";CHB COUPLING:DC,RANGE:500E-3,TYPEOFFSET:VOLTS, OFFSET:1.E0,INVERT:ON,PROBE:"NOT INSTALLED"`

Acquire Commands

Table 3-3: Acquire Commands

<table>
<tr><th>Header</th><th>Link</th><th>Argument</th><th>Description</th></tr>
<tr><td>ACQuire</td><td>AVErage:</td><td><NRx></td><td>Sets the number of averages to perform in AVErage mode.
Limits: 1 to 1024
Factory setting: 16
<table>
<tr><th>Number of Averages</th><th>Resolution of Curve Data</th></tr>
<tr><td>1–3</td><td>11 bits</td></tr>
<tr><td>4–15</td><td>12 bits</td></tr>
<tr><td>16–98</td><td>13 bits</td></tr>
<tr><td>99–1024</td><td>14 bits</td></tr>
</table></td></tr>
<tr><td>ACQuire</td><td>GEOmetry:</td><td>ON
OFF
RUN</td><td>Enables internal vertical geometry correction.
Factory setting SCD1000 OFF, SCD5000 ON
Performs internal calibration to create the correction table to improve vertical linearity using the instrument's current acquisition settings.</td></tr>
<tr><td>ACQuire</td><td>HLDNxt:</td><td>ON
OFF</td><td>Turns on or off holdnext acquisition mode. ACQuire STATe must be set to HLDNxt.
Factory setting: OFF
Example: <code>ACQUIRE HLDNXT:ON</code></td></tr>
<tr><td>ACQuire</td><td>LENgth:</td><td>256
512
1024</td><td>Selects the record length in sample points of all records. See Acquisition System in Section 1.
Limits: 256, 512, 1024.
Factory setting: 512
Example: <code>ACQUIRE LENGTH:256</code></td></tr>
<tr><td>ACQuire</td><td>MODe:</td><td>NORmal
ADVance
AVErage</td><td>Sets the acquisition mode. NORmal fills only the record specified by the STArt command. ADVance fills a specified number of consecutive records set by NRECord starting with record specified by the STArt command. AVErage averages a number of acquisitions set by ACQuire:AVErage. The result is placed in the record specified by the STArt command. See also Acquisition Sequence and Acquisition Process in Section 1.
Factory setting: NORmal
Example: <code>ACQUIRE MODE:ADVANCE</code></td></tr>
<tr><td>ACQuire</td><td>NRECord:</td><td><NRx></td><td>Sets the number of consecutive records to fill in ADVance mode.
Limits: 1 to 16.
Factory setting: 1
Example: <code>ACQUIRE NRECORD:4</code></td></tr>
</table>

Table 3-3: Acquire Commands (Cont.)

Header	Link	Argument	Description
ACQuire	STARt:	<NRx>	Selects the record where the next acquisition starts. Records 1, 2, 3 and 4 are stored in nonvolatile memory. Limits: 1 to 16. Factory setting: 1 Example: `ACQUIRE START:2`
ACQuire	STATe:	STOp RUN HLDNxt	Controls the acquisition state. STOp immediately stops the acquisition sequence. RUN starts the acquisition sequence and causes the digitizer to perform as many acquisitions as possible. HLDNxt completes one acquisition process and then stops. See Acquisition Sequence and Acquisition Process in Section 1 for more information. At the end of each acquisition process an operation complete (OPC) SRQ is generated.
ACQuire	TIME:	<NRx>	Sets the time window duration. Limits: 5 ns to 100 μs Factory setting: 1E−6 (1 μs) Example: `ACQUIRE TIME:10E-9`
ACQuire?			Queries for all the acquisition settings: STATe, HLDNxt, TIMe, LENgth, MODe, NRECord, STArt, and LASt Example: `ACQUIRE?` Response: `ACQUIRE STATE:STOP,HLDNXT:OFF,TIME:5.E-9LENGTH:512, MODE:ADVANCE,NRECORD:8,AVERAGEL16,START:2, LAST:2,GEOMETRY:OFF`
ACQuire?	AVErage		Queries for the number of acquisitions to average when in the Average mode. Example: `ACQUIRE? AVERAGE` Response: `ACQUIRE AVERAGE:16`
ACQuire?	GEOmetry		Queries for the state of internal geometry correction. Example: `ACQUIRE? GEOMETRY` Response: `ACQUIRE GEOMETRY ON/OFF`
ACQuire?	HLDNxt		Queries for the state (ON or OFF) of the holdnext acquisition mode. Example: `ACQUIRE? HLDNXT` Response: `ACQUIRE HLDNXT:OFF`
ACQuire?	LASt		Query only. Queries for the number of the last valid record. Only completed records are valid. Example: `ACQUIRE? LAST` Response: `ACQUIRE LAST: 6`

Table 3-3: Acquire Commands (Cont.)

Header	Link	Argument	Description
ACQuire?	LENgth		Queries for the record length in sample points. Example: `ACQUIRE? LENGTH` Response: `ACQUIRE LENGTH:1024`
ACQuire?	MODe		Queries for the acquisition mode (NORmal, ADVance or AV-Erage). Example: `ACQUIRE? MODE` Response: `ACQUIRE MODE:ADVANCE`
ACQuire?	NRECord		Queries for the number of records to acquire when in AD-Vance mode. Example: `ACQUIRE? NRECORD` Response: `ACQUIRE NRECORD:8`
ACQuire?	STARt		Queries for the first record to be filled. Example: `ACQUIRE? START` Response: `ACQUIRE START:2`
ACQuire?	STATe		Queries for the state of the acquisition process (STOp, RUN,or HLDNxt). Example: `ACQUIRE? STATE` Response: `ACQUIRE STATE:HLDNXT`
ACQuire?	TIME		Queries for the time window setting. Example: `ACQUIRE? TIME` Response: `ACQUIRE TIME:5.E-9`

Trigger Commands

Table 3-4: Trigger Commands

Header	Link	Argument	Description
ARM		INTERnal EXTernal	Selects the source of the trigger arming signal: INTERnal automatically arms at the start of each sequence; EXTernal arms at a closure to ground of the rear panel ARM INPUT connector. This function operates with later version Control boards; noncompatible versions elicit an error message. Example: `ARM INTERnal`
ARM?			Queries for the setting of the arming mode (Internal or External). Example: `ARM?`
MTRig			Set only. Immediately triggers the digitizer. Example: `MTRIG` (This command has no argument.)
TRIgger	COUPling:	AC DC (SCD1000 and SCD5000 with Option 01)	SCD1000: Sets trigger signal coupling to AC,or DC (AC attenuates signal components <1 kHz). SCD5000: AC coupling only. Factory setting: AC Example: `TRIGGER COUPLING:DC`
TRIgger	DELay:	<NRx>	Positions the time window relative to the trigger event. Trigger delay can be specified in terms of percent of the record length or seconds. See Triggering in Section 1. Limits: 0 to 9 times the record length. Factory setting: 0 Example:`TRIGGER POSITION:50` (Delay is 50%.)
TRIgger	LEVEl:	<NRx>	Sets trigger level to the value specified by <NRx>. Units specified by TYPELevel command (% or volts). See Section 1 for more information on triggering. Limits: AC Coupling: ±100% of vertical range; DC Coupling: ±50% of vertical range Factory setting: 0.0 volts Example: `TRIGGER LEVEL:25` (Trigger level is set to 25% of full-scale range if the typelevel is set to percent.)
TRIgger	MODe:	AUTo NORmal	Selects trigger mode. In AUTo mode, triggering occurs when the trigger event is detected or 360 ms after the start of acquisition sequence, whichever comes first. In Normal mode, only a proper trigger event can trigger the digitizer. Factory setting: AUTo Example: `TRIGGER MODE:NORMAL`

Table 3-4: Trigger Commands (Cont.)

Header	Link	Argument	Description
TRIgger	SLOpe:	PLUs MINUs	Sets trigger slope to positive (PLUs) or negative (MINUs) edge triggering Factory setting: PLUs Example: `TRIGGER SLOPE:MINUS`
TRIgger	SOUrce:	SCD1000: CHA CHB ADD EXTernal SCD5000 INTernal CALIBRATOR SCD5000 with Option 01 INTernal EXTernal	Sets trigger source to channel A, B, the algebraic sum of A and B,or the external input. SCD5000: Sets the trigger source to the external input or the internal time calibrator signal. SCD5000 Option 01 sets the trigger source to the external input or the internal trigger pickoff. Factory setting: SCD1000: CHA; SCD5000: EXTernal Example: `TRIGGER SOURCE:CHB`
TRIgger	TYPEDelay	PERCent SECond	Sets the unit of trigger delay to percent or seconds. Factory setting: SECond Example: `TRIGGER TYPEDELAY:PERCENT`
TRIgger	TYPELevel:	PERCent VOLts	Sets the units of trigger level to percent of full scale range or to volts. PERCent allowed only for internal trigger sources. External source forces TYPELevel to VOLts. See also TRIgger LEVEl command and Triggering in Section 1. Factory setting: VOLTs Example: `TRIGGER TYPELEVEL:PERCENT`
TRIgger?			Queries for all trigger settings: SOUrce, TYPELevel, LEVEl, TYPEDelay, DELlay, SLOpe, COUPling, and MODe. Example: `TRIGGER?` Response: `TRIGGER SOURCE:CHB,TYPELEVEL:PERCENT,LEVEL:40, TYPEDELAY:PERCENT,DELAY:50,SLOPE:PLUS, COUPLING:AC,MODE:AUTO`
TRIgger?	COUPling		Queries for the setting of the trigger coupling. Example: `TRIGGER? COUPLING` Response: `TRIGGER COUPLING:AC`
TRIgger?	DELay		Queries for the setting of the trigger delay. Example: `TRIGGER? DELAY` Response: `TRIGGER DELAY:150` (Delay is 150 percent.)
TRIgger?	LEVEl		Queries for the setting of the trigger level. Example: `TRIGGER? LEVEL` Response: `TRIGGER LEVEL:125.E-3`

Table 3-4: Trigger Commands (Cont.)

Header	Link	Argument	Description
TRIgger?	MODe		Queries for the setting of the trigger mode (AUTo or NORmal). Example: `TRIGGER? MODE`
TRIgger?	SLOpe		Queries for the setting of the trigger slope (PLUs or MINUs). Example: `TRIGGER? SLOPE` Response: `TRIGGER SLOPE:MINUS`
TRIgger?	SOUrce		Queries for the setting of trigger source: SCD1000: CHA, CHB, ADD, or EXTernal: SCD5000: EXTernal, INTernal Option 01), or CALIBRATOR. Example: `TRIGGER? SOURCE` Response: `TRIGGER SOURCE:EXTERNAL`
TRIgger?	TYPEDelay		Queries for unit of the trigger delay (PERCent or SECond). Example: `TRIGGER? TYPEDELAY` Response: `TRIGGER TYPEDELAY:SECOND`
TRIgger?	TYPELevel		Queries for unit of the trigger level (PERCent or VOLts). Example: `TRIGGER? TYPELEVEL` Response: `TRIGGER TYPELEVEL:PERCENT`

Waveform Preamble Commands

The waveform preamble contains scaling, encoding and other information that the controller can use to reconstruct the waveform from the data. Some of the data in the query are values set by the DATA command parameters and other commands. See Table 3-6 for DATA commands.

Table 3-5: Waveform Preamble Commands

Header	Link	Argument	Description
WFMpre?			Query only. Queries for all WFMpre data. Example: `WFMPRE?` Response: `WFMPRE WFID:"CH1 7 89-09-22 07:24:33 25",ENCDG:BINARY,NR.PT:512;PT.FMT:Y,XINCR: 5.E-9,PTOFF:64,XZERO:0,XUNIT:SECONDS, YMULT:3.91.E-3,YZERO:100.E-3,YOFF:127, YUNIT:VOLTS,BYT/NR:1,BN.FMT:RI,BIT/NR:8, CRVCHK:NULL`
WFMpre?	BIT/nr		Query only. Queries for the number of bits per binary waveform data point (the sample point). The range is 11 to 14 bits. Example: `WFMPRE? BIT/NR` Response: `WFMPRE BIT/NR:11`
WFMpre?	BN.fmt		Query only. Queries for the Tek Codes & Formats binary number format. This value is always RI (right justified). Example: `WFMPRE? BN.FMT` Response: `WFMPRE BN.FMT:RI`
WFMpre?	BYT/nr		Query only. Queries for the number of bytes per binary waveform data point (sample point). This value is always 2 bytes per sample point. Example: `WFMPRE? BYT/NR` Response: `WFMPRE BYT/NR:2`
WFMpre?	BYT.or		Query only. Queries the order of curve data byte order. The first byte transmitted of the curve data word is identified using this query. Example: `WFMPRE? BYT.OR` Response: `WFMPRE BYT.OR:MSB`
WFMpre?	CRVchk		Query only. Queries for the checksum (NONE, NULL, or CHKSM0) that is appended to the binary waveform data stream. NONE is returned when WFTx is IL. NULL is returned when WFTx is DL. CHKSM0 is returned when WFTx is TCF. See WFTx command on page 3-12. Example: `WFMPRE? CRVCHK` Response: `WFMPRE CRVCHK:NULL`

Table 3-5: Waveform Preamble Commands (Cont.)

Header	Link	Argument	Description
WFMpre?	ENCdg		Query only. Queries for the encoding of the binary waveform data stream sent from the digitizer. This value is always BINARY. Example: `WFMPRE? ENCDG` Response: `WFMPRE ENCDG:BINARY`
WFMpre?	NR.pt		Query only. Queries for the number of points in the waveform to be transmitted. This value is set by the DATA COUNt and DATA CNTrecord commands (see page 3-13). Response is a signed integer. Example: `WFMPRE? NR.PT` Response: `WFMPRE NR.PT:512`
WFMpre?	PT.Fmt		Query only. Queries for the point format of the binary waveform data. This value is always "Y" meaning that the byte defines the amplitude of the waveform at each sample interval. Example: `WFMPRE? PT.FMT` Response: `WFMPRE PT.FMT:Y`
WFMpre?	PT.Off		Query only. Queries for the number of sample points between the trigger point and the first point being transmitted. This value is affected by the DATA STARt and TRIGGER POSITION commands. Example: `WFMPRE? PT.OFF` Response: `WFMPRE PT.OFF:127`
WFMpre?	WFId		Query only. Queries for the waveform identification string. The response is a quoted string indicating the channel number, record number, date and time of acquisition, and the number of missing data points on the centroided waveform ("Ch# REC# date time xx"). If more than one record is being sent,only the beginning record number is indicated. Example: `WFMPRE? WFID` Response: `WFMPRE WFID:"CHA 4 89-12-15 23:14:22.62 54"`
WFMpre?	XINcr		Query only. Queries for the sample interval of the waveform. The response is a floating point number with an exponent. This value is set by the ACQUire TIME command. Example: `WFMPRE? XINCR` Response: `WFMPRE XINCR:50.E-9`
WFMpre?	XUNit		Query only. Queries for the horizontal unit of measure for the waveform. This value is always SEConds. Example: `WFMPRE? XUNIT` Response: `WFMPRE XUNIT:"SECONDS"`

Table 3-5: Waveform Preamble Commands (Cont.)

Header	Link	Argument	Description
WFMpre?	XZEro		Query only. Queries for the horizontal offset of the waveform data. The response is <NR3> and is always zero. Example: `WFMPRE? XZERO` Response: `WFMPRE XZERO:0E-3`
WFMpre?	YMUl		Query only. Queries for the vertical scale factor (multiplier in volts) of the waveform data. This number is any of the full-scale vertical range settings divided by 512 or 2048 (the current vertical resolution). The response is a floating point number with an exponent. Example: `WFMPRE? YMULT` Response: `WFMPRE YMULT:3.91.E-3`
WFMpre?	YOFf		Query only. Queries for the center value of the waveform data. Example: `WFMPRE? YOFF` Response: `WFMPRE YOFF:1024`
WFMpre?	YUNit		Query only. Queries for the vertical unit of measure for the waveform. Example: `WFMPRE? YUNIT` Response: `WFMPRE YUNIT:"VOLTS"`
WFMpre?	YZEro		Query only. Queries for the vertical offset of the waveform. This value is set by the CH<x> OFFSET command. The response is a floating point number with an exponent. Example: `WFMPRE? YZERO` Response: `WFMPRE YZERO:100.E-3`
WFTx		DL IL TCF	Sets the waveform transfer format. DL = Definite Length Binary Block. IL = Indefinite Length Binary Block. TCF = Tek Codes and Formats. See Section 5 for more information on transfer formats. Factory setting: DL Example: `WFTX IL`
WFTx?			Queries for the waveform transfer format (DL, IL, or TCF). Example: `WFTX?` Response: `WFTX TCF`

Data and Waveform Commands

The CURVE? query causes the SCD to transmit waveform data to the controller. The amount of data that is sent is defined by the DATA command parameters (DATA statement). See Table 3-5 earlier in this section.

Table 3-6: Data and Waveform Commands

Header	Link	Argument	Description
CURVe?			Query only. Sends the SCD's binary waveform data to the GPIB port. The data sent is specified by the DATA command parameters. Example: `CURVE?` The response to CURVe? depends on the transmission format (WFTx commands) and the DATA statement. See page 3-12 for the WFTx command. ***NOTE***: *Data which was interpolated rather than recorded is flagged by setting the 15th bit in the data word (Data would be of the pattern: 4xxxH).*
DATA	BYTEOrder:	MSB LSB	MSB selects the most significant byte of the data portion to be transmitted first. LSB selects the least significant byte of the data portion to be transmitted first Example: `DATA BYTEORDER: MSB` `DATA? BYTEORDER`
DATA	CNTrecord:	<NRx>	Sets the number of records to be transferred. The first record is set by the DATA STREcord command. Limits: 1 to 16 Factory setting: 1 Example: `DATA CNTRECORD:4`
DATA	COUNt:	<NRx>	Sets the number of points in the curve to be transferred (the starting point is included in the transfer). If COUNt:0 is specified,the entire record is transmitted. Limits: 0 to record length Factory setting: 0 Example: `DATA COUNT:128`
DATA	FLAGbit:	ON OFF	ON selects the interpolation flag bit (bit 15) to be enabled on all curve data that was generated by interpolation. OFF selects masking of the interpolation flag bit (bit 15) on all curve data output. Example: `DATA FLAGBIT:ON` `DATA? FLAGBIT`
DATA	STARt:	<NRx>	Sets the starting point in the selected record where transferred waveform data starts. Limits: 1 to record length. Factory setting: 1 Example: `DATA START:64`

Table 3-6: Data and Waveform Commands (Cont.)

Header	Link	Argument	Description
DATA	STREcord:	<NRx>	Selects the first record to be transferred. Limits: 1 to 16 Factory setting: 1 Example: `DATA STRECORD:10`
DATA?			Queries for all settings of the data command for all channels: CNTrecord, COUNt, STARt and STREcord. Example: `DATA?` Response: `DATA CNTRECORD:0,COUNT:1024,START:1, STRECORD:1`
DATA?	BYTEOrder		Queries for the data transmission byte order. Example: `DATA? BYTEORDER` Response: `DATA BYTEORDER:MSB`
DATA?	CNTrecord		Queries for the number of records to include in a waveform transfer. Example: `DATA? CNTRECORD` Response: `DATA CNTRECORD:16`
DATA?	COUNt		Queries for the number of points to include in a waveform data transfer. Example: `DATA? COUNT` Response: `DATA COUNT:1024`
DATA?	FLAGbit		Queries the status of the interpolation flag bit (bit 15) for curve data output. Example: `DATA? FLAGBIT` Response: `DATA? FLAGBIT:OFF`
DATA?	STARt		Queries for the data transfer starting point in the selected record. Example: `DATA? START` Response: `DATA START:64`
DATA?	STREcord		Queries for first record to include in a waveform transfer. Example: `DATA? STRECORD` Response: `DATA STRECORD:1`
GEOMArray?			Query only. Sends the vertical geometry correction array data to the GPIB port only. Only DL format is allowed and the byte order is always MSB first. The WFTx setting is ignored (see WFTx command on page 3-12). See section **?** for more information. Example: `GEOMARRAY?` Response: `GEOMARRAY #3581 <data>... {null checksum}`

Table 3-6: Data and Waveform Commands (Cont.)

Header	Link	Argument	Description
INTERPolate?		<NRx>	Query only. Queries for the number of interpolated data points of the specified record. Limits: 1 to 16 Example: INTERPOLATE? 1:12
INTERPolate?			Query only. Queries for the number of interpolated data points of all records. Example: INTERPOLATE? 1:12, 2:512, 3:1024 {etc... to 16 recs}
LINArray?			Query only. Sends the raw, uncentroided waveform data to the GPIB port. Only DL format is allowed. The WFTx setting is ignored (see WFTx command on page 3-12). Refer to Figure 5-1 for data format. Example: LINARRAY? Response: LINARRAY #517584 <data>...{null checksum}
REFArray?			Query only. Sends the blanking pixel map of the target to the GPIB. This array is used in the digitizer to remove target irregularities. Only DL format is allowed. The WFTx setting is ignored (see WFTx command on page 3-12). Refer to Figure 5-1 for data format. Example: REFARRAY? Response: REFARRAY #6524289 <data>...{null checksum}
REPEat?			Query Only. Starts repeat cycle set up by the REPSet command. The SCD repeatedly (according to values set by REPSet command) acquires and then transmits binary waveform data to the controller. (Any command from the bus or front panel aborts the REPEat process.) The data sent is specified by the DATA command parameters. Example: REPEAT? The response to this command is the waveform data acquired and transmitted to the controller. Transmission format is specified by the WFTX command (see page 3-12).
REPSet	NREPEat:	<NRx>	Sets the SCD to execute repeat mode acquisition and transfer mode. In this mode, the SCD is set to capture the number of records defined using NRECORD command and automatically transfer the waveform data to a waiting GPIB controller. The controller does not need to query for the waveform data transfer using the CURVe? query. If <NRx> = 0, the process is repeated indefinitely until the SCD is listen addressed with any command. At that time, the process is terminated. Limits: 0 to ($2^{32}-1$) Factory setting: 1 Example: REPSET NREPEAT:10

Table 3-6: Data and Waveform Commands (Cont.)

Header	Link	Argument	Description
REPSet?			Queries for the number of times to execute the repeat cycles. Example: `REPSET?` Response: `REPSET NREPEAT:10`
REPSet?	NREPEat		Queries for the number of times to execute the repeat cycle. Example: `REPSET? NREPEAT` Response: `REPSET NREPEAT:12`
TIMESt?			Query only. Queries for the time stamps of all acquired records. The value of the time stamp is the date and time of each trigger event, in yy-mm-dd hh:mm:ss.ss format. Example: `TIMEST?` Response: `TIMEST? 1:"89-12-15 12:42:53.42:,2:"89-12-15 13:22:54.22", 3:"89-12-15 16:22:33.23", 4:"89-12-15 18:22:34.76", 5:"...."... to 16 records.`
TIMESt?	<ui>		Query only. Queries for the date/time stamp of the specified record. The value of the time stamp is the date and time of the trigger event in yy-mm-dd hh:mm:ss.ss format. Example: `TIMEST? 12` Response: `TIMEST 12:"89-12-15 12:42:33.61"`
WAVfrm?			Query only. Sends the waveform preamble and waveform data to the GPIB port. The transmitted data depends on the DATA statement and the WFTx command. This query is equivalent to sending a WFMpre? query followed by a CURVe? query. See Table 3-5 for the WFMpre? query and WFTx commands. Example: `WAVFRM?` Response: See WFMpre? query in Table 3-5 and CURVe? query at the beginning of this table.

Status and Event Commands

The following commands are used to control and report the details of operating status to the controller. Details on status bytes and events codes can be found in Section 4.

Table 3-7: Status and Event Commands

Header	Link	Argument	Description
ALLEv?			Query only. Queries the SCD for all event codes. If the LONgform command is ON, the event code is followed by a quoted string describing the event code. If OFF, only the event code is sent. To return all event codes, either the RQS OFF command must first be sent or all events must have been serially polled. If RQS is ON, only the most recent event code will be returned followed by an error. See RQS command below. See also Section 4 for more information on the event codes. Example: `ALLEV?` Response: `ALLEV 156, "Unknown symbol", 157, "Syntax error"` (RQS is OFF.)
EVEnt?			Query only. Queries the SCD for the most recent event code. If the LONgform command is set to ON, the event code is followed by a quoted string describing the event code. If LONgform is OFF, only the event code is sent. If RQS is ON, an event code will be returned only if a serial poll has been performed before requesting the event code. If RQS is OFF, a serial poll is not necessary prior to requesting the event code. However, corresponding status bytes are lost when consecutive event codes are requested. See the RQS command later in this table. See also Section 4 for information on status bytes and event codes. Example: `EVENT?` Response: `EVENT 455,"Self test completed successfully"`
EVQty			Query only. Queries the SCD for how many events are waiting to be queried (up to a maximum of 20). The response is a signed integer. Example: `EVQTY?` Response: `EVQTY 3`

FPStat?			Query only. Queries for all 20 Front Panel status messages.
			Example: `FPSTAT?`
			Response: `FPSTAT 1: "Power on initialization complete",1:"",`
			`2:"Self test completed successfully",2:"", ...`
			`{continue for all 20 status msgs}`

Table 3-7: Status and Event Commands (Cont.)

Header	Link	Argument	Description
FPStat?		<NRx>	Query only. Queries for one of the 20 Front Panel status messages that are buffered within the system. Status messages may occupy one or two lines on the display. Each of the status lines are output as separate strings using this query. Limits: 1 to 20 Example: `FPSTAT? 1` Response: `FPSTAT 1: "Power on initialization complete?,1:""`
ID?			Query only. Queries the SCD for information about the digitizer. The response includes the firmware version numbers for the digitizer and Display Unit. Example: `ID?` Response: `ID "TEK/SCD1000,V81.1,DIG/1.0, DSY/3.00`
OPTion?			Query only. Queries for the options installed in the digitizer. Possibilities are OPT 1E: TEK type II probe OPT 2E: SMA input connectors OPT 1P: Fast wfm capture OPT 2F: HSDO & battery backed-up linear array OPT 01: Delay line (SCD5000 only) Example: `OPTION?` Response: `OPTION "01 Delay line"`
RQS		ON OFF	Enables or disables the digitizer's ability to assert the SRQ line when an event occurs or a condition changes. ON enables; OFF disables. When OFF, the digitizer does not request service from the controller. The controller must poll the digitizer to determine if it needs to be serviced. See also SRQMask command in this table and Section 4 for more details. Factory setting: ON Example: `RQS OFF`
RQS?			Queries for the RQS status. Example: `RQS` Response: `RQS ON`
SRQmask	ABSTouch:	ON OFF	Enables (ON) or disables (OFF) SRQ assertion as the result of a front panel change, either by the ABSTouch command or button pushes. See also the ABSTouch command in Table 3-8. Factory setting: OFF Example: `SRQMASK ABSTOUCH:OFF`

Table 3-7: Status and Event Commands (Cont.)

Header	Link	Argument	Description
SRQmask	CMDerr: EXERr: EXWarn: INErr: INWarn: OPCmpl: USR1: USR2:	ON OFF	Enables or disables the ability of the SCD to assert SRQ on each of these status conditions. See Section 4 for more information on errors, warnings, user, and operation complete conditions. Factory settings: CMDerr: ON,EXErr: ON,EXWarn: ON, INERr:ON,INWarn: ON,OPCmpl: ON,USR1: OFF,USR2: OFF Example: `SRQMASK CMDERR:ON,EXERR:ON,EXWARN:ON, INERR:ON,INWARN:ON,OPCMPL:ON,USR1:OFF,USR2:OFF`
SRQmask?			Queries for the states (ON or OFF) of all SRQ masks. See Section 4 for more information on errors, warnings, user, and operation complete conditions. Example: `SRQMASK?` Response: `SRQMASK ABSTOUCH:OFF,CMDERR:ON, EXERR:ON,XWARN:ON,INERR:ON,INWARN:ON, OPCMPL:ON,USR1:OFF,USR2:OFF`
SRQmask?	ABSTouch CMDerr EXERr EXWarn INErr INWarn OPCmpl USR1 USR2		Queries for the states (ON or OFF) of the individual SRQMask settings. See Section 4 for more information on errors, warnings, user, and operation complete conditions. Example: `SRQMASK? ABSTOUCH` Response: `SRQMASK ABSTOUCH:ON.`
UID		<qstring>	Assigns an identifying name to the device. The name must be a quoted string no longer than ten characters (for example, "MSTRSCD"). Set at factory to instrument serial number. Example: `UID "DIG_2"`
UID?			Queries for the instrument's ID string. The response is a ten character quoted string. Example: `UID?` Response: `UID "B010101"`
VERSion?			Query only. SCD sends firmware version number. Response is <digitizer firmware version #>,<display firmware version #>. Example: `VERSION?` Response: `VERSION "DIG FW#1.0 DSY FW#3.00"`

GPIB Related Commands

Table 3-8: GPIB Related Commands

Header	Link	Argument	Description
ABSTouch		<NRx>,<NRx>	Emulates a touch to a front-panel button or a "click" of the variable knob designated by the coordinates <NRx> and <NRx>. Figure 3-1 identifies the coordinates possible with the SCD Display Unit. These coordinates are stored in a buffer (ABSTouch buffer). The last 20 ABSTouch commands and front panel button presses are stored. ABSTouch coordinates from the front panel are not stored if RWLS is active. Factory setting: None Example: `ABSTOUCH 0,8`
		CLEar	Clears the coordinates in the ABSTouch buffer. The ABSTouch buffer is always cleared at power-up. Example: `ABSTOUCH CLEAR`
ABSTouch?			Queries for the coordinates in the ABSTouch buffer. The response is two signed integers indicating the touch area. See Figure 3-1 for touch area coordinates. If the ABSTouch buffer is empty, the response is −1,−1. Example: `ABSTOUCH?` Response: `ABSTOUCH 2,8`

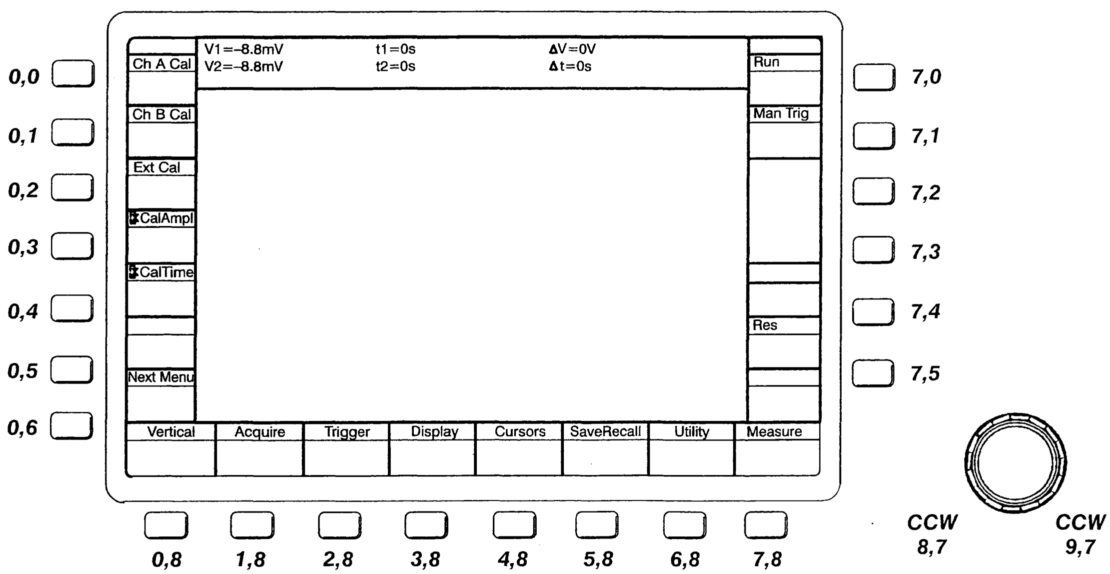

Figure 3-1: Front Panel Coordinates for ABSTouch

Table 3-8: GPIB Related Commands (Cont.)

Header	Link	Argument	Description
DEBug	GPIb:	ON OFF	Sets the state of GPIB debugging. When ON, the IEEE–488.1 bus traffic to the SCD is displayed on the Display Unit. See Debug Mode in Section 1. Factory setting: OFF Example: `DEBUG GPIB:ON`
DEBug?	GPIb		Queries for the state (OFF or ON) of GPIB debugging. Example: `DEBUG? GPIB` Response: `DEBUG ON`
DT		RUN STOp HLDNxt OFF	Sets the acquisition state the SCD enters when the next GET is received. See Table 3-3 (ACQUire STATe command) for more information on these settings Factory setting: OFF Example: `DT RUN`
DT?			Queries for the group execute trigger acquisition state. Example: DT? Response: `DT RUN`
HELp?			Queries for list of all SCD command headers. Example: `HELP?`
INIt		PANel GPIb [ALL]	Set only. Resets settings to factory settings for instrument (PANel), IEEE–488.1 (GPIB), or both (ALL). See Tables 3-20 and 3-21 for factory settings of PANel and GPIb. An OPC SRQ is generated when PANel or GPIb is sent. Example: `INIT ALL`
LONgform		ON OFF	Controls number of characters reported to controller. When ON, complete spelling of headers, links, and arguments are reported. (Affected by PATH command.) Responses to EVENT? and ALLEV? queries include event numbers and quoted string description of event. number(s). When OFF, headers, links, and arguments are abbreviated to minimum ambiguity. Responses to EVENT? and ALLEV? queries are limited to event number(s). Factory setting: ON Example: `LONGFORM ON`
LONgform?			Queries for the setting (OFF or ON) of the LONgform command. Example: `LONGFORM?` Response: `LONGFORM ON`

Table 3-8: GPIB Related Commands (Cont.)

Header	Link	Argument	Description
PATh		ON OFF	Sets the type of response to queries. When ON, the header and link are returned with the argument (for example, CHA OFFSET:10). When OFF, only the arguments are returned to the query (for example,10). Factory setting: ON Example: `PATH OFF`
PATh?			Queries for the state (ON or OFF) of the path setting. Example: `PATH?` Response: `PATH ON`
USER1 USER2		<qstring1>, <qstring2>	Labels the Display Unit's front panel USER buttons with <qstring1> on line 1 and <qstring2> on line 2. The strings can be up to eight characters each. Factory setting: `"","" ` Example: `USER1"Group","Trig"`
USER1? USER2?			Queries the specified front panel USER button for its labels. The response is a set of two quoted strings (<qstring>) containing the labels for each line. Pressing either user button causes a USER SRQ to be generated if the USER SRQ is unmasked. Example: `USER1?` Response: `USER1 "Send","Wavefrm"`

Cursor Commands

Table 3-9: Cursor Commands

Header	Link	Argument	Description
CRS?			Queries for all settings of both cursors. Example: `CRS?` Response: `CRS1LOCTN:WIN2,XPOINT:123,XTIME:65.E-9, YCOORD:2.57.E-6;CRS2LOCTN:WIN2,XPOINT:158, XTIME:83.E-9,YCOORD:1.07.E-6`
CRS1 CRS2	LOCTn:	WIN<ui>	Places the specified cursor in the window specified by <ui>. Limits: <ui> can be from 1 to 4. Factory setting: Cursor 1: Window 1; Cursor 2: Window 1 Example: `CRS1 LOCTN:WIN1`
CRS1 CRS2	XPOint:	<NRx>	Places the specified cursor at sample point location <NRx>. Limits: <NRx> can be from 0 to (Record Length – 1) Factory setting: Cursor 1: point 0; Cursor 2: point 0 Example: `CRS1 XPOINT:127`
CRS1? CRS2?			Queries for the settings of each of the above cursor commands: LOCTn, XPOint, XTIMe, and YCOord. Example: `CRS1?` Response: `CRS1 LOCTN:WIN2,XPOINT:123, XTIME:65.E-9,YCOORD:2.57.E-6`
CRS1? CRS2?	LOCTn		Queries for the window number in which the specified cursor is located. Example: `CRS2? LOCTN` Response: `CRS2 LOCTN:WIN4`
CRS1? CRS2?	XTIMe		Query only. Queries for the time in seconds of the selected cursor. The response is a floating point number with an exponent. Example: `CRS1? XTIME` Response: `CRS1 XTIME:112.E-3`
CRS1? CRS2?	XPOint		Queries for the sample point of the specified cursor. The response is an integer. Example: `CRS2? XPOINT` Response: `CRS2 XPOINT:365`
CRS1? CRS2?	YCOord		Query only. Queries for the amplitude (in volts) of the specified cursor. The response is a floating point number with an exponent. Example: `CRS1? YCOORD` Response: `CRS1 YCOORD:65.E-2`

Table 3-9: Cursor Commands (Cont.)

Header	Link	Argument	Description
CRSD	TYPETime:	HZ SECond	Sets the unit of Δt measurements to hertz or seconds. Measurements between cursor 1 and cursor 2 are displayed in the selected unit. Factory setting: SECond Example: `CRSD TYPETIME:SECOND`
CRSD?			Queries for the typetime value and the Δt and Δy measurement values. Example: `CRSD` Response: `CRSD TYPETIME:SECOND,T:14.3.E-9, Y:1.54.E-6`
CRSD?	T		Query only. Queries for the Δt measurement value in seconds. Δt is the time difference between the locations of cursor 2 and cursor 1. The response is a floating point number with an exponent. Example: `CRSD? T` Response: `CRSD T:122.E-9`
CRSD?	TYPETime		Queries for the units of Δt measurements. Example: `CRSD? TYPETIME` Response: `CRSD TYPETIME:HZ`
CRSD?	Y		Query only. Queries for the Δy measurement value in volts. Δy is the voltage difference between the locations of cursor 2 and cursor 1. The response is a floating point number with an exponent. Example: `CRSD? Y` Response: `CRSD Y:12.5.E-3`
CURSors		ON OFF	Turns ON or OFF the display of the cursors. Factory setting: ON Example: `CURSORS ON`
CURSors?			Query for the state (ON or OFF) of the cursor display. Example: `CURSORS?` Response: `CURSORS ON`
GRATicule		ON OFF	Turns graticule waveform display mode on or off. This command applies to all waveform display windows. Factory setting: OFF Example: `GRATICULE ON`
GRATicule?			Queries for the state of the graticule display mode. Example: `GRATIcule.` Response: `GRATICULE ON`

Save/Recall Settings Commands

Table 3-10: Save/Recall Commands

Header	Link	Argument	Description
ERAse		<NRx>	Clears the saved settings located in <NRx>. Factory setting: None Example: `ERASE 2`
LLSet?			Queries for the contents of the LLSet binary block. The format is <&><data><&><data><&><data>...<EOI>. The LLSet binary block contains all of the digitizer settings. The user may store the results of an LLSet? query and return them to the digitizer at a later time to restore the digitizer to the state it was in when the LLSet? query was executed.
		<bblock>	This command contains no header. It's argument is a binary block which was generated by an LLSet? query and stored external to the instrument. This binary block specifies the settings for the instrument. LLSet sets up the digitizer quicker than using an ASCII string generated by querying all settings and resending it. However, the settings should also be saved as an ASCII string because the <bblock> may become obsolete if the SCD firmware version is changed.
RECAll		<NRx>	Recalls the instrument settings stored in a nonvolatile RAM area specified by <NRx>. (The settings are stored in nonvolatile RAM using the SAVE command as described below.) An OPC SRQ is generated upon completion. Limits: <NRx> ranges from 1 to 10. Factory setting: None Example: `RECALL 1`
SAVE		<NRx>	Stores the current instrument settings in the location in nonvolatile memory specified by <NRx>. Settings can be recalled using the RECAll command. An OPC SRQ is generated upon completion. Limits: <NRx> ranges from 1 to 10. Factory setting: None Example: `SAVE 1`
SET?			Queries for all current instrument settings. Example: `SET?` Response: `H1 RANGE:1,OFFSET:10.....`

Instrument/Data Protection Commands

Table 3-11: Instrument/Data Protection Commands

Header	Link	Argument	Description
SAFEguard	ACQProtect:	ON OFF	When ON, the digitizer will not initiate an acquisition or a function that performs acquisitions such as calibration, setref, and diagnostics from front panel input. GPIB command input is uneffected by this control. When OFF, the front panel has it's normal operational control. Factory setting: `OFF` Example: `SAFEGUARD ACQPROTECT: OFF`
SAFEguard	LINConvert:	<NRx>	Set only. Centroid the current linear array (HSDO array if installed). The current instrument setup is used to determine the record to place the centroided results and the generation of the waveform preamble. Record scaling, record placement and geometry correction may all be controlled by adjusting the instrument setting prior to running this command. Since no trigger event is associated with the centroided record the timestamp is marked "TIME UNKNOWN". This command when used with SAFEguard STOPAcq will allow you to generate a centroided and corrected curve from the battery backed up Option 2F Linear Array. If the instrument power was inadvertently removed too soon after a trigger event for the instrument to completely process the waveform. Limits: 1 to 16 Example: `SAFEGUARD LINCONVERT: 2`
SAFEguard	PROTect: (SCD1000 only)	ON OFF	When ON, the digitizer automatically disconnects the inputs when it detects an overvoltage condition. When OFF, the inputs are not protected. However, a service request can be issued if an overvoltage condition is detected. ***NOTE*** *Operation of the instrument with Protect = OFF will damage the instrument and void the warranty if an input overvoltage condition occurs.* Factory setting: ON Example: `SAFEGUARD PROTECT:OFF`
SAFEguard	PUPtst:	ON OFF	When ON and instrument switch #8 is OFF, the digitizers executes a self-test at power-up. When OFF and instrument switch #8 is OFF, the digitizer does not execute a self-test. Factory setting: ON. Example: `SAFEGUARD PUPTST:OFF`

Table 3-11: Instrument/Data Protection Commands (Cont.)

Header	Link	Argument	Description
SAFEguard	SECURE		Set only. Erases all memory data and resets all parameters to their factory settings.Diagnostics are run (if enabled). POWER ON and SETTINGS LOST SRQs are generated. Example: `SAFEGUARD SECURE`
SAFEguard	STOPAcq		Set only. Causes the Acquisition machine of the instrument to immediately move to the acquire stop state from the acquire holdnext or acquire run states. If no trigger is received prior to this command the curve data and timestamp of the previous acquisition will be preserved. The waveform preamble data for the curve that remains will be lost. Example: `SAFEGUARD STOPACQ`
SAFEguard?			Queries for state of all SAFEguard settings. Example: `SAFEGUARD?` Response: `SAFEGUARD PROTECT:ON,PUPTST:OFF`
SAFEguard?	ACQProtect		Queries for the acquire protect setting (ON or OFF). Example: `SAFEGUARD? ACQPROTECT` Response: `SAFEGUARD ACQPROTECT:OFF`
SAFEguard?	PROTect (SCD1000 only)		Queries for the input protection setting (OFF or ON). Example: `SAFEGUARD? PROTECT` Response: `SAFEGUARD PROTECT:ON`
SAFEguard?	PUPtst		Queries for the power-up self-test setting (OFF or ON). Example: `SAFEGUARD? PUPTST` Response: `SAFEGUARD PUPTST`

Display Commands

Table 3-12: Display Commands

Header	Link	Argument	Description
DISplay		ON OFF	Turns ON or OFF the Display Unit. (The SCD executes faster when the display is OFF.) Factory setting: ON Example: `DISPLAY OFF`
DISplay?			Queries for the state of the Display Unit. Example: `DISPLAY?` Response: `DISPLAY OFF`
HEXPMd		ALIgned INDep	Selects whether expansion occurs for all windows at the same time by the same expansion setting (ALIgned) or for only the selected window (INDep). Factory setting: ALIGNED Example: `HEXPMD INDEP`
HEXPMd?			Queries for the horizontal expansion mode (ALIGNED or INDEP). Example: `HEXPMD?` Response: `HEXPMD INDEP`
NWIn		1 2 4	Selects the number of windows for displaying waveforms. 1, 2,or 4 windows can be displayed at the same time. Factory setting: 1 Example: `NWIN 4`
NWIn?			Queries for the number of displayed windows (1, 2, or 4). Example: `NWIN?` Response: `NWIN 4`
TEXt	CHAR:	<NRx>	Set only. Specifies the starting column for the TEXT STRIng command. Limits: 1 to 64 Factory setting: 1 Example: `TEXT CHAR:10`
TEXt	CLEar:	<NRx>	Set only. Clears the text on line <NRx> of the display. If <NRx> is 0, all lines are cleared. Factory setting: None Example: `TEXT CLEAR:2`

Table 3-12: Display Commands (Cont.)

Header	Link	Argument	Description
TEXt	LINE:	<NRx>	Set only. Specifies the starting line number for the TEXT STRIng command. Record bar lines cannot be used for displaying text. Limits: 1 to 16. Rows are divided evenly among displayed windows. (See Figure 3-2.) Factory setting: 1 Example: `TEXT LINE:6`
TEXt	STRIng:	<qstring>	Set only. Writes the text string (<qstring>) at the location specified by TEXT CHAR and TEXT LINE commands. Text is only allowed in waveform areas. Table 3-21 lists the TEXT command character set. Record 0 may be used to display text only. Limits: 16 rows × 64 cols. Rows are divided evenly among the number of displayed windows. See Figure 3-2. Factory setting: "" Example: `TEXT STRING:"Trig position -25%."`
WIN<ui>	EXPnt:	<NRx>	Selects point of waveform around which expansion takes place. Limits: 0 to (Record Length − 1) Factory setting: 0 Example: `WIN1 EXPNT:38`
WIN<ui>	HEXPNd:	<NRx>	The horizontal expansion factor can be set to 1, 2, 4, or 8 to expand 512 or 1024 data point records. Otherwise HEXPNd equals 1, 2, or 4. Limits: 1, 2, 4, 8 Factory setting: 1 Example: `WIN2 HEXPND:2`
WIN<ui>	RECOrd:	<NRx>	Displays waveform data from record <NRx> in window <ui>. Factory setting: Win1: 1; Win2: 1; Win3:1; Win4: 1 Example: `WIN4 RECORD:24`
WIN<ui>	VEXpnd:	<NRx>	Vertically expands window <ui> by <NRx>. <NRx> can be 1, 2, or 4. If <NRx> is 1, the entire vertical range is displayed. Factory setting: 1 Example: `WIN4 VEXPND:2`

Table 3-12: Display Commands (Cont.)

Header	Link	Argument	Description

One Window

Two Windows

Four Windows

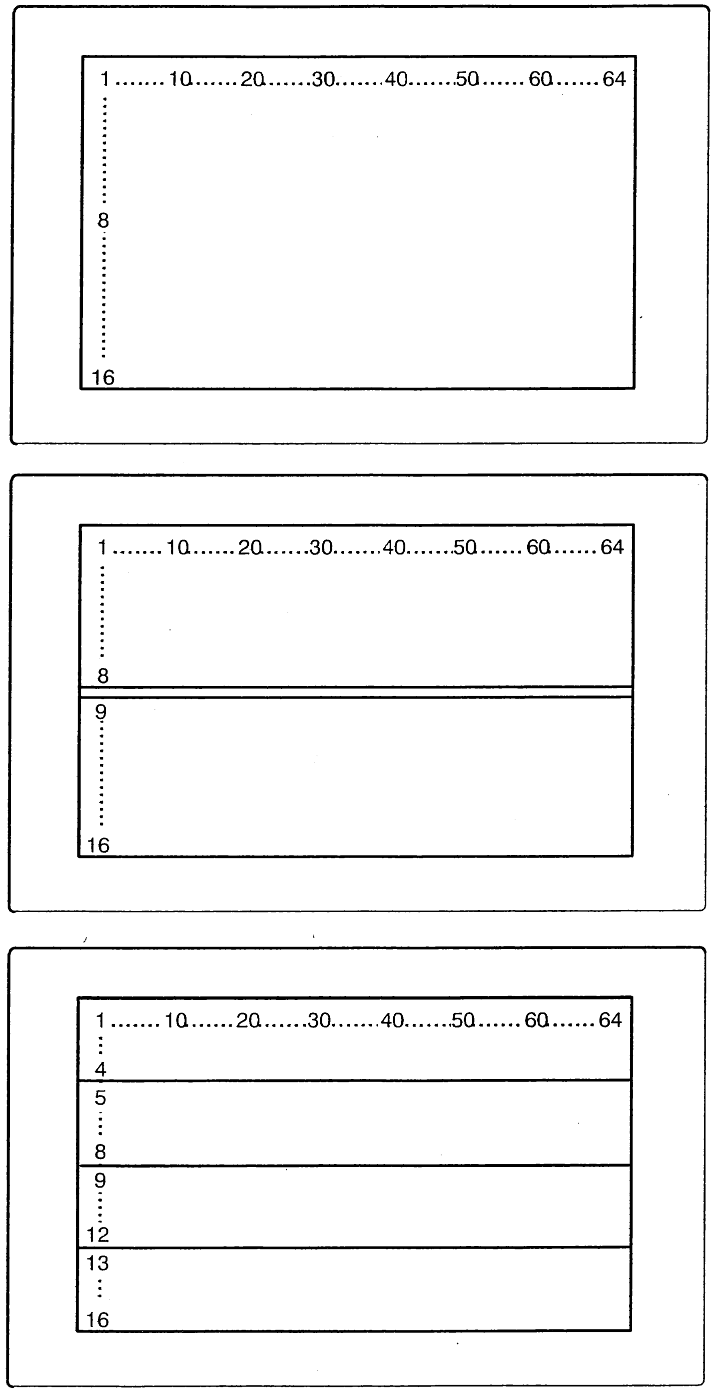

Figure 3-2: Text Areas

Table 3-12: Display Commands (Cont.)

Header	Link	Argument	Description
WIN<ui>?			Queries for all the settings (EXPnt, HEXPNd, RECOrd, VEXpnd) of window <ui>. Example: `WIN1?` Response: `WIN1EXPNT:129,HEXPND:8,RECORD:2, VEXPND:2`
WIN<x>?	EXPnt		Queries for window <ui>'s expansion point. The response is a signed integer. Example: `WIN3? EXPNT` Response: `WIN3 EXPNT:116`
WIN<x>?	HEXPNd		Queries for horizontal expansion value of window <ui>. The response is a signed integer: 1, 2, 4, or 8. Example: `WIN4? HEXPND` Response: `WIN4 HEXPND:4`
WIN<x>?	RECOrd		Queries for the record from which window <ui> displays its data. The response is a signed integer. Example: `WIN2? RECORD` Response: `WIN2 RECORD:12`
WIN<x>?	VEXpnd		Queries for the vertical expansion value of window <ui>. The response is a signed integer. Example: `WIN4? VEXPND` Response: `WIN4 VEXPND:2`
WIN?			Queries for all the settings (EXPnt, HEXPNd, RECOrd,V EXpnd) of all the windows (1, 2, 3, 4). Example: `WIN?` Response: `WIN1 EXPNT:129,HEXPND:1,RECORD:2, VEXPND:2;WIN2 EXPNT:332,HEXPND:2,RECORD:7, VEXPND:4;WIN3 EXPNT:129,HEXPND:1,RECORD:2, VEXPND:2;WIN4 EXPNT:332,HEXPND:1,RECORD:7, VEXPND:4`

Front Panel Commands

Table 3-13: Front Panel Commands

Header	Link	Argument	Description
BELl	BUTton:	ON OFF	Turns sound for button clicks ON or OFF. Factory setting: ON Example: `BELL BUTTON: OFF`
BELl	KNOb:	ON OFF	Turns sound for knob clicks ON or OFF. Factory setting: ON Example: `BELL KNOB: ON`
BELl	RINg		Sounds a beep. Example: `BELL RING`
BELl?			Queries for the settings of both the knob and button sounds. Example: `BELL?` Response: `BELL BUTTON:ON,KNOB:ON`
BELl?	BUTton		Queries for the setting (ON or OFF) of the button sound. Example: `BELL? BUTTON` Response: `BELL BUTTON:OFF`
BELl?	KNOb		Queries for the setting (ON or OFF) of the knob sound. Example: `BELL? KNOB` Response: `BELL KNOB:OFF`
FPAnel		ON OFF	When ON, front panel changes from the knob and buttons are allowed. When OFF, the front panel is locked out as in RWLS.
FPAnel?			Queries for the state (OFF or ON) of the FPANEL command. Example: `FPANEL?` Response: `FPANEL OFF`

Diagnostics and Calibration Commands

Diagnostics allow checking of several SCD subsystems. Calibration provides internal calibration of digitizer circuits. Calibration should be run whenever the values from the SCD are suspect, or whenever the operating environment of the SCD changes. Calibration should not be run within the first 20 minutes after power-up.

Table 3-14: Diagnostic and Calibration Commands

Header	Link	Argument	Description
BATdate?			Queries for the date when the NVRAM ICs were first powered. (NVRam battery life is 8–10 years). The format is yy-mm-dd. Example: `BAT?` Response: `BAT "89-09-24"`
CALIBRATE		[ALL] CRT GEOmetry HORizontal INPut VERTical TRIgger	Performs internal calibration of input circuitry (SCD1000 only). Performs internal calibration of horizontal circuitry. Performs internal calibration of vertical circuitry. Performs internal calibration of trigger circuitry. Performs internal calibration to align CRT tilt and intensity. Performs internal calibration to create the correction table to improve vertical linearity. Performs internal calibration of horizontal, vertical, and trigger circuitry. Each calibrate function generates an operation complete (OPC) SRQ when done. Example: `CAL TRIGGER`
CALIBRATE?			Queries for self-calibration status. The response is a quoted string that identifies the sections that failed or passed. Example: `CALIBRATE?` Response: `CALIBRATE "PASSED"`
CALOut	EXTernal:	AMPL TIME	Connects the time calibrator signal to the external cal connector. In the SCD1000 both channels A & B are forced to OFF. Connects the amplitude calibrator signal to the external cal connector. In the SCD1000 both channels A & B are forced to OFF. Factory setting: TIME (SCD1000), AMPL (SCD5000) Example: `CALOUT EXTERNAL:AMPL`

Table 3-14: Diagnostic and Calibration Commands (Cont.)

Header	Link	Argument	Description
CALOut	CH[A|B]:		SCD1000 only
		AMPL	Connects the 50 Ω amplitude calibrator signal to the channel [A|B] input. Channel [A|B] vertical coupling is forced to OFF. Calout External is forced to Time and the alternate calout channel is forced to OFF.
		AMPL4[50]	Connects the 50 Ω amplitude calibrator signal to the channel [A|B] input. Channel [A|B] vertical coupling is forced to OFF. Calout External is forced to Time and the alternate calout channel is forced to OFF.
		OFF	Disconnects calibrator signals from the channel [A|B] input. Factory setting: OFF Example: `CALO CHA:TIME`
		TIME	Connects the time calibrator signal to the channel [A|B] input. Channel [A|B] vertical coupling is forced to OFF. Calout External is forced to Amplitude and the alternate calout channel is forced to OFF.

CALOut?			Queries the settings of the EXTernal CHA and CHB calibrator settings.
			Example: `CALOUT?`
			Response: `CALOUT EXTERNAL: AMPL;`
			`CHA: OFF,`
			`CHB: OFF`

CALOut?	CH[A|B]		Queries for the selection of the calibrator signal supplied to CH[A|B]. Example: `CALOUT? CHB` Response: `CALOUT CHB:OFF`
CALOut?	EXTernal		Queries for the selection of the signal connected to the calibrator output connection. Example: `CALOUT? EXTERNAL` Response: `CALOUT EXTERNAL:TIME`
CALIBRATOr	AMPLItude:	<NRx>	Sets the calibrator signal amplitude. Limits: SCD1000: 0 VDC, ±40 mVDC, ±80 mVDC, ±0.2 VDC, ±0.4 VDC, ±0.8 VDC, ±2 VDC, and ±2.5 VDC; SCD5000: 0 VDC, ±0.5 VDC, ±1.0 VDC, ±2.0 VDC, ±3.0 VDC, and ±4.0 VDC Factory setting: 2.5 (SCD1000), 2.0 (SCD5000) Example: `CALIBRATOR AMPLITUDE:2`

Table 3-14: Diagnostic and Calibration Commands (Cont.)

Header	Link	Argument	Description
CALIBRATOr	TIME:	<NRx>	Sets the calibration signal time period. Limits: 4E−9 to 80E−6 Factory setting: 800E−9 Example: `CALIBRATOR TIME:4E-9`
CALIBRATOr?			Queries for all settings of the calibrator signal: amplitude and time period. Example: `CALIBRATOR?` Response: `CALIBRATOR AMPLITUDE:1.0,TIME:8.E-6`
CALIBRATOr?	AMPLItude		Queries for the calibrator signal amplitude. Example: `CALIBRATOR? AMPLITUDE` Response: `CALIBRATOR AMPLITUDE:2.5`
CALIBRATOr?	TIME		Queries for the calibrator signal time period. Example: `CALIBRATOR? TIME` Response: `CALIBRATOR TIME:800.E-9`
CCOnstant?			Queries for all calibration constants contained in NVRAM. Example: `CCONSTANT?` Response: `CCONSTANT 1:2048...351:0.00`
CCOnstant?	<ui>		Queries for the calibration constant specified by <ui>. Example: `CCONSTANT? <33>` Response: `CCONSTANT 33:1234`
CDAte?			Queries for the date when the last calibration was performed. The response is a quoted string. The format is yy-mm-dd. Example: `CDATE?` Response: `CDATE "89-09-24"`
DIAg?			Query only. Queries for results of the last diagnostics executed, which can be either power-up self-test or tests set up by TESt command. Response is PASSED, FAILED, or BYPASSED. If TESt VERBose is ON (see below), an ASCII string is also reported describing the test result. Example: `DIAG?` Response: `DIAG PASSED`
TESt	LOOp:	ON OFF	Sets test looping. When ON, the selected tests are repeated until any GPIB command is issued. When OFF, the tests are done only once. (Must be enabled by an internal jumper.) Factory setting: OFF Example: `TEST LOOP:ON`

Table 3-14: Diagnostic and Calibration Commands (Cont.)

Header	Link	Argument	Description
TESt	NUM:	<NRx>	Runs only the test specified by (<NRx>) as referenced in Table 3-19. Factory setting: 1 Example: `TEST NUM:3`
TESt	SYS:	ALL	Runs all tests, and generates an operation complete (OPC) SRQ when done. Factory setting: ALL Example: `TEST SYS:FPASYS`
		DIG	Runs tests associated with the processor board only. See Table 3-19 for more information.
		FP	Runs tests associated with the front panel only. See Table 3-19 for more information.
		MPU	Runs tests associated with the acquisition system only. See Table 3-19 for more information.
		OPTion	Runs test associated with the HSDO and Fast Waveform Capture options. See Table 3-19.
TESt	VERBose:	ON OFF	Sets DIAG? response format. If ON, an ASCII string of up to 130 characters describes the results of the first test that failed,or the last test executed if no failures were detected. If OFF, the response to queries on test results is abbreviated to PASSED or FAILED. Factory setting: OFF Example: `TEST VERBOSE:OFF`
TESt?			Queries for all test settings: LOOp, NUM, SYS,and VERBose. Example: `TEST?` Response: `TEST LOOP:OFF,NUM:1,SYS:FP,VERBOSE:OFF`
TESt?	LOOp		Queries for the state of test looping. See TESt LOOp earlier. Example: `TEST? LOOP` Response: `TEST LOOP:OFF`
TESt?	NUM		Queries for the number of the test to be run (see Table 3-19). The response is an unsigned integer. See TESt NUM command earlier. Example: `TEST? NUM` Response: `TEST NUM:3`
TESt?	SYS		Queries for the group of tests to be run. The response indicates which subsystem is checked: acquisition (MPU), front panel (FP), processor board (DIG),or ALL. See TESt SYS earlier. Example: `TEST? SYS` Response: `TEST SYS:FP`

Table 3-14: Diagnostic and Calibration Commands (Cont.)

Header	Link	Argument	Description
TESt?	VERBose		Queries for state (OFF or ON) of test verbosity. See TESt VERBose earlier. Example: `TEST? VERBOSE` Response: `TEST VERBOSE:OFF`
VIDeo		ON OFF	When ON, target video can be viewed in real time using an external monitor (factory service switch and internal jumper must also be set). Set to OFF at power-up. (Intended for calibration use only.) Factory setting: OFF Example: `VIDEO ON`
VIDeo?			Queries for the setting of the video command. Example: `VIDEO?` Response: `VIDEO OFF`

Utility Commands

Table 3-15: Utility Commands

Header	Link	Argument	Description
CLOck	DATE:	<qstring>	Sets the date of the internal clock in yy-mm-dd format. Factory setting: Current date Example: `CLOCK DATE:"89-12-23"`
CLOck	TIME:	<qstring>	Sets the time of the internal clock in hh:mm:ss format. The time should be set in 24-hour format. Factory setting: Current time Example: `CLOCK TIME:"14:25:12"`
CLOck?			Queries for the time and date. Example: `CLOCK?` Response: `CLOCK DATE:"89-12-22",TIME:"22:12:34"`
CLOck?	DATE		Queries for the date. Response is a quoted string in yy-mm-dd format. Example: `CLOCK? DATE` Response: `CLOCK DATE:"89-12-21"`
CLOck?	TIME		Queries for the time. Response is a quoted string in hh:mm:ss format. Example: `CLOCK TIME` Response: `CLOCK TIME:"15:23:33"`
CRTBkgnd		<NRx>	Sets CRT background sensitivity. Over enhancement produces a noisy target image background and elicits the error message: "linear array overflow". Limits: 0 to 100% Example: `CRTBgnd 30`
CRTBkgnd?			Queries for the CRT background sensitivity. Example: `CRTBkgnd?` Response: `CRTBkgnd 30`
FOCus		<NRx>	Adjusts the write gun's focus. Affects only the current time window. Limits: 0 to 100% Factory setting: 50 Example: `FOCUS 25`
FOCus?			Queries for the current focus setting (0 to 100%). Example: `FOCUS?` Response: `FOCUS 32`

Table 3-15: Utility Commands (Cont.)

Header	Link	Argument	Description
INTEnsity	<NRx>		Adjusts the write gun's beam intensity. Affects only the current time window. Limits: 0 to 100% Factory setting: Depends on the time window Example: `INTENSITY 34`
INTEnsity?			Queries for the intensity setting (0 to 100%). Example: `INTENSITY?` Response: `INTENSITY 34`
RAW			The RAW command selects what will be seen on the display when the target image is selected. To set the display to view the target image over GPIB the following procedure should be used: 1. Save the current settings: SAVE 9. 2. INIT the instrument: INI. 3. Recall the saved settings: REC 9. 4. Use the ABSTouch command to select the Utility Mode menu: ABS 6,8. (The target image is seen on the LCD display when Utility Mode menu containing the CRT settings is selected.)
		LINArray	Selects the waveform stored in the linear array when viewing the target image.
		REFArray	Selects the reference array defect map when viewing the target image.
RAW?			Queries for the selection of what will be seen when the display is set to view the target image is selected. Example: `RAW?` Response: `RAW LINEARRAY`

Reference Array Correction Commands

Table 3-16: Reference Array Correction Commands

Header	Link	Argument	Description
REFList?			Query only. Returns the reference array defects coordinate list. This is a list of the locations on the target where defects were detected during the reference array correction cycles. The format of the defects coordinate list is: REFList min_x, min_y, max_x,max_y,....
SETRef		OFF	Turns off Reference Array correction.
		ON	Turns on Reference Array correction.
		RUN	Runs Reference Array correction cycles. Reference array correction cycles are run to record accumulated target defect data. A more detailed description of reference array correction is given in the SCD1000/SCD5000 Operator's Manual. Any further input on the front panel or the GPIB will abort the correction cycle.
			Factory setting: ON
SETRef?			Query for the setting of target defect correction. If SETRef is running, reference array creation will be stopped and the reference array data lost. SETRef must be run again, without interruption to restore the correction array. Example: `SETRef?` Response: `SETREF ON`

Plot Commands

Table 3-17: Plot Commands

Header	Link	Argument	Description
PDAte		ON OFF	If on the current date setting in the SCD is added to the plot. Factory setting: ON Example: `PDAte OFF`
PDAte?			Queries whether PDAte is on or off for plots. Example: `PDate?` Response: `PDAte ON`
PLOT?			When the SCD is next talked addressed the unit will send a HPGL compatible representation of the information currently on the display unit. Example: `PLOT?`
PTItle		<qstring>	Up to 50 character string to use for plot title. This must be sent as a quoted string. To eliminate any title from the plot send the PTItle command with a single space quoted string ("Ê"). To restore the SCD ID? as the title send the PTItle command as a null string (""). Factory setting: Instrument ID? response Example: `PTItle "Event #7"` Example: `PTItle "Ê"` Example: `PTItle ""`
PTItle?			Queries for the current plot title string Example: `PTItle?` Response: `PTItle "Test #11"`

Measurement Commands

Table 3-18: Measurement Commands

Header	Link	Argument	Description
AREA?			Query for AREA measurement of waveform data bounded by AREAZone. See RESUlts? AREA – Units of measure “Vs” (vertical units seconds).
AREAZone		DISTAl MEASZone MESial PROXimal	Used to determine boundaries for an area measurement. If MEASZone is selected then the area measurement is bound by the current selection for MEASZone, either full waveform or between cursors. Factory setting: MEASZone Example: `AREAZone PROXimal`
AREAZone?			Returns the current means being used to bound area measurements. Example: `AREAZone?` Response: `AREAZone MEASZone`
BASE?			Query for BASE line value as determined by BASEMode METhod or LEVEl of waveform data bounded by MEASUre MEASZone. See RESUlts? BASE – Units of measure “V” (vertical units).
BASEAber?			Query for BASEAber value (Minimum value – Base value) as determined by BASEMode METhod or LEVEl of waveform data bounded by MEASUre MEASZone. See RESUlts? BASEAber – Units of measure “V” (vertical units)
BASEMode	METhod:	ABSOlute HISTOGram HISTOMean MINImum	Select method to calculate baseline of the measurement zone. Baseline can be based from a histogram of the lower half of the vertical range of the data, as either maximum occurrence or average count.
BASEMode	LEVEl:	<NRx>	Further baseline can be based on the minimum value within the measurement zone or based on a user selected value (selection of ABSolute.enables LEVEl). Factory setting: METhod: HISTOGram LEVEl:0 Example: `BASEMode METhod:MINImum`
BASEMode?			Queries for current method and level of baseline. Example: `BASEMode?` Response: `BASEMode METhod:HISTOMean,LEVEl:240E-3`
BASEMode?	METhod		Queries for current means of establishing the baseline. Example: `BASEMode? METhod` Response: `BASEMode METhod:HISTOGram`

Table 3-18: Measurement Commands (Cont.)

Header	Link	Argument	Description
BASEMode?	LEVEl		Queries for the current LEVEl to use for baseline. Example:`BASEMode? LEVEl` Response: `BASEMode LEVEl: 2.6`
BASETop?			Query for BASETop value (Top value – Base value) as determined by BASEMode and TOPMode METhod or LEVEl of waveform data bounded by MEASUre MEASZone. See RESUlts? BASETop – Units of measure are "V" (vertical units).
CROSS?	DFAll DRIse MAXLoc MFAll MINLoc MPEriod MRIse PFAll PRIse		Queries for the interpolated waveform array index of an individual crossing location within the measurement zone. Returns –1 if the crossing was not found. Example: `CROSS? PRISE` Response `CROSS PRISE:47.83`
CROSS?			A query only that returns an array of 9 interpolate array indexes of the waveform data representing the points used for timing measurements plus the first location of minimum and maximum values found in the measurement zone. Returns –1 if the crossing was not found. Example: `CROSS?` Response: `CROSS PRISE:101.01,PFALL:86.99, DRISE:134.74,DFALL:59.45,MRISE:119.20, MFALL:71.56,MPERIOD:175.27,MAXLOC:45.00, MINLOC:511.00`
DISTAl?			Query for value of DISTAl used in all timing measurements. See RESUlts? DISTAl – Units of measure "V" (vertical units).
DISTLevel	PERCent: LEVEl:	<NRx> <NRx>	Used to set the value to be used for the distal level crossing (crossing closest to the top line). Whether PERCent or LEVEl is used is determined by LEVMode. Factory setting: DISTLevel PERCent: 90 DISTLevel LEVEl: 0 Example: `DISTLevel PERCent: 80`
DISTLevel?			Query for current level of distal level. Example: `DISTLevel?` Response: `DISTLevel PERCent: 90, LEVEl: 2.7`
DISTLevel?	PERCent LEVEl		Query for current value of distal level for either PERCent or LEVEl. Example: `DISTLevel? PERCent` Response: `DISTLevel PERCent: 90`

Table 3-18: Measurement Commands (Cont.)

Header	Link	Argument	Description
FALL?			Query for value (Proximal crossing – Distal crossing on a qualified edge) as determined by DISTLevel, PROXLevel and LEVMode of the first full qualified falling edge of the waveform data bounded by MEASUre MEASZone. See RESUlts? FALL – Units of measure “s” (seconds)
FALLSlew?			Query for fall time slew rate value ((Distal amplitude – Proximal amplitude) / (Proximal crossing – Distal crossing on a qualified edge)) as determined by DISTLevel, PROXLevel and LEVMode of the first full qualified falling edge of the waveform data bounded by MEASUre MEASZone. See RESUlts? FALL-Slew – Units of measure “V/ns”
FREquency?			The reciprocal of the period determined by three consecutive edge qualified mesial level crossing of waveform data bounded by MEASUre MEASZone. See RESUlts? FREquency – Units of measure “Hz”
LEVMode		PERCent ABSOlute	Use either the percent or absolute value for the proximal, mesial, and distal levels. Factory setting: LEVMode PERCent Example: `LEVMode ABSOlute`
LEVMode?			Query for style of level being used to determine proximal, mesial, and distal crossings. Example: `LEVMode?` Response: `LEVMode PERCent`
MAXImum?			Query for maximum value of the waveform data bounded by MEASUre MEASZone. See RESUlts? MAXImum – Units of measure “V” (vertical units).
MEAN?			Query for mean value of the waveform data bounded by MEASUre MEASZone. See RESUlts? MEAN – Units of measure “V” (vertical units).
MEASUre	FUNction:	ON OFF	Turns execution of measurements on or off. Factory setting: MEASUre FUNction: OFF Example: MEASUre FUNction: ON
MEASUre	MANmeas		Executes the measurement routine on the currently acquired waveform data in the selected record. It will also display the measurements that have been selected.

Table 3-18: Measurement Commands (Cont.)

Header	Link	Argument	Description
MEASUre	MEASZone:	CURSors FULl WIN1 WIN2 WIN3 WIN4	Select the waveform region over which measurements will be made. Measurements can be made over all of the waveform data, data between cursors (inclusive) or data between the end points of a display window. ***NOTE:*** *The Cursors and Measurement Zone Window are not tied to the Measured Record. The Measurement record and the record displayed in the measurement zone window do not have to be the same. The measurement zone window simply defines end points that are then applied to the measurement record.* Factory setting: MEASUre MEASZone: FULl Example: `MEASUre MEASZone: CURSors`
MEASUre	WAVfrm:	<NRx>	Assigns record to make the waveform measurements on. Range is record 1 to record 16. Factory setting: MEASUre WAVfrm: 1 Example: `MEASUre WAVfrm: 12`
MEASUre	WINDow:	WIN1 WIN2 WIN3 WIN4	Tells which waveform window to display results of measurements (maximum of 8 at any one time) selected for display. Factory setting: MEASUre WINDow: WIN1 Example: `MEASUre WINDow: WIN2`
MEASUre?			Query to determine current status of measurement function, the measurement zone, and display area. Example: `MEASUre?` Response: `MEASUre FUNction: ON, WAVfrm: 1, MEASZone:CURSors, WINDow: WIN1`
MEASUre?	FUNction: MEASZone: WAVfrm: WINDow:		Query for current state of measurement execution status, measurement zone, which waveform record to measure, or waveform window of display selected results. Example: `MEASUre? FUNction` Response: `MEASUre FUNction: OFF`
MESIal?			Query for value of MESIal used in all timing measurements. See RESUlts? MESIal – Units of measure "V" (vertical units)
MESLevel	PERCent: LEVEl:	<NRx> <NRx>	Used to set the value to be used for the mesial level crossing (crossing between the proximal and distal crossings). WhetherPERCent or LEVEl is used is determined by LEVMode. Factory setting: MESLevel PERCent: 50 MESLevel LEVEl: 0 Example: `MESLevel PERCent: 55`
MESLevel?			Query for current level of mesial level Example: `MESLevel?` Response: `MESLevel PERCent: 50, LEVEl: 2.7`

Table 3-18: Measurement Commands (Cont.)

Header	Link	Argument	Description
MESLevel?	PERCent LEVEl		Query for current value of mesial level for either percent or level. Example: `MESLevel? PERCent` Response: `MESLevel PERCent: 46`
MINImum?			Query for minimum value of the waveform data bounded by MEASUre MEASZone. See RESUlts? MINImum – Units of measure "V" (vertical units)
MSList	AREA: BASE: BASEAber: BASETop: DISTAl: FALL: FALLSlew: FREquency: MAXImum: MEAN: MESIal: MINImum: PERIod: PK_pk: PROXImal: RISE: RISESlew: RMS: TOP: TOPAber: WIDth:	ON OFF	Determines which measurements will be displayed on the display unit (maximum of 8 at any one time). Position on screen determined by MEASUre WINDow. Factory setting: ALL MSList selections are OFF. Example: `MSList MINImum ON, MAXImum ON, PERIod: ON,PROXima: OFF`
MSList	CLEar		Turns OFF all currently selected displayed measurements.
MSList?			Query for the display state of all of the measurements. Example: `MSList?` Response: `MSList MAXImum: OFF, TOP: OFF, DISTAl: OFF, MESIal: OFF, PROXImal: OFF, BASE: OFF, MINImum: OFF, PK_pk: OFF, BASETop: OFF, TOPAber: OFF, BASEAber: OFF, RISE: OFF, RISESlew: OFF, FALL: OFF, FALLSlew: OFF, WIDth: OFF, PERIod: OFF, FREquency: OFF, AREA: OFF, MEAN: OFF, RMS: OFF`

Table 3-18: Measurement Commands (Cont.)

Header	Link	Argument	Description
MSList?	AREA BASE BASEAber BASETop DISTAl FALL FALLSlew FREquency MAXImum MEAN MESIal MINImum PERIod PK_pk PROXImal RISE RISESlew RMS TOP TOPAber WIDth		Queries for the display state of each parameter. Example: `MSList? AREA` Response: `MSList AREA: OFF`
PERIod?			The period determined by three consecutive edge qualified mesial level crossing of waveform data bounded by MEASUre MEASZone. See RESUlts? PERIod – Units of measure "s".
PK_pk?			Query for the peak to peak value (MAXImum value – MINImum value) of waveform data bounded by MEASUre MEASZone. See RESUlts? PK_pk – Units of measure are "V" (vertical units).
PROXImal?			Query for value of PROXImal used in all timing measurements. See RESUlts? PROXImal – Units of measure "V" (vertical units).
PROXLevel	PERCent: LEVEl:	<NRx> <NRx>	Used to set the value to be used for the proximal level crossing (crossing nearest the baseline). Whether PERCent or LEVEl is used is determined by LEVMode. Factory setting: PROXLevel PERCent: 10 PROXLevel LEVEl: 0 Example: `PROXLevel PERCent:20`
PROXLevel?			Query for current level of proximal level. Example: `PROXLevel?` Response: `PROXLevel PERCent: 20, LEVEl: -1.7`
PROXLevel?	PERCent LEVEl		Query for current value of proximal level for either percent or level. Example: `PROXLevel? PERCent` Response: `PROXLevel PERCent:12`

Table 3-18: Measurement Commands (Cont.)

Header	Link	Argument	Description
RESUlts?			Returns all of the measurements made on the selected waveform over the specified measurement zone. If a measurement is not found NAN (2.0E+308) is returned. Example: `RESUlts?` Response: `MAXImum: 212.4E-3, TOP: 167.0E-3, DISTAl: 118.1E-3, MESIal: -77.4E-3, PROXImal: -272.9E-3, BASE: -321.8E-3, MINImum: -345.2E-3, PK_pk: 557.6E-3, BASEAber: 23.4E-3, TOPAber: 45.4E-3, BASETop: 488.8E-3, RISE: 330.E-9, RISESlew: 1.184E-3, FALL: 270.E-9, FALLSlew: 1.451E-3, WIDth: 466.E-9, PERI-od:1.015E-6, FREQuency: 985.221E3, AREA:-298.7E-9, MEAN: -60.2E-3, RMS: 186.3E-3`
RESUlts?	AREA BASE BASEAber BASETop DISTAl FALL FALLSlew FREquency MAXImum MEAN MESIal MINImum PERIod PK_pk PROXImal RISE RISESlew RMS TOP TOPAber WIDth		Queries for individual measurements made on the selected waveform over the selected measurement zone. If a measurement is not found NAN (2.0E+308) is returned. Example: `RESUlts? BASE` Response: `RESUlts BASE: -3211.8E-3`
RISE?			Query for rise time value (Distal crossing – Proximal crossing on a qualified edge) as determined by DISTLevel, PROXLevel and LEVMode of the first full qualified falling edge of the waveform data bounded by MEASUre MEASZone. See RESUlts? RISE – Units of measure "s" (seconds).
RISESlew?			Query for rise time slew rate value (Distal amplitude – Proximal amplitude) / (Distal crossing – Proximal crossing) on a qualified edge) as determined by DISTLevel, PROXLevel and LEVMode of the first full qualified falling edge of the waveform data bounded by MEASUre MEASZone. See RESUlts? RISESlew – Units of measure "V/ns".

Table 3-18: Measurement Commands (Cont.)

Header	Link	Argument	Description
RMS?			Query for RMS value (square root of the mean of the sum of the squares – AC+DC measurement) of the waveform data bounded by MEASUre MEASZone. See RESUlts? RMS – Units of measure "V" (vertical units).
TOP?			Query for TOP line value as determined by TOPMode METhod or LEVEl of waveform data bounded by MEASUre MEASZone. See RESUlts? TOP – Units of measure "V" (vertical units)
TOPAber?			Query for TOPAber value (Maximum value – Top value) as determined by TOPMode METhod or LEVEl of waveform data bounded by MEASUre MEASZone. See RESUlts? TOPAber – Units of measure "V" (vertical units).
TOPMode	METhod: LEVEl:	ABSOlute HISTOGram HISTOMean MAXImum <NRx>	Select method to calculate the top line of the measurement zone. Top line can be based from a histogram of the upper half of the vertical range of the data, as either maximum occurrence or average count. Further, Top Line can be based on the maximum value within the measurement zone or based on a user selected value. Selection of ABSolute.enables LEVEl. Factory setting: METhod: HISTOGram LEVEl:0 Example: `TOPMode METhod: MAXImum`
TOPMode?			Queries for current method and level of the top line. Example: `TOPMode?` Response: `TOPMode METhod: HISTOMean, LEVEl: 240E-3`
TOPMode?	METhod		Queries for current means of establishing the top line. Example: `TOPMode? METhod` Response: `TOPMode METhod: HISTOGram`
TOPMode?	LEVEl		Queries for the current level to use for the top line. Example: `TOPMode? LEVEl` Response: `TOPMode LEVEl: 2.6`

Table 3-18: Measurement Commands (Cont.)

Header	Link	Argument	Description
UNIts?			Queries for units of measure of all measurements made on the selected waveform over the selected measurement zone. Note “V” represents volts which is the native vertical mode of the SCD. If a probe that encodes other units is used these will be used (e.g., Tek Type II I/F optical probe would use “µW”. Example: `UNIts?` Response: `MAXImum: "V", TOP: "V", DISTAl: "V",MESIal: "V", PROXImal: "V", BASE: "V", MINImum: "V", PK_pk: "V", BASEAber: "V", TOPAber: "V", BASETop: "V", RISE: "s", RISESlew: "V/ns", FALL: "s", FALLSlew: "V/ns", WIDth: "s",PERIod: "s", FREQency: "Hz", AREA: "Vs", MEAN: "V", RMS: "V"`
UNIts?	AREA BASE BASEAber BASETop DISTAl FALL FALLSlew FREquency MAXImum MEAN MESIal MINImum PERIod PK_pk PROXImal RISE RISESlew RMS TOP TOPAber WIDth		Queries for units of measure of individual measurements made on the selected waveform over the selected measurement zone. Note “V” represents volts which is the native vertical mode of the SCD. If a probe that encodes other units is used these will be used (e.g., Tek Type II I/F optical probe would use “µW”. Example: `UNIts? FALL` Response: `UNIts FALL: "s"`
WIDth?			The width determined by the first two consecutive edge qualified mesial level crossing of waveform data bounded by MEASUre MEASZone. See RESUlts? WIDth – Units of measure “s”.

Table 3-19: Test List For The Test Command

Number	Name	Subsystem	Description
1	Real Time Clock	MPU	Verifies that tick interrupts occur at the correct rate.
2	GPIB	MPU	Verifies the GPIB interface.
3	Bus Error	MPU	Verifies the bus error detect logic.
4	Timer	MPU	Verifies that the timer interrupts at the correct rate.
5	ROM0 Part Number	MPU	Retrieves the part number from the ROM header.
6	ROM1 Part Number	MPU	Retrieves the part number from the ROM header.
7	ROM2 Part Number	MPU	Retrieves the part number from the ROM header.
8	ROM3 Part Number	MPU	Retrieves the part number from the ROM header.
9	Display Unit ROM Part Number	MPU	Retrieves the part number from the display unit ROM.
10	NVRAM	MPU	Verifies that NVRAM works correctly.
11	Video	FP	Verifies video RAM/LCD display.
12	Button	FP	Exercises knobs and buttons.
13	Front Panel Communication	FP	Verifies communication between the front panel 68705 CPU and the 68010 MPU.
14	Digital Acquisition With Memory Test	DIG	Verifies digital acquisition hardware and memory (reference & linear array).
15	Digital Acquisition Without Memory Test	DIG	Same test as 14 without the memory test.
16	Serial Bus	DIG	Verifies communications over the serial bus to the analog, read, and write boards.
17	Option Test	OPT	Verifies HSDO (Option 2F) and Fast Waveform Capture (Option 1P) options are correctly readable and writeable by the 68010 MPU.
18	Option 01 Communication Test	OPT	Checks Option 01 host port communication.
19	Option 2F Battery Back-up Test	OPT	Checks that NVRAM on the Option 2F board will retain waveform data across a power-down.

Table 3-20: Instrument Factory Settings and Limits

Header	Link	Factory Settings	Limits (N/A = Not Applicable)
VMOde		CHA	SCD1000 only
CH<x>	RANge	1	100E−3 to 10 (probe attenuation = x1)
CH<x>	OFFSet	0	±1 to ±100
CH<x>	TYPEOffset	VOLTS	N/A
CH<x>	COUPling	AC	DC, AC & OFF allowed only on SCD1000
CH<x>	INVert	OFF	ON, OFF (SCD1000) only
TRIgger	COUPling	AC DC (SCD1000 and SCD5000 Opt 01)	Depends on Source. See Triggering in Section 1.
TRIgger	MODE	AUTO	N/A
TRIgger	LEVEl	0.0	Internal source: ±0.625*full-scale voltage range External source: ±6.25 volts
TRIgger	TYPELevel	VOLTS	N/A
TRIgger	DELay	0	0 to 9 times record length
TRIgger	TYPEDelay	SECOND	N/A
TRIgger	SLOpe	PLUS	N/A
TRIgger	SOUrce	INTERNAL (SCD5000 with Opt 01) EXTERNAL (SCD5000) CHA (SCD1000)	N/A
ARM		INTERnal	N/A
ACQuire	MODe	NORMAL	N/A
ACQuire	STATe	STOP	N/A
ACQuire	TIME	1E−6 (1 µs)	5E−9 to 100E−6 (5 ns to 100 µs)
ACQuire	LENgth	512	256, 512, or 1024.
ACQuire	NRECord	1	1 to 16
ACQuire	STARt	1	1 to 16
ACQuire	HLDnxt	OFF	N/A
ACQuire	DBLsweep	OFF	N/A
ACQuire	GEOmetry	OFF(SCD1000) ON (SCD5000)	
ACQuire	AVErage	16	1 to 1024
ACQuire	LASt	1	1 to 16
CRS1	LOCTn	WIN1	1 ≤LOCTn ≤4
CRS1	XPOint	0	0 ≤XPOint ≤(RL−1)
CRS2	LOCTn	WIN1	1 ≤LOCTn ≤4
CRS2	XPOint	0	0 ≤XPOint ≤(RL−1)
CRSD	TYPETime	SECOND	N/A

NVRAM Calibration Constants 06/24/2012

CCONSTANT 0:2048,
1:2048,
2:117,
3:37,
4:128,
5:114,
6:127,
7:127,
8:127,
9:127,
10:150,
11:127,
12:120,
13:129,
14:2048,
15:2048,
16:127,
17:110,
18:127,
19:24,
20:3280,
21:2052,
22:127,
23:250,
24:127,
25:127,
26:127,
27:127,

SCD1000
Response to CCO? command
for S/N B040 272

Table 3-20: Instrument Factory Settings and Limits (Cont.)

Header	Link	Factory Settings	Limits (N/A = Not Applicable)
CURSors		ON	N/A
HEXPMd		ALIGNED	N/A
NWIn		1	1, 2, or 4
GRAticule		OFF	N/A
CRTBkgrd		0	0 to 100
INTEnsity		Set by CRT self-cal	0 to 100
FOCus		Set by CRT self-cal	0 to 100
MEASUre	FUNction	OFF	
MEASUre	MEASZone	FULl	
MEASUre	WAVfrm	1	
MEASUre	WINDow	WIN1	
WIN<ui> WIN<ui> WIN<ui> WIN<ui>	EXPnt HEXPNd RECOrd VEXpnd	0 1 All windows: 1 1	0 to (Record Length – 1) 1, 2, 4, or 8 1 ≤RECOrd ≤nNRECord 1, 2, or 4 (SCD5000)
SAVe		1	1 to 10
RECAll		1	1 to 10
VIEW		OFF	Accessible from Display Unit only

Table 3-21: IEEE−488.1 Factory Settings and Argument Limits

Header	Link	Factory Settings	Limits (N/A = Not Applicable)
BELl	BUTton	ON	N/A
BELl	KNOb	ON	N/A
DATA	BYTEOrder	MSB	N/A
DATA	CNTrecord	1	1 ≤ CNTrecord ≤ (Number of Records)
DATA	COUnt	0	0 ≤ COUnt ≤ (Record Length-STArt)
DATA	FLAGbit	ON	N/A
DATA	STArt	1	1 ≤ STArt ≤ Record Length
DATA	STRecord	1	1 ≤ STRecord ≤ NRECord
DEBug	GPIb	OFF	N/A
DISplay		ON (only if Display Unit is present)	N/A
DT		OFF	N/A
FPAnel		ON (only if Display Unit is present)	N/A
LONgform		ON	N/A
PATh		ON	N/A
REPSet	NREPEat	1	0 ≤ NREPEat ≤ (2^{32}−1) (0 = infinite repeat)
RQS		ON	N/A
SAFEguard	ACQProtect	OFF	N/A
SAFEguard	LINConvert	N/A	1 ≤ RECOrd ≤ 16
SAFEguard	PROTect	ON	SCD1000 only
SAFEguard	PUPtst	ON	Affected by rear panel switch #8
SRQmask	ABSTouch	OFF	N/A
SRQmask	CMDerr	ON	N/A
SRQmask	EXErr	ON	N/A
SRQmask	EXWarn	ON	N/A
SRQmask	INErr	ON	N/A
SRQmask	INWarn	ON	N/A
SRQmask	OPCmpl	ON	N/A
SRQmask	USR1	OFF	N/A
SRQmask	USR2	OFF	N/A
TESt	LOOp	OFF	N/A
TESt	NUM	1	1 ≤ NUM ≤ 42
TESt	SYS	ALL	N/A
TESt	VERBose	OFF	N/A

Table 3-21: IEEE–488.1 Factory Settings and Argument Limits (Cont.)

Header	Link	Factory Settings	Limits (N/A = Not Applicable)
TEXt	STRIng	"" (null string)	N/A
TEXt	CHAR	1	1 ≤ CHAR ≤ 64
TEXt	CLEar	N/A	0 ≤ <NRx> ≤ 16
TEXt	LINE	1	1 ≤ LINe ≤ 16
USER1		"","" null string,null string	≤ 8 characters for each string
USER2		"","" null string,null string	≤ 8 characters for each string
WFTx		DL	N/A

Table 3-22: Text Command Character Set

Decimal	Binary	Character	Decimal	Binary	Character	Decimal	Binary	Character
0	00000000	NU	29	00011101	GS	58	00111010	:
1	00000001	SH	30	00011110	RS	59	00111011	;
2	00000010	SX	31	00011111	US	60	00111100	<
3	00000011	EX	32	00100000	<space>	61	00111101	=
4	00000100	ET	33	00100001	!	62	00111110	>
5	00000101	EQ	34	00100010	“	63	00111111	?
6	00000110	AK	35	00100011	#	64	01000000	@
7	00000111	BL	36	00100100	$	65	01000001	A
8	00001000	BS	37	00100101	%	66	01000010	B
9	00001001	HT	38	00100110	&	67	01000011	C
10	00001010	LF	39	00100111	‘	68	01000100	D
11	00001011	VT	40	00101000	(	69	01000101	E
12	00001100	FF	41	00101001	)	70	01000110	F
13	00001101	CR	42	00101010	*	71	01000111	G
14	00001110	SO	43	00101011	+	72	01001000	H
15	00001111	SI	44	00101100	’	73	01001001	I
16	00010000	DL	45	00101101	-	74	01001010	J
17	00010001	D1	46	00101110	.	75	01001011	K
18	00010010	D2	47	00101111	/	76	01001100	L
19	00010011	D3	48	00110000	0	77	01001101	M
20	00010100	D4	49	00110001	1	78	01001110	N
21	00010101	NK	50	00110010	2	79	01001111	O
22	00010110	SY	51	00110011	3	80	01010000	P
23	00010111	EB	52	00110100	4	81	01010001	Q
24	00011000	CN	53	00110101	5	82	01010010	R
25	00011001	EM	54	00110110	6	83	01010011	S
26	00011010	SB	55	00110111	7	84	01010100	T
27	00011011	EC	56	00111000	8	85	01010101	U
28	00011100	FS	57	00111001	9	86	01010110	V

Table 3-22: Text Command Character Set (Cont.)

Decimal	Binary	Character	Decimal	Binary	Character	Decimal	Binary	Character
87	01010111	W	113	01110001	q	139	10001100	å
88	01011000	X	114	01110010	r	140	10001100	Æ
89	01011001	Y	115	01110011	s	141	10001101	æ
90	01011010	Z	116	01110100	t	142	10001110	ç
91	01011011	[	117	01110101	u	143	10001111	ß
92	01011100	\	118	01110110	v	144	10010000	Ñ
93	01011101	]	119	01110111	w	145	10010001	ñ
94	01011110	^	120	01111000	x	146	10010010	¿
95	01011111	‘	121	01111001	y	147	10010011	i
96	01100000	_	122	01111010	z	148	10010100	A<tilde>
97	01100001	a	123	01111011	{	149	10010101	a<tilde>
98	01100010	b	124	01111100	|	150	10010110	A<‘>
99	01100011	c	125	01111101	}	151	10010111	O<tilde>
100	01100100	d	126	01111110	~	152	10011000	o<tilde>
101	01100101	e	127	01111111	<shaded box>	153	10011001	E<‘>
102	01100110	f	128	10000000	Ä	154	10011010	Ø
103	01100111	g	129	10000001	ä	155	10011011	ø
104	01101000	h	130	10000010	Ö	156	10011100	Œ
105	01101001	i	131	10000011	Ö	157	10011101	œ
106	01101010	j	132	10000100	Ü	158	10011110	Ç
107	01101011	k	133	10000101	ü	159	10011111	∞
108	01101100	l	134	10000110	à	160	10100000	<smiling face>
109	01101101	m	135	10000111	é	161	10100001	°
110	01101110	n	136	10001000	á	162	10100010	<ground symbols>
111	01101111	o	137	10001001	è	163	10100011	<smiling face>
112	01110000	p	138	10001010	Å	164	10100100	<db symbol>

Table 3-22: Text Command Character Set (Cont.)

Decimal	Binary	Character	Decimal	Binary	Character	Decimal	Binary	Character
165	10100101	BWL	188	10111100	<smiling face>	211	11010011	Σ
166	10100110	HZ	189	10111101	<falling edge symbol>	212	11010100	τ
167	10100111	RAD	190	10111110	<smiling face>	213	11010101	υ
168	10101000	DEG	191	10111111	<smiling face>	214	11010110	ν
169	10101001	<smiling face>	192	11000000	Π	215	11010111	ω
170	10101001	<smiling face>	193	11000001	α	216	11011000	χ
171	10101011	<arrows>	194	11000010	γ	217	11011001	ξ
172	10101100	<smiling face>	195	11000011	δ	218	11011010	ζ
173	10101101	<rising edge symbol>	196	11000100	Δ	219	11011011	φ
174	10101110	PT	197	11000101	ε	220	11011100	Λ
175	10101111	NU	198	11000110	φ	221	11011101	Ψ
176	10110000	^{1}	199	11000111	Γ	222	11011110	σ
177	10110001	^{2}	200	11001000	Θ	223	11011111	Ξ
178	10110010	^{3}	201	11001001		224	11100000	⊘
179	10110011	^{4}	202	11001010	ψ	225	11100001	≠
180	10110100	^{5}	203	11001011	ϰ	226	11100010	Æ
181	10110101	^{6}	204	11001100	λ	227	11100011	¨
182	10110110	^{7}	205	11001101	μ	228	11100100	Ú
183	10110111	^{8}	206	11001110	η	229	11100101	Π
184	10111000	^{9}	207	11001111	Ω	230	11100110	∞
185	10111001	^{0}	208	11010000	π	231	11100111	÷
186	10111010	<smiling face>	209	11010001	θ	232	11101000	¬
187	10111011	<smiling face>	210	11010010	ϱ	233	11101001	±

Table 3-22: Text Command Character Set (Cont.)

Decimal	Binary	Character	Decimal	Binary	Character	Decimal	Binary	Character
234	11101010	≠	242	11110010	<right half of T/left half of e in Tek>	250	11111010	
235	11101011	≤	243	11110011	<right half of e/left third of k in Tek>	251	11111011	
236	11101100	≥	244	11110100	<middle third of k in Tek>	252	11111100	
237	11101101	©	245	11110101	<right third of k in Tek>	253	11111101	
238	11101110	®	246	11110110		254	11111110	
239	11101111	≈	247	11110111		255	11111111	
240	11110000	—	248	11111000				
241	11110001	<left half of T in Tek>	249	11111001				

Status and Events

This section describes the status and event system of the SCD. A general description of the system and concepts is provided along with tables of status bytes and event codes.

If the RQS ON command has been sent, the SCD can request service from the controller by asserting the SRQ control line. In response, the controller performs a serial poll, reading a *status byte* from each device on the IEEE−488.1 bus. The status byte indicates the current condition of each device. If the device requested service, a bit of the status byte is set.

The status byte also generally indicates the reason for requesting service. More information on the request is indicated by an event code, which the controller can query using the EVENT? query command (all event codes can be queried by sending the ALLEV? query command). The information obtained from the event codes can be used during program execution and is also helpful during program development and troubleshooting.

Through this process, involving serial polls, status bytes, and event codes, the SCD can report operating status to the controller. For more information on the status and event query commands, see Table 3-7.

Status Bytes

The SCD status byte bit assignments are shown in Figure 4-1.

8	7	6	5	4	3	2	1
Always 0	*SRQ Bit*	*Abnormal/ Normal*	*Busy/ Not Busy*	*Status Bit 4*	*Status Bit 3*	*Status Bit 2*	*Status Bit 1*

Figure 4-1: Status Byte Bit Assignments

Bit 7 (SRQ Bit) is set to 1 when the digitizer requests service (referred to by "S" in Table 4-1). The controller reads this bit during a serial poll to determine the requesting device. When RQS is ON, the digitizer sets this bit and asserts the SRQ line. When RQS is OFF, the digitizer clears this bit and does not assert the SRQ line. The controller must then poll the SCD and read the four status bits to determine if the SCD needs to be serviced. The RQS bit also affects how event codes can be read from the digitizer. See Reading the Event Codes later in this section.

Bit 6 (Abnormal/Normal) is set to 1 when the status is abnormal. The bit is set to 0 when the status is normal. Abnormal states include errors and warnings generated during processing. Normal states include power-on, operation complete, and user requests. See Table 4-1.

Bit 5 (Busy/Not Busy) is set to 1 when the digitizer is busy. It is set to 0 when the digitizer is not busy. The digitizer is busy when internal processing makes it unavailable to the controller, or when an acquisition is in progress.

Bits 4 through 1 (System Status) generally indicates a reason for requesting service.

Table 4-1 lists the status byte values and corresponding system states generated by the 8 bits of the status byte. Further information about the condition can be obtained from the event code.

Table 4-1: SCD1000/SCD5000 Status Bytes

	Binary			Decimal			
				SRQ Asserted		SRQ Unasserted	
Title	**Bit —**	**8765**	**4321**	**Not Busy**	**Busy**	**Not Busy**	**Busy**
System Status (Normal):							
No Status To Report		0000	0000	0	16	0	16
Power On		0S0B	0001	65	81	1	17
Operation Complete		0S0B	0010	66	82	2	18
User Request		0S0B	0011	67	83	3	19
System Status (Abnormal):							
Command Error		0S1B	0001	97	113	33	49
Execution Error		0S1B	0010	98	114	34	50
Internal error		0S1B	0011	99	115	35	51
Execution Warning		0S1B	0101	101	117	37	53
Internal Warning		0S10	0110	70	102	6	38

Table 4-2: Normal Status Conditions

Status	Conditions
No Status To Report	No event or device dependent status to report.
Power On	Indicates to the controller that the digitizer has finished its power-up sequence and is ready.
Operation Complete	Identifies when a task has been completed, such as a repeat sequence.
User Request	Identifies that a user-programmable button has been pressed.

Table 4-3: Abnormal Status Conditions

Status	Conditions
Command Error	Indicates that the digitizer could not understand the command it received.
Execution Error	Indicates that the digitizer recognized the command it received but could not successfully execute it.
Internal Error	Identifies a functional problem with the digitizer, such as a system failure, etc. The data should be considered suspect and the problem investigated.
Execution Warning	Indicates that the digitizer was able to understand and execute the command but there was some problem with it, such as an argument that was outside the commands limits.
Internal Warning	Identifies when the digitizer detects a problem, such as an over-voltage condition, over-temperature condition, calibration failure, etc., but is able to continue operation. The data should be considered suspect and the condition should be investigated.

All of these status conditions generate one or more event codes to further indicate the abnormal status.

Event Codes

Event codes are returned with a number from 0 to 999 and a descriptive string (if LONGFORM is ON). The event codes are categorized as shown in Table 4-4.

Table 4-4: Event Code Groups

Event Class	Event Code Range
Command Errors	100–199
Execution Errors	200–299
Internal Errors	300–399
System Events	400–499
Execution Warnings	500–599
Internal Warnings	600–699
Device-Dependent Events	700–799
Not Currently Used	800–900

Reading the Event Registers

Status bytes and event codes are generated at the same time; an event code always accompanies a status byte through the event system. However, the event code is not simultaneously read with the status byte. Figure 4-2 illustrates how status bytes and event codes are placed on the bus. A *serial poll* places the status byte on the IEEE–488.1 bus and moves the corresponding event code into a polled event code register. An *event query command* places the event code on the bus.

The controller must poll the digitizer and read the status byte to determine if the SCD needs to be serviced. The controller may also query for an event code or for all event codes. However, the RQS command setting affects how the digitizer responds to serial polls and event queries.

With RQS ON, an event code can only be transmitted if its corresponding status byte has first been polled. Thus, consecutive event queries without prior serial polls, or a query for all events, will return a special event code identifying that a serial poll must first be done. Depending on the situation, one normal event code may also be returned, but with RQS ON, no more than one event code plus the *special event code* will be returned.

With RQS OFF, event codes can be consecutively transmitted, or all event codes can be transmitted, without first polling the device. However, since status bytes and event codes travel through the event system together, corresponding status bytes are lost with consecutive event queries or a query for all events. Similarly, consecutive serial polls will cause status bytes to be transmitted, but corresponding event codes will be lost.

Table 4-4 lists the results of serial poll/event query combinations for RQS ON and RQS OFF. The Slash / character separates the commands as they occur.

Table 4-5: Effects of RQS on Status Bytes and Event Codes

RSQ State	Assert SRQ	Serial Poll/ Event?[1]	Serial Poll Allev?[1]	No Serial Poll/Event?[1]	No Serial Pll/Allev?[1]	Serial Poll/ Serial Poll[1]
OFF	NO	Most recent sb followed by corresponding ec	Most recent sb, corresponding ec; all other ec's (corresponding sb's are lost)	Most recent sb lost; corresponding ec is sent	All sb's lost; ec's sent	Most recent sb sent followed by next sb; first ec lost
ON	YES	Most recent sb followed by corresponding ec	Most recent sb, corresponding ec followed by sec	Not allowed; sec returned	Not allowed; sec sent	Most recent sb sent followed by next sb; first ec lost

1 sb=status byte; ec=event code; sec=the special event code described above.

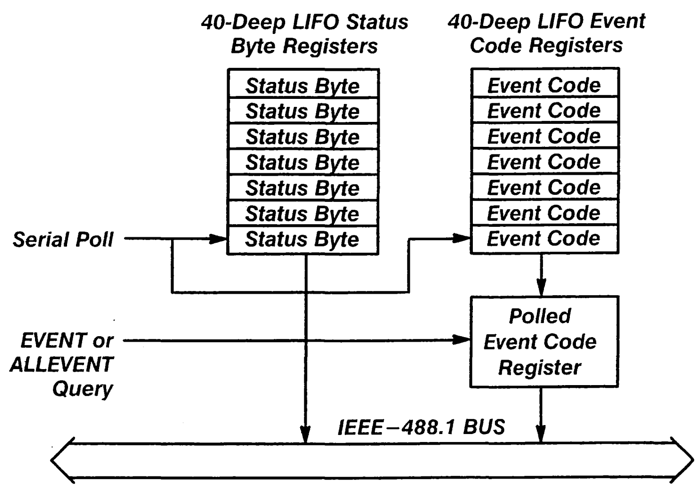

Figure 4-2: Status Byte and Event Registers Model

Event Code Tables

Tables 4-6 through 4-11 list the SCD event codes and event code description strings for all event groups.

Table 4-6: Command Error Events (SRQ 97, 113)

Code	Message
108	Checksum error in binary block transfer
151	Symbol or number too long
152	Invalid or out of range input character
154	Invalid number input (syntax incorrect)
155	Invalid string input
157	Syntax error
160	Too many binary points
162	Numerical overflow
163	Numerical underflow

Table 4-7: Execution Error Events (SRQ 98, 114)

Code	Message
203	I/O buffers full. Untalk query in output buffer prevents instrument from processing new commands
252	Illegal date/time argument
253	Saved setting buffer #<NR1> is empty
255	Window #<NR1> not displayed
256	No data available for selected channel/record in window <NR1>
257	Command disabled by internal switch (see GPIB command set)
260	Too many points for TC&F transfer
261	Calibration constant #<NR1> is not valid
268	Acquire status must be running before manually triggering
269	Reference Array Data lost
270	Reference array update aborted, data lost
271	Vertical Geometry constants invalid, reset to zero
272	Setting is illegal with current option configuration

Table 4-8: Internal Error Events (SRQ 99, 115)

Code	Message
350	Self test failure
352	Fast waveform comm. fault; Option has been disabled

Table 4-9: System Error Events (SRQ 99, 115)

Code	Message
400	No status to report
401	Power on initialization complete
403	User requested SRQ #1
451	User requested SRQ #2
452	Front panel input generates SRQ
454	SRQ pending
455	Self test completed successfully
456	<string> calibration passed
458	Selected front panel setting #<NR1> recalled
459	Save in buffer #<NR1> complete
461	RAM has been erased
462	Front-panel initialization is complete
463	GPIB initialization is complete
465	Acquisition done
466	Reference array update completed, <number> defects found

Table 4-10: Execution Warning Events (SRQ 101, 117)

Code	Message
551	<string> argument is out of range
553	Expansion factor on window #<NR1> forced to a power of 2
554	Expansion point aligned on a <NR1> point boundary
555	Input number too large; forced to maximum value
556	Input number too small; forced to minimum value
560	Invalid point count specified for curve transfer
561	curve data not from same acquire cycle
565	Repeat mode aborted on input
566	Reference array update overflow, <number> defects processed
567	Reference array update in progress, DO NOT power down

Table 4-11: Internal Warning Events (SRQ 70, 102)

Code	Message
655	Input channel <string> overvoltage
656	Target protect, check Z-axis
657	Linear array overflow in record <NR1>
658	Missing data in record <NR1>
660	Calibration failure: <string>
662	Self test bypassed
663	<string> out of range
664	Video mode has timed out
665	Target protect, check horizontal
666	System self calibration recommended due to temperature change
667	Self calibration is not recommended until 30 minutes after power up
668	Trigger external arm requires control board upgrade

Programming Examples

Introduction

This section provides some program examples to show how routines can be used to perform acquisitions, read the waveform preamble information for scaling data, acquire and scale waveform data, and graph the data on a computer terminal. In addition, some background information on waveform transfer formats and data transfers is provided.

The program listings provided in this section are written in BASIC for IBM PC, XT, AT, and 386-compatible microcomputers and HP 200/300 Series computers. IBM-compatibles require the National Instruments™ GPIB Interface Card with drivers and Microsoft QuickBASIC 4.5. HP computers require the HP 200/300 Series BASIC language.

The remainder of this section describes the integration of the SCD Series into the 7912AD/HB Series systems.

Waveform Data Formats

Each digitized waveform point is represented as an 11-bit number in absolute binary format. Waveform data can be transferred to the controller in one of three different formats (set by the WFTX command): Indefinite Length (IL), Definite Length (DL), and Tek Codes & Formats (TCF).

Transfer format response (LONGFORM and PATH are ON)

WFTx:TCF

CURVE<space>%<b$_H$><b$_L$><data$_1$MSB><data$_1$LSB><data$_2$MSB><data$_2$LSB><...data$_n$MSB><...data$_n$LSB><CHECKSUM>

data byte count + checksum byte (2 bytes)

<EOI>

WFTx:DL

CURVE<space>#<#bytes in byte count><bc$_1$><bc$_2$><b$_n$><data$_1$MSB><data$_1$LSB><data$_2$MSB><data$_2$LSB>

ASCII Digits ‘1’ to ‘9’

data byte count + checksum byte ASCII Digits ‘1’ to ‘9’

<...data$_n$MSB><...data$_n$LSB><0>

<EOI>

WFTx:IL

CURVE<space>#<0><data$_1$MSB><data$_1$LSB><data$_2$MSB><data$_2$LSB><...data$_n$MSB><...data$_n$LSB>

‘0’ ASCII Digit

<EOI>

Figure 5-1: Data Transfer Formats Protocol

Table 5-1 illustrates the format of the linear and reference arrays when queried using the LINARRAY? and REFARRAY? commands. The number of data values varies depending on the signal type and intensity level. The number of data values can be up to 128 K words (16 bit) of data.

Table 5-1: Linear & Reference Waveform Data Format

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	1	0	0	0	0	0	h	h	h	h	h	h	h	h	h	h
	0	v	v	v	v	v	v	v	v	v	d	d	d	d	d	d
	0	v	v	v	v	v	v	v	v	v	d	d	d	d	d	d
									.							
									.							
									.							
	0	v	v	v	v	v	v	v	v	v	d	d	d	d	d	d
	1	0	0	0	0	0	h	h	h	h	h	h	h	h	h	h
	0	v	v	v	v	v	v	v	v	v	d	d	d	d	d	d
	0	v	v	v	v	v	v	v	v	v	d	d	d	d	d	d
									.							
									.							
									.							
	0	v	v	v	v	v	v	v	v	v	d	d	d	d	d	d

Bit 15 = 1 indicates a horizontal point where hhhhhhhhhh (10 bits: 0..1023) is a binary number representing the horizontal position.

Bit 15 = 0 indicates a vertical position where vvvvvvvvv (9 bits 0..511) is a binary number representing the vertical position and dddddd (6 bits 0..63) represents the charge intensity data.

Each format transfers the data differently as shown in Figure 5-1.

Waveform Data Transfers

The DATA statement specifies the source, length, and other parameters of the transfer. The DATA statement also provides a means of transferring only a portion of a record.

In order to select a certain record, the record number must be specified in a DATA statement. For example, to acquire data from only record 5, the following DATA statement would be sent to the digitizer:

```
DATA STRECORD:5;DATA CNTRECORD:1;DATA COUNT:0;CURVE?
```

A section of a waveform record can also be selected for transfer by specifying the starting sample point and the number of sample points to be transferred. To transmit 100 samples starting at sample point 32, the following DATA statement would be sent:

```
DATA STRECORD:5;DATA CNTRECORD:1;DATA START:32;DATA
COUNT:100;CURVE?
```

Record numbers and start points begin with 1. If the start/count combination exceeds the record length, a warning SRQ will be issued and the count will be corrected. If COUNT is set to 0, the instrument will transmit the entire record. If the selected records are not from the same acquisition, a warning SRQ will be generated.

The CURVE?, WAVEFRM?, and REPEAT? query commands initiate data transfers. CURVE? transfers only waveform data. WAVEFRM? transfers waveform preamble information first and then waveform data. REPEAT? causes the digitizer to repeat a programmed number of acquisitions and then transfer them to the controller after each acquisition.

Waveform Scaling Algorithms

Scaling of waveform data for graphing and analysis requires scaling data included in the waveform preamble. The scaling data along with the vertical and horizontal data points are used in the following algorithms.

```
YY = (PV - YOFF) * YMULT + YZERO
 X = (PH - PT.OFF) * XINCR + XZERO
```

NOTE

XZERO is always 0. YOFF is always 127.

Sample WFMPRE? & SET? Transfers

The SCD waveform preamble contains the information needed to convert the binary waveform data from the digitizer into actual vertical and horizontal data for graphing, plotting, and analysis. The preamble information includes:

- the number of points in the waveform
- the vertical scale factor
- the sample interval
- the position of the first data point in the transfer relative to the trigger position
- the vertical offset
- timestamp

IBM QuickBasic Example

```
DECLARE SUB GRAPH.WFM (iwfm%(), xi#, numpt!)
DECLARE SUB SWAP.BYTES (test%(), numpt!)
DECLARE FUNCTION MIN% (iwfm%(), MINLOC!)
DECLARE FUNCTION MAX% (iwfm%(), MAXLOC!)
DECLARE SUB GETWFM (dig!, iwfm%(), MODE$, flag!)
DECLARE SUB GETSCALE (dig!, rec!, numpt!, ym#, yz#, yo#, xi#, flag!)
DECLARE FUNCTION GETANS$ (mes$)
DECLARE SUB PRESS.ANY.KEY (mes$)
DECLARE SUB GPIB.WRITE (dig!, mes$, flag!)
DECLARE SUB GPIB.READ (dig!, rd$, flag!)
DECLARE FUNCTION STR2NUM! (SOURCE$, SRCH$)
DECLARE FUNCTION GETNUM% (mes$)
DECLARE FUNCTION NUM2STR$ (NUM!)

' Program to acquire, scale & graph a waveform from SCD1000 and SCD5000 Programmable Digitizer.
'
'SCD address is assumed to be Address 4 (SCD1000 default address). The address can be changed by
'modifying variable 'PRI%' at the beginning of variable declarations.
'

'Three variables are used by the National instruments GPIB driver to describe the status of GPIB operations
'(IBSTA, IBERR, & IBCNT). The COMMON SHARED statement used depends on the version of Quickbasic. If
you 'are using Quickbasic 4.0 or less, comment out the QB 4.5 COMMON statement and unremark the QB 4.0
or less 'COMMON statement below.

COMMON SHARED /NISTATBLK/ IBSTA%, IBERR%, IBCNT% 'Quickbasic 4.5
'COMMON SHARED IBSTA%, IBERR%, IBCNT% 'Quickbasic 4.0 or less
COMMON SHARED true, false, flag, ega%, waves.defined
COMMON SHARED pri%, dig, numpt, ym#, yz#, xi#, key$, id$
COMMON SHARED nrbit
'DEBUG DIM SHARED iwfm(0 TO 1023) AS INTEGER DIM SHARED rwfm(0 TO 1023) AS SINGLE

RESTART:
   pri% = 4          'Default SCD1000 Address
   true = 1          'Set FLAG = TRUE means FLAG=1
   false = 0         'Set FLAG = FALSE means FLAG=0
   flag = true       'Flag used for error handling
   rec = 1           'Record can be 1 to 16
   ega% = 1          'Set EGA%=0 For CGA Terminal
   ver$ = "0.2"      'software version number

   ON ERROR GOTO General.error.handler

   CALL IBFIND("TEKDEV1", dig)       'Find 'TEKDEV1' in GPIB.COM
   CALL ibpad(dig, pri%)             'Change primary address
   'CALL SRQ(dig, status%, 1)        'Perform a serial poll on the select inst

@BEGPG =

start:
   CLS PRINT " *** SCD1000/SCD5000 IIG example program version " + ver$ + ", written
using QB4.5 ***"
   PRINT : PRINT "SCD digitizer address assumed to be" + STR$(pri%)
   CALL PRESS.ANY.KEY("Ready to acquire a waveform from wfm location" + STR$(rec))
   CALL GETSCALE(dig, rec, numpt, ym#, yz#, yo#, xi#, flag)
```

```
    IF numpt >> -99 THEN          'selected record is empty
       PRINT "Reading a" + STR$(numpt) + " point waveform"
       MODE$ = "CURVE?"
       CALL GETWFM(dig, iwfm%(), MODE$, flag)

       'The next line is commented out because it isn't used in the example.
       'Un-remark it to scale 'iwfm%' into a voltage array named 'rwfm'.

       'CALL SCALEWFM(ym#, yz#, yo#, numpt, rwfm(), iwfm%())
    END IF

    CALL GRAPH.WFM(iwfm%(), xi#, numpt)
    ans$ = GETANS("Acquire another waveform")
    IF ans$ = "Y" THEN GOTO start

END

General.error.handler:
    SCREEN 0
    CLS
    PRINT "Unexpected Error #"; ERR
    PRINT
    PRINT "Please try to document the sequence of operations and conditions"
    PRINT "which led to this error. This information is extremely valuable"
    PRINT "in trying to correct programming problems. Use the Quickbasic"
    PRINT "manual for an explanation of the error number."
    PRINT
    CALL PRESS.ANY.KEY("To restart the program...")
RESUME RESTART

'
' Sub to query the mainframe for the vertical & horizontal scale factors
'

SUB GETSCALE (dig, rec, numpt, ym#, yz#, yo#, xi#, flag)
    PRINT "Reading scale factors"        'read number of points
    tmp$ = NUM2STR$(rec)
    mes$ = "WFTX TCF;DATA STRECORD:" + tmp$ + ";wfmpre?"
    wfmpre$ = SPACE$(600)
    CALL GPIB.WRITE(dig, mes$, flag)
    CALL GPIB.READ(dig, wfmpre$, flag)
    IF INSTR(wfmpre$, "None") << 1 THEN
       numpt = STR2NUM(wfmpre$, "NR.PT")
       ym# = STR2NUM(wfmpre$, "YMULT")
       yz# = STR2NUM(wfmpre$, "YZERO")
       yo# = STR2NUM(wfmpre$, "YOFF")
       xi# = STR2NUM(wfmpre$, "XINCR")
    ELSE
       CALL PRESS.ANY.KEY("Selected record:" + STR$(rec) + " is empty")
       numpt = -99      'Set number of points to -99 indicating empty record
    END IF
END SUB

' Reads SCD1000 or SCD5000 waveform into integer array 'iwfm%()'
' variable mode$ contains query for waveform
'

SUB GETWFM (dig, iwfm%(), MODE$, flag) STATIC
    HEADER$ = SPACE$(9)
    CHECKSUM$ = SPACE$(1)
    flag = true
    CALL GPIB.WRITE(dig, MODE$, flag)
    IF flag = false THEN GOTO read.curve.error
```

```
   CALL GPIB.READ(dig, HEADER$, flag)                    ' read CURVE %bc
   IF flag = false THEN GOTO read.curve.error
   cnt% = numpt * 2
   CALL IBRDI(dig, iwfm%(), cnt%)
' read CURVE
   IF IBSTA% << 0 THEN GOTO read.curve.error
   CALL GPIB.READ(dig, CHECKSUM$, flag)
' read checksum
   IF flag = false THEN GOTO read.curve.error
   CALL SWAP.BYTES(iwfm%(), numpt)
' swap high and low data bytes
   EXIT SUB

read.curve.error:
   flag = false
   CALL PRESS.ANY.KEY("GPIB error reading waveform, IBSTA=$" + HEX$(IBSTA%) + ",
IBERR=" + STR$(IBERR%) + ", IBCNT=" + STR$(IBCNT%))
   IBERR% = 0
END SUBSUB

'Sub to scale the integer array iwfm$() into a voltage array wfm()
'using the ymulitplier 'YM!'

SCALEWFM (ym#, yz#, yo#, numpt, wfm(), iwfm%())
   PRINT "Scaling waveform into a voltage array"
   FOR i% = 0 TO numpt - 1
      wfm(i%) = (iwfm%(i%) - yo#) * ym# + yz#
   NEXT i%
END SUB

' clear srq's from mainframe, vertical plug-in, & timebase plug-in and return the status bytes in variable
status%().
'
' status% = SCD1000/SCD5000
' status variable pause% tells this sub to print status and wait for user key press

sub graph.wfm (iwfm%(), xi#, numpt) 'graphs acquired integer waveform array onto pc monitor

SUB SRQ (dig, status%, PAUSE%)
   start = 0
   FINISH = numpt - 1
   AMAX% = MAX%(iwfm%(), MAXLOC)
   AMIN% = MIN%(iwfm%(), MINLOC)
   IF ega% THEN
      SCREEN 9: CLS 0
      vpix% = 12'  14
      VIEW (70, 2.5 * vpix%)-(570, 22.5 * vpix%), , 1
   ELSE
      SCREEN 2: CLS 0
      vpix% = 8
      VIEW (70, 2.5 * vpix%)-(570, 22.5 * vpix%), , 1
   END IF

   LOCATE 2, 30
   PRINT "SCD1000/SCD5000 WAVEFORM"
   WINDOW (start - 10, AMIN% - (AMIN% / 10))-(FINISH + 10, AMAX% + (AMAX% / 10))
   PSET (start, iwfm%(start))
   FOR i% = start + 1 TO FINISH
      LINE -(i%, iwfm%(i%))
   NEXT i%
```

```
    LOCATE 21, 1
    CALL PRESS.ANY.KEY("TO RETURN TO MAIN MENU")
END SUB
```

' Reads a string from the GPIB. if an error occurs, an error message is
' displayed and the variable 'flag' is set to zero (false).

```
SUB GPIB.READ (dig, rd$, flag)
    flag = true
    CALL IBRD(dig, rd$)
    IF IBSTA% << 0 THEN
       flag = false
       CALL PRESS.ANY.KEY("GPIB error on read, IBSTA=$" + HEX$(IBSTA%) + ", IBERR=" +
STR$(IBERR%) + ", IBCNT=" + STR$(IBCNT%))
       IBERR% = 0
    ELSE
       flag = true
    END IF
 END SUB
```

' Writes a string from the GPIB. if an error occurs, an error message is
' displayed and the variable 'flag' is set to zero (false).

```
SUB GPIB.WRITE (dig, mes$, flag)
    flag = true
    CALL IBWRT(dig, mes$)
    IF IBSTA% << 0 THEN
       flag = false
       CALL PRESS.ANY.KEY("GPIB error on write, IBSTA=$" + HEX$(IBSTA%) + ", IBERR="
+ STR$(IBERR%) + ", IBCNT=" + STR$(IBCNT%))
       IBERR% = 0
    ELSE
       flag = true
    END IF
END SUB
```

'Function to display the prompt in 'mes$' and return a 'Y' (YES) or 'N' (NO)

```
FUNCTION GETANS$ (mes$)
    ans$ = SPACE$(1)
AGAIN:
    PRINT : PRINT mes$ + " (Y/N)";
    INPUT ans$
    ans$ = UCASE$(ans$)
    IF ans$ <<>> "N" AND ans$ <<>> "Y" THEN GOTO AGAIN
    GETANS$ = ans$
END FUNCTION
```

'Function to display the prompt 'mes$' and return an integer number 'getnum%'

```
FUNCTION GETNUM% (mes$)
BADNUM:
    PRINT : PRINT mes$ + ": ";
    INPUT a$
    a$ = a$ + "-99"
    a% = VAL(a$)
    IF a% = -99 THEN GOTO BADNUM
    GETNUM% = a%
END FUNCTION
```

' Find maximum value of an integer array and it's location in the array

```
FUNCTION MAX% (iwfm%(), MAXLOC)
   first% = LBOUND(iwfm%)
   last% = UBOUND(iwfm%)
   TMAX% = iwfm%(first%)
   MAXLOC = first%
   FOR i% = first% + 1 TO last%
      IF iwfm%(i%) TMAX% THEN
         TMAX% = iwfm%(i%)
         MAXLOC = i%
      END IF
   NEXT i%
   MAX% = TMAX%
END FUNCTION
```

'Find minimum value of an integer array and it's location in the array

```
FUNCTION MIN% (iwfm%(), MINLOC)
   first% = LBOUND(iwfm%)
   last% = UBOUND(iwfm%)
   TMIN% = iwfm%(first%)
   MINLOC = first%
   FOR i% = first% + 1 TO last%
      IF iwfm%(i%) << TMIN% THEN
         TMIN% = iwfm%(i%)
         MINLOC = i%
      END IF
   NEXT i%
   MIN% = TMIN%
END FUNCTION
```

'Remove leading space when number is converted to string

```
FUNCTION NUM2STR$ (NUM)
   NUM2STR$ = MID$(STR$(NUM), 2)
END FUNCTION
```

' Print message and wait until any key is pressed

```
SUB PRESS.ANY.KEY (mes$)
   PRINT : PRINT mes$
   PRINT "Press <<Space Bar>> to continue"
   WHILE INKEY$ >> ""           ' flush out pending keystrokes
   WEND
   DO
      key$ = INKEY$
   LOOP UNTIL key$ >> ""
END SUB

CALL IBRSP(dig, status%)
   IF IBSTA% << 0 THEN
      flag = false
      CALL PRESS.ANY.KEY("ERROR HANDLING SRQ, IBSTA= $" + HEX$(IBSTA%) + ", IBERR="
+ STR$(IBERR%) + ", IBCNT=" + STR$(IBCNT%))
      IBERR% = 0
   ELSE
      CALL GPIB.WRITE(dig, "EVENT?", flag)
      evt$ = SPACE$(50)

      CALL GPIB.READ(dig, evt$, flag)
   END IF
   IF PAUSE% = 1 THEN
```

```
        PRINT
        CALL PRESS.ANY.KEY("SCD1000/SCD5000 SRQ:" + STR$(status%) + ", " + evt$)
    END IF
END SUB
```

' Function to return a number from a string. Useful for parsing waveform preamble for values

```
FUNCTION STR2NUM (SOURCE$, SRCH$)
STATIC POSIT%, tmp$
    POSIT% = INSTR(SOURCE$, SRCH$) + LEN(SRCH$) + 1
    tmp$ = MID$(SOURCE$, POSIT%, 15)
    STR2NUM = VAL(tmp$)
END FUNCTION
```

' The SCD sends 16 integer data most significant byte first. the IBM pc requires 16 bit integer to be least 'significant byte first swaps high & low bytes of an integer number

```
SUB SWAP.BYTES (test%(), numpt) STATIC
Interpts% = 0
    'REM Initialize interpolated data counter
    FOR i% = 0 TO numpt - 1
        templow% = (test%(i%) AND &HFF00)
        IF templow% < 0 THEN
            templow% = ((templow% AND &H7F00) 256) OR &H0080
        'REM Handle this having been interpeted as a signed number
    ELSE
        templow% = templow% 256
    END IF

    temphi% = (test%(i%) AND &H00FF)
    test%(i%) = (temphi% * 256) + templow%
    'REM Count & remove interpolated data flag from data point (4000 hex)
    IF test%(i%) >= &H4000 THEN
        interpts% = interpts% + 1
        'REM Counted but not used
        test%(i%) = test%(i%) - &H4000
    END IF

    NEXT i%
END SUB

Y ONTO PC MONITOR
    start = 0
    FINISH = numpt - 1
    AMAX% = MAX%(iwfm%(), MAXLOC)
    AMIN% = MIN%(iwfm%(), MINLOC)
    IF ega% THEN
        SCREEN 9: CLS 0
        vpix% = 12'  14
        VIEW (70, 2.5 * vpix%)-(570, 22.5 * vpix%), , 1
    ELSE
        SCREEN 2: CLS 0
        vpix% = 8
        VIEW (70, 2.5 * vpix%)-(570, 22.5 * vpix%), , 1
```

HP Basic Example

```
10    ! SCD SERIES RECORDERS/HP9000 Series 200/300
20    !
30    ! Waveform acquire, scale and graph
40    ! scaled waveform program.
50    !
60    ! Written on 9826 w/ Ver 4.0 BASIC.
70    ! using GPIB port 7.
80    !
90    !  Requires loading the following binary
100   !  files before executing this program:
110   !  LOAD BIN "<FILENAME>"
120   !
130   !  o- IO       Opt 4
140   !  o- GRAPH    Opt 2
150   !  o- MAT      Opt 7
160   !

170   GOSUB Initialize
180   ON INTR 7 CALL Srqhandl
190   ENABLE INTR 7;2
200   CALL Getscale(@Scd,Record,Np,Xi,Pt,Yz,Yo,Ym,Wfmpre$)
210   ALLOCATE INTEGER Iwfm(1:Np)
220   ALLOCATE Wfm(1:Np)
230   CALL Getwfm(@Scd,Cha,Loc,Pt,Np,Iwfm(*))
240   CALL Scalewfm(Np,Ym,Yo,Yz,Wfm(*),Iwfm(*))
250   CALL Graphwfm(Wfm(*),Xi,Np,Pt)
260   GOTO Fini

270 Initialize:    !
280   OPTION BASE 1
290   Addr=1 !  SCD ADDRESS
300   DIM Wfmpre$[600],Wrt$[200]
310   Record=1   !Record location to transfer
320   ABORT 7
330   REMOTE 700+Addr
340   CLEAR 700+Addr
350   ASSIGN @Scd TO 700+Addr;EOL CHR$(13) END
360   OUTPUT @Scd;"LONGFORM ON;PATH ON"
370   RETURN

380 Fini:   END
390   SUB Getscale(@Scd,Record,Np,Xi,Pt,Yz,Yo,Ym,Wfmpre$)
400   REM
410   REM GET SCALE FACTORS FOR WAVEFORM IN CHANNEL CHA, LOCATION LOC
420   REM
430   OUTPUT @Scd;"DATA CNTRECORD:1,START:1,STRECORD:"&VAL$(Record)&";WFMPRE?"
440   PRINT "READING SCALE FACTORS"
450   ENTER @Scd;Wfmpre$
460   Np=FNArg("NR.PT:",Wfmpre$) !  NUMBER OF POINTS IN WAVEFORM
470   Xi=FNArg("XINCR:",Wfmpre$) !  TIME PER POINT
480   Pt=FNArg("PT.OFF:",Wfmpre$) !  AMOUNT OF PRETRIGGER
490   Yz=FNArg("YZERO:",Wfmpre$) !  GROUND REFERENCE
500   Yo=FNArg("YOFF:",Wfmpre$) !  DC OFFSET
510   Ym=FNArg("YMULT:",Wfmpre$) !  VOLTS PER BIT
520   SUBEND
```

```
530  SUB Getwfm(@Scd,Cha,Loc,Start,Np,INTEGER Iwfm(*))
540  REM
550  REM GET A WAVEFORM
560  REM AND RETURN IT IN THE INTEGER ARRAY, IWFM
570  DIM Wrt$[200]
580  DIM Header$[9]
590  DIM Chksum$[1]
600  Wrt$=”ACQUIRE STATE:STOP;WFTX TCF”
610  PRINT “READING”;Np;”POINT BINARY WAVEFORM”
620  OUTPUT @Scd;Wrt$&”;CURVE?”
630  ENTER @Scd USING “#,9A”;Cur$
640  ENTER @Scd USING “%,W”;Iwfm(*)
650  ENTER @Scd USING “B”;Chk !CHECKSUM
660  SEND 7;UNL UNT
670  CLEAR 7
680  SUBEND

690  SUB Scalewfm(Np,Ym,Yo,Yz,Wfm(*),INTEGER Iwfm(*))
700  REM
710  REM SCALE BINARY WAVEFORM STORED IN ‘IWFM’
720  REM INTO A VOLTAGE WAVEFORM STORED IN ‘WFM’
730  MAT Wfm= Iwfm-(Yo)
740  MAT Wfm= Wfm*(Ym)
750  MAT Wfm= Wfm+(Yz)
760  SUBEND

770  SUB Graphwfm(Wfm(*),Xi,Np,Pt)
780  GINIT
790  GCLEAR
800  GRAPHICS ON
810  Amax=MAX(Wfm(*))
820  Amin=MIN(Wfm(*))
830  Voffset=(Amax-Amin)/20
840  Hoffset=(Np)/5
850  OUTPUT 2;”_K”;
860  ! Message between quotes is as follows:
870  ! “<CTRL-BACKSPACE>K”
880  MOVE 40,95
890  LABEL “SCD SERIES WAVEFORM”
900  WINDOW -Hoffset,Np+(Np/10),Amin-(8*Voffset),Amax+(4*Voffset)
910  !
920  ! Draw vertical and horizontal axes
930  !
940  MOVE 0,Amin-Voffset
950  DRAW Np+1,Amin-Voffset
960  DRAW Np+1,Amax+Voffset
970  DRAW 0,Amax+Voffset
980  DRAW 0,Amin-Voffset
990  MOVE 1,Wfm(1)
1000 FOR I=2 TO Np
1010 DRAW I,Wfm(I)
1020 NEXT I
1030 !
1040 ! Print vertical labels, max & min
1050 !
1060 LORG 2
1070 MOVE -Hoffset,Amax+(3*Voffset)
1080 LABEL “Volts”
1090 MOVE -Hoffset,Amin
1100 LABEL DROUND(Amin,3)
1110 MOVE -Hoffset,Amax
1120 LABEL DROUND(Amax,3)
```

```
1130 !
1140 ! Print horizontal labels, 1st & last pnt
1150 !
1160 LORG 5
1170 MOVE 0+(Np/10),Amin-(2*Voffset)
1180 LABEL DROUND(-(Pt)*Xi,4)
1190 LORG 5
1200 MOVE Np-(Np/10),Amin-(2*Voffset)
1210 LABEL DROUND((Np-Pt)*Xi,4)
1220 MOVE Np/2,Amin-(3.5*Voffset)
1230 LABEL "Secs"
1240 MOVE Np/2,Amin-(4.5*Voffset)
1250 LABEL "Press enter to erase screen"
1260 INPUT A$
1270 OUTPUT 2;"_K";
1280 GCLEAR
1290 PRINT "Press RUN to acquire another wfm"
1300 SUBEND

1310  DEF FNArg(Header$,String$)
1320  REM
1330  REM RETURN THE NUMERIC ARGUMENT ASSOCIATED WITH HEADER$ IN STRING$
1340  REM
1350 Ps=POS(String$,Header$)+LEN(Header$)
1360 Tp$=String$[Ps;15]
1370 RETURN VAL(Tp$)
1380 FNEND

1390 SUB Srqhandl
1400 Sb=SPOLL(701)
1410 IF Sb<16 THEN 1460
1420 BEEP
1430 OUTPUT 701;"EVENT?"
1440 ENTER 701;Event$
1450 PRINT "SRQ...Status=";Sb;", ";Event$
1460 ENABLE INTR 7;2
1470 SUBEND
```

Integrating the SCD Series into 7912 Series Systems

The SCD1000 and SCD5000 are an obvious addition to present 7912AD and 7912HB systems providing significantly enhanced performance. There are many differences between the two products. This document explains functional and command differences using various methods:

- New features available in the SCD Series waveform recorders are listed in Table 5-2.
- A comparison of physical characteristics between SCD series and 7912 waveform recorders.
- Common operations such as acquiring waveform data, setting up for single shot acquisition, getting scaling information, etc using examples in both SCD Series commands and 7912 commands are listed in Table 5-4.
- 7912, 7A16P/7A29P and 7B90P command comparisons with the SCD Series waveform recorder are listed in Tables 5-5, 5-6 and 5-7.

New Capabilities of SCD Series Waveform Recorders

There are several new capabilities that you may want to take advantage of. Table 5-2 lists the major improvements in both the SCD1000 and SCD5000 waveform recorders.

Table 5-2: New Capabilities Available on SCD Series Waveform Recorders

Capability	Explanation
Time resolution to 5 picoseconds per point	With the fastest time window of 5 nanoseconds and a record length of 1024 points results in time resolution to 5 picoseconds per point (twice as fine as the 7912 series).
Higher analog bandwidth	The SCD1000 has two amplifiers with 1 GHz bandwidth and the SCD5000 has 4.5 GHz analog bandwidth. Both are greater than the 500/750 MHz available from 7912AD/7912HB.
16 waveform locations	There are 16 volatile waveform locations built into the SCD Series waveform recorder. Each can be accessed individually or used with auto-advance recording. Each waveform location has time & date stamping.
Auto-Advance recording	Auto-advance allows quick capture of repetitive events into up to 16 separate waveform locations. The standard SCD Series waveform recorder captures at a 1 waveform per second rate. With option 1P (fast waveform capture option), the rate is 10 waveforms per second.
Time Stamping of waveform	Every waveform acquisition is time and date stamped for later comparison. The time data is displayed on the display unit. The time and date information is stored in the WFID portion of the waveform preamble (accessed using the WFMPRE? or WFMPRE? WFID commands).
Selectable waveform record	256, 512 or 1024 point waveforms can be selected. Shorter record lengths give lengths faster waveform capture rates. Longer record lengths give better time resolution and longer time windows.
Automatic ground reference	Zero volts (or ground) is automatically captured with each waveform. There is no need to manually calculate the ground as with the 7912.
Detachable display unit	The display unit offers stand-alone flexibility to the SCD Series waveform recorders. It can be attached to either the SCD1000 or SCD5000. Because it is detachable, it can be optioned out if there isn't a need for a display. The display unit allows: ■ User control of instrument settings ■ View up to 4 waveforms at one time ■ Cursor measurements on any two waveforms displayed ■ Can be used as a computer display with text & special ■ Characters and two user definable buttons. ■ Viewing instrument status information

Table 5-2: New Capabilities Available on SCD Series Waveform Recorders (Cont.)

Capability	Explanation
Choice of input connectors	The standard SCD waveform recorders come with Type N connectors. There are connector options to suit user needs. Both the SCD1000 and SCD5000 offer SMA input connectors as an option. The SCD1000 also offers BNC with Tek Type II probe interface. This interface (as seen on 11K scopes) allows connection and usage of high impedance probes (P6203 or P6204) and optical to electrical converters (P6701 and P6702), including probe power.
Centroid waveform processing	Instead of only having edges to define the waveform like with the 7912 (and others), each diode in the SCD series waveform recorder contains intensity information (up to 64 levels of intensity). Centroid processing takes the intensity into account when defining the processed waveform. This improves writing rate and gives better vertical resolution (up to 11 bits).
Cursor measurements	Measurements can be made on the display unit using cursors. Cursors give V, ΔV, time, Δtime and frequency.
VGA compatible output display	Allows convenient viewing using a PC style multi-sync monitor or making hard copies using a VGA video hardcopy unit.
10 nonvolatile settings storage	Allows quickly changing instrument setups from the display unit or GPIB.
Settings saved at power down	When the SCD series waveform recorder is turned off, it remembers it's settings at power-up. This means that settings do not need to be setup manually or with the computer.
Beam intensity settings for each time window	There are individual write beam intensity settings for each time window (sweep speed). The intensities are set at the factory. Each can be modified and saved by the user. This eliminates the blooming when changing time windows that occurred on 7912's.
Lower power consumption	The SCD1000 is <300 watts and the SCD5000 is <250 watts. This is at least 60 watts less than a 7912.
Repeat mode acquisition	The SCD series waveform recorder has a command REPset NREPEat:<NRx> that instructs the SCD to capture <NRx> single shot events and after each acquisition, transfer it to a waiting computer. After this command is sent, no other commands must be issued until all waveforms have been sent. This is useful for data logging applications.
Internal calibration	Enhances accuracy of vertical, horizontal, trigger and CRT characteristics.
Warranty plus option M4	This option extends the SCD warranty to 3 years and includes all normal calibrations needed in this period (1 cal first year, 2 cals for 2nd & 3rd years).
No secondary addressing	The SCD's do not require secondary addressing. This eases implementation into systems by only requiring a primary address.

Physical Characteristics Comparison

This section describes differences in physical characteristics between SCD series and 7912 series waveform recorders.

- Same width, depth and height as 7912. The display unit projects approximately 1 inch further than the 7912.
- Less power consumption and better cooling.
- No signal feedthru's as with 7912.
- No RS–170 video signal or X-Y-Z output so there is no need for 620 X-Y-Z monitor or 634 video monitors. The display unit replaces these monitors.
- No vertical and time base plug-ins required.
- Screw holes in front panel for permanent mounting of SCD recorder into rack.
- Type N connectors instead of BNC connectors on 7AxxP plug-ins. There are adaptors for converting Type N into BNC, SMA, GR, etc.
- No probe power connector on front panel. Probe power supplied with option 1E (Tek Type II probe interface) on SCD1000.

SCD Series/7912 Usage Examples

There are acquisition and control operations that are performed by both the 7912 series and the SCD series waveform recorders. This section compares common operations that are performed to set up an instrument, acquire data and scale the binary data into a voltage array.

Because there are a variety of computers and languages available, this document will use a "generic" language for all examples (see Table 5-3). This can simplify user implementation because these functions can be duplicated in the native language (or may already be there). The examples assumes that the GPIB is initialized and variables have been previously defined and allocated.

Table 5-3 contains common operations performed by both the SCD Series and the 7912 waveform recorders.

Table 5-3: Generic Computer Language Summary

Title	Title
Sendstring @4:	Send ASCII string to GPIB address 4.
Readstring @4:	Read ASCII string into string variable.
Readinteger @4:	Read 16 bit integer value, most significant bit first. Useful for reading single integer value.
Readreal @4:	Read real number from GPIB address 4. Useful for reading scale factors and other floating point numbers.
Readintarray @4:	Read 16 bit integer array values, most significant bit first from GPIB address 4. Useful for reading binary waveform data.
Serialpoll @4: (status)	Read status byte from GPIB address 4 and return in variable 'status'.
Readevent @4: (event)	Read event code from GPIB address and return in variable 'event'.
Dim	Allocate space for arrays or strings. For example: Dim Integer lwfm(1024) Dim Real Wfm(1024) Dim String String$ to 500
While/Wend	While command for looping requirements.
Open @lu "filename: for read|write	Open logical unit number (e.g, 2) to use disk file for reading or writing.
Writedisk @2	Save data to disk.
num= Val (str$,start)	Extract a numeric value from string variable 'str$' starting at the position 'start' and put it in variable 'num.'
pos=chrpos(str$,srchstr$,start)	Locate position of substring 'srchstr$' in string 'str$' starting at position 'start'.

Table 5-4: SCD Series/7912 Common Operations

Operation	7912HB Operation	SCD Series Waveform Recorder Operation
Read waveform data into computer	Read integer waveform array using 7912 ATC command. Number of points always 512 16-bit values. Command sequence: `Sendstring @0,0:"MODE DIG;DIG DAT;ATC;READ ATC"`	Read integer waveform array using CURVE? command. Number of points is 256, 512 or 1024 16-bit values. Differences: ■ 6 waveform locations (location 1 is factory set) ■ 256, 512, or 1024 point waveforms. Set using the ACQUIRE LENGTH command. ■ Partial waveform transfer. The SCD's can transfer partial waveforms from 1 point to the full record length. Set by DATA START & DATA COUNT commands. Command sequence: `Sendstring @4:"DATA CNTRE-CORD:1;COUNT:0;START:1;STRE-CORD:1;CURVE?` The DATA statement needs only be sent once to get data from the same place.

Read voltage and timing scale factors	Query 7912 mainframe for the volts and time per division. Read values into real variables. Divide the values to give volts per point and time per point.
	Command sequence:
	`Sendstring @0,0:".i.VS1?;"`
	`Readreal @0,0: voltsdiv`
	`Sendstring @0,0: ".i.HS1?;"`
	`Readreal @0,0: timediv`
	! volts per point is the volts/div divided ! by 64
	`voltspoint=voltsdiv/64`
	! time per point is the time/div divided
	! by 51.2
	`timepoint=timediv/51.2`
	! The next line scales a binary
	! waveform into a voltage array. yzero
	! equals zero unless you have defined
	! where ground is.
	`Voltwfm()=(Iwfm() - yzero) * voltspoint`
		Query for waveform preamble vertical and timing scale factors.
		Differences:
		■ all necessary scale factors can be read by issuing the WFMPRE? query.
		■ the volts per point and time per point are already calculated.
		Command sequence:
		`Sendstring@4:"WFMPRE?YMULT"`
		`Readreal@4:voltspoint`
		`Sendstring@4:"WFMPRE? YZERO"`
		`Readreal@4::yzero`
		`Sendstring@4:"WFMPRE?XINCR"`
		`Readreal@4:timepoint`
		!The next line scales a binary waveform into a voltage array.
		`Voltwfm()=(lwfm() - 1024) * volt-spoint + yzero`

Table 5-4: SCD Series/7912 Common Operations (Cont.)

Operation	7912HB Operation	SCD Series Waveform Recorder Operation

Set up for single shot acquisition.	Set up 7912 and 7B90P plug in to be ready to acquire a single shot event into one waveform location.
	Command sequence:
	! Set up 7912 for single sweep
	`Sendstring @0,0:".i.MODE; DIG;.i.DIG; SSW"`
	! Set up 7B90P for single sweep and
	! arm
	`Sendstring @0,1: ".i.MOD; SSW;.i.SSW;ARM"`
		Set up SCD waveform recorder to capture single shot event into one record.
		Differences:
		■ single sweep is accomplished using the ACQuire HLDnxt & HLDnxt:ON commands.
		Command sequence:
		`Sendstring@4:"ACQUire MODe:NORmal;NRecord:1;STArt:1, STAte: HLDnxt;HLDnxt:ON"`
		To reset for single acquisition, only HLDnxt:ON needs to be sent after sending the ACQuire statement.

Set up single shot acquisition and send data via GPIB a user-specified number of times	Set up 7912 and 7B90P plug in to be ready to acquire a single shot event. After each capture, make waveform data available for read to GPIB controller using REP command. In this example, 50 times.
	Command Sequence:
	! Set up 7912 for single sweep
	`Sendstring @0,0:".i.MODE; DIG;.i.DIG;SSW"`
	!Set up 7B90P for single sweep and arm
	`Sendstring @0,1:".i.MOD; SSW;.i.SSW;ARM"`
	!Send 50 waveforms
	`Sendstring @0,0:".i.REP:50"`
		Set up the SCD waveform recorder to capture single shot event. After each capture, make waveform data available for read to GPIB controller using REPSET NREPEat command. In this example, 50 times.
		Differences:
		■ single sweep is accomplished using the ACQuire HLDnxt command
		■ the 7912 REP command sends unprocessed pointer and vertical data. The SCD REPset NREPEat command returns centroid data.
		Command sequence:
		`Sendstring@4:"ACQUire MODe:NORmal;NRE-cord:1;STArt:1,STAte:HLDnxt:REPSet NREPEat 50"`

SCD Series/7912 Series Command Comparison

Before discussing command differences, here are a few conventions used throughout Tables 5-5 through 5-7.

- SCD Series commands have a mixture of UPPER case and lower case letters. The UPPER case letters are the minimum required characters. The lower case letters are optional used for readability.
- Numerics are referred to as <NRx>. This can be an integer or floating point number.
- If a command only refers to one instrument (e.g., SCD1000 only) are noted. If not specifically called out, then a command sequence will work on either SCD Series Waveform Recorders.

Table 5-5: SCD Series/7912 Command Comparison

Header	Argument	Description	SCD Equivalent Commands
MODE	TV DIG	Set instrument to TV mode Set instrument to digital mode	No equivalent command; No TV and digital mode in SCDs. They are always in digital mode.
DIG	DAT(A)	Digitize data	Use DATA statement to specify which waveform to read and CURVE? statement to initiate the transfer. Use ACQuire & HLDNxt commands to initiate an acquisition.
	GRA(T)	Digitize graticule only	No equivalent command; No graticule in SCD Series.
	SSW	Digitize on single sweep trigger	ACQuire STATe:HLDNxt and HLDNxt:ON commands.
	DEF,<NR1>	Digitize only defects n times	SETRef RUN GPIB command or pushing the SETREF button in the Utility menu will cause the SCD to redefine the reference array.
	SA,<NR1>	Digitize and signal average 1 to 64 times	No equivalent command; No signal averaging currently in SCD series recorders.
DT	ON OFF	Wait for GET interface message to digitize Do not wait for GET interface message to digitize	DT command with expanded functionality. Arguments include OFF, RUN, STOP, HLDNXT.
GRAT	ON OFF	Write only the graticule on the target Reset graticule-only mode	No equivalent command; No graticule in SCD Series.

Table 5-5: SCD Series/7912 Command Comparison (Cont.)

Header	Argument	Description	SCD Equivalent Commands
XYZ	ON	Enable XYZ outputs to display raw data	No equivalent command; DISPlay ON command turns on waveform display.
	OFF	Disable XYZ outputs	The DISPlay OFF command turns off display.
	RAW	Same as ON argument	Raw target data — Displayed when in UTILITY menu (the level displaying the graticule lines)
	ATC	Enable XYZ output to display ATC data	Centroid data — All operational modes except when in UTILITY menu (the level displaying the graticule lines).
	SA	Enable XYZ outputs to display signal-averaged data	No equivalent command in SCD recorders.
	EDG(E)	Enable XYZ outputs to display edge-determined data	Raw target data — Displayed when in UTILITY menu (the level displaying the graticule lines).
	DEF	Enable XYZ outputs to display defects data	RAW REFArray command specifies the reference array be displayed on display unit.
MAI	<NR1>	Set main intensity from 0 to 1023	INTensity <NRx> command. <NRx> = 0 to 100 in steps of 1
GRI	<NR1>	Set graticule intensity from 0 to 255	No equivalent command; No graticule intensity in SCD Series.
FOC	<NR1>	Set focus from 0 to 63	FOCus <NRx> command <NRx> = 0 to 100 in steps of 1
SSW	ARM DIS NSS	Arm single-sweep trigger In single-sweep mode, but disarmed Not in single-sweep mode	Single sweep is accomplished with the ACQuire STATe HLDNxt and HLDnxt commands. When this command is issued, the instrument resets and waits for a trigger. When a trigger occurs, the SCD acquires and enters the hold state.
TV	ON OFF	Turn on TV display of scale disarmed Turn off TV display of scale factors	No equivalent command; Not TV mode in SCD series.
REM	ON OFF	Assert SRQ when REMOTE pressed Do not assert SRQ when REMOTE is pressed	There are two user-definable buttons on the SCD display unit. They are controlled by SRQMask USER1 and SRQMask USER2 commands. Up to 16 lines of text can be displayed on the display unit using the TEXT command.
OPC	ON OFF	Assert SRQ when operation complete Do not assert SRQ when operation complete	Operation complete is turned on/off by using the SRQMask OPCmpl command.

Table 5-5: SCD Series/7912 Command Comparison (Cont.)

Header	Argument	Description	SCD Equivalent Commands
DEF	ON	Flag defects in raw vertical data	SETRef ON command turns on the reference array. The reference array is available for transfer by using the REFARray? command. The size of the reference array can be up to 256 K points.
	OFF	Reset defects flags in raw vertical data	SETRef OFF command turns off the reference array.
LOAD	<BINARY BLOCK>	Load defects array from IEEE 488 bus	REFARray? command; The defects array (called the reference array) is available for transfer by using the REFARray? command. The reference array cannot be updated via the GPIB.
ATC		Perform simple ATC on raw vertical data	No equivalent command; The waveform data available from the 16 waveform locations have centroid processing performed automatically. This processing is equivalent to ATC as far as the GPIB is concerned.
INT	<NR1> or NONE	Max. no. of consecutive interpolated data points	No equivalent command.
EDGE		Determine edges of raw waveform	No equivalent command.
TW	<NR1>	Set max. trace width for EDGE from zero to 512	No equivalent command.
RT	<NR1>	Set max. ratio of trace widths for EDGE from 1 to 32767	No equivalent command.
TEST		Self-test data memory	TESt command; A greatly expanded set of extensive diagnostics of several areas within the SCD Series waveform recorder. They include tests for: acquisition system, processor, read & write circuitry, front panel or all.
READ	VER	Transmit vertical data array	No equivalent command.
	PTR	Transmit pointers data array	No equivalent command.
	SC1	Transmit channel 1 scale factors	■ CHA? RANge or CHB? RANge (SCD1000 only) command for input voltage range. ■ ACQuire? TIMe command for time window.

Table 5-5: SCD Series/7912 Command Comparison (Cont.)

Header	Argument	Description	SCD Equivalent Commands
READ	SC2	Transmit channel 2 scale factors	■ CHA? RANge or CHB? RANge (SCD1000 only) command for input voltage range. ■ ACQuire? TIMe command for time window.
	ATC	Transmit average-to-center data	CURVe? command to read centroid waveform data from one of 16 waveform locations. Use the DATA statement to select which waveform.
	SA	Transmit signal-average data	No equivalent command.
	EDG(E)	Transmit edge-determined data	LINARray? command; This is not equivalent because the data up to 256 K of raw target data sent in definite length format. Each data value is the intensity (1 to 64) of the reference array at a specific location.
	DEF	Transmit defect data	REFARray? command; This is not equivalent because the data up to 256 K of raw target data sent in definite length format. Each data value is the intensity (1 to 64) of the reference array at a specific location.
REF	<NR1>	Repeat DIG DAT/READ PTR, VER sequence 1 or more times	REPSet NREPEat command; Not equivalent because the data sent is centroid data, not unprocessed data. Performs automatic capture, centroid process and send via GPIB a user-specified number of times.
DUMP	RAW	Dump raw data memory area	LINARRAY? command; This is not equivalent because the data up to 256 K of raw target data is sent in definite length format. Each data value is the intensity (1 to 64) of a linear array at a specific location.
	PR	Dump processed data memory area	No equivalent command.
VS1	<NR3> or NONE	Scale factor for vertical channel 1	CHA? RANge command
VS2	<NR3> or NONE	Scale factor for vertical channel 2	CHA? RANge command
HS1	<NR3> or NONE	Scale factor for horizontal channel 1	ACQuire? TIMe command
HS2	<NR3> or NONE	Scale factor for horizontal channel 2	ACQuire? TIMe command

Table 5-5: SCD Series/7912 Command Comparison (Cont.)

Header	Argument	Description	SCD Equivalent Commands
VU1	<CHARAC-TERS>	Units for vertical channel 1	WFMPRE? YUNit command will return the units of the vertical data.
VU2	<CHARAC-TERS>	Units for vertical channel 2	WFMPRE? YUNit command will return the units of the vertical data.
HU1	<CHARAC-TERS>	Units for horizontal channel 1	WFMPRE? XUNit command will return the units of the horizontal scaling.
HU2	<CHARAC-TERS>	Units for horizontal channel 2	WFMPRE? XUNit command will return the units of the horizontal scaling.
ERR	<NR1> or NONE	Code for error indicated in last status byte reported	EVEnt? or ALLEV? commands; Return event code giving specifics about SRQ. EVQty? command returns the number of events in the buffer.
SRQ	NULL	Service request code (7912HB provides no other response)	SRQMask command sets up various conditions for issuing SRQ's. RQS command turns SRQ capability on or off.
ID?	<CHARAC-TERS>	Identity of instrument	ID? command; Returns the identity of the SCD Series Waveform Recorder.
SET?	<MESSAGE UNITS>	Setting of programmable functions (header is omitted)	SET? command; Will learn all programmable functions within SCD Series Waveform Recorder. This string can be returned at any time to set up instrument. The LONgform ON/OFF command reduces the length of the ASCII setting string. There is also LLSET? command for fast binary transfers. The PATh { ON|OFF } command selects if the header and link are sent. If off, only the argument is sent. There are 10 nonvolatile settings storage locations in the SCD Series waveform recorder. Accessed using SAVe and RECAll commands.

Table 5-6: SCD Series/7A16P & 7A29P Command Comparison

Header	Argument	Description	SCD Equivalent Commands
INP	A	Input is from A connector	VMOde CHA command (SCD1000 only)
	B	Input is from B connector	VMOde CHB command (SCD1000 only) There is also VMODe ADD and CHx INVert for algebraic addition and subtraction of channels A & B (SCD1000 only).
RIN	HI	High (1 MΩ) input impedance is selected	No equivalent command. If using option 1E (Tek type II probe interface) with SCD1000, high impedance probes like the Tektronix P6203 and P6204 can be used.
	LOW	Low (50 Ω) input impedance is selected	No equivalent command. SCD series Waveform Recorders are 50 Ω.
BW	LIM	Limited bandwidth (20 MHz) is selected	No equivalent command; No bandwidth limit.
	FUL	Full bandwidth is selected	
CPL	AC	Input is AC coupled	CHA COUPling:AC or CHB COUPling:AC
	DC	Input is DC coupled	CHA COUPling:DC or CHB COUPling:DC
	GND	Input is grounded	CHA COUPling:OFF or CHB COUPling:OFF
CPL?	OVL	7A29P ONLY Overload is returned if input is in OVERLOAD condition. (Query only). Returns an error if used in a set command.	No equivalent command
POL	NOR	Amplifier polarity is normal	CHA INVert:OFF or CHB INVert:OFF (SCD1000 only)
	INV	Amplifier polarity is inverted	CHA INVert:ON or CHB INVert:ON (SCD1000 only)
V/D	<NRx>	Volts/Division is set to argument must be a number in the range of 0.01 to 1 in a 1−2−5 sequence. V/D 0 means probe is on IDENTIFY.	CHA RANge:<NRx> or CHB RANge:<NRx> (SCD1000 only) <NRx>= 100E−3 to 10 in 1−2−5 sequence No probe id return value
POS	<NRx>	Vertical position of trace (from center screen) is set to <NRx>; range is −10.22 to +10.24 is 0.02 steps For example, POS 2 corresponds to +2.00 div above center.	CHA OFFSet:<NRx> or CHB OFFSet:<NRx> (SCD1000 only) <NRx>= ±2.5 times vertical range (volts) ±250 % in steps of 1 CHA TYPEOffset:{VOLTs|PERcent} sets the units for offset

Table 5-6: SCD Series/7A16P & 7A29P Command Comparison (Cont.)

Header	Argument	Description	SCD Equivalent Commands
VAR	OFF	Variable off — deflection factors are calibrated	No equivalent command
	ON	Variable on — deflection factors are uncalibrated	
PRB?	X1	1X or unencoded probe is present on selected input	No equivalent command
	X10	10X probe is present on selected input	
	X100	100X probe is present on selected input	
	ID	Returned when probe ID button is pressed	
ID?		Returns the plug-in type; for example TEK/7A29P,V77.1,F1.0	ID? command; Returns the identity of the SCD Series Waveform Recorder.
SET?	<MESSAGE UNITS>	Setting of programmable functions (header is omitted)	SET? command; Will learn all programmable functions within SCD Series Waveform Recorder. This string can be returned at any time to set up instrument. The LONGFORM ON/OFF command reduces the length of the ASCII settings string. There is also LLSET? command for fast binary transfers. There are 10 nonvolatile settings storage locations in the SCD Series Waveform Recorder. Accessed using SAVE and RECALL commands.

Table 5-7: SCD Series/7B90P Command Comparison

Header	Argument	Description	SCD Equivalent Commands
MOD	PPA	Peak-to-Peak auto trigger mode is selected	TRIgger MODe:AUTo command
	NOR	Normal triggering mode is selected	TRIgger MODe:NORmal command
	SSW	Single-Sweep Triggering mode is selected	ACQuire STATe:HLDNxt and HLDNxt:ON commands
CPL	AC	Trigger signal is AC coupled	TRIgger COUPling:AC command
	DC	Trigger signal is DC coupled	TRIgger COUPling:DC command
	LFR	Trigger signal is AC coupled with low frequency roll off	No equivalent command
	HFR	Trigger signal is AC coupled with high frequency roll off	No equivalent command
SRC	INT	Trigger source is internal	TRIgger SOUrce command. Choices of source are CHA, CHB and ADD (SCD1000 only). In SCD5000 choices are INT or EXT.
	LIN	Trigger source is the line voltage	No equivalent command
	EXT	Trigger source is external input	TRIgger SOUrce:EXT command
	E10	Trigger source is external input attenuated by 10	No equivalent command
T/D	<NR3>	Time/Division is set to <NRx>; range is 5E−10 to 5E−1 in 1−2−5 sequence. Query returns <NR3> value.	ACQuire TIMe:<NRx> command <NRx>= 5 E−9 to 100 E−6 in 1−2−5 sequence. The SCD Series waveform recorder is programmed using time window (total time) rather than time per division. Time window = Time/div * 10
MAG	ON	Sweep magnifier is turned on (10X)	No equivalent command
	OFF	Sweep magnifier is turned off (1X)	
POS	<NR2>	Horizontal position of sweep is set to <NRx>. Range is −6.4 to +6.39 in 0.0125 steps (80 steps/division). Query returns <NR2>	TRIgger DELay:<NRx> command <NRx>= 0 to (5 * time window) (seconds) 0 to 500% (percent) TRIgger TYPEdelay:SECond|PERcent command selects units for setting trigger delay. With zero trigger delay, there is ≈2.5 ns of pretrigger information.
HOL	<NRx>	Trigger holdoff period is <NRx>; range is 0 to 63 uncalibrated	No equivalent command

Table 5-7: SCD Series/7B90P Command Comparison (Cont.)

Header	Argument	Description	SCD Equivalent Commands
EOS	ON	End-of-sweep SRQ signal is enabled	SRQMask OPCmpl:ON command will issue an operation complete SRQ at end of acquisition.
	OFF	End-of-sweep SRQ signal is disabled	
TRI	ON	Trigger light is on (Read-only; TRI? returns TRI ON/OFF)	No equivalent command
	OFF	Trigger light is off (Read-only)	
SSW	ARM	Single sweep is armed. A GET (Group Execute Trigger) IEEE−488 universal command has the same effect.	Single sweep is accomplished with the ACQuire STATe HLDNxt and HLDNXt:{ON | OFF} commands. When these commands are issued, the instrument resets and waits for a trigger. When a trigger occurs, the SCD acquires and enters the hold state.
	DIS	Single Sweep is disarmed (Read-only; SSW? returns SSW ARM/DIS)	
ID?		Query only; Returns the plug-in type Example Response: Tek/7B90P,V77.1,LLL	ID? command; Returns the identity of the SCD Series Waveform Recorder.
SET?	<MESSAGE UNITS>	Setting of programmable functions (header is omitted)	SET? command; Will learn all programmable functions within SCD Series Waveform Recorder. This string can be returned at any time to set up instrument. The LONGFORM ON/OFF command reduces the length of the ASCII settings string. There is also LLSET? command for fast binary transfers. There are 10 nonvolatile settings storage locations in the SCD Series Waveform Recorder. Accessed using SAVE and RECALL commands.

Option 2F

High Speed Data Output (HSDO)

Option 2F provides nonvolatile storage (battery backup) of Linear Array Data and is an alternative to GPIB output for Curve and Linear Array Data.

HSDO data encoding is absolute binary. The Option 2F interface allows SCD1000 and 5000 instruments to transfer waveform data encoded in 16-bit words at a 2 MHz maximum rate. With the GPIB command HSDO FORmat, the 16-bit words may be transferred 1 byte at a time, high byte first (MSB). The HSDO port is output enabled with the GPIB HSDO STATe and HSDO DUMp: CONTinuous commands, or by a combination of internal and external switch settings.

The HSDO port provides high speed data transfer to the Tektronix 9503/9504 Fast Data Cache system and to interfaces such as Digital Equipment Corporation DRV 11–B or Hewlett Packard GPIO (see special cabling requirements in Tables NO TAG and 6-2). Most computers, including MS-DOS based, support this type of parallel port interface.

Connectors

HSDO	(High Speed Data Output)	
Type	DB 37	Mating connector: 3M 3357–9237
		Cable: 3M 3659/37
Signal Level	TTL	
ACQ-CONT	(Acquire Continuous Data)	
Type	BNC	
Signal Level	TTL	

Dump Continuous Mode

Dump Continuous repeatedly outputs acquisition data from the HSDO port until specifically inactivated, or a new acquisition is initiated. This allows external control of the acquisition process. Dump Continuous transfers Linear Array data exclusively, and is activated by the GPIB command HSDO DUMp: CONTinuous. This mode may be implemented manually (by a certified service technician only) as follows. Set DIP switch 2 on the instrument rear panel to closed; set DIP switch 2 to closed and DIP switch 3 to open on the Processor board. If Dump Continuous is activated manually, the instrument will power-up in the Hold Next acquisition state; the HSDO transfer mode will be 1 (Handshake).

When activated, Dump Continuous mode loops continuously, transferring the contents of the Linear Array over the HSDO port. The loop may be interrupted by setting the states on two HSDO pins. Setting HS STAT 3 (pin 28) low causes an acquisition to occur followed by continuous transmission of data; setting HS STAT 2 (pin 27) low restarts continuous transmission of data from its start point.

The rear panel ACQ-CONT BNC allows the same control as HSDO connector HS STAT 3 (pin 28), permitting acquisition control from another source.

Two output pins provide the Controller with digitizer and HSDO transmission status, HS CNTL 0 (pin 20) and HS CNTL 1 (pin 21). HS CNTL 0 is high when data is to be read from the digitizer. HS CNTL 1 toggles for each new data transmission.

The following is an example of how the HS STAT and HS CNTL pins may be used to retransmit or force an acquisition while in Continuous Dump mode.

To Retransmit:

1. Halt HSDO port handshake data
2. Note the state of HS CNTL 1 (pin 21)
3. Set HS STAT 2 (pin 27) low
4. Monitor HS CNTL 1, await toggle state
5. Following HS CNTL 1 toggle, return HS STAT 2 high
6. Resume HSDO port handshake data output

To Reacquire:

1. Halt HSDO port handshake data
2. Set HS STAT 3 (pin 28) low
3. Wait for HS CNTL 0 (pin 20) to transition high (digitizer enabled, ACQUire STATe: HLDNxt)
4. Set HS STAT 3 high
5. Wait for HS CNTL 0 to transition low (acquisition complete, ACQUire STATe: STOP) and HS CNTL 1 (pin 21) to toggle. The instrument is ready for data transmission.

6. Resume HSDO port handshake data output

When an acquisition is initiated (and before the trigger), HS STAT 3 ignores requests for data retransmission and acquisition aborts. Retransmission requests are not accepted until acquisition is complete.

Handshake Transfer Mode

Two HSDO port communication protocols are available, Handshake and Synchronous.

Transfer Mode 1 (Handshake) — Data is output to an external device (the external device initiates the transfer). This mode is full handshake compatible with Digital Equipment Corporation DRV 11–B and Hewlett Packard GPIO.

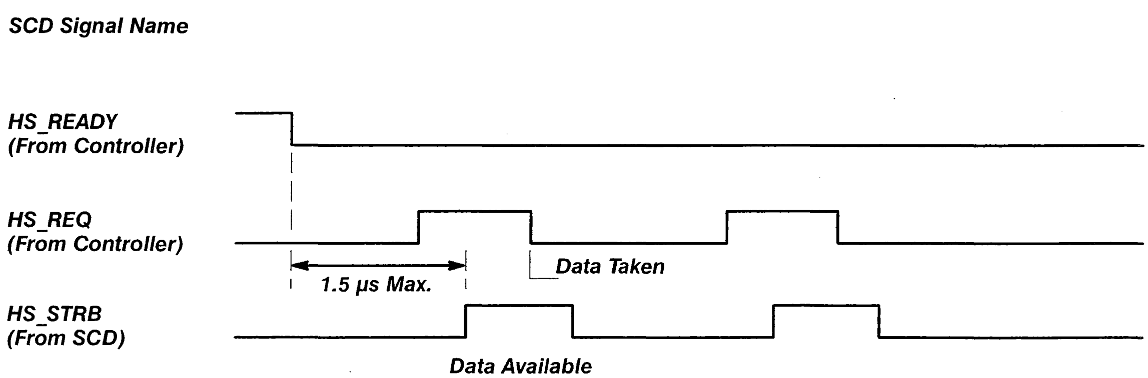

Figure 6-1: Handshake Mode Timing Diagram

Transfer Mode 2 (Synchronous) — Data is transferred to a custom interface. The interface accepts data on a clock edge generated by the SCD. No handshake is used.

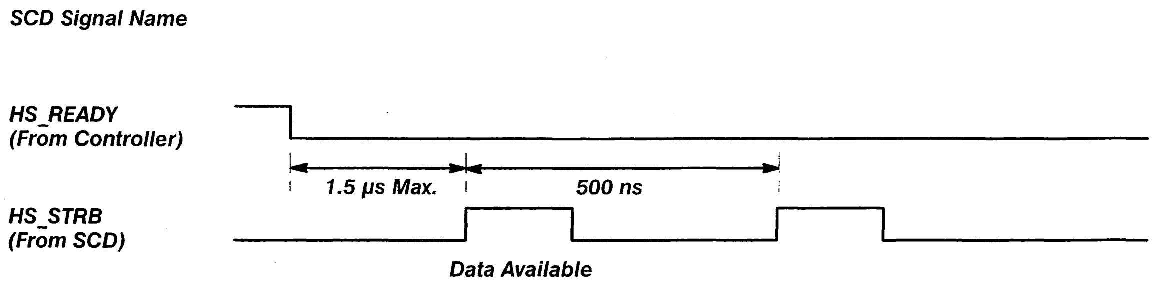

Figure 6-2: Synchronous Mode Timing Diagram

GPIB Commands

Option 2F adds the following GPIB commands:

Header	Link	Argument	Description
HSDO	DUMp	OFF	Sets the HSDO dump mode to off.
		CONTinuous	Repeatedly outputs acquired data until a new acquisition is requested; following a new acquisition, the new data is repeatedly output, etc. Refer also to the Option 2F alternate interface description in this manual. Factory setting: OFF Example: HSDO DUMp: CONTinuous Interactions: HSDO STATE forced to OFF HSDO MODE forced to 1 (Handshake)
	FORmat:	BYTE	HSDO interface outputs one 8-bit byte at a time.
		WORd	All 16 bits of the HSDO interface used for output. Transfers 2 bytes (one waveform data point) at a time. Byte output is in the LSB of the interface, MSB first. Factory setting: WORd Example: HSDO FORmat: WORd
	MODe:	<NRx>	NRx = 1: selects HSDO Handshake mode for data output to external devices (DRV 11–B and GPIO). NRx = 2: selects HSDO Synchronous mode for data output to external devices. Data is transferred to a custom interface accepting data on a clock edge generated by the SCD. No handshake used. Limits: 1 or 2 Factory setting: 1 Example: HSDO MODe: 1
	STATe:	OFF	Inactivates the HSDO (the GPIB port is used for waveform transfers).
		ALL	The HSDO outputs all memory regardless of valid data quantity (262144 bytes fixed data length).
		VALid	The HSDO outputs only valid data (variable data length depends on information acquired). Factory setting: OFF Example: HSDO STATe: VALid

GPIB Query Commands

Option 2F adds the following query selections:

Header	Link	Argument	Description
HSDO?			Returns all HSDO settings. Example: HSDO? Response: HSDO STATE: OFF, MODE: 1, FORMAT: WORD, LENGTH: 12555, DUMP: OFF
	DUMp		Returns HSDO Dump settings. Example: HSDO? DUMp Response: HSDO DUMP: OFF
	FORmat		Returns HSDO Format settings. Example: HSDO? FORmat Response: HSDO FORMAT: WORD
	LENgth		Query only; returns the length of HSDO port data in bytes. If HSDO: STATe is set to VALid, the length of data sent is returned. Example: HSDO? LENgth
	MODe		Returns the HSDO Mode setting. Example: HSDO? MODe Response: HSDO MODE: 1
	STATe		Returns the HSDO State setting. Example: HSDO? STATe Response: HSDO STATE: OFF, MODE: 1, FORMAT: WORD, LENGTH: 12555, DUMP: OFF

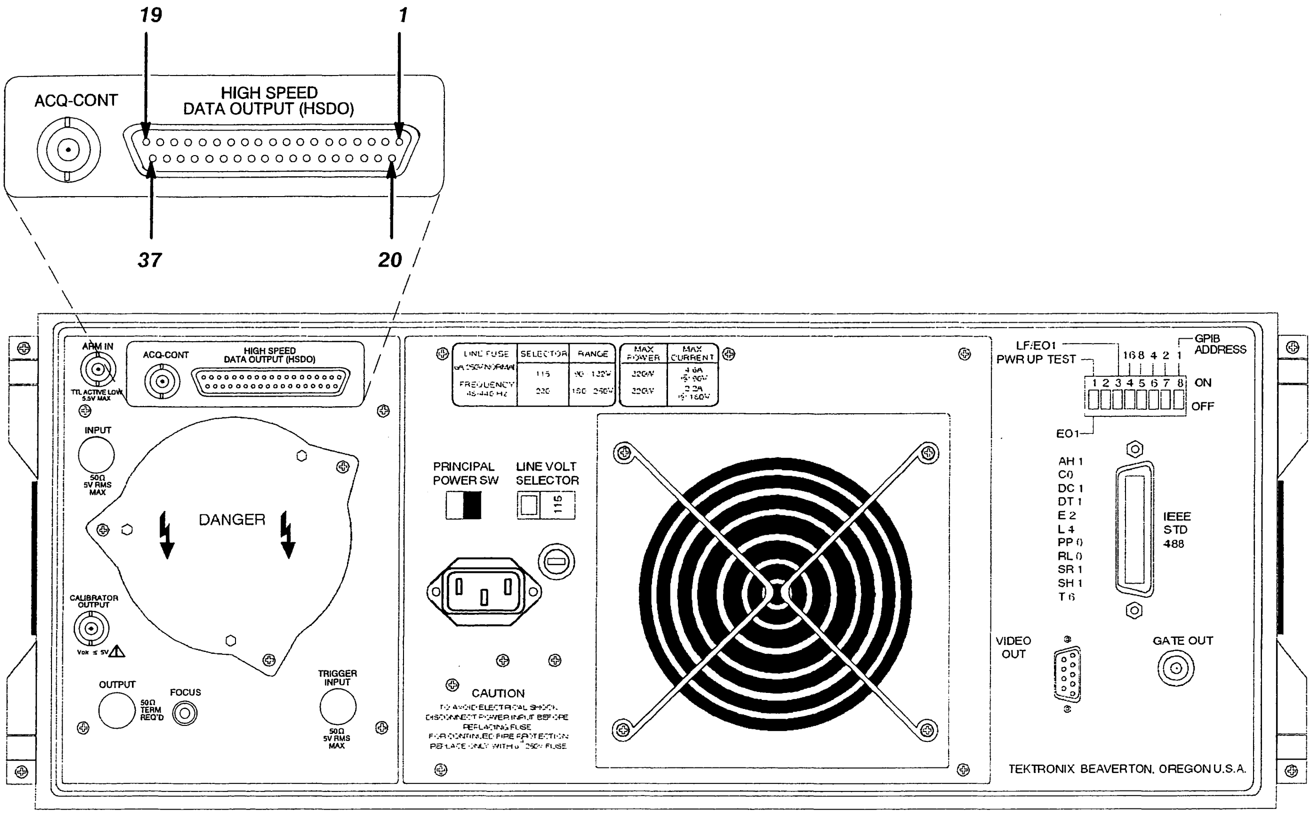

Figure 6-3: Location of HSDO Rear Panel Connector (SCD1000)

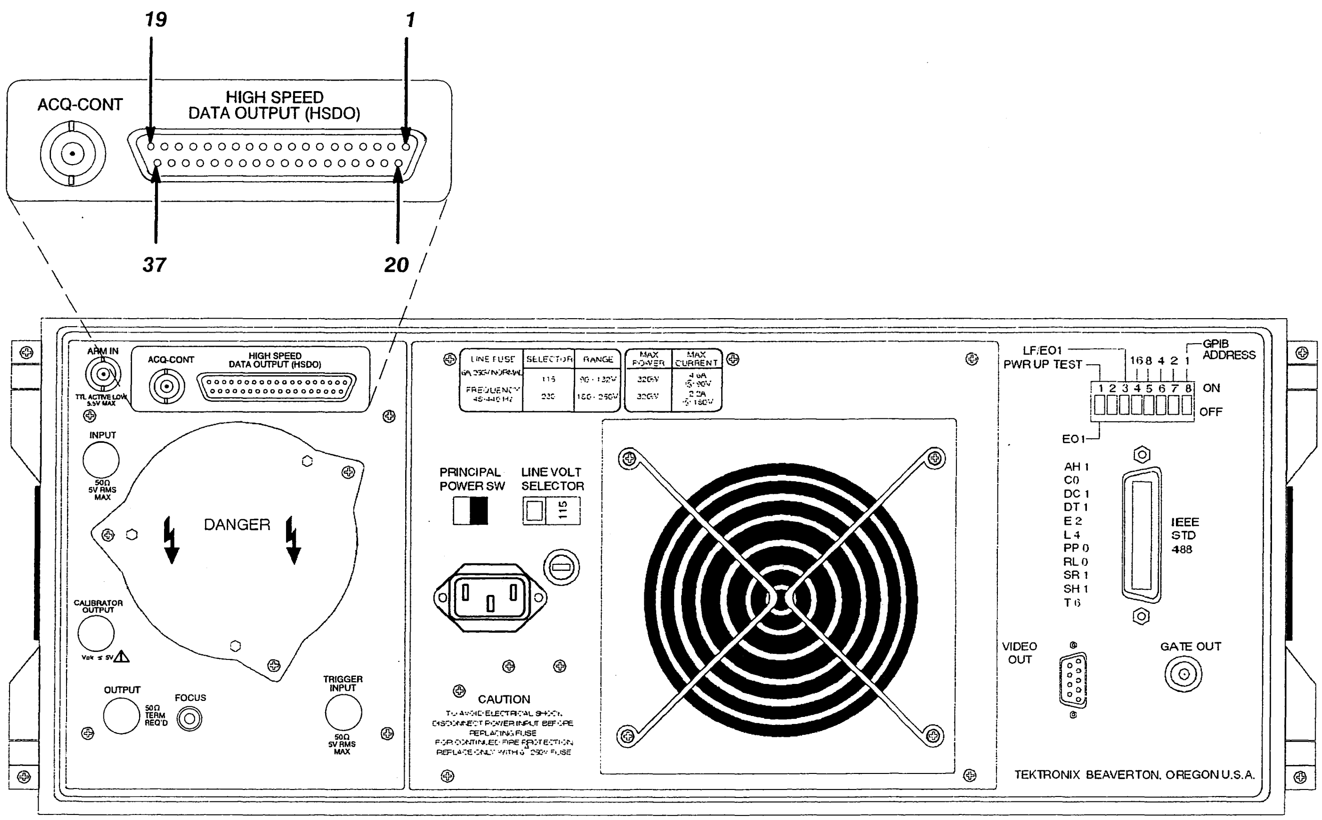

Figure 6-4: Location of HSDO Rear Panel Connector (SCD5000)

Table 6-1: SCD Series to DEC DRV11-B Cabling

SCD Pin	Signal Name	Direction (Pin to Pin)	DRV11–B Pin	Signal Name	Description
1	HSDO0	→	J2–UU	00 IN H	LOW BYTE DATA
2	HSDO1	→	J2–SS	01 IN H	LOW BYTE DATA
3	HSDO2	→	J2–PP	02 IN H	LOW BYTE DATA
4	HSDO3	→	J2–MM	03 IN H	LOW BYTE DATA
5	HSDO4	→	J2–KK	04 IN H	LOW BYTE DATA
6	HSDO5	→	J2–HH	05 IN H	LOW BYTE DATA
7	HSDO6	→	J2–EE	06 IN H	LOW BYTE DATA
8	HSDO7	→	J2–CC	07 IN H	LOW BYTE DATA
9	HSDO8	→	J2–DD	08 IN H	HIGH BYTE DATA
10	HSDO9	→	J2–FF	09 IN H	HIGH BYTE DATA
11	HSDO10	→	J2–JJ	10 IN H	HIGH BYTE DATA
12	HSDO11	→	J2–LL	11 IN H	HIGH BYTE DATA
13	HSDO12	→	J2–NN	12 IN H	HIGH BYTE DATA
14	HSDO13	→	J2–RR	13 IN H	HIGH BYTE DATA
15	HSDO14	→	J2–TT	14 IN H	HIGH BYTE DATA
16	HSDO15	→	J2–VV	15 IN H	HIGH BYTE DATA
17	HSREQ	←	J2–B	BUSY H	Request for next word
18	HSREADY	←	J1–F	READY H	LOW indicates DRV11 is ready
19	HS_STRB	→	J1–B	CYCLE REQ H	Latch data on rising edge
20	HS_CNTL 0	→	J1–L	STATUS A	Contains mode of SCD Series instrument
21	HS_CNTL 1	→	J1–R	STATUS B	Contains mode of SCD Series instrument
22	VCC	→	J2–F	A00H	Tied to +5 V through a 1 K resistor
23	HSSYSRES	→	J2–D	ATTN H	Terminates DMA transfers
24	C1	→	J2–T	C1 H	Must be HIGH for DATA transfer to DRV11. Driven high by SCD Series instrument.
25	C0	→	J2–N	C0 H	Must be LOW for DATA transfer to DRV11. Connected to ground by SCD Series instrument.
26	HS_STAT 0	←	J2–V	FNCT 1 H	Not used

Table 6-1: SCD Series to DEC DRV11-B Cabling (Cont.)

SCD Pin	Signal Name	Direction (Pin to Pin)	DRV11–B Pin	Signal Name	Description
27	HS_STAT 1	←	J2–R	FNCT 2 H	See Continuous Dump mode
28	HS_STAT 2	←	J2–LK	FNCT 3 H	See Continuous Dump mode
29	HSOK	→			Not used
30	HSATTN	←			Not used
31	DGND				Logic Ground
32	DGND				Logic Ground
33	DGND				Logic Ground
34	DGND				Logic Ground
35	DGND				Logic Ground
36	VCC		J2–J	WC INC EN H	
37	VCC		J2–J	BA INC EN H	

Table 6-2: SCD Series to HP GPIO Cabling

SCD Pin	Signal Name	Direction (Pin to Pin)	GPIO Pin	Signal Name	Description
1	HSDO0	→	42	DI0	LOW BYTE DATA
2	HSDO1	→	41	DI1	LOW BYTE DATA
3	HSDO2	→	40	DI2	LOW BYTE DATA
4	HSDO3	→	39	DI3	LOW BYTE DATA
5	HSDO4	→	38	DI4	LOW BYTE DATA
6	HSDO5	→	37	DI5	LOW BYTE DATA
7	HSDO6	→	36	DI6	LOW BYTE DATA
8	HSDO7	→	35	DI7	LOW BYTE DATA
9	HSDO8	→	34	DI8	HIGH BYTE DATA
10	HSDO9	→	33	DI9	HIGH BYTE DATA
11	HSDO10	→	32	DI10	HIGH BYTE DATA
12	HSDO11	→	31	DI11	HIGH BYTE DATA
13	HSDO12	→	30	DI12	HIGH BYTE DATA
14	HSDO13	→	29	DI13	HIGH BYTE DATA
15	HSDO14	→	28	DI14	HIGH BYTE DATA
16	HSDO15	→	27	DI15	HIGH BYTE DATA
17	HSREQ	←	19	PCTL	LOW means not ready. HIGH means request.
18	HSREADY	←		DGND	Not used. From SCD Series instrument pin 35.
19	HS_STRB	→	44	PFLG	Latch data; clear PCTL on rising edge.
20	HS_CNTL 0	→	47	STI0	Contains mode of SCD Series instrument
21	HS_CNTL 1	→	48	STI1	Contains mode of SCD Series instrument
22	VCC	→			Not used
23	HSSYSRES	→	46	EIR	Interrupt host
24	C1	→			Not used
25	C0	→			Not used
26	HS_STAT 0	←	22	CTL0	Not used
27	HS_STAT 1	←	23	CTL1	See Continuous Dump mode

Table 6-2: SCD Series to HP GPIO Cabling (Cont.)

SCD Pin	Signal Name	Direction (Pin to Pin)	GPIO Pin	Signal Name	Description
28	HS_STAT 2	←			See Continuous Dump mode
29	HSOK	→	45	PSTS	The HSDO mode is ready and OK
30	HSATTN	←	21	PRESET	Not used
31	DGND	↔	1	LOGIC GND	
32	DGND	↔	18	LOGIC GND	
33	DGND	↔	24	LOGIC GND	
34	DGND	↔	26	LOGIC GND	
35	DGND	↔	49	LOGIC GND	
36	VCC	↔			
37	VCC	↔			
			43	SAFETY GND	
			25	SAFETY GND	

ASCII & GPIB Code Chart

Table 7-1: The ASCII & GPIB Code Chart

	0	1	2	3	4	5	6	7
0	0 NUL 0 0	20 DLE 10 16	40 0 space 20 32	60 16 0 30 48	100 0 @ 40 64	120 16 P 50 80	140 0 ‘ 60 96	160 16 p 70 112
1	1 GTL SOH 1 1	21 LLO DC1 11 17	41 1 ! 21 33	61 17 1 31 49	101 1 A 41 65	121 17 Q 51 81	141 1 a 61 97	161 17 q 71 113
2	2 STX 2 2	22 DC2 12 18	42 2 ” 22 34	62 18 2 32 50	102 2 B 42 66	122 18 R 52 82	142 2 b 62 98	162 18 r 72 114
3	3 ETX 3 3	23 DC3 13 19	43 3 # 23 35	63 19 3 33 51	103 3 C 43 67	123 19 S 53 83	143 3 c 63 99	163 19 s 73 115
4	4 SDC EOT 4 4	24 DCL DC4 14 20	44 4 $ 24 36	64 20 4 34 52	104 4 D 44 68	124 20 T 54 84	144 4 d 64 100	164 20 t 74 116
5	5 PPC ENQ 5 5	25 PPU NAK 15 21	45 5 % 25 37	65 21 5 35 53	105 5 E 55 69	125 21 U 55 85	145 5 e 65 101	165 21 u 75 117
6	6 ACK 6 6	26 SYN 16 22	46 6 & 26 38	66 22 6 36 54	106 6 F 46 70	126 22 V 56 86	146 6 f 66 102	166 22 v 76 118
7	7 BEL 7 7	27 ETB 17 23	47 7 ’ 27 39	67 23 7 37 55	107 7 G 47 71	127 23 W 57 87	147 7 g 67 103	167 23 w 77 119
8	10 GET BS 8 8	30 SPE CAN 18 24	50 8 (28 40	70 24 8 38 56	110 8 H 48 72	130 24 X 58 88	150 8 h 68 104	170 24 x 78 120
9	11 TCT HT 9 9	31 SPD EM 19 25	51 9) 29 41	71 25 9 39 57	111 9 I 49 73	131 25 Y 59 89	151 9 i 69 105	171 25 y 79 121
A	12 LF A 10	32 SUB 1A 26	52 10 * 2A 42	72 26 : 3A 58	112 10 J 4A 74	132 26 Z 5A 90	152 10 j 6A 106	172 26 z 7A 122
B	13 VT B 11	33 ESC 1B 27	53 11 + 2B 43	73 27 ; 3B 59	113 11 K 4B 75	133 27 [5B 91	153 11 k 6B 107	173 27 { 7B 123
C	14 FF C 12	34 FS 1C 28	54 12 , 2C 44	74 28 < 3C 60	114 12 L 4C 76	134 28 \ 5C 92	154 12 l 6C 108	174 28 | 7C 124
D	15 CR D 13	35 GS 1D 29	55 13 – 2D 45	75 29 = 3D 61	115 13 M 4D 77	135 29] 5D 93	155 13 m 6D 109	175 29 } 7D 125
E	16 SO E 14	36 RS 1E 30	56 14 . 2E 46	76 30 > 3E 62	116 14 N 4E 78	136 30 ^ 5E 94	156 14 n 6E 110	176 30 ~ 7E 126
F	17 SI F 15	37 US 1F 31	57 15 / 2F 47	77 UNL ? 3F 63	117 15 O 4F 79	137 UNT _ 5F 95	157 15 o 6F 111	177 rubout 7F 127
	ADDRESSED COMMANDS	UNIVERSAL COMMANDS	LISTEN ADDRESSES		TALK ADDRESSES		SECONDARY ADDRESSES OR COMMANDS	

KEY

octal	25 PPU	GPIB code
	NAK	ASCII character
hex	15 21	decimal