TELEDYNE LECROY
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MAUI

Oscilloscopes Remote Control and Automation Manual

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Introduction

This manual documents the requirements for remote control of Teledyne LeCroy's MAUI™ oscilloscopes using either traditional IEEE 488.2 (GPIB) commands or Windows® Component Object Model (COM) Automation commands.

The manual is divided into the following sections:

Part 1: Making the Remote Connection describes all the methods for gaining access to a MAUI oscilloscope (device) from a remote computer (controller). It details the software and hardware requirements for each method.

Part 2: Automation Programming Reference describes the MAUI COM architecture and explains how to use Automation to control the oscilloscope remotely using manual methods or remote control programs.

Part 3: Automation Control Variable Reference details the MAUI COM architecture for configuring and controlling the oscilloscope. It is most useful for developers of remote control applications.

Part 4: Automation Result Interface Reference details the MAUI COM architecture for reading back data from the oscilloscope. It is most useful for developers of remote control applications.

Part 5: IEEE 488.2 Programming Reference describes the LeCroy legacy remote control implementation and provides an overview of GPIB programming conventions. It also provides information for understanding MAUI waveform transfer and the waveform template.

Part 6: IEEE 488.2 Command Reference details the legacy remote control commands supported by MAUI oscilloscopes.

Resources

Teledyne LeCroy provides many free resources to help you receive the greatest value from your instrument. Most of the software and documentation mentioned in this manual can be downloaded from our website; links are provided to other sites where relevant. In addition, many manuals and code examples for further reference are installed when you install our software.

Software

Download software from: teledynelecroy.com/support/softwaredownload.

Under Oscilloscope Downloads, click the link to **Software Utilities** and browse the list of tools.

Manuals

Download manuals, application notes, and lab briefs from: teledynelecroy.com/support/techlib.

Use the sidebar at the left of the page to select the document category, then browse the list of links.

Technical Support

Registered users can contact their local Teledyne LeCroy service center at the number listed on our website.

You can also submit Technical Support requests via the website at:

teledynelecroy.com/support/techhelp

Select the oscilloscope model you are using and the category into which your question falls.

Notational Conventions

Notational Symbols

Commands shown in this reference make use of the following notational symbols:

Symbol	Function	Example
< >	Encloses header paths or placeholders	<channel>:VOLT_DIV <v_gain>
:=	Separates a placeholder from a description of the type and range of values that may replace it	<v_gain> := 5.0 mV to 2.5 V
{ }	Encloses required values, one of which must be used in the command	TRMD {SINGLE, AUTO, NORM, STOP}
[ ]	Encloses optional values	
…	Indicates the items to its left or right can be repeated any number of times	

Sources

The character *n* is used to denote the greatest number of an oscilloscope object, such as input channels or math function traces, supported by your instrument. On a two-channel oscilloscope, C1 through C*n* should be taken to mean C1 and C2, whereas on an eight-channel oscilloscope, C1 through C8, and so forth.

The following mnemonics may be used where <source> is indicated in commands.

Note: These are the sources supported by legacy commands. Other sources may be available with the addition of software options (Views, Streams, Histograms, etc.), depending on the operation. Use XStreamBrowser to check the application Automation object hierarchy.

Object	Mnemonic	Note
Analog Channels	C1, C2, C3, C4,....C*n*	
Sensor Channels	SE1,....SE*n*	
Digital Groups	Digital1,....Digital4	
Math Functions	F1,....F*n*, TA, TB, TC, TD	Math trace names TA, TB, TC, and TD used on legacy LeCroy instruments have been replaced by F1, F2, F3 and F4, respectively. Existing programs that utilize the old trace names will work with MAUI oscilloscopes, but these mnemonics are not returned in query responses. Instead, the query will return the corresponding F1, F2, F3, and F4.
User-Defined Parameters	P1,....P*n* CUST1,...CUST5	Parameter names CUST1 through CUST5 used on legacy LeCroy instruments have been replaced by P1, etc. As with math traces, these mnemonics may be used in programs but are not returned by queries.
Memories	M1,...M*n*	
Zooms	Z1,....Z*n*	

Units

Numeric values can be expressed in code as numeric fixed point or exponential. However, only the fixed point value is displayed in tables and on descriptor boxes.

Note: This manual reflects the units supported in MAUI XStreamDSO software v.8.5.0.0 and later. Many, but not all, of the units listed here are supported in earlier versions of XStreamDSO.

Table of Mnemonics

Units may be expressed using the following mnemonics.

Note: Specify only the base unit in code, do not add prefixes. Units are automatically scaled up or down within the list of standard, SI prefixes (atto to Exa) based on the relative size of the source signal(s). For example a 1000 V reading is shown as 1 kV, while a .1 V reading is shown as 100 mV. When the multiplication factor is 1 V = 1 Pascal, a 1 millivolt (mV) reading is displayed as 1 mPa rather than .001 Pa or 100e-3 Pa.

Note: Time and Dimensionless units are available only for certain measurements and acquisition commands.

Category	Unit	Mnemonic
Mass	gram	G
	slug	SLUG
Volume	liter	L
	cubic meter	M3
	cubic inch	IN3
	cubic foot	FT3
	cubic yard	YARD3
Angle	radian	RAD
	arcdegree	DEG
	arcminute	MNT
	arcsecond	SEC
	cycle	CYCLE
	revolution	REV
	turn	TURN

Category	Unit	Mnemonic
Force/Weight	Newton	N
	grain	GR
	ounce	OZ
	pound	LB
Velocity	meter/second	M/S
	inch/second	IN/S
	foot/second	FT/S
	yard/second	YARD/S
	mile/second	MILE/S
Acceleration	meter/second^2	M/S2
	inch/second^2	IN/S2
	foot/second^2	FT/S2
	standard gravity	GN
Pressure	Pascal	PAL
	bar	BAR
	atmosphere, technical	AT
	atmosphere, standard	ATM
	Torr	TORR
	pound/square inch	PSI
Temperature	degree Kelvin	K
	degree Celsius	CEL
	degree Fahrenheit	FAR
Energy	Joule	J
	British Thermal Unit	BTU
	calorie	CAL

Category	Unit	Mnemonic
Rotating Machine	radian/second	RADPS
	frequency (Hertz)	HZ
	revolution/second	RPS
	revolution/minute	RPM
	torque N•m	NM
	torque in•oz	INOZ
	torque in•lb	INLB
	torque ft•lb	FTLB
	power, mechanical (Watt)	W
	horsepower	HP
Magnetic	Weber	WB
	Tesla	T
	inductance (Henry)	H
	magnetic field strength	A/M
	permeability	HENRYPM
Electrical	Ampere	A
	Volt	V
	Watt	W
	power, apparent	VA
	power, reactive	VAR
	power factor	PF
	capacitance (Farad)	F
	Coulomb	C
	Ohm	OHM
	Siemen	SIE
	electrical field strength	V/M
	electrical displacement field	CPM2
	permittivity	FARADPM
	conductivity	SIEPM
Time	second	S
	minute	MIN
	hour	HOUR
	day	DAY
	week	WEEK

Category	Unit	Mnemonic
Dimensionless	percent	PCT
	percent min-max	PCTMNMX
	decibel	DB
	decibel milliwatt	DBM
	decibel Volt	DBV
	decibel millivolt	DBMV
	decibel microvolt	DBUV
	decibel microampere	DBUA
	decibel referred to carrier	DBC
	decade	DECADE
	unit interval	UI
	Q-scale	Q
	bit	BIT
	byte	BYTE
	baud	BAUD
	least significant bit	LSB
	poise	POISE
	parts per million	PPM
	pixel	PIXEL
	division	DIV
	event	EVENT
	sample	SAMPLE
	segment	SEG
	sweep	SWEEP

Combining Units

SI units may be combined following these rules:

- For the quotient of two units, use the character " / "
- For the product of two units, use the character " . "
- For exponents, append the digit to the unit with no space (e.g., " S2 " for seconds squared).

Note: Some units are converted to simple units (e.g., " V.A " becomes " W ").

Part 1: Making the Remote Connection

You can fully control your instrument remotely using either:

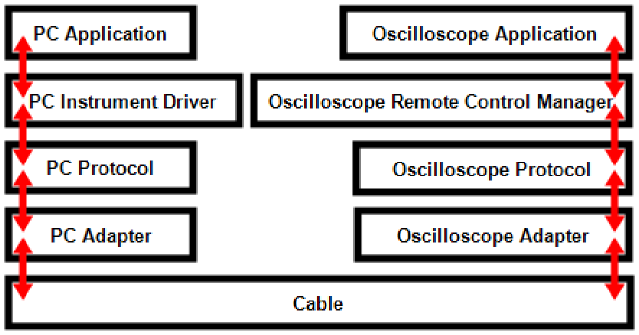
- COM Automation commands
- IEEE 488.2 General Purpose Interface Bus (GPIB) commands

The remote connection can be made over a variety of physical interfaces such as ENET, GPIB, LSIB, or USBTMC, using several interface drivers and protocols.

This section describes the software tools for remote control and procedures for making the remote connection from a controller to an oscilloscope.

Understanding Remote Control Layers

It is helpful to understand some high-level concepts regarding how the oscilloscope is operated through remote control and the terminology employed throughout this section.



From bottom to top, the components interact in the following manner:

The **cable** is the physical conduit between the controller (usually a PC) and the oscilloscope, connected on either end to the hardware **interface**. Interfaces vary based on oscilloscope model and include ENET (often labeled LAN on the oscilloscope), USBTMC, GPIB, and LSIB.

Depending on the interface selected, you may require a **PC adapter** in order to connect the cable. This is particularly true for LSIB and GPIB. ENET ports are typically standard and do not require special adapters.

The oscilloscope may also require an **oscilloscope adapter** to make the connection.

Different **protocols** can be used for transmitting messages between the controller and the oscilloscope. This selection again depends on the hardware interface. Available protocols include VICP (based on TCP/IP), VXI-11 (for the LXI standard), USBTMC, GPIB, and LSIB.

PC instrument drivers are programs that enable the controller to interface with the oscilloscope, such as ActiveDSO, VISA drivers, IVI drivers and LabVIEW drivers. They are the software complement to the hardware interface. These programs do the work of encapsulating your programs messages into the requisite interface messages that manage the exchange between device and controller.

The oscilloscope **Remote Control Manager** includes the drivers needed to make the software interface from the oscilloscope side. Teledyne LeCroy oscilloscopes are shipped with everything necessary for remote control functionality pre-installed. All you have to do to is select which protocol you want to use for remote control from the instrument's Remote dialog.

The **oscilloscope application** (XStreamDSO) is the program that displays, transforms, and measures digitized input signals and enables you to control the instrument. It is also the program that exchanges information with the PC applications over the remote connection.

PC applications are programs residing on the controller that exchange data with the oscilloscope application or function as a remote command console, such as WaveStudio, LabVIEW, MATLAB, and custom applications.

Software Tools for Remote Control

Many free software tools are available to help you make and manage the remote connection. See Resources for download information. This software is to be installed on the PC/controller. Teledyne LeCroy oscilloscopes are pre-installed with all necessary software for remote control.

Interface Drivers

ActiveDSO

Based on Microsoft's ActiveX technology, ActiveDSO simplifies programming for Teledyne LeCroy oscilloscopes within the Microsoft environment. ActiveDSO provides interface drivers and a client library to make the remote connection over ENET, GPIB or USBTMC interfaces. It also supports many Automation features besides remote control. See ActiveDSO.

VISA

VISA-compliant drivers also provide the necessary software interface for remote control over ENET, GPIB, or USBTMC. Add-on tools like NI-VISA handle device communications for many programming languages, such as C++, LabVIEW, and Python. An installation of NI-VISA (or a VISA driver that behaves exactly like it) is required if you cannot use ActiveX technologies such as ActiveDSO or WaveStudio. NI-VISA is always required if you are uisng the USBTMC interface for remote control.

LeCroy VICP Passport and VICP Client Library

The VICP Passport was developed specifically for those using NI-VISA with the Teledyne LeCroy VICP protocol. It provides the requisite VISA Passport functions for VICP communications.

Not technically a driver, the VICP Client Library provides the necessary toolkit for developing a VICP interface to the oscilloscope from machines that are not running Windows.

LeCroyScope IVI Driver

The VISA-based LeCroyScope IVI Driver is an Interchangeable Virtual Instrument technology that provides a standard API for communication with instruments. Provided to meet LXI standard requirements, the driver strictly adheres to the IVI-Scope instrument class and includes both IVI-C and IVI-COM drivers. See *Introducing the LXI Interface* for instructions on using the driver.

Note: Although provided for LXI compliance, you can use the IVI Driver even if your remote control setting is TCP/IP (VICP), rather than LXI (VXI-11).

LabVIEW Drivers

The LeCroy_Wave_Series driver, created using the LabVIEW project architecture, is available for Windows users who wish to control their oscilloscope through a National Instruments LabVIEW™ program. The lcwave driver, an llb LabView library, is available for those using pre-Windows oscilloscope models. Both drivers can be used over an ENET, GPIB, or USBTMC connection. See *Lab Brief WM832: Getting Started with the "lcwave" and "LeCroy Wave Series" LabVIEW Drivers* for instructions.

Connectivity Tools

XStreamBrowser

The XStreamBrowser utility enables you to view, copy, and modify the COM object hierarchy of the connected oscilloscope application. See XStreamBrowser.

WaveStudio

For PCs running Windows 10, 7, VISTA, or XP, WaveStudio is a remote control console that provides a graphical user interface for oscilloscope setup, waveform inspection, and data transfer. It supports TCPIP, LXI, GPIB, LSIB, or USBTMC/USB488 connections. See WaveStudio.

ScopeExplorer

For PCs running Windows 2000 or XP, ScopeExplorer is a connectivity tool that interfaces legacy model Teledyne LeCroy oscilloscopes (e.g., LCxxx, LTxxx, 93xx) to the Windows desktop.

Connecting via ENET

Teledyne LeCroy oscilloscopes employ a standard Ethernet interface for utilizing the TCP/IP transport layer.

Hardware

For purposes of remote control, you may either:

- Connect the oscilloscope to a LAN port or hub using a straight Ethernet (ENET) cable
- Connect the oscilloscope directly to the controller using a crossover cable or a straight cable capable of directional switching (most modern, standard ENET cables do this).

Tip: If you are concerned mainly with system throughput, a LAN connection is not recommended as network traffic may slow down oscilloscope data transfer rates. Use a direct connection, or consider using LSIB if your oscilloscope supports it.

IP Address

The oscilloscope is preset to accept DHCP addressing. Be sure the controller and the oscilloscope are on the same subnet.

The oscilloscope is delivered with a default IP address, which is pulled from our network prior to shipment. You can find this address by navigating to Utilities > Utilities Setup > Remote. Keep in mind this address will likely change as soon as the instrument is connected to your network.

You may also address the oscilloscope using the *hostname*. The default hostname is the serial number printed on the back of the instrument and on the registration card. If your network is served by a DNS server, the hostname must be the instrument name that is recognizable to the name server. For direct (coaxial or straight ENET) connections, it may be easiest to make the initial connection using the hostname.

You may optionally assign a static IP address to the oscilloscope using the standard Windows networking dialogs .

Tip: To access the Windows control panel, choose File > Minimize or go to Utilities > Utilities Setup > Remote and select Net Connections.

Protocol Selection

There are two protocol options for remote control via ENET:

- VICP, for which you select the TCP/IP remote control setting
- VXI-11, for which you select the LXI remote control setting

Connecting with VICP

The TCP/IP (VICP) remote control setting uses port 1861 and the proprietary VICP protocol for transmitting messages.

Note: LabVIEW programmers should use the TCP/IP (VICP) setting with an installation of NI-VISA and VICP Passport to communicate with Teledyne LeCroy oscilloscopes.

Controller Set Up

Open port 1861 on the controller for TCP/IP communications.

If the controller runs Windows, install NI-VISA to manage the interface functions of the VICP connection. NI-VISA users should also install the **VICP Passport**.

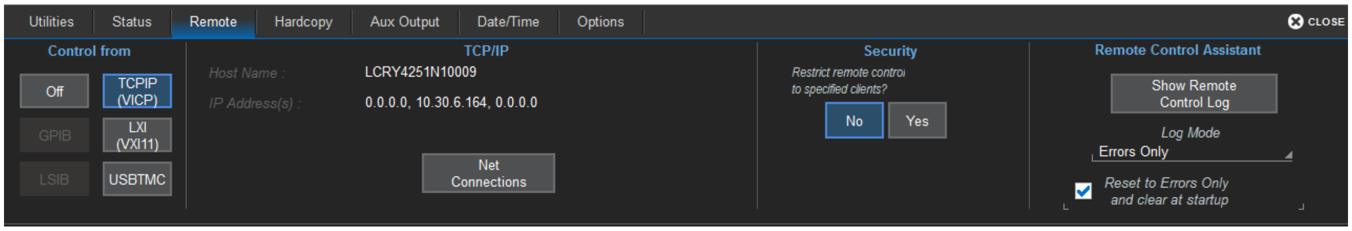
Those who are *not* running Windows should install the **LeCroyVICP Client Library**. This library can be downloaded free of charge from www.SourceForge.net. You will need to use the library to program your own VICP interface.

If you are running Windows and can utilize ActiveX controls, we highly recommend installing ActiveDSO on the controller to simplify communications with the oscilloscope.

Optionally, install the LeCroyScope IVI driver or a LabVIEW driver.

Oscilloscope Set Up

Go to **Utilities > Utilities Setup > Remote** and choose **TCP/IP (VICP)**.



Host Name : LCRY4251N10009
IP Address(s) : 0.0.0.0, 10.30.6.164, 0.0.0.0
Restrict remote control to specified clients? No
Log Mode: Errors Only
✓ Reset to Errors Only and clear at startup

Record the instrument's IP address for use in VISA resource strings and function calls.

VICP Protocol

VICP is the Versatile Instrument Control Protocol, the proprietary protocol used by the TCP/IP (VICP) remote control setting on Teledyne LeCroy oscilloscopes. This protocol aims to emulate IEEE488.2 and includes operation bits corresponding to SRQ, EOI, Clear, and others in a header that is defined by the VICP protocol.

VICP is registered with IANA to communications port 1861.

Code to parse VICP packets is publicly available at: http://www.SourceForge.net.

See the Application Brief *LAB_WM827: Understanding VICP and the VICP Passport*.

VICP Headers

The format of the header sent before each data block of a VICP transmission, both to and from the instrument, is set out in the following table:

Byte Number	Purpose
0	Operation
1	Header Version
2	Sequence Number*
3	Spare (reserved for future expansion)
4	Block Length, (bytes of data), MSB
5	Block Length (bytes of data)
6	Block Length (bytes of data)
7	Block Length, (bytes of data), LSB

* The sequence number is used to synchronize write/read operations to simulate 488.2 “discard unread response” behavior. Valid range is 1 to 255 (zero is omitted intentionally).

VICP Operation Bits

Operation bits are as follows:

Data Bit	Mnemonic	Purpose
D7	DATA	Data block (D0 indicates termination with/without EOI)
D6	REMOTE	Remote Mode
D5	LOCKOUT	Local Lockout (Lock out front panel)
D4	CLEAR	Device Clear (if sent with data, clear occurs before data block is passed to parser)
D3	SRQ	SRQ (Device to PC only)
D2	SERIAL POLL	Request a serial poll
D1	Reserved	Reserved for future expansion
D0	EOI	Block terminated in EOI Logic 1 = use EOI terminator Logic 0 = no EOI terminator

VISA Addressing

Code strings such as "TCPIP::<*IP address*>::1861::SOCKET" may or may not work when using VICP depending on how the application handles instrument responses. The data returned will include header information that needs to be parsed, and allowances must be made to trap situations where a transfer is not complete, or where there is an unread response from the instrument. SOCKET connections should work properly if you are using the VICP Client Library.

Teledyne LeCroy developed the VICP Passport to handle socket connections more reliably when using NI-VISA. Instead of "TCPIP::<*IP address*> . . .", use "VICP::<*IP address*>" to make the connection.

Connecting With VXI-11

LXI is an industry-standard specification for LAN-based instruments that utilizes the VXI-11 protocol for TCP/IP communications and instrument discovery. For information, visit www.lxistandard.org.

Teledyne LeCroy oscilloscopes are LXI Class-C compliant. We have implemented a full-featured stack that allows any command or query to be sent using the VXI-11 protocol, beyond the LXI requirements for discovery and execution of simple *IDN? queries.

Note: You can use the VXI-11 protocol for remote control of Teledyne LeCroy oscilloscopes even if your network is not LXI compliant. For those who cannot utilize ActiveX or are programming in newer languages such as C#, LXI (VXI-11) is the best remote control setting.

Note: If your oscilloscope runs on Windows 10, you must run from the Administrative User account in order to use LXI for remote control.

Resources

The LXI specification stipulates that vendors supply:

- An IVI driver for the instrument.

  Note: Some newer versions of NI-VISA install with IVI drivers. The LeCroyScope IVI driver is required to connect to MATLAB applications using LXI (VXI-11). See Resources.

- A web server to simplify remote control configuration. To access this page from the controlling PC, enter the oscilloscope IP address in URL field of a browser.

Controller Setup

Open port 111 on the controller for TCP/IP communications.

Install NI-VISA to manage the interface functions of the underlying TCP/IP connection.

If you are running Windows and can utilize ActiveX controls, we highly recommend installing ActiveDSO on the controller to simplify communications with the oscilloscope.

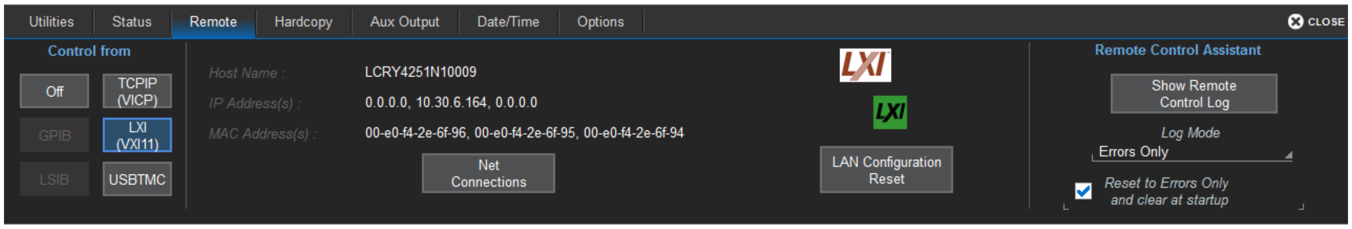
Optionally, install the LeCroyScope IVI driver or LabVIEW driver.

Oscilloscope Setup

If the oscilloscope runs on Windows 10, change to the Administrative User:

1. Choose **File > Exit** to stop the oscilloscope application and show the desktop.
2. From the Windows **Start menu** ⊞, hover over the Teledyne LeCroy logo and select **user LCRYADMIN**. Enter the administrative password **SCOPEADMIN** (all uppercase).
3. Double-click the **StartDSO icon** to restart the oscilloscope application.

Go to **Utilities > Utilities Setup > Remote** and choose **LXI (VXI-11)**.



Host Name : LCRY4251N10009
IP Address(s) : 0.0.0.0, 10.30.6.164, 0.0.0.0
MAC Address(s) : 00-e0-f4-2e-6f-96, 00-e0-f4-2e-6f-95, 00-e0-f4-2e-6f-94
Log Mode: Errors Only
✓ Reset to Errors Only and clear at startup

We recommend that you modify the password for LAN access. The default username is **lxi.lecroyuser** and password is **lxi**. You can reset to these defaults by pressing **LAN Configuration Reset**.

Record the instrument's IP address for use in VISA resource strings and function calls.

Connecting via USBTMC

USBTMC is a protocol built on top of USB that allows GPIB-like communication with USB devices. The USBTMC protocol supports service requests, triggers, and other GPIB-specific operations.

Some (not all) MAUI oscilloscopes offer a USBTMC remote control setting. Check your product datasheet to confirm if this is supported.

Hardware

Connect a USB A-B cable from any *host* port on the controller to the *device* port on the oscilloscope, which is usually specifically marked USBTMC.

Controller Set Up

Install NI-VISA v 3.0 or later on the controller PC.

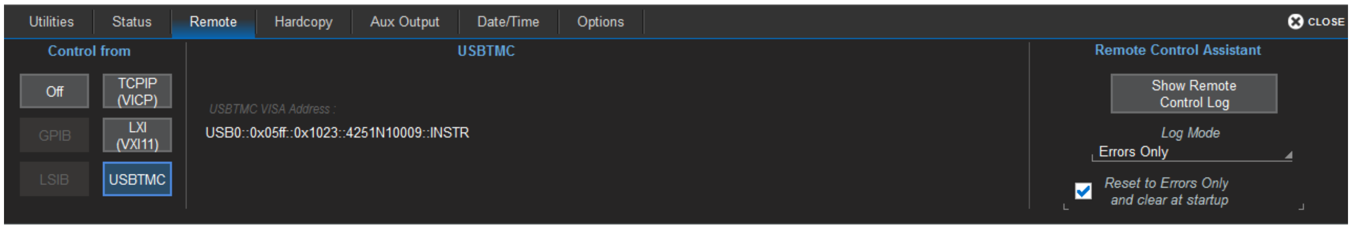
Note: NI-VISA is always required for the USBTMC connection.

If you are running Windows and can utilize ActiveX controls, we highly recommend installing ActiveDSO on the controller to simplify communications with the oscilloscope.

Optionally, install a LabVIEW driver.

Oscilloscope Set Up

Go to **Utilities > Utilities Setup > Remote** and select the **USBTMC** remote control setting.



USBTMC VISA Address :
USB0::0x05ff::0x1023::4251N10009::INSTR

Log Mode
Errors Only

☑ Reset to Errors Only and clear at startup

Record the USBTMC VISA Address for use in VISA resource strings.

Connecting via GPIB

The IEEE 488.2 General Purpose Interface Bus, or GPIB, interconnects independent devices by means of a cable bus. Although largely replaced by other serial buses, Teledyne LeCroy's IEEE 488.2 command set is still supported by all MAUI oscilloscopes. See the IEEE 488.2 Command Reference.

GPIB is offered as an optional, factory-installed interface on most MAUI oscilloscopes over 350 MHz bandwidth. You can send Automation commands over the GPIB interface using the VBS command, it is not restricted to the IEEE 488.2 commands.

Caution: Do not install third-party GPIB driver software on Teledyne LeCroy oscilloscopes; this can result in a non-functional GPIB interface. The only GPIB driver designed to operate on the instrument is included with your oscilloscope's firmware.

The optional USB2-GPIB Converter enables you to take advantage of high-speed transfer from the oscilloscope using the USB2 interface on newer MAUI oscilloscopes. However, this is still treated as a GPIB connection in VISA resource strings. See the *USB2-GPIB Converter User's Manual*.

Hardware

If both controller and oscilloscope have a GPIB port, connect them using a GPIB cable.

If using the USB2-GPIB Converter, connect the converter from the GPIB port on the controller to a USB2 port on the oscilloscope. On the first connection, accept and install the device driver. The driver is located at: C:\Program files\LeCroy\XStream\Drivers_X86(or X64)\GPIB2USB. The installer is called dpinst.exe.

Reboot the instruments.

Controller Set Up

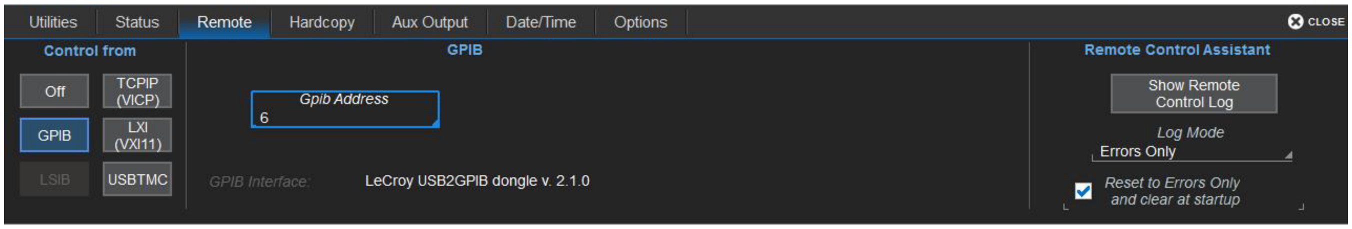
Install NI-VISA to manage the interface functions of the GPIB connection.

If you are running Windows and can utilize ActiveX controls, we highly recommend installing ActiveDSO on the controller to simplify communications with the oscilloscope.

Optionally, install a LabVIEW driver.

Oscilloscope Set Up

On the oscilloscope, go to **Utilities > Utilities Setup > Remote** and select the **GPIB** option. If necessary, modify the oscilloscope's **GPIB Address**.



Gpib Address: 6

GPIB Interface: LeCroy USB2GPIB dongle v. 2.1.0

Log Mode: Errors Only

☑ Reset to Errors Only and clear at startup

Connecting via LSIB

The LeCroy Serial Interface Bus, or LSIB, is a proprietary standard for high-speed data transfer from the oscilloscope with speeds up to 325 MB/s. Teledyne LeCroy’s exclusive LSIB solution is based on the wired PCI Express standard that uses a 4-lane bus for remote data transfer. An LSIB API is published.

While LSIB offers significant improvements in data transfer rate over 100Base-T ENET, USBTMC, and GPIB, the LSIB API is geared toward waveform and data transfer and does not provide for many other common remote control functions such as remote set up, "hardcopy" screen capture, etc.

LSIB is an optional, factory-installed interface on WavePro, WaveMaster, and LabMaster series oscilloscopes.

Hardware

Install the LSIB host board or host card on the controller PC, then connect the controller to the oscilloscope using the LSIB cable.

See the *LSIB Host Interfaces Operator's Manual* for instructions on making the LSIB connection.

Controller Set Up

Run the LSIB installer for Windows or Linux on the controller. After installation, the online LSIB API (LSIB-API-Ref-OLH-E.chm), can be found in:

C:\Program Files\LeCroy\XStream\LSIB\Docs

Oscilloscope Set Up

On the oscilloscope, go to **Utilities > Utilities Setup > Remote** and select the **LSIB** remote control option.

Shut down both the oscilloscope and the controller. Restart the oscilloscope first, followed by the controller. You do not have to wait for the oscilloscope's boot cycle to complete to restart the controller.

Configuring DCOM Connections

The Windows Distributed Component Object Model (DCOM) permits the distribution of different components of a single application across two or more networked computers, supporting the remote display and control of applications. Accessing a networked oscilloscope remotely via DCOM is equivalent to logging on to the oscilloscope itself and executing programs "locally."

A DCOM connection is necessary to execute remote control programs, unless you use ActiveDSO or NI-VISA to handle the remote message interface. It is also required to control the oscilloscope from a remote PC using XStreamBrowser.

Caution: **DCOM connections to Teledyne LeCroy oscilloscopes running Windows 10 are not currently supported.** We cannot guarantee the behavior of the MAUI firmware (XStreamDSO) when operated through such a connection. Use ActiveDSO or NI-VISA to manage the remote interface to these oscilloscopes, and use the local copy of XStreamBrowser to view the Automation hierarchy. You can safely use DCOM to connect from a Windows 10 PC to a Windows 7 oscilloscope.

Note: DCOM is pre-configured on WaveSurfer 3000 oscilloscopes, which run the Windows CE platform and do not allow access to a desktop; you can omit performing these connection procedures. Install WaveStudio instead of XStreamBrowser on the remote PC to view the Automation hierarchy.

To complete this process, you will:

1. Confirm the Windows OS on controller and oscilloscope: go to the Windows desktop, right-click on the **My Computer icon** and choose **Properties**. Follow the procedures below indicated for your operating system.
2. Confirm the NT domain of both controller and oscilloscope.
3. Configure the remote PC to permit DCOM connections.
4. Configure the oscilloscope DCOM settings, including creating user accounts (if required).
5. Test the connection.

Note: You must have Administrator privileges on both the PC and the oscilloscope to complete DCOM configuration.

Confirm Network Domain and User Accounts

If the oscilloscope is not on the same NT domain as the controller PC, you will need to set up an account for the PC user ***in the oscilloscope domain*** using the ***exact same user name and password*** as on the PC. That same user must also be allowed into the oscilloscope DCOM section. Before proceeding, consult your Network Administrator regarding your network configuration.

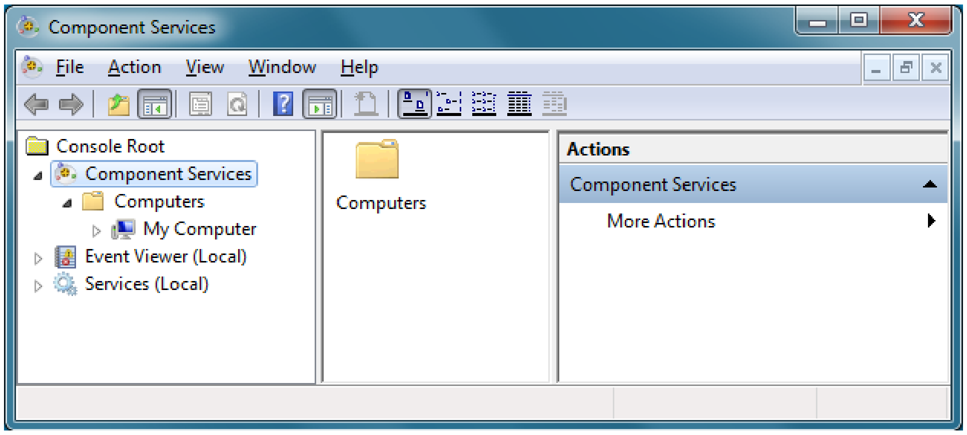
If the machines are on different domains, verify the user name and password for each user account that will be used to send Automation commands to the oscilloscope. You will need this information to complete the configuration on the oscilloscope.

Windows 7 and 10 DCOM Configuration

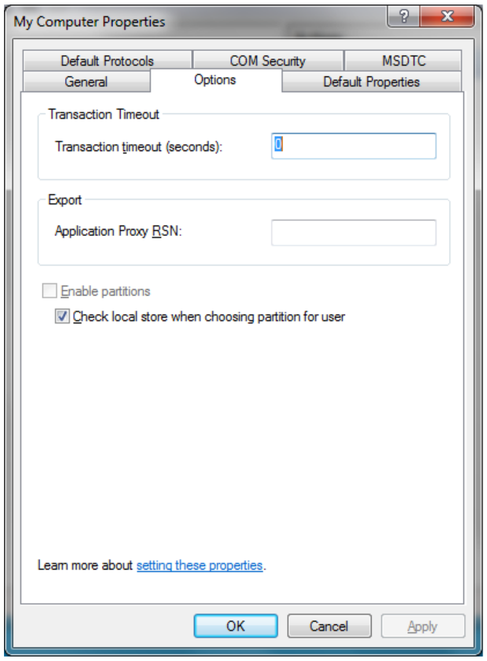
On the Controller

Follow these steps if the PC is running the Windows 7 or Windows 10 operating system.

1. Go to the Windows **Start** menu and type **dcomcnfg.exe** in **Search programs and files**.
2. Expand **Component Services** until you see My Computer. Right-click on **My Computer** and choose **Properties**.



3. On the **Options** tab, enter **0** for **Transaction timeout**, then click **Apply**.



Transaction Timeout
Transaction timeout (seconds): 0

Export
Application Proxy RSN:

☐ Enable partitions
☑ Check local store when choosing partition for user

Learn more about setting these properties.

4. Open the **Default Properties** tab. Make sure **Enable distributed COM on this computer** is checked. If not check it and click **Apply**.

On the Oscilloscope

Note: These steps are only for oscilloscopes running Windows 7. Do not use DCOM to interface with oscilloscopes running Windows 10, use ActiveDSO or NI-VISA.

We recommend connecting a keyboard and mouse to the oscilloscope before beginning this procedure. Use any USB ports.

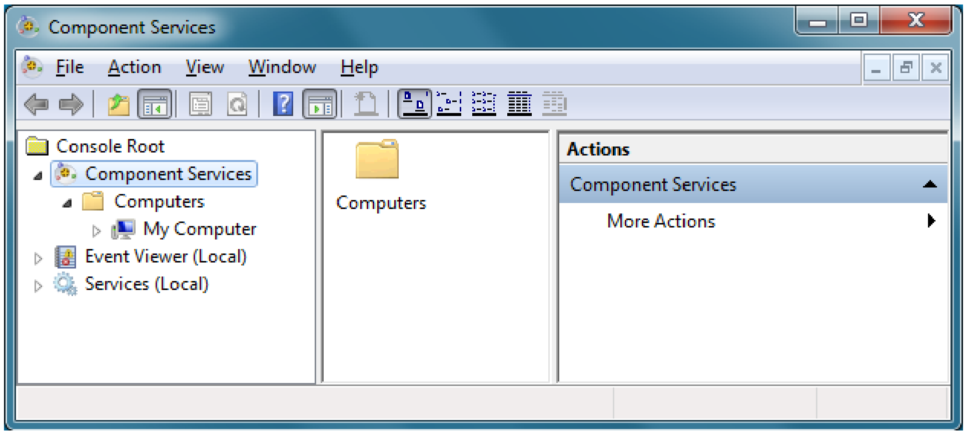
Create Users

1. Choose **File > Minimize** to display the Windows desktop.
2. Windows 7: Go to **Start** > **Control Panel** > **User Accounts** > **Manage User Accounts**.

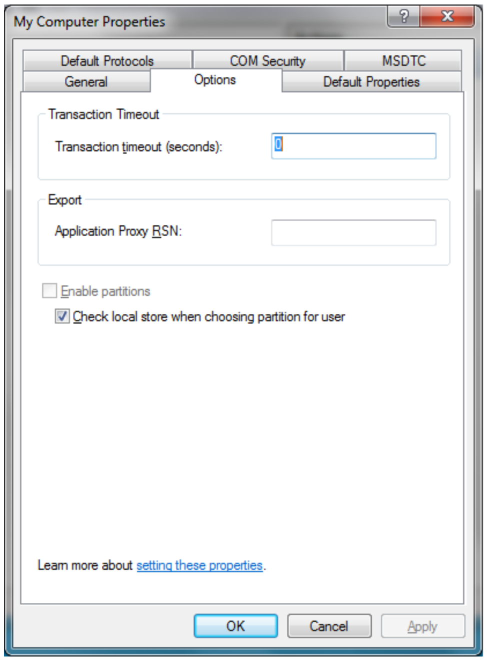
   Windows 10: Go to **Start** > **Settings** > **Accounts** > **Other People**.
3. For each user that is to access the oscilloscope remotely, **Add** a user ("Another work or family user") with the same user name and password as on the PC. Be sure the user is created as a Local Administrator.

Configure DCOM Settings

1. Go to the Windows **Start** menu and enter **dcomcnfg.exe** in **Search programs and files**.
2. Expand **Component Services** until you see My Computer. Right-click on **My Computer** and choose **Properties**.



3. On the **Options** tab, enter **0** for **Transaction timeout**, then click **Apply**.



Transaction Timeout

Transaction timeout (seconds): 0

Export

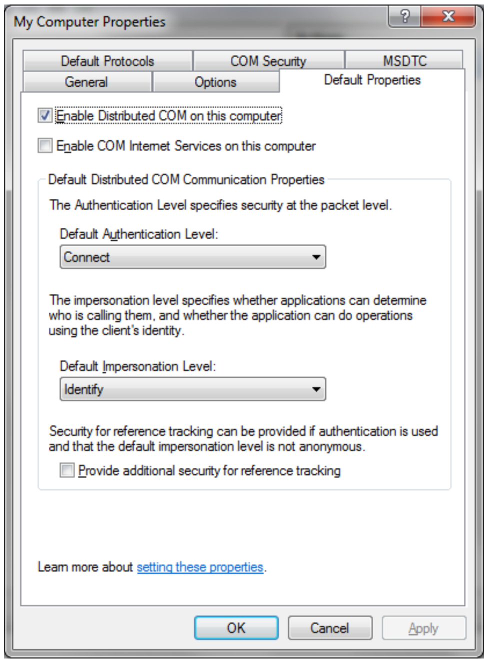
Application Proxy RSN:

☐ Enable partitions

☑ Check local store when choosing partition for user

Learn more about setting these properties.

4. Open the **Default Properties** tab. Make sure **Enable distributed COM on this computer** is checked. If not check it and click **Apply**. Close the dialog when done.



☑ Enable Distributed COM on this computer

☐ Enable COM Internet Services on this computer

Default Distributed COM Communication Properties

The Authentication Level specifies security at the packet level.

Default Authentication Level: Connect

The impersonation level specifies whether applications can determine who is calling them, and whether the application can do operations using the client's identity.

Default Impersonation Level: Identify

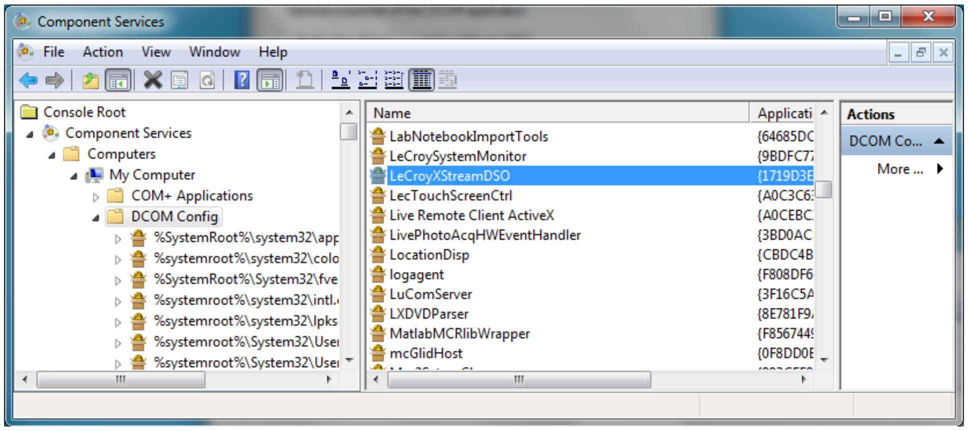
Security for reference tracking can be provided if authentication is used and that the default impersonation level is not anonymous.

☐ Provide additional security for reference tracking

Learn more about setting these properties.

5. On the Component Services window, navigate to **Component Services** > **Computers** > **My Computer** > **DCOM Config** and select it.

6. From the list on the right, right-click on **LeCroyXStreamDSO** and choose **Properties**.


Component Services
File
Action
View
Window
Help
Console Root
Component Services
Computers
My Computer
COM+ Applications
DCOM Config
%SystemRoot%\system32\app
%systemroot%\system32\colo
%SystemRoot%\System32\fve
%systemroot%\system32\intl.
%systemroot%\system32\lpks
%systemroot%\System32\Use
%systemroot%\System32\Use
Actions
DCOM Co...
More ...

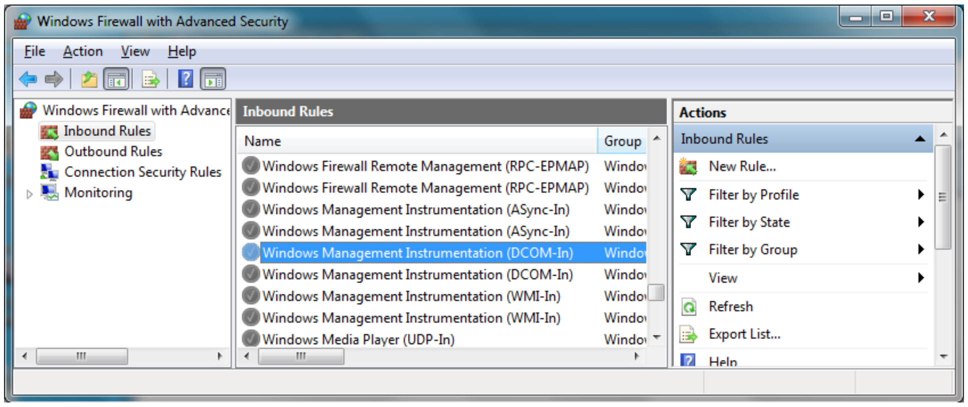
Name	Applicati
LabNotebookImportTools	{64685DC
LeCroySystemMonitor	{9BDFC77
LeCroyXStreamDSO	{1719D3E
LecTouchScreenCtrl	{A0C3C6:
Live Remote Client ActiveX	{A0CEBC
LivePhotoAcqHWEventHandler	{3BD0AC
LocationDisp	{CBDC4B
logagent	{F808DF6
LuComServer	{3F16C5A
LXDVDParser	{8E781F9,
MatlabMCRlibWrapper	{F856744
mcGlidHost	{0F8DD0E

7. On the Properties dialog, open the **Identity tab** and select **The interactve user**. **Apply** and close Properties and Component Services.

Open Firewall

1. Go to the Windows **Start** menu and enter **wf.msc** in **Search programs and files**.

2. Open **Inbound Rules**. For both Inbound rules named **Windows Management Instrumentation (DCOM-In)**, right-click and choose **Enable Rule**. Close Windows Firewall dialog.



Name	Group
Windows Firewall Remote Management (RPC-EPMAP)	Windo
Windows Firewall Remote Management (RPC-EPMAP)	Windo
Windows Management Instrumentation (ASync-In)	Windo
Windows Management Instrumentation (ASync-In)	Windo
Windows Management Instrumentation (DCOM-In)	Windo
Windows Management Instrumentation (DCOM-In)	Windo
Windows Management Instrumentation (WMI-In)	Windo
Windows Management Instrumentation (WMI-In)	Windo
Windows Media Player (UDP-In)	Windo

3. Choose **Start** > **Shutdown** > **Log Off**, then log back in as the new user that was created on the oscilloscope.

Windows XP or Vista DCOM Configuration

On the Controller

Follow these steps if the controller PC is running Windows XP or Vista operating system.

1. Go to Start > Run, enter dcomcnfg.exe and click OK.

   Note: If Run is not in your Start menu, open a terminal and run dcomcnfg.exe.

2. Expand Component Services > Computers.
3. If you see a Windows Security Alert pop-up, click Unblock.
4. In the Computers folder, right-click My Computer and choose Properties.
5. On the Properties dialog, open the Options tab and change Transaction Timeout to 0. Click Apply.

On the Oscilloscope

Follow these steps if your oscilloscope is running Windows XP or Vista operating system.

Contact Technical Support for assistance if your oscilloscope is running Windows XP Embedded.

Open Firewall

1. Go to Start > Control Panel > Firewall. For Vista machines, click Change Settings.
2. On the Windows Firewall dialog, open the Exceptions tab.
3. Select LeCroyXStreamDSO Main Application.
4. Click Add Port.
5. On the Add Port dialog, make the following settings, then click OK:
   - Name: DCOM
   - Port number: 135
   - TCP: selected

Turn Off Simple File Sharing

1. Go to Start > Control Panel > Folder Options.
2. On the Folder Options dialog, open the View tab and clear the checkbox Use simple file sharing.
3. Click OK.

Create Users

If the oscilloscope is on the same NT domain as the controller, you can skip this procedure.

If the oscilloscope is *not* on the same NT domain as the controller, each PC user that is to send Automation commands to the oscilloscope must have a corresponding user account on the oscilloscope, configured with the identical user name and password. Both accounts must have Administrator privileges.

1. On the Windows desktop, right-click on My Computer and choose Manage.
2. Expand the hierarchy to display Local Users and Groups > Users. Select Users
3. Right-click on a blank area of the dialog and choose New User.
4. Enter the User name and Password exactly as they appear on the controller PC. Confirm password.
5. Deselect User must change password at next logon.
6. Click Close.

Configure DCOM Settings

1. Go to Start > Run, enter dcomcnfg.exe and click OK.

   Note: If Run is not in your Start menu, open a terminal and run dcomcnfg.exe.

2. Expand Component Services.
3. If a Windows Security Alert pop-up appears, click Unblock.
4. Expand Computers, right-click on My Computer, and select Properties.
5. Open the Options tab and set the Transaction timeout to 0. Click Apply.
6. Open the Default Properties tab, select Enable Distributed COM on this computer, and choose a Default Authentication Level of Connect.
7. Open the COM Security tab and under Launch and Activation Permission click Edit Limits.
8. On the Launch Permission dialog, click Add.

9. On the Select Users... dialog:

   - If the PC and oscilloscope are on the same NT domain, select the PC user account.
   - If the PC and oscilloscope are *not* on the same NT domain, enter the PC user account name and click Check Names.

   Click OK.

10. On the Launch Permissions dialog, check Allow for all permissions. Click OK.
11. On the Component Services window, expand My Computer > DCOM Config. Right-click on LeCroyXStreamDSO and choose Properties.
12. Open the Identity tab and select The interactive user.
13. Open the Security tab, under Launch and Activation Permissions select Customize, then click Edit.
14. On the Select Users... dialog:

    - If the PC and oscilloscope are on the same NT domain, select the PC user account.
    - If the PC and oscilloscope are *not* on the same NT domain, enter the PC user account name and click Check Names.

    Click OK.

15. On the Launch Permissions dialog, check Allow for all permissions. Click OK.
16. On the Security tab, under Access Permissions, select Customize and click Edit. Repeat Steps 14 and 15.
17. Choose Start > Shut Down > Restart to reboot the oscilloscope.

Testing the DCOM Connection

Download the free XStreamBrowser from the Oscilloscope Software Utilities page at:

http://teledynelecroy.com/support/softwaredownload/

Install it on the PC and use it to **Connect to Remote Instrument** (DCOM).

If the DCOM connection is properly configured, you should now see the oscilloscope application object hierarchy appear in the XStreamBrowser window.

Note: WaveSurfer 3000 users should instead install the WaveStudio software, which will display the COM hierarchy of a connected device when Automation Browser is selected.

Testing the Remote Connection

Once you have completed all the steps required to make the remote connection to your oscilloscope, test that you can "see" it from the controller and send remote commands.

Using WaveStudio

The free WaveStudio software is capable of testing several types of remote connection as well as serving as a remote command terminal for controlling the oscilloscope. A trial copy is installed on the oscilloscope, and another may be installed on Windows-based PCs. For download information, see Resources.

Follow these steps to test the connection:

1. Click the Add Scope button on My Scope Explorer or the Scope menu ribbon.
2. On the Add Device dialog, select the remote connection type.
3. Enter the oscilloscope's network name or address and click OK.

If the oscilloscope is found, an entry is added to the My Scope Explorer window. The status should indicate the device is "Alive." This confirms the connection is working.

If the oscilloscope is found but cannot be connected, after a brief time out an entry is added to My Scope Explorer indicating the selected device is "Dead." Check the address and physical connection again. If you still cannot connect, consult with your Network Administrator.

Using the PING Command

For LAN users, both the physical cable connection and proper host TCP/IP configuration can be verified using the Ping command.

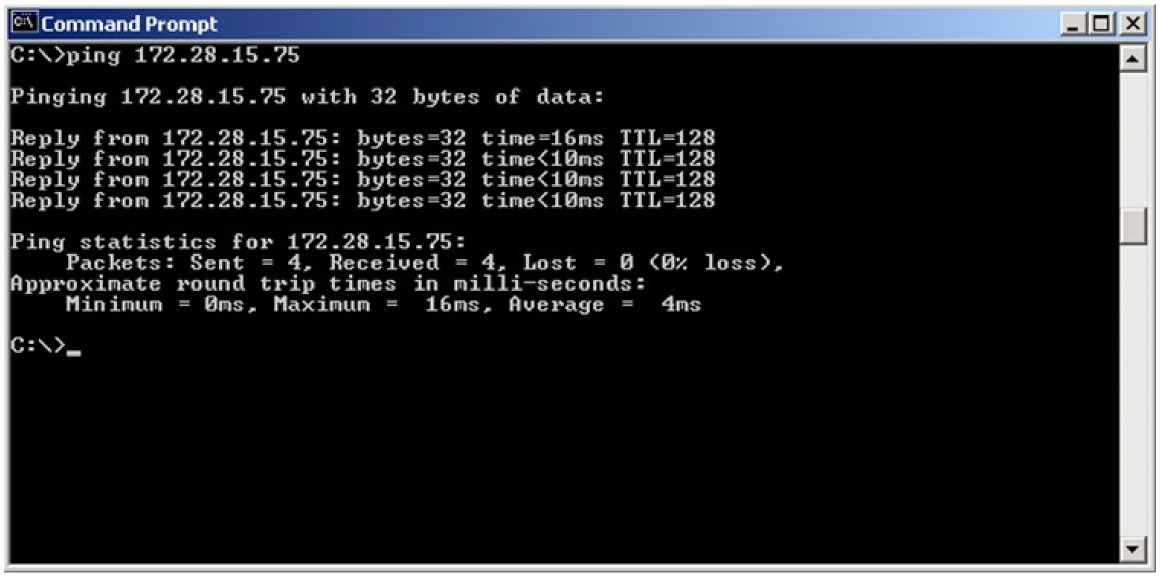
Note: PING is a good way to check the network connection, but it doesn't guarantee the socket connection to the oscilloscope at port 1861. Connecting via WaveStudio or XStreamBrowser is a better test.

At an MS-DOS prompt, type:

```
ping <IP_address>
```

where <IP_address> is the address assigned to the oscilloscope.

The Command Prompt window shows an exchange similar to that below if the Ping is successful. The Ethernet connection is shown as established and the ping command has sent a message to the instrument and waited for a response. If a timeout occurs, the IP address used for the destination (the oscilloscope) is incorrect or not within the subnet mask of the host's IP.



```
C:\>ping 172.28.15.75

Pinging 172.28.15.75 with 32 bytes of data:

Reply from 172.28.15.75: bytes=32 time=16ms TTL=128
Reply from 172.28.15.75: bytes=32 time<10ms TTL=128
Reply from 172.28.15.75: bytes=32 time<10ms TTL=128
Reply from 172.28.15.75: bytes=32 time<10ms TTL=128

Ping statistics for 172.28.15.75:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum =  16ms, Average =  4ms

C:\>_
```

Successful ping showing reply.

Remote Control Assistant

The Remote Control Assistant (RCA) feature of MAUI oscilloscopes maintains a log of remote control commands received and responses issued (which would include Automation controls sent within the VBS command), allowing the programmer to receive feedback on errors in his or her source code.

The RCA has several modes of operation: Off, Errors Only, and Full Dialog.

- In **Errors Only** mode (the default), the RCA will keep a log of any mistakes in the commands received, and display the error detected.
- In **Full Dialog** mode, all commands and responses are logged.

This selection can be made by going to **Utilities > Utilities Setup > Remote** on the oscilloscope.

Touch **Show Remote Control Log** on the Remote dialog to pop up a window showing the log file. From there you can clear the log or save it as a text file.

The RCA can also be set by using the remote commands COMM_HELP (CHLP) and COMM_HELP_LOG (CHL).

ActiveDSO

ActiveDSO is a proprietary ActiveX™ control that enables Teledyne LeCroy oscilloscopes to be controlled by and exchange data with a variety of Windows applications that support the ActiveX standard. Microsoft Office suite, Internet Explorer, Visual Basic, Visual C++, and Visual Java are a few of the many applications and languages that support ActiveX controls.

ActiveDSO hides the intricacies of programming in ActiveX and provides a simple and consistent interface to the controlling application. The ActiveDSO control may be used as either:

- An "invisible" object accessed via a scripting language, for example, VBS.
- A visible object embedded in an OLE Automation compatible client, such as a VBA macro launched by a Windows application button.

Note: Many of our Automation examples utilize Visual Basic Script (VBS), the "built in" Automation language, as it is syntactically identical to our LeCroy Setup Script (.LSS). Do not confuse VBS with Visual Basic for Applications (VBA), a subset of Visual Basic used extensively within Windows applications, such as Excel, as a macro "programming" language. Some things that work in VBS do not work in VBA.

A great benefit of ActiveDSO is that it is completely independent of the remote hardware interface. The connection via ENET (TCP/IP), GPIB, or USBTMC is made by a single command near the start of a program. It may be used to send Automation commands or legacy IEEE 488.2 remote control commands.

Download the ActiveDSO software free of charge from our website (see Resources) and install ActiveDSO on the controller PC. The driver installs with the *ActiveDSO Developer's Guide*. This manual documents all the methods and properties used to program ActiveDSO objects. Following are some simple examples. More extensive examples are installed in the ActiveDSO program folder.

Instantiating the ActiveDSO Control

The control's external name is always: LeCroy.ActiveDSOCtrl.1

The control's CLSID is 450A9897-D9C9-11D1-9966-0000F840FC5E

Following are instantiations of the control as an "invisible" object used to pass remote commands in several commonly used languages. In each case, the control is aliased as "dso", although for this you may substitute whatever you wish.

Language	

VBA	`Dim dso As Object`
	`Set dso = CreateObject("LeCroy.ActiveDSOCtrl.1")`

Python	`import win32com.client`
	`dso=win32com.client.Dispatch("LeCroy.ActiveDSOCtrl.1")`

Visual C++	`CActiveDSO dso;`
	`RECT dummyRect;`
	`dso.Create("LeCroy.ActiveDSOCtrl.1","HiddenWindowForDSOControl",0,dummyRect, this,0);`

ActiveDSO Methods for Remote Control

Following are several ActiveDSO methods that are particularly useful for remote control. See the *ActiveDSO Developer's Guide* for an explanation of all ActiveDSO methods.

MakeConnection

This method establishes the connection from controller to oscilloscope. It is a single line of code that requires only that you pass the oscilloscope interface an address to which to connect.

The following table shows the MakeConnection string for each remote interface type.

Interface	Syntax	Example
TCP/IP	`MakeConnection("IP: <IP address>")`	`MakeConnection("IP: 172.25.9.22")`
LXI	`MakeConnection("VXI11: <IP address>")`	`MakeConnection("VXI11: 172.25.9.22")`

GPIB	`MakeConnection("GPIB[x]: <GPIB address>")`
	`x:= 0 to 3 (optional)`
		`MakeConnection("GPIB: 4")`

USBTMC	`MakeConnection("USBTMC: <VISA resource string>")`	`MakeConnection("USBTMC:`
		`USB0::0x05FF::0x1023::2807N59057::INSTR")`

Note: When the VISA resource string is used with ActiveDSO for remote control, it is preceded by a single colon space instead of the double colon used with a VISA driver.

Disconnect

The Disconnect method disconnects the control from the device. This method performs the necessary termination functions, which will cleanup and disconnect the interface connection.

WriteString

The WriteString method sends a command string to the connected device with or without a terminating EOI (End or Identify). It can be used with Automation or legacy remote commands.

WriteString follows the syntax:

```
<controlName>.WriteString("<textString>", <EOI Boolean>)

<controlName>:=  name used to instantiate the ActiveDSO control

<textString>:= command string sent to the device

<EOI Boolean>:= {1, 0}
```

If EOI is set to 1 (TRUE), the command terminates with EOI, and the device interprets the command right away. This is normally the desired behavior.

If EOI is set to 0 (FALSE), a command may be sent in several parts with the device starting to interpret the command only when it receives the final part, which should have EOI set to TRUE.

ReadString

The ReadString method reads a string response from the instrument and can be used to read the results of queries.

```
' Read the amplitude parameter measurement, store in cell L3 of Excel worksheet

Call o.WriteString("c1:pava? ampl", 1)
Worksheets("Sheet1").Cells(3, 12).Value = o.ReadString(500)

' Read the rise time parameter measurement into variable

Call o.WriteString("c1:pava? rise", 1)
RiseTime = o.ReadString(500)
```

VISA

VISA refers to the Virtual Instrument Software Architecture, an API widely used in Test & Measurement for communicating with instruments from a PC. With the installation of a VISA driver, the programmer needs only provide a VISA resource string to create a connection to a remote instrument, and VISA passes subsequent write or read data requests and the corresponding VISA passport to the instrument.

A VISA driver that behaves exactly like NI-VISA is required for remote connection to Teledyne LeCroy oscilloscopes over the ENET, USBTMC, and GPIB interfaces if you cannot utilize ActiveX technology (such as ActiveDSO and WaveStudio) on your network. Programmers should download and read the IVI VISA specification document for their programming language to fully understand the VISA API. It is always a good idea to install the IVI VISA API in order to decouple your Automation program from the driver used.

We have tested our instruments with National Instrument's implementation of VISA, NI-VISA, and recommend an installation of this if you are making the remote connection from a Windows machine. NI-VISA can be downloaded from: https://www.ni.com/visa/

Note: For NI-VISA licensing requirements and fees, see https://www.ni.com/visa/license.htm.

Unless you install NI-VISA, you will have to program your own remote control interface. We supply the VICP Client Library for those who wish to use the VICP protocol but cannot use NI-VISA because they are not working in the Windows environment.

VICP Passport for NI-VISA

Those using NI-VISA for VICP connections in the Windows environment should install the VICP Passport. The passport is a plug-in DLL for NI-VISA that provides a translation layer between the standard NI-VISA API and Teledyne LeCroy's VICP protocol. See the Application Brief *LAB_WM827: Understanding VICP and the VICP Passport* for more information.

Note: NI-VISA provides the necessary VISA passports for LXI, GPIB, and USBTMC connections; VICP Passport is only necessary if you're using VICP protocol.

Download VICP Passport from teledynelecroy.com. See Resources.

VISA Resource Strings

Use one of the following VISA resource strings to make the remote connection:

VICP (TCP/IP)	`VICP::`*`<IP address>`*
	`VICP::`*`<hostname>`*
	
	`Examples:`
	`VICP::172.29.9.22`
	`VICP::LCRY4201N10003`

VXI-11 (LXI)	`TCPIP0::`*`<IP address>`*`::INSTR`
	`TCPIP0::`*`<hostname>`*`::INSTR`
	
	`Examples:`
	`TCPIP0::172.29.9.22::INSTR`
	`TCPIP0::LCRY4201N10003::INSTR`

GPIB	`GPIB::`*`<GPIB address>`*`::INSTR`
	
	`Example:`
	`GPIB::4::INSTR`

USBTMC	`USBTMC::`*`<USB interface number::manufacturer ID::model code::serial number>`*`::INSTR`
	
	`Example:`
	`USBTMC::USB0::0x05FF::0x1023::2807N59057::INSTR`

The suffix ::INSTR is not necessary for VICP, but those using other protocols should continue to use the full syntax.

The <*hostname*> string is the name by which the DNS server knows the instrument (often the serial number) and can be used only if the oscilloscope and controller are both connected by LAN to a name server.

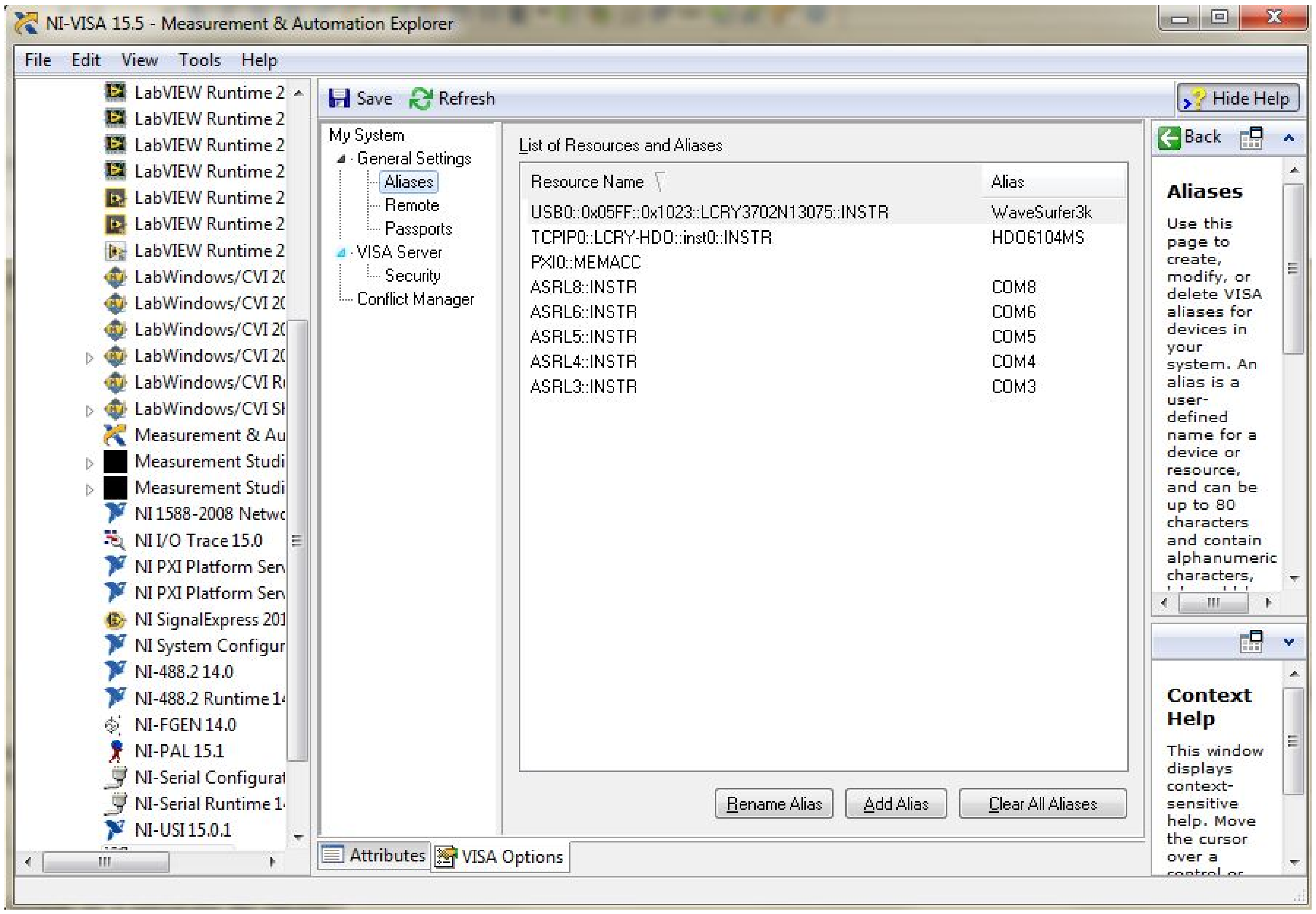
On the oscilloscope, go to **Utilities > Utilities Setup > Remote** to find the instrument address and serial number.

Using VISA Aliases

For LXI (VXI-11), GPIB, and USBTMC connections, VISA aliases can be used instead of the full VISA resource string, allowing you to decouple your remote control programs from DHCP changes or long, cumbersome device addresses.

Note: VISA aliases cannot be used with the VICP protocol.

Tools like NI-MAX (Measurement & Automation Explorer) make it very easy to assign aliases to any device in your system, which are automatically updated whenever the address is changed.



List of Resources and Aliases

Resource Name	Alias
USB0::0x05FF::0x1023::LCRY3702N13075::INSTR	WaveSurfer3k
TCPIP0::LCRY-HDO::inst0::INSTR	HDO6104MS
PXI0::MEMACC	
ASRL8::INSTR	COM8
ASRL6::INSTR	COM6
ASRL5::INSTR	COM5
ASRL4::INSTR	COM4
ASRL3::INSTR	COM3

Aliases

Use this page to create, modify, or delete VISA aliases for devices in your system. An alias is a user-defined name for a device or resource, and can be up to 80 characters and contain alphanumeric characters,

Context Help

This window displays context-sensitive help. Move the cursor over a

Once the alias is assigned, simply replace the full VISA connect string with the alias in your code. For example, in this Python script, instead of:

```
import visa
rm = visa.ResourceManager()
lecroy = rm.open_resource("TCPIP0::HDO-LCRY::inst0::INSTR")
```

You could send:

```
import visa
rm = visa.ResourceManager()
lecroy = rm.open_resource("HDO6104MS")
```

WaveStudio

WaveStudio is a PC-based connectivity tool that interfaces a Teledyne LeCroy oscilloscope to a Windows XP, Vista, 7 or 10 operating system, with support for 32- and 64-bits. It is a fast and easy way to analyze acquired waveforms offline, or to remotely control an oscilloscope from your desktop. WaveStudio is also used to access the Automation hierarchy of WaveSurfer 3000 model oscilloscopes.

Unlike XStreamBrowser, which works solely within the Windows COM architecture, WaveStudio can connect to a device over most of the available remote interfaces, making it a good way to test different remote connections.

Note: WaveStudio does not support LSIB connections to the instrument. Choose another remote connection if you wish to use WaveStudio for remote control.

Setting Permissions

WaveStudio is preset so that only users with Administrator rights can run it. If you wish to use WaveStudio from a PC that does not have Administrator privileges:

1. Navigate to **C:\Program Files\LeCroy\XStream\WaveStudio.exe**, then right-click and choose **Properties**.
2. Open the **Compatibility** tab and deselect **Run this program as an Administrator**.

Connecting to a Device

To use WaveStudio to make the remote connection to an oscilloscope:

1. Configure both the PC running WaveStudio and the oscilloscope to support the remote control method you wish to use.
2. Launch WaveStudio and click the **Add Scope** icon either on the Scope ribbon or at the top of the My Scope Explorer window.
3. Select the **remote control method** in use.
4. Enter the oscilloscope's domain **name or address**, depending on the remote connection type (e.g., IP address for TCP/IP, GPIB address for GPIB).
5. The device should now appear in the **My Scope Explorer** window with a status of **Alive**.

   If it does not appear or is not Alive, select it and click the **Edit** icon. Check that you have entered the correct name or address. Change it if necessary.

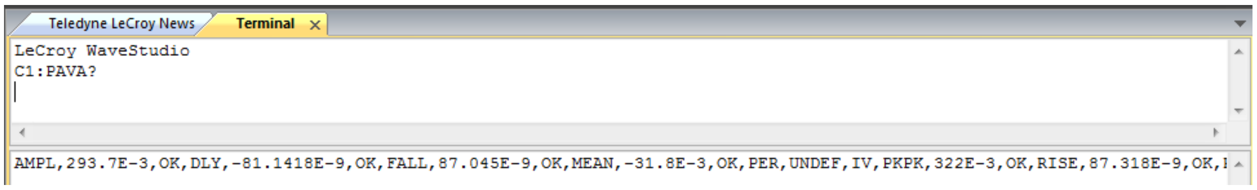
   Tip: Go to Utilities > Utilities Setup > Remote on the oscilloscope to check the remote control method and the device name or address. These must match what is entered in WaveStudio. If DHCP is in use, the address may have changed since the oscilloscope was originally added to WaveStudio.

Sending Remote Commands

WaveStudio includes a terminal window from which you can execute IEEE 488.2 remote control commands. Use the VBS command to send Automation commands.

1. Follow the procedure above to connect to the oscilloscope. If the device is already added to My Scope Explorer, just select it from the list.
2. When the connection is Alive, select **Terminal** from the list of objects/folders belonging to the device in My Scope Explorer.
3. At the top of the Terminal window, immediately below the words "LeCroy WaveStudio," enter the remote command or query and Return.

   Replies to queries appear in the bottom section of the Terminal window.

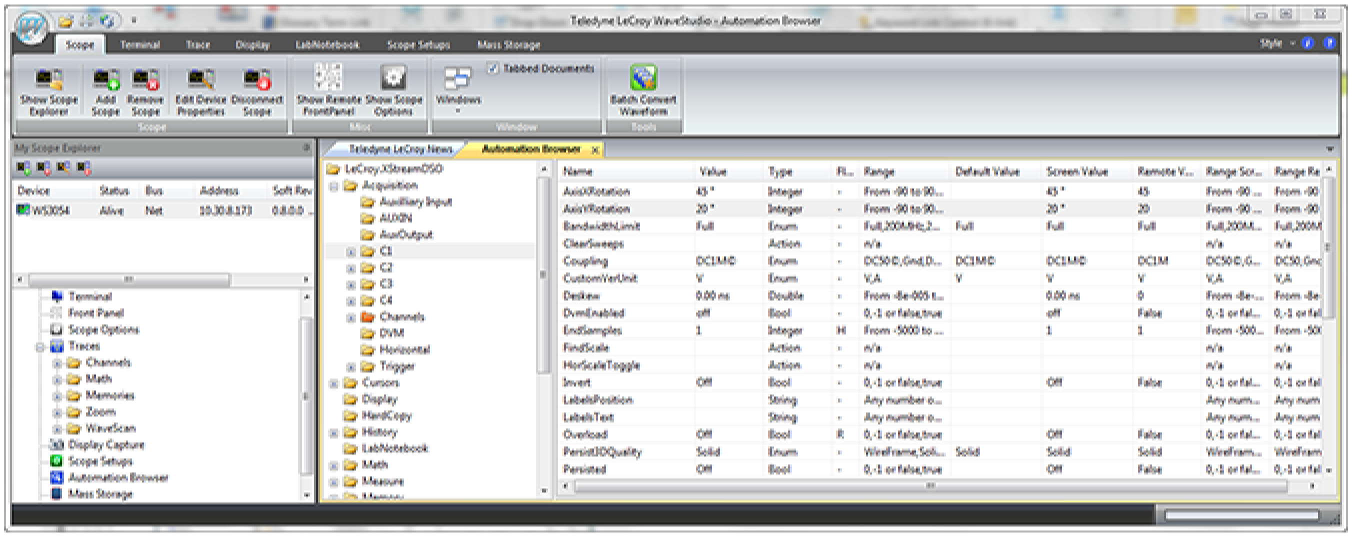


```
LeCroy WaveStudio
C1:PAVA?
```

```
AMPL,293.7E-3,OK,DLY,-81.1418E-9,OK,FALL,87.045E-9,OK,MEAN,-31.8E-3,OK,PER,UNDEF,IV,PKPK,322E-3,OK,RISE,87.318E-9,OK,
```

Automation Browser for WaveSurfer 3000

For WaveSurfer3000 oscilloscopes, WaveStudio includes an Automation Browser feature that exposes the instrument's COM object hierarchy, the same as does XStreamBrowser for other oscilloscope models.



Device	Status	Bus	Address	Soft Rev
WS3054	Alive	Net	10.30.8.173	0.8.0.0 ...

Name	Value	Type	Fl...	Range	Default Value	Screen Value	Remote V...	Range Scr...	Range Re
AxisXRotation	45 °	Integer	-	From -90 to 90...		45 °	45	From -90 ...	From -90
AxisYRotation	20 °	Integer	-	From -90 to 90...		20 °	20	From -90 ...	From -90
BandwidthLimit	Full	Enum	-	Full,200MHz,2...	Full	Full	Full	Full,200M...	Full,200M
ClearSweeps		Action	-	n/a				n/a	n/a
Coupling	DC1MΩ	Enum	-	DC50Ω,Gnd,D...	DC1MΩ	DC1MΩ	DC1M	DC50Ω,G...	DC50,Gnc
CustomVerUnit	V	Enum	-	V,A	V	V	V	V,A	V,A
Deskew	0.00 ns	Double	-	From -8e-005 t...		0.00 ns	0	From -8e-...	From -8e
DvmEnabled	off	Bool	-	0,-1 or false,true		off	False	0,-1 or fal...	0,-1 or fal
EndSamples	1	Integer	H	From -5000 to ...		1	1	From -500...	From -50(
FindScale		Action	-	n/a				n/a	n/a
HorScaleToggle		Action	-	n/a				n/a	n/a
Invert	Off	Bool	-	0,-1 or false,true		Off	False	0,-1 or fal...	0,-1 or fal
LabelsPosition		String	-	Any number o...				Any num...	Any num
LabelsText		String	-	Any number o...				Any num...	Any num
Overload	Off	Bool	R	0,-1 or false,true		Off	False	0,-1 or fal...	0,-1 or fal
Persist3DQuality	Solid	Enum	-	WireFrame,Soli...	Solid	Solid	Solid	WireFram...	WireFram
Persisted	Off	Bool	-	0,-1 or false,true		Off	False	0,-1 or fal...	0,-1 or fal

Part 2: Automation Programming Reference

This section is a guide to the Automation capabilities of Teledyne LeCroy's MAUI™ (also known as XStream) oscilloscopes.

While Teledyne LeCroy has always striven to maximize compatibility, the underlying technologies used by Automation require the Microsoft Windows® operating system (minimum 32-bit), and this system was introduced only with our MAUI instruments. Automation is not available on the older oscilloscope families. These instruments can be controlled remotely using legacy IEEE 488.2 remote control commands.

Automation Overview

Automation (formerly referred to as “OLE Automation”) is a Microsoft technology that is primarily used to enable cross-application macro programming. It is based upon the Component Object Model (COM), which is similar in nature to CORBA more commonly found in the UNIX world. In addition to supporting the familiar ASCII-based remote commands that have been used to control all Teledyne LeCroy oscilloscopes for many years, all Windows-based MAUI instruments fully support control by Automation interfaces.

Using COM, the controlling application can run directly on the instrument without requiring an external controller. Alternatively, it can run from a remote, networked computer using Microsoft’s distributed COM standard (DCOM).

It is important to note that Automation itself is not language dependent; it can be performed using any programming language that supports COM.

General Architecture

An application that “exposes Automation objects” is referred to as an “Automation server.” Automation objects expose “Automation interfaces” to the controlling “Automation client.” The oscilloscope application on MAUI oscilloscopes (XStreamDSO) is an Automation server that can be controlled locally or remotely by Automation clients.

Automation objects can take the form of:

- Invisible "objects" created by script, such as a Visual Basic script to change oscilloscope settings and read back the new measurement results
- Visible objects embedded in an application, such as a button that launches a macro containing an Automation subroutine

Uses of Automation

Automation has many uses:

- Instrument setup (panel files)
- Remote control from external Windows applications
- Exposing waveform data and measurement results to external Windows applications
- Custom math/measurement processing and user interface customizations (with XDEV)

This section concentrates on using Automation for remote set up, control, and waveform/data transfer, the functions traditionally performed by GPIB remote control.

Automation Compared to IEEE 488.2 Remote Control

Automation does not necessarily replace the IEEE 488.2 legacy remote command set, which is also supported by MAUI instruments (and will continue to be). Rather, it augments it and allows another class of application to be created that can be executed locally or remotely.

Automation, however, can be considered as the "native language" of MAUI instruments. All of the instrument's controls and features are available to the Automation client, whereas only some of the instrument features have been implemented in the 488.2 remote command set.

The following table summarizes the differences between the two approaches to remote control:

	IEEE 488.2 Remote Control	Automation Remote Control
Physical transport	TCP/IP and LXI over Ethernet, GPIB, LSIB, or USBTMC*	Inter-process using COM, inter-PC using DCOM (TCP/IP)
Textual parsing of instrument responses required	Yes, all instrument responses need 'parsing' to extract useful information	No, each element in the Automation hierarchy appears as a "variable" to the Automation client
Compatibility with legacy programs/instruments	Yes, in most cases remote control applications written for legacy instruments will work without modification	No, Automation is a standard first introduced with MAUI (XStreamDSO)
Ability to control the oscilloscope application from "inside the box"	Yes, by using the VICP (TCP/IP) protocol to talk to the "localhost"	Yes, natively
Ease of use	Not trivial, although easier using a tool such as ActiveDSO** that hides some of the complexities	Very easy with scripting languages and MS Office productivity tools
Format of waveform results	Binary or ASCII; both require parsing before use	Arrays of floating point values
Control from MS Office suite	Possible via ActiveDSO utility	Yes, natively

* Not all interfaces available on all models. GPIB and LSIB available with hardware option.

** ActiveDSO is an ActiveX based driver for Teledyne LeCroy oscilloscopes

XStreamBrowser

The XStreamBrowser utility enables you to view, copy, and modify the COM object hierarchy of a Windows-based MAUI™ oscilloscope from a remote PC. It is essential for writing Automation programs, as it always shows all the Automation objects on the instrument at the exact current configuration–including those objects belonging to software options. It can also be used as a remote control console, enabling you to directly alter the configuration of Automation control variables.

XStreamBrowser is installed on all MAUI oscilloscopes for local browsing, but it may also be installed on any PC for remote control. You must first allow a DCOM connection between the PC and oscilloscope, then connect the XStreamBrowser to the device. The browser window is populated when the DCOM connection is successful.

Note: If using WaveSurfer 3000 or any oscilloscope running on the Windows 10 operating system, install the WaveStudio software instead of XStreamBrowser. The COM object hierarchy of a connected device is shown in the WaveStudio Automation Browser.

Caution: The version of XStreamBrowser available for download on our website is a 32-bit version that will run on 64-bit machines. It is intended *only* for installation on remote PCs, *not* on oscilloscopes. A 64-bit version of XStreamBrowser is already installed on 64-bit MAUI oscilloscopes. Installing the 32-bit version over this will cause registry conflicts. Likewise, if you have installed the 64-bit MAUI firmware on your PC, you already have a copy of the 64-bit XStreamBrowser. If it was uninstalled, reinstall the MAUI firmware, rather than install the 32-bit version of XStreamBrowser.

Connecting to a Local Device

To launch XStreamBrowser on the oscilloscope:

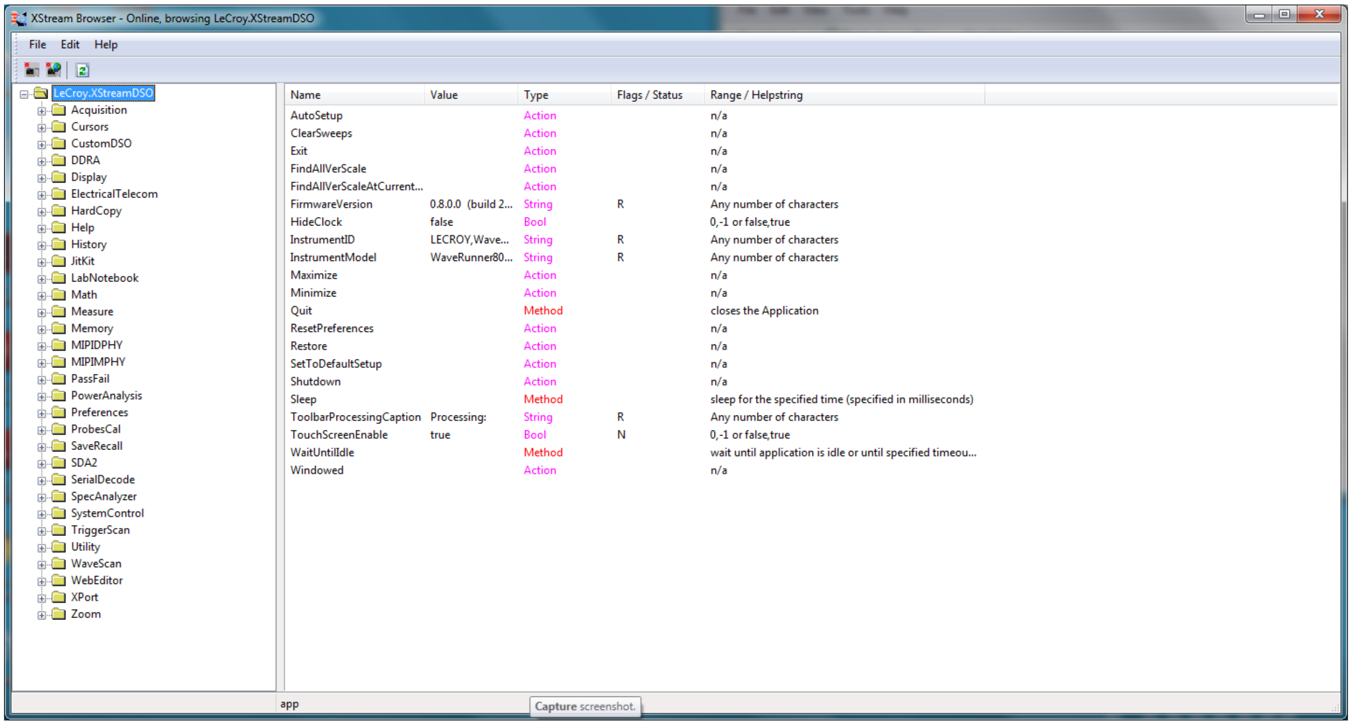
1. Choose **File->Minimize** to display the Windows desktop.
2. Double-click the **XStreamBrowser** icon.
3. Select the connection icon.

Connecting to a Remote Device

1. Be sure the oscilloscope is configured to allow a DCOM connection from the PC.
2. Launch XStreamBrowser on the PC.
3. Select the connection icon.
4. Enter the network **IP Address** of the oscilloscope, then click **OK**.

Note: It is best to use the IP Address, not the DNS or UNC name. If the oscilloscope application is not running, initiating the connection from XStreamBrowser will start it; however, it will not power on a device that is powered off. Be sure the device is turned on before connecting.

When the connection to a device is established, the XStreamBrowser window is populated with the oscilloscope application object hierarchy.



LeCroy.XStreamDSO
- Acquisition
- Cursors
- CustomDSO
- DDRA
- Display
- ElectricalTelecom
- HardCopy
- Help
- History
- JitKit
- LabNotebook
- Math
- Measure
- Memory
- MIPIDPHY
- MIPIMPHY
- PassFail
- PowerAnalysis
- Preferences
- ProbesCal
- SaveRecall
- SDA2
- SerialDecode
- SpecAnalyzer
- SystemControl
- TriggerScan
- Utility
- WaveScan
- WebEditor
- XPort
- Zoom

Name	Value	Type	Flags / Status	Range / Helpstring
AutoSetup		Action		n/a
ClearSweeps		Action		n/a
Exit		Action		n/a
FindAllVerScale		Action		n/a
FindAllVerScaleAtCurrent...		Action		n/a
FirmwareVersion	0.8.0.0 (build 2...	String	R	Any number of characters
HideClock	false	Bool		0,-1 or false,true
InstrumentID	LECROY,Wave...	String	R	Any number of characters
InstrumentModel	WaveRunner80...	String	R	Any number of characters
Maximize		Action		n/a
Minimize		Action		n/a
Quit		Method		closes the Application
ResetPreferences		Action		n/a
Restore		Action		n/a
SetToDefaultSetup		Action		n/a
Shutdown		Action		n/a
Sleep		Method		sleep for the specified time (specified in milliseconds)
ToolbarProcessingCaption	Processing:	String	R	Any number of characters
TouchScreenEnable	true	Bool	N	0,-1 or false,true
WaitUntilIdle		Method		wait until application is idle or until specified timeou...
Windowed		Action		n/a

Root application object hierarchy of XStreamDSO, the "engine" of MAUI oscilloscopes.

Refreshing the Display

If you change the state of the oscilloscope in any way while connected to XStreamBrowser, select the icon to refresh the object hierarchy. While settings you "push" from XStreamBrowser will appear immediately, settings changed elsewhere must be "pulled" into the XStreamBrowser browser display.

Disconnecting

Only one connection may be made at one time. To disconnect from the device, choose **File > Close Session**.

Use the window closebox or choose **File > Exit** to close the XStreamBrowser application.

Viewing XStreamDSO Objects

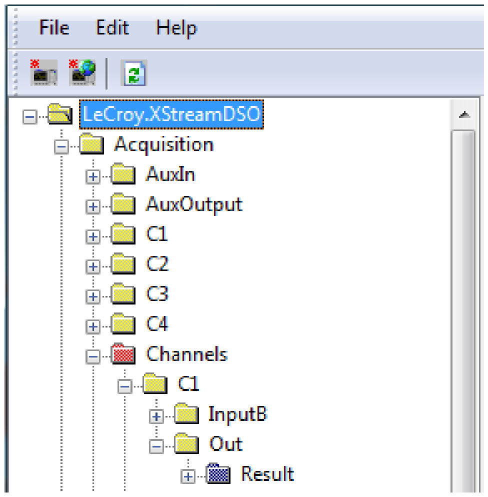
The number of different objects in a complete oscilloscope setup is obviously large and changes with the installation of new firmware and software options. XStreamBrowser helps you quickly find the object path and valid values corresponding to any instrument control.

The object hierarchy exposed by MAUI instruments is rooted at the **Application** object. This object is always named **LeCroy.XStreamDSO**.

All major instrument subsystems are available from this object, and many of these subsystems themselves may be broken down further. As new software options are activated on the oscilloscope, these subsystems are added to the Application object hierarchy.

Anything exposed by the object hierarchy can be controlled or read back via Automation.

Object Hierarchy



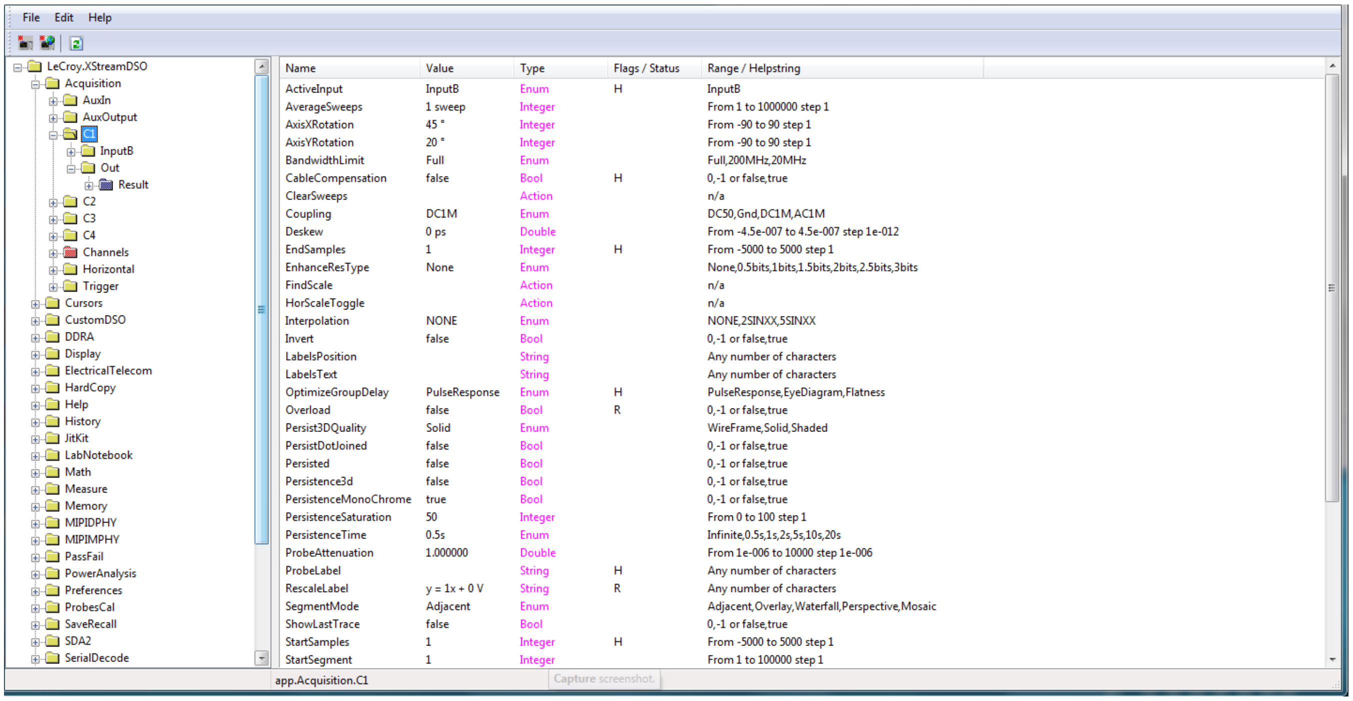
The left-hand pane of the XStreamBrowser window contains an expandable navigation "tree." The object hierarchy is tiered; for example, the Acquisition subsystem is comprised of a variety of objects, each with child objects.

The right-hand pane shows the Control Variables or Properties related to the object selected from the navigation tree.

Control Variables

The majority of the items you will find as you expand the navigation tree are Control Variables, or CVARs for short. These are shown as yellow folders in the XStreamBrowser window.

CVARs provide an interface for accessing scope configurations and for executing methods and actions. When viewed from XStreamBrowser, many CVARs appear to be properties, but are actually objects with properties such as **Name**, **Value**, and **Type**, to name a few. See Control Variables for a description of CVAR Types, Properties, and Methods.



Name	Value	Type	Flags / Status	Range / Helpstring
ActiveInput	InputB	Enum	H	InputB
AverageSweeps	1 sweep	Integer		From 1 to 1000000 step 1
AxisXRotation	45 °	Integer		From -90 to 90 step 1
AxisYRotation	20 °	Integer		From -90 to 90 step 1
BandwidthLimit	Full	Enum		Full,200MHz,20MHz
CableCompensation	false	Bool	H	0,-1 or false,true
ClearSweeps		Action		n/a
Coupling	DC1M	Enum		DC50,Gnd,DC1M,AC1M
Deskew	0 ps	Double		From -4.5e-007 to 4.5e-007 step 1e-012
EndSamples	1	Integer	H	From -5000 to 5000 step 1
EnhanceResType	None	Enum		None,0.5bits,1bits,1.5bits,2bits,2.5bits,3bits
FindScale		Action		n/a
HorScaleToggle		Action		n/a
Interpolation	NONE	Enum		NONE,2SINXX,5SINXX
Invert	false	Bool		0,-1 or false,true
LabelsPosition		String		Any number of characters
LabelsText		String		Any number of characters
OptimizeGroupDelay	PulseResponse	Enum	H	PulseResponse,EyeDiagram,Flatness
Overload	false	Bool	R	0,-1 or false,true
Persist3DQuality	Solid	Enum		WireFrame,Solid,Shaded
PersistDotJoined	false	Bool		0,-1 or false,true
Persisted	false	Bool		0,-1 or false,true
Persistence3d	false	Bool		0,-1 or false,true
PersistenceMonoChrome	true	Bool		0,-1 or false,true
PersistenceSaturation	50	Integer		From 0 to 100 step 1
PersistenceTime	0.5s	Enum		Infinite,0.5s,1s,2s,5s,10s,20s
ProbeAttenuation	1.000000	Double		From 1e-006 to 10000 step 1e-006
ProbeLabel		String	H	Any number of characters
RescaleLabel	y = 1x + 0 V	String	R	Any number of characters
SegmentMode	Adjacent	Enum		Adjacent,Overlay,Waterfall,Perspective,Mosaic
ShowLastTrace	false	Bool		0,-1 or false,true
StartSamples	1	Integer	H	From -5000 to 5000 step 1
StartSegment	1	Integer		From 1 to 100000 step 1

app.Acquisition.C1

CVAR properties shown in the right-hand pane of XStreamBrowser window.

The **Range/Helpstring** column provides short form information about the possible values the variable can take.

The **Flags/Status** column contains coded information about the object.

Flag/Status	Indicates
R	**For CVARs**: Read only. **For Properties**: Readable.
W	**For CVARs**: Wrapping, incrementing the value will "wrap around" from max. to min., or vice versa. **For Properties**: Writable.
H	Hidden: not visible on any GUI dialog or menu.
g	Grey: appears "greyed out" on GUI indicating it is disabled or not settable.
B	Backwards: incrementing the CVAR value will decrease the value.
N	Nonvolatile: value is saved in the application's "nonvolatile" settings file. These CVARs are typically user preferences and are not affected by Recall Default Setup.
A	AutoRepeat: the CVAR action should be repeated if a button on the GUI is held down.
M	MultiLine: the CVAR value may be rendered on multiple lines of the GUI.
L	LateUpdate: the CVAR value may be updated when it is read/refreshed.

Actions and Methods

Besides the configuration CVARs, automation also provides for Actions that may be applied at the application or subsystem level.

For example, to clear sweeps for all subsystems, the Automation command would be:

```
app.ClearSweeps
```

Methods are similar to Actions but may take parameters from the caller and may possibly return a value, whereas, Actions do not support any parameters or return values. An example of a Method is app.Acquisition.Acquire, which takes both "timeout" and "force trigger" arguments.

Result Interfaces

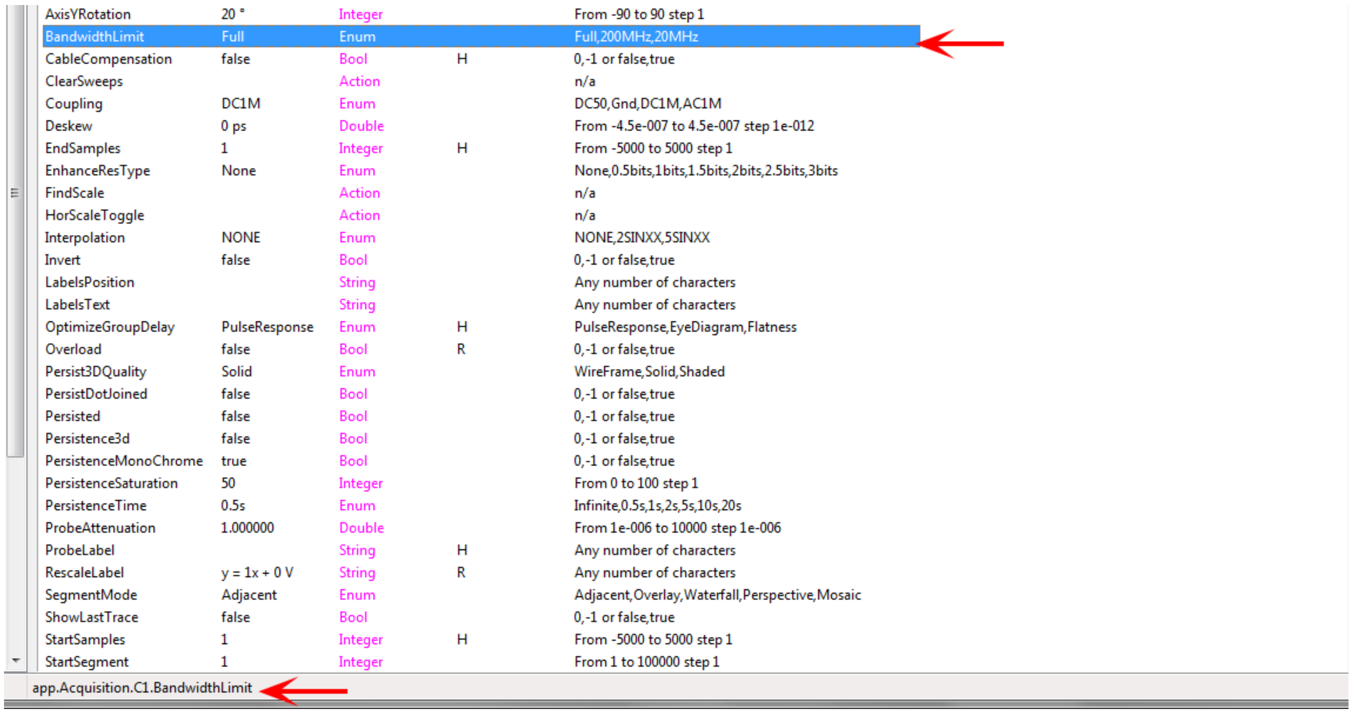
The grey folders are Result Interfaces. Result Interfaces contain more than just the basic results of oscilloscope operations, such as waveform data and measurement values; they include information about horizontal and vertical resolution, event times, number of sweeps, histogram peaks, etc. The **Type** column of the XStreamBrowser window shows the result interface type. See Result Interfaces for a description of the Types and Variables.

Collections

Collections, which are shown as pink folders in XStreamBrowser, contain sets of similar objects. For example, the app.Acquisition.Channels collection contains input channel objects (C1, C2, etc.). Objects in Collections folders are dynamically linked to those in the yellow folders; changing the value in either place changes it everywhere. Collection subfolders are referenced by indexing the collection name with the subfolder name.

Copying from XStreamBrowser

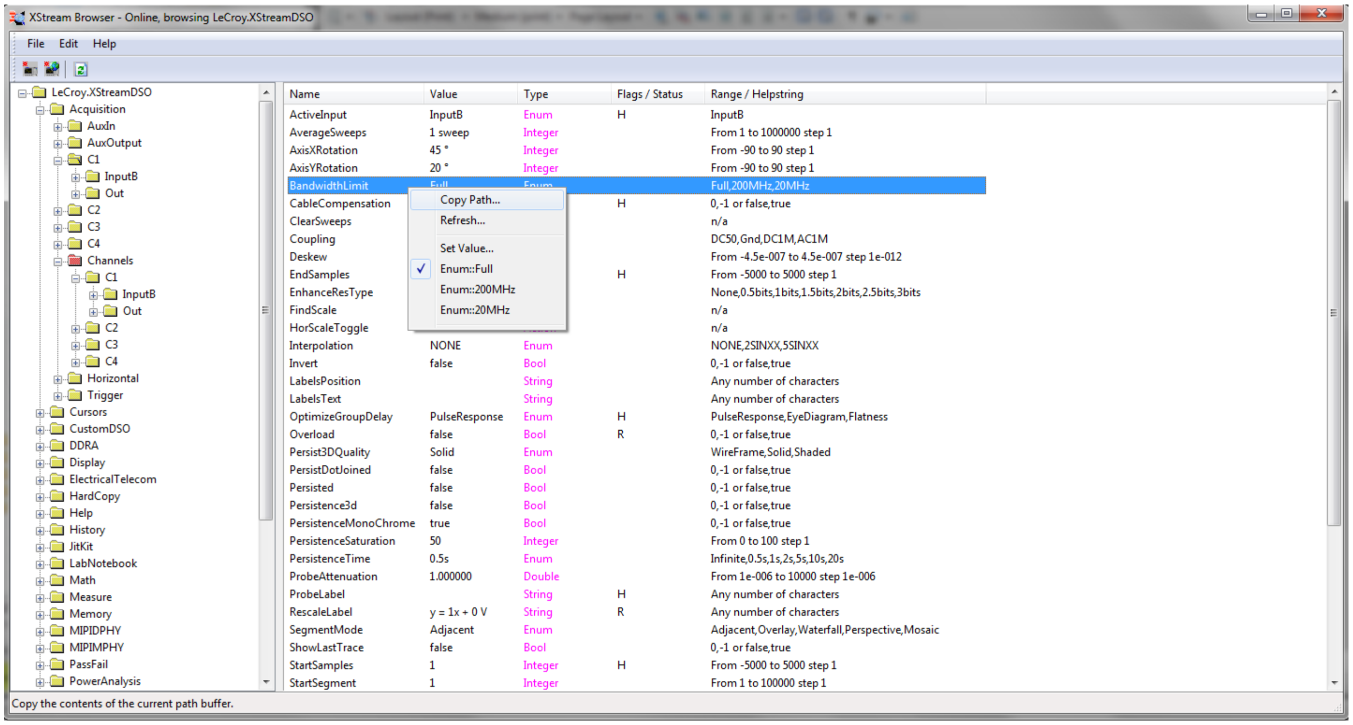
When a variable is selected from the right-hand pane, the message bar at the bottom of the screen shows the full object path in correct notation for sending as an Automation command:



AxisYRotation	20 °	Integer		From -90 to 90 step 1
BandwidthLimit	Full	Enum		Full,200MHz,20MHz
CableCompensation	false	Bool	H	0,-1 or false,true
ClearSweeps		Action		n/a
Coupling	DC1M	Enum		DC50,Gnd,DC1M,AC1M
Deskew	0 ps	Double		From -4.5e-007 to 4.5e-007 step 1e-012
EndSamples	1	Integer	H	From -5000 to 5000 step 1
EnhanceResType	None	Enum		None,0.5bits,1bits,1.5bits,2bits,2.5bits,3bits
FindScale		Action		n/a
HorScaleToggle		Action		n/a
Interpolation	NONE	Enum		NONE,2SINXX,5SINXX
Invert	false	Bool		0,-1 or false,true
LabelsPosition		String		Any number of characters
LabelsText		String		Any number of characters
OptimizeGroupDelay	PulseResponse	Enum	H	PulseResponse,EyeDiagram,Flatness
Overload	false	Bool	R	0,-1 or false,true
Persist3DQuality	Solid	Enum		WireFrame,Solid,Shaded
PersistDotJoined	false	Bool		0,-1 or false,true
Persisted	false	Bool		0,-1 or false,true
Persistence3d	false	Bool		0,-1 or false,true
PersistenceMonoChrome	true	Bool		0,-1 or false,true
PersistenceSaturation	50	Integer		From 0 to 100 step 1
PersistenceTime	0.5s	Enum		Infinite,0.5s,1s,2s,5s,10s,20s
ProbeAttenuation	1.000000	Double		From 1e-006 to 10000 step 1e-006
ProbeLabel		String	H	Any number of characters
RescaleLabel	y = 1x + 0 V	String	R	Any number of characters
SegmentMode	Adjacent	Enum		Adjacent,Overlay,Waterfall,Perspective,Mosaic
ShowLastTrace	false	Bool		0,-1 or false,true
StartSamples	1	Integer	H	From -5000 to 5000 step 1
StartSegment	1	Integer		From 1 to 100000 step 1

app.Acquisition.C1.BandwidthLimit

Right-click and choose **Copy Path**. The text is automatically placed in the clipboard, from where it can be easily copied into remote control programs.



- LeCroy.XStreamDSO
  - Acquisition
    - AuxIn
    - AuxOutput
    - C1
      - InputB
      - Out
    - C2
    - C3
    - C4
    - Channels
      - C1
        - InputB
        - Out
      - C2
      - C3
      - C4
    - Horizontal
    - Trigger
  - Cursors
  - CustomDSO
  - DDRA
  - Display
  - ElectricalTelecom
  - HardCopy
  - Help
  - History
  - JitKit
  - LabNotebook
  - Math
  - Measure
  - Memory
  - MIPIDPHY
  - MIPIMPHY
  - PassFail
  - PowerAnalysis

Name	Value	Type	Flags / Status	Range / Helpstring
ActiveInput	InputB	Enum	H	InputB
AverageSweeps	1 sweep	Integer		From 1 to 1000000 step 1
AxisXRotation	45 °	Integer		From -90 to 90 step 1
AxisYRotation	20 °	Integer		From -90 to 90 step 1
BandwidthLimit	Full	Enum		Full,200MHz,20MHz
CableCompensation			H	0,-1 or false,true
ClearSweeps				n/a
Coupling				DC50,Gnd,DC1M,AC1M
Deskew				From -4.5e-007 to 4.5e-007 step 1e-012
EndSamples			H	From -5000 to 5000 step 1
EnhanceResType				None,0.5bits,1bits,1.5bits,2bits,2.5bits,3bits
FindScale				n/a
HorScaleToggle				n/a
Interpolation	NONE	Enum		NONE,2SINXX,5SINXX
Invert	false	Bool		0,-1 or false,true
LabelsPosition		String		Any number of characters
LabelsText		String		Any number of characters
OptimizeGroupDelay	PulseResponse	Enum	H	PulseResponse,EyeDiagram,Flatness
Overload	false	Bool	R	0,-1 or false,true
Persist3DQuality	Solid	Enum		WireFrame,Solid,Shaded
PersistDotJoined	false	Bool		0,-1 or false,true
Persisted	false	Bool		0,-1 or false,true
Persistence3d	false	Bool		0,-1 or false,true
PersistenceMonoChrome	true	Bool		0,-1 or false,true
PersistenceSaturation	50	Integer		From 0 to 100 step 1
PersistenceTime	0.5s	Enum		Infinite,0.5s,1s,2s,5s,10s,20s
ProbeAttenuation	1.000000	Double		From 1e-006 to 10000 step 1e-006
ProbeLabel		String	H	Any number of characters
RescaleLabel	y = 1x + 0 V	String	R	Any number of characters
SegmentMode	Adjacent	Enum		Adjacent,Overlay,Waterfall,Perspective,Mosaic
ShowLastTrace	false	Bool		0,-1 or false,true
StartSamples	1	Integer	H	From -5000 to 5000 step 1
StartSegment	1	Integer		From 1 to 100000 step 1

Copy the contents of the current path buffer.

VBS Command

For users who wish to harness the power of Automation, but are currently using “traditional” GPIB remote control commands, there is a solution: the VBS command. This will enable you to control the advanced features of MAUI oscilloscopes that are not supported by GPIB commands.

VBS is also used to encapsulate Automation commands whenever there is a remote connection to the oscilloscope other than DCOM (ActiveDSO, VISA driver, etc.).

Below are two, equivalent methods for setting the V/Div of Channel 1. The first examples uses a GPIB command, VDIV; the second uses the VBS command:

```
C1:VDIV 0.5

VBS 'app.Acquisition.C1.VerScale = 0.5'
```

In its query form, the following are equivalent:

```
C1:VDIV?

VBS? 'return = app.Acquisition.C1.VerScale'
```

Note: For the query form, including 'return = *object*' is important, as it indicates which value you wish to be returned to the caller.

The VBS Command/Query is documented in more detail in the GPIB command reference.

Approach 1: Control from XStreamBrowser

When a PC has a DCOM connection to a networked oscilloscope, a copy of XStreamBrowser running on the PC has the same read/write capabilities as the version that is running locally on the oscilloscope. The oscilloscope's entire XStreamDSO object hierarchy is exposed and editable from XStreamBrowser. This is perhaps the simplest way to remotely control the oscilloscope.

This exercise modifies the oscilloscope channel C1 Vertical Scale setting directly from XStreamBrowser installed on the PC.

Make the Connection

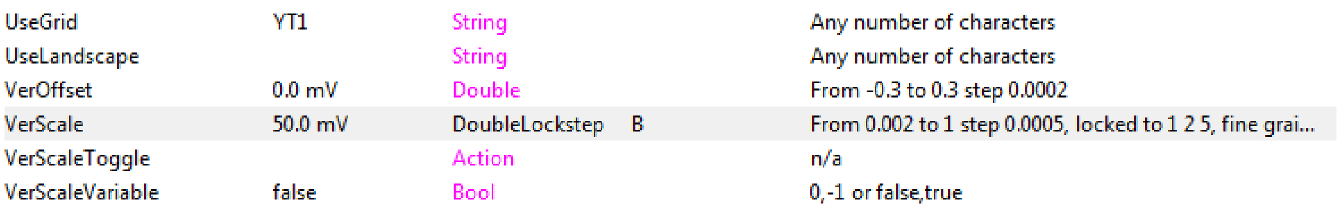
1. Connect the oscilloscope to your LAN, or directly to the PC using a cross-over cable.
2. Turn on the oscilloscope and go to **Utilities > Utilities Setup > Remote** and choose control from **TCP/IP**.
3. Create a DCOM connection to the oscilloscope.
4. Download and install a copy of XStreamBrowser on the PC.
5. Open XStreamBrowser on the PC and connect to the oscilloscope.
6. When the oscilloscope appears in the Devices list, click on it to show the application hierarchy.

Find and Modify the Object

The Vertical settings associated with channels are part of the Acquisition subsystem, as they control the characteristics of the ADCs at the input, directly affecting acquisition.

Since we're looking to modify a setting that affects the Acquisition subsystem, expand the Acquisition folder to display the C1 object. Select the C1 object folder so that the C1 CVARs appear in the right-hand window pane.

As you scroll down, you'll see the VerScale CVAR, showing whatever value was last set for that channel on the oscilloscope, in this example, 50.0 mV.

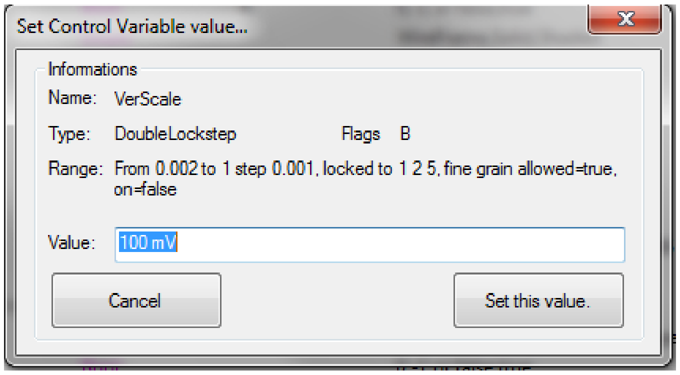


UseGrid	YT1	String		Any number of characters
UseLandscape		String		Any number of characters
VerOffset	0.0 mV	Double		From -0.3 to 0.3 step 0.0002
VerScale	50.0 mV	DoubleLockstep	B	From 0.002 to 1 step 0.0005, locked to 1 2 5, fine grai...
VerScaleToggle		Action		n/a
VerScaleVariable	false	Bool		0,-1 or false,true

XStreamBrowser tell us the following about this control:

- The Type column shows it is a DoubleLockstep
- The Flags/Status column shows B, meaning it is Backwards and incrementing the CVAR will decrease the value.

- The Range/Helpstring column shows an acceptable range of 0.002 to 1 step 0.0005. meaning it can be set anywhere from 0.002 to 1 in increments as small as .0005. If Variable Gain is left on, the next value possible is 0.0025.
- The additional statement that it is "locked to 1 2 5, fine grain..." is fully visible if we right-click on the VerScale line and choose Copy to display the Set Control Variable dialog:



Set Control Variable value...

Informations

Name: VerScale

Type: DoubleLockstep Flags B

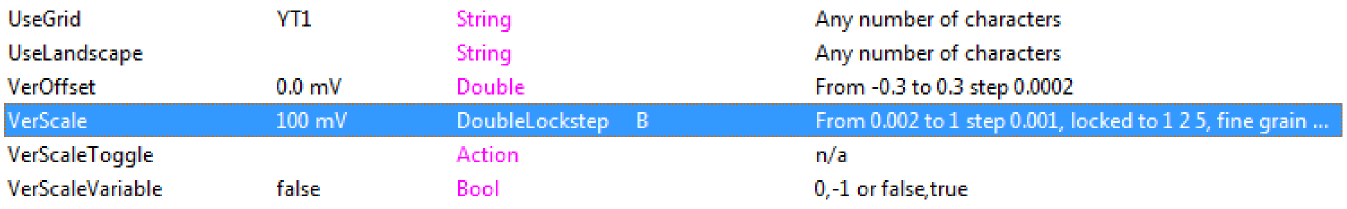
Range: From 0.002 to 1 step 0.001, locked to 1 2 5, fine grain allowed=true, on=false

Value: 100 mV

While fine grain (Variable Gain) adjustments are allowed on this oscilloscope (true), the Var. Gain setting is currently off (on=false), so the control would adjust in stepped increments of 1, 2, or 5 units (in sequence) were it being operated from the oscilloscope touch screen. Starting at 0.002, the next value would be 0.005.

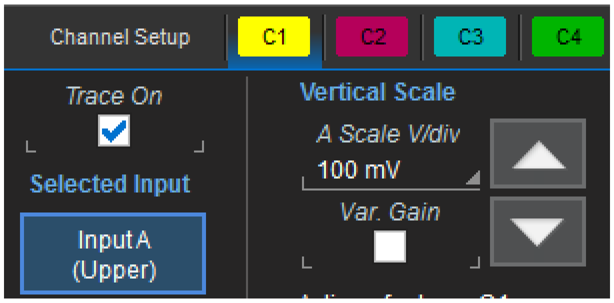
Enter a new **Value** of 100 mV and choose to **Set this value**.

Back on the XStreamBrowser window, you will see that the C1 VerScale setting has changed:



UseGrid	YT1	String	Any number of characters
UseLandscape		String	Any number of characters
VerOffset	0.0 mV	Double	From -0.3 to 0.3 step 0.0002
VerScale	100 mV	DoubleLockstep B	From 0.002 to 1 step 0.001, locked to 1 2 5, fine grain ...
VerScaleToggle		Action	n/a
VerScaleVariable	false	Bool	0,-1 or false,true

And the oscilloscope immediately reflects this change, as well:



Note that here we can see the Var. Gain setting is deselected.

That's all that is required to remotely set up a MAUI oscilloscope from your PC.

Approach 2: Program in VBS

Setup (or Panel) files, which are used to save and recall the state of the instrument between sessions, are traditionally binary files with an internal structure that is neither documented nor obvious to the user. In MAUI oscilloscopes, however, this is not the case. Setups are ASCII text files that contain a complete Visual Basic Script “program”. In effect, each time a panel is saved, the instrument writes a program that, when executed, returns the instrument to the saved state.

VBS programs function like Setup files that are written and executed remotely.

Note: Customization and setup files stored by the instrument have file extension “.lss” (LeCroy Setup Script). These files are syntactically identical to Microsoft VBS files, which have a “.vbs” extension.

In this exercise, we'll create and execute a simple VBS program on the PC that:

- Connects to a networked oscilloscope
- Performs an AutoSetup
- Changes the oscilloscope grid mode
- Reads back the Grid Mode and Vertical Scale
- Disconnects

Preliminary Setup

1. As with Exercise 1, it is assumed there is a DCOM connection between the PC and an oscilloscope on the same network, and that XStreamBrowser is installed on the PC.
2. On the oscilloscope, go to **Utilities > Utilities Setup > Remote** and confirm that the **TCP/IP (VICP)** setting is selected. Note the oscilloscope's IP address.
3. Open XStreamBrowser and NotePad or another text editor on the PC.

Program

Note: Characters in angle brackets are placeholders. Omit the brackets from your code.

Connect

CreateObject is the Visual Basic function that creates an instance of a COM Server. The argument “LeCroy.XStreamDSO” refers to the oscilloscope application. Once it has instantiated (connected to) the oscilloscope application, it requires some kind of ‘handle’ (pointer) so that it can later be used to communicate with the instrument. CreateObject returns a handle, which is stored in the app variable.

In the text editor, write the VBS connect string:

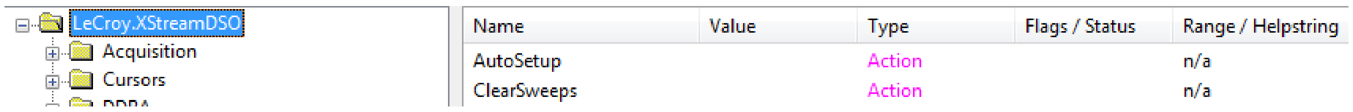
```
Set app = CreateObject("LeCroy.XStreamDSO")
```

Note: Only a single instance of the XStreamDSO software can run on a system at one time. If the software is already running when CreateObject is called, a handle to that running instance is returned. If XStreamDSO is not running, it will be started.

AutoSetup

AutoSetup is an Action that utilizes default Vertical and Timebase settings and a 50% level Edge trigger to quickly set up an acquisition on the oscilloscope. The first active input channel is used as the triggger source.

AutoSetup occurs "above" the individual subsystems in the XStreamDSO application hierarchy, at the root object LeCroy.XStreamDSO. In XStreamBrowser, you will find it in the root folder. Had this command involved only C1, for example, you would have navigated to Acquisition > C1 and selected it to show the C1 CVARs.



Name	Value	Type	Flags / Status	Range / Helpstring
AutoSetup		Action		n/a
ClearSweeps		Action		n/a

You can see AutoSetup is an Action from the Type column. Most of what occurs at this top level are Actions.

Right-click on AutoSetup and choose **Copy Path**.

Go back to the text editor window, and paste the AutoSetup command into your program:

```
app.AutoSetup
```

Change Grid Mode

The Grid Mode determines how many grids appear on the oscilloscope display at once. This is one setting where a change can be perceived without an input signal. Grid Mode affects the oscilloscope display, so it is found within the Display subsystem.

In XStreamBrowser, expand the Display folder until you see the CVARs in the right-hand window pane.

Navigate to the object GridMode. You can see the valid settings in Range/Helpstring include Auto, Single, Dual, Quad, etc.

Right-click on GridMode and choose **Copy Path**. You'll see from the XStreamBrowser window message bar that the object path is:

```
app.Display.GridMode
```

Note that the controls are arranged in a hierarchy, with each level delimited by a decimal point (.).

Paste the line into your remote control program, then set the new value of Quattro:

```
app.Display.GridMode = “Quattro”
```

Using the app handle, this line of code sets the Grid Mode control of the Display system to the value “Quattro”.

Note: WaveSurfer 3000, WaveSurfer 10, and HDO4000 oscilloscopes only support Auto, Single, and XY Grid Modes. You can choose any of these for the exercise, but note that if you go from Auto to Single, the change will only be evident by looking at the Display setup dialog.

Read Back Grid Mode and Vertical Scale

Create a variable to read back the value currently set in the equivalent control. In the text editor, write the line:

```
myGridMode = app.Display.GridMode
```

This line of code retrieves the current value of the app.Display.GridMode CVAR and stores it within the variable myGridMode.

Note: In VBS it is not necessary to dimension variables before using them (for example, using statements like “Dim myVerScale as Double”).

To get the value of the C1 Vertical Scale, create a new line for the variable myVerScale.

In XStreamBrowser, navigate to the Acquisition > C1 folder and click on it to show the CVARs. Right click on VerScale and **Copy Path**. Paste it behind the "myVerScale" variable:

```
myVerScale = app.Acquisition.C1.VerScale
```

For this exercise, the "read back" method will be the standard Visual Basic Message Box dialog. Add two lines using the MsgBox function to display the values of the two variables you created:

```
MsgBox myGridMode
MsgBox myVerScale
```

Disconnect

Add a line of code to end the program and close the connection to the oscilloscope:

```
Set app = Nothing
```

Execute

You should see the following script in your text editor:

```
'Connect to the XStreamDSO application
Set app = CreateObject("LeCroy.XStreamDSO")

      'Perform action AutoSetup and change grid mode setting
      app.AutoSetup
      app.Display.GridMode = "Quattro"

      'Read back grid mode and vertical scale
      myGridMode = app.Display.GridMode
      myVerScale = app.Acquisition.C1.VerScale
      MsgBox myGridMode
      MsgBox myVerScale

'Disconnect
Set app = Nothing
```

Save the file as Exercise2.vbs.

Open Windows Explorer and navigate to Exercise2.vbs. Double-click on the file to execute it.

If these steps were followed correctly, you should observe the oscilloscope perform an AutoSetup and enter the Quattro-grid display mode. The new grid mode will be evident from the four grids, one in each quadrant of the display.

Approach 3: Program Using ActiveDSO

As not all controllers can utilize the Windows DCOM architecture, there is another simplified method for remote control of the XStreamDSO application: ActiveDSO, Teledyne LeCroy's proprietary Active-X control. ActiveDSO can be used for much more than just remote control programs, but this exercise shows how the same Automation commands used for remote control in Exercise 2 could be sent using ActiveDSO, instead.

ActiveDSO also has the advantage of working with programming languages besides Visual Basic, such as Python and Visual C++, making it easy to utilize as a remote control/waveform transfer subroutine within other programs, or as part of a custom remote control interface. For more information, see the ActiveDSO topic in the "Making the Remote Connection" section.

Preliminary Setup

1. Download ActiveDSO from teledynelecroy.com (see Resources) and install it on the PC.
2. Open XStreamBrowser and NotePad or another text editor on the PC.
3. Turn on the oscilloscope. For this exercise, we'll continue to use VBS and a LAN connection, so confirm the oscilloscope is connected to LAN (or has a cross-over connection to your PC).
4. Go to **Utilities > Utilities Setup > Remote** and confirm the **TCP/IP (VICP)** setting.
5. Note the oscilloscope's IP address.

Program

Note: Characters in angle brackets are placeholders. Omit the brackets from your code.

Connect

In the text editor, instantiate the ActiveDSO control:

```
Set dso = CreateObject("LeCroy.ActiveDSOCtrl.1")
```

Then, invoke the MakeConnect method, in this case using the oscilloscope's IP address:

```
Call dso.MakeConnection("IP:<IP address>")
```

This method could have used USBTMC, GPIB, or any other supported connection type. You would want to be sure to choose control from that same interface on the oscilloscope Remote dialog.

AutoSetup

Besides the instantiation method, the most obvious difference between using native VBS and using ActiveDSO is in how commands are sent. With ActiveDSO, Automation controls are nested within the VBS command. Write the line:

```
Call dso.WriteString("VBS 'app.AutoSetup'", 1)
```

The Boolean "1" is telling the XStreamDSO application to interpret the command immediately.

You could also use WriteString with the legacy IEEE 488.2 command set. For example, write:

```
Call dso.WriteString("C1:VDIV 200 mV", 1)
```

This command will reset the Vertical Scale, same as did the "app.C1.VerScale" Automation command sent in Exercise 1. Either legacy commands or VBS Automation commands can be sent using WriteString.

Change Grid Mode

Add another line to the program to change the Grid Mode from Quattro back to Auto, or any other grid mode supported by your oscilloscope model:

```
Call dso.WriteString("VBS 'app.Display.GridMode = "Auto"'", 1)
```

Note: When using ActiveDSO with Excel VBA, arguments must be placed inside two double quotes, so the above call would be: `Call dso.WriteString("VBS 'app.Display.GridMode = ""Auto""'", 1)`

If you wish, add lines for any other setup changes you'd like to make, using the XStreamBrowser to find the CVAR and copying the path into the VBS command.

Read Back Grid Mode and Vertical Scale

There are several ActiveDSO methods to read back parameter results and waveform data, but a simple way to read setup values is to use the VBS? query with the Automation control.

In your program, write:

```
Call dso.WriteString("VBS? 'app.Display.GridMode'", 1)
Call.dso.WriteString("VBS? 'app.Acquisition.C1.VerScale'", 1)
```

Notice we're still using WriteString to "read back," as what we're doing is writing the string that is the VBS query. The query, by its nature, returns information. Again, we're including the Boolean 1 that tells the oscilloscope to interpret the instruction immediately.

What we still need to specify is how to display the result text:

```
Call dso.WriteString("VBS? 'return = app.Acquisition.C1.VerScale'", 1)
myString = ReadString(numbytes)
MsgBox (myString)
```

Disconnect

Write the following lines to disconnect from the XStreamDSO application and end the program:

```
dso.Disconnect
Set dso = Nothing
```

Execute

You should now see the following program, or similar, in your text editor:

```
'Connect to the XStreamDSO application
Dim dso As Object
Set dso = CreateObject("LeCroy.ActiveDSOCtrl.1")
Call dso.MakeConnection("IP:<IP address>")

'Send commands to AutoSetup, change grid mode and vertical scale
Call dso.WriteString("VBS 'app.AutoSetup'", 1)
Call dso.WriteString("C1:VDIV 200 mV", 1)
Call dso.WriteString("VBS 'app.Display.GridMode = "Auto"'", 1)

'Query grid mode and vertical scale, show result in Message Box
Call dso.WriteString("VBS? 'app.Display.GridMode'", 1)
Call.dso.WriteString("VBS? 'app.Acquisition.C1.VerScale'", 1)
Call dso.WriteString("VBS? 'return = app.Acquisition.C1.VerScale'", 1)
myString = ReadString(numbytes)
MsgBox (myString)

'Disconnect
dso.Disconnect
Set dso = Nothing
```

Save the file as Exercise3.vbs.

Open Windows Explorer and navigate to Exercise3.vbs. Double-click on the file to execute it.

If these steps were followed correctly, you should again observe the oscilloscope perform an AutoSetup then change display mode and vertical scale. Check the C1 descriptor box to see that the Vertical Scale has changed.

Approach 4: Program Using VISA

If you do not wish to utilize ActiveX controls like ActiveDSO, any programming language that can connect through VISA can be used to send Automation commands. Teledyne LeCroy oscilloscopes are designed to work with VISA drivers for ENET, USBTMC, or GPIB remote connections. It is not necessary to have a DCOM connection when you are using a VISA driver.

In this exercise, we'll create a Python script designed to connect over the LAN, as in the previous exercise, but using LXI remote control settings.

Note: All the code examples given here use the LXI VISA resource string, not the TCP/IP VISA resource string. Both the TCP/IP and LXI settings utilize the TCP/IP layer, but the higher-level protocol is different, as is the VISA resource string. You can use the LXI option to communicate with oscilloscopes even if your network is not set up to be LXI compliant.

Preliminary Setup

This exercise requires a bit more setup than the previous, but by doing so, it will better demonstrate how you may use Automation to set up and retrieve measurement data.

1. On the PC, install a VISA driver , Python, and the compatible Python for Windows extensions.
2. Turn on the oscilloscope. Be sure it is connected to your LAN.
3. Connect one of the passive probes delivered with your oscilloscope to the **Cal Out/Aux Out** on the front of the instrument (what it is named will vary by model) and the **C1** input.
4. Go to **Utilities > Utilities Setup > Aux Output** and choose to output a **1 KHz, 1 Volt Square Wave** or whatever is the default selection for your oscilloscope (there should be a button).
5. Adjust your timebase until you see a stable pulse on the oscilloscope.
6. Go to **Utilities > Utilities Setup > Remote** and select the **LXI (VXI-11)** setting. Note the oscilloscope's IP address.
7. On the PC, open XStreamBrowser and Notepad or another text editor.

Program

Note: Characters in angle brackets are placeholders. Omit the brackets from your code.

Connect to the Oscilloscope

In your text editor, write these lines to make the remote connection to VISA and to the oscilloscope:

```
import visa
rm = visa.ResourceManager()
lecroy = rm.open_resource("TCPIP0::<hostname|IP address>::INSTR")
lecroy.timeout = 5000
lecroy.clear()
```

If your oscilloscope and PC are both known to the same network name server, you can use the hostname syntax (e.g., "TCPIP0::LCRY0450N70355::INSTR") instead of the actual IP address.

The timeout of 5000 milliseconds ensures the oscilloscope will wait 5000 milliseconds for operations to complete whenever writing commands or reading responses. Reading continues until the entire response is received (EOI is reached) or for 5 full seconds. After 5 seconds, there will be a "time out" error.

The clear is intended to clear out the buffers on the oscilloscope listing the commands sent to it and also responses sent from it. Clear removes anything leftover from a previous use and is a good practice as a first step in any program.

Several other preliminary settings can be made to prepare the general oscilloscope "environment" prior to writing new setups or reading measurements. In your program, type:

```
lecroy.write("COMM_HEADER OFF")
lecroy.write(r"""vbs 'app.settodefaultsetup' """)
```

The command "COMM_HEADER OFF" is a legacy 488.2 command that tells the oscilloscope "don't return the command header with query result." This helps to read back values in a format that is more friendly to being viewed on screen or imported into other programs.

Recalling the default setup, while not required, ensures that all setups are at a known baseline value before you begin.

Notice that the method 'app.settodefaultsetup' is the first actual Automation command being passed to the oscilloscope. It is enclosed in the VBS command wrapper, as are all Automation commands sent by remote connection, rather than through a COM/DCOM connection.

Note: The three double-quotes around the VBS command are required because the double-quotes around the arguments within the command could be interpreted by Python as the end of the command string. You would probably create a function to put the VBS wrapper around whatever automation commands you wanted to send. Here, we're showing each full line of code for demonstration.

Timing and Synchronization

In any remote control program, it is important to set up "checks," periodically querying that processes are complete before starting new ones, or that old measurements are cleared before taking new ones, etc. Querying the 'app.WaitUntilIdle' method can tell your program when it is safe to proceed.

In your program, enter the query:

```
r = lecroy.query(r"""vbs? 'return=app.WaitUntilIdle(5)' """)
```

This will inform the program when the Recall Default setup has been completed and the oscilloscope application is idle for 5 seconds (the default unit for this command) before going on to set up the new acquisition.

Set Up Acquisition

Every program that is to acquire new data, whether raw waveform data or post-processing measurement results, must set up an acquisition. It is important before taking any new acquisition to *stop* the previous one. Failure to do this is a principal reason for inaccurate measurements. Add the line:

```
lecroy.write(r"""vbs 'app.acquisition.triggermode = "stopped" ' """)
```

Using XStreamBrowser, find suitable replacements for <*value*> in following acquisition CVARs, and add these lines to your program:

```
lecroy.write(r"""vbs 'app.acquisition.trigger.edge.level = <value>' """)
lecroy.write(r"""vbs 'app.acquisition.triggermode = "single" ' """)
lecroy.write(r"""vbs 'app.acquisition.horizontal.maximize = "<value>" ' """)
```

Note: Be sure not to forget the double-quotes around those values that are String or Enum types.

Set Up Measurements

As with the default setup, it is a good idea to clear all measurement definitions and previous sweeps before proceeding with new measurements:

```
lecroy.write(r"""vbs 'app.measure.clearall ' """)
lecroy.write(r"""vbs 'app.measure.clearsweeps ' """)
```

As you may have noticed by now, Automation commands are more granular than legacy 488.2 commands. Generally, more lines of code must be sent to achieve the same end result, because every relevant application object must be set to a particular state. However, this granularity is also what makes Automation more powerful.

To set up measurements, we have to first turn on measurements, then turn on statistics, then turn on the parameter, then set what we want the parameter to measure, then set the parameter source (what input it will measure), etc. Using XStreamBrowser, find a suitable <*value*> for 'app.measure.p1.paramengine'.

Tip: Select a single source measurement appropriate to your 1 KHz, 1 V pulse wave.

```
lecroy.write(r"""vbs 'app.measure.showmeasure = true ' """)
lecroy.write(r"""vbs 'app.measure.statson = true ' """)
lecroy.write(r"""vbs 'app.measure.p1.view = true ' """)
lecroy.write(r"""vbs 'app.measure.p1.paramengine = "<value>" ' """)
lecroy.write(r"""vbs 'app.measure.p1.source1 = "C1" ' """)
```

Acquire

Now write code to arm the acquisition. Again, timing is important: this example takes 10 acquisitions, forcing a trigger if none occurs after 0.1 seconds (the second and first arguments, respectively, of 'app.acquisition.acquire'), then uses the 'app.WaitUnitIdle' method to wait for 5 seconds after all acquisition processing is complete before measuring.

```
for i in range(0,10):
     r = lecroy.query(r"""vbs? 'return=app.acquisition.acquire( 0.1 , True )' """)
     r = lecroy.query(r"""vbs? 'return=app.WaitUntilIdle(5)' """)
     if r==0:
            print "Time out from WaitUntilIdle, return = {0}".format(r)
```

Read Back Measurement Results

Read the Out.Result object of the P1 parameter into a variable of your choosing, and print the value.

Just as the Automation commands were sent within the VBS command wrapper, the Automation query is sent within the VBS? query wrapper. For <*var*>, you can substitute the name of the measurement you choose earlier.

```
<var> = lecroy.query(r"""vbs? 'return=app.measure.p1.out.result.value' """)
print "<var> = {0}".format(<var>)
```

Disconnect

Finally, close the remote connections to the scope and to VISA, in the reverse of the order in which you opened them:

```
lecroy.close()
rm.close()
```

Execute

Save the file as Exercise4.py. Navigate to the file on your PC and execute it.

If these steps were followed correctly, you should observe the oscilloscope resume the Default Setup. The Measure table should appear below the waveform, showing the results of the measurement you set in P1. Meanwhile, the following should appear in your console:

```
Time out from WaitUntilIdle = <value>
<var> = <value>
```

Control Variables

Traditionally, properties presented to an Automation client are simple “variables” with types such as Integer (int), String (BSTR), Floating Point (single, double), etc. However, on MAUI oscilloscopes, CVARs are an extension of the traditional Automation pattern, without affecting how they appear to most Automation clients (see the topic on early/late binding). This enables an Automation client to not only set and query the current value of a control, but also to query its limits. This is useful in the generation of instrument-independent applications, or applications that present scope controls in a graphical user interface in which limits are required.

Setting Control Variables

All CVARs have the default property of Value. A CVAR such as VerScale (Volts/Div) may be set in VBS as follows:

```
app.Acquisition.C1.VerScale = 0.5
```

Its current value may be queried with:

```
CurrentValue = app.Acquisition.C1.VerScale
```

The following methods are also supported (for this CVAR type) :

```
double GetAdaptedValue
SetRequestedValue(double)
double GetRequestedValue
double GetDefaultValue
double GetGrainValue
double GetMaxValue
double GetMinValue
```

For example:

```
app.Acquisition.C1.VerScale.SetRequestedValue(1.0)
minValue = app.Acquisition.C1.VerScale.GetMinValue
maxValue = app.Acquisition.C1.VerScale.GetMaxValue
```

The sample file **D:\Scripts\Automation\ExampleCvarTypes.vbs** contains code for querying and displaying CVAR properties for each type of control variable, including the status flags. Commands such as these are useful for ascertaining the state of the oscilloscope prior to changing setups or taking other actions.

Note: In the sample file, after instantiating the app object, the programming variable "acq" was set to take the place of "app.acquisition" in all commands, and other variables are set at the beginning of each type, depending on the child objects being substituted (e.g., acqHorz replaces app.Acquisition.Horizontal). This is to simplify coding.

Control Variable Types

The **Type** column of the XStreamBrowser window shows the control type. Control variable type designations are as follows:

Type	Definition
Action	Action (no arguments or value)
Bool	Boolean value given as { false| true} or { 0| -1 }
Color	RGB value triplex "R,G,B"
Double	Double-precision floating point value
DoubleLockstep	Double-precision floating point value locked to a non- linear (e.g., 1, 2, 5) stepped sequence.

Enum	List value. All lists begin with the zero element. Value may be specified by name in quotes or position in the list, for example:
	app.Acquisition.Horizontal.SampleMode = 0
	app.Acquisition.Horizontal.SampleMode = "RealTime"

FileName	Legal DOS path
Integer	32-bit Integer value
String	String value

Properties and Methods

The properties and methods available for each control are type-specific. Below are the most common:

Type	Properties and Methods
Integer	VARIANT Value Value(VARIANT) int GetAdaptedValue SetRequestedValue(int) int GetRequestedValue int GetDefaultValue int GetGrain int GetMax int GetMin Increment(int)

Type	Properties and Methods
Double	VARIANT Value Value(VARIANT) double GetAdaptedValue SetRequestedValue(double) double GetRequestedValue double GetDefaultValue double GetGrainValue double GetMaxValue double GetMinValue Increment(int)
DoubleLockstep	See Double
Enum	VARIANT Value Value(VARIANT) int GetAdaptedValue SetRequestedValue(int) int GetRequestedValue int GetDefaultValue int GetMax int GetMin int GetNumberOfValueStates Increment(int) BSTR GetRangeStringScreen BSTR GetRangeStringRemote
String	VARIANT Value Value(VARIANT) int GetMaxLength BSTR GetRequestedValue BSTR GetAdaptedValue SetRequestedValue(BSTR)
Bool	VARIANT Value Value(VARIANT) BOOL GetAdaptedValue BOOL GetRequestedValue BOOL GetDefaultValue Set Clear
Action	ActNow

Result Interfaces

Tip: The sample scripts for exposing results that are referred to in this section are installed with XStreamDSO v.8.5.x.x. and later.

"Out.Result" properties are results of the last completed acquisition. They are not affected if other controls are changed after that acquisition was completed. This distinction between "Out.Result" properties and other controls is most important when the trigger mode is Single or Stopped. Treat "Out.Result" properties as read-only.

Note: Although you can write the properties of a result, it is not advisable, as the result properties and data will be updated on next acquisition.

Caution: It is highly recommended that you STOP acquisitions before accessing result data. Most remote control problems are caused by failure to follow this practice.

Several of the Out.Result properties mention the "frame": this is the term used to describe the visible portion of the trace, which is generally smaller than the acquired waveform. The frame could be used, for example, to display a 500 pt window onto a 1 Mpt trace, or show the center 10 mV of a 100 mV trace.

Several properties, most significantly the DataArray object, are Variants containing either a one- or two-dimensional array. Dimension the target variable as a Variant type, and assign the DataArray property to it. See DataArray for examples of its use within each of the Result interfaces.

Result Interface Types

Result Interface type designations are as follows:

Type	Definition
Digital	Digital (bi-state) waveform generated by mixed-signal oscilloscope.
Histogram	Histogram trace.
Param	Individual results and result arrays for measurement parameters and Pass/Fail test qualifiers.
Persist	Eye diagrams or other waveshapes that are the result of overlaying multiple waveforms.
Table	Tabular results primarily used in conjunction with the various low-speed serial decoding options.
Waveform	Basic Voltage vs. Time waveforms.
XY	XY waveforms.

Digital

The Digital interface is found when using a mixed-signal input to generate digital (bi-state) waveforms. These waveforms are contained in the Digital*n* trace name, where *x* = 1, 2, 3 etc. Each Digital*n* trace is a bus that may contain multiple digital lines, with a maximum number dependent on the capabilities of the mixed-signal oscilloscope option. The key property in the Digital interface is the DataArray, which is a 2D array containing the value of each sample of each digital line in the bus.

Example paths to Digital Result interfaces:

```
app.LogicAnalyzer.Digital1.Out.Result
app.LogicAnalyzer.Digital2.Out.Result
```

Histogram

The Histogram interface is used for all histogram traces. Histograms can be configured on most oscilloscopes as a math function (Fn). Histograms are also used in various analysis modes, especially on Serial Data Analyzers, where the HTIE trace is the source data for the algorithm to calculate Total jitter (Tj). The key property is BinPopulations, which is a 1D array of the bin populations.

Example paths to HTIE Result interfaces:

```
app.Math.F1.Out.Result
app.SDA.Htie.Out.Result
```

Note: This example assumes that F1 is set up as a Histogram.

Param

The Parameter interface is used in the Measurement and Pass/Fail systems to hold both individual results and result arrays. The key properties for the Parameter interface are Value and ValueArray. Value holds the last measurement or P/F result, while ValueArray holds all measurements taken for the last acquisition. This is an important distinction to remember depending on the measurement assigned to the parameter, as the values may or may not be the same. For example: if the source waveform is 1000 cycles of square wave, then the Frequency measurement will have 1000 values in the ValueArray and Value will be the same as the 1000th (last). Whereas, Min or Max measurements on that same waveform will only have one value in the ValueArray, and Value will be that same value.

Example paths to Param Result interfaces:

```
app.Measure.P1.Out.Result
app.Measure.P1.Sdev.Result
app.Measure.Measure("P1").Out.Result
```

Persist

The Persist interface is most often found when using software options that create eye diagrams or other waveshapes that are the result of overlaying multiple waveforms. (Note that this does not apply to the Persistence display mode.) The key property in the Persist interface is the DataArray, which is a 2D array containing the population of each pixel of the persistance map.

Example paths to Persist Result interfaces:

```
app.SDA.Eye.Out.Result
app.SDA.Eye2.Out.Result
```

Table

Table results interfaces are primarily used in conjunction with the various low-speed serial decoding options, such as CAN, I2C, SPI, UART, etc. When the table is displayed, the user has access to information about the messages decoded for the last acquisition. Retrieving data from the Table interface involves some knowledge of the table's structure, in terms of the columns that are displayed and the cell types. The CellType and CellValue are the key properties to use to retrieve the table's data. See the information in the CellValue property for more information.

Example paths to Table Result interfaces:

```
app.SerialDecode.Decode1.Out.Result
app.SerialDecode.Objects("Decode2").Out.Result
```

Waveform

Waveform Results interfaces can be found wherever there are basic Voltage vs. Time waveforms. Examples include channel (C*n*), memory (M*n*), math function (F*n*) and zoom (Z*n*) traces, as well as others that are associated with specific analysis packages, such as the Power waveform used in the PAS package. In general, these waveforms are usual voltage vs time, unless a current probe or other method of changing the vertical units (e.g., the Rescale Math function) is employed. The key property in the Waveform interface is the DataArray, which is a 1D array containing the value of each sample in the waveform.

Example paths to Waveform Result interfaces:

```
app.Acquisition.C1.Out.Result
app.Acquisition.Channels("C1").Out.Result
app.Math.F2.Out.Result
app.Zoom.Z3.Out.Result
app.SDA.Btub.Out.Result
```

Note: Traces like F2 and Z3 can hold plots, like histograms, which do not use the Waveform interface.

XY

The XY interface is used on XY waveforms. Users can create an XY waveform by selecting this option in the Display Setup... screen. XY waveforms allow you to see how the signal on one channel moves in relation to another. The key property is the DataArray, which is a 2D array that returns the voltages on the X and Y sources for each XY pair.

Example path to the XY Result interface:

```
app.Math.XY.Out.Result
```

Result Variable Types

Type	Definition
Integer	16-bit signed integer
Long	32-bit signed integer
Double	8-byte floating point type
String	Array of characters
Object	Object with its own interface
Variant	Variable that is dimensioned without indicating a variable type

Exposing Waveforms

Waveform data is exposed as a simple array using **app.*Subsystem*.*Wfmn*.Out.Result.Samples**. *Wfmn* can be any object defined within the XStreamDSO object hierarchy that produces a waveform trace (generally C*n*, F*n*, M*n*, SE*n*, and Z*n*).

The sample script **D:\Scripts\Automation\ExampleWaveform.vbs** gets the sample points in analog trace C1 by accessing app.Acquisition.C1.Out.Result.Samples and dumps them into a text file.

Digital Waveforms

Digital waveforms are two-dimensional arrays, the DataArray being the samples and the TimeArray being the time associated with the samples. As each digital bus may have up-to-18 lines (D0-D17), the DataArray has at least two columns, being the Sample Number and the Digital Line from which it was taken.

Each sample has a time, but it is not easily calculated from the timebase, as with analog waveforms, as the digital pulses on each line may have different widths. To accurately expose a digital waveform, you must access both arrays and correlate the times with the samples from each line.

The sample script **D:\Scripts\Automation\ExampleDigital.vbs** gets the arrays in a digital trace that has been stored in M1, determines the number of lines in the bus, correlates the times with the samples, and dumps the results in a text file.

Tip: To see how this works, recall the Digital entry from D:\Scripts\Automation\AutomationExamplesLabNotebook.lnb. This will copy a 3-line digital trace into M1, which is accessed by the script.

Sequence Mode Waveforms

In MAUI firmware version 7.7.x.x and later, the segment index is supported as an argument to the Out.Result property. For example, the following commands return results for segment 1 of the respective waveform (which is a Sequence Mode acquisition):

```
set myResult = app.Acquisition.C1.Out.Result(1)
set myResult = app.Math.F1.Out.Result(1)
```

Zero (0) or no argument returns the result related to the last segment. A segment index greater than the total number of segments also returns the result related to the last segment.

Waveform Status Property

The waveform result includes a Status property (bit-field) that reflects 'warning' and 'error' conditions. There is no bit for "valid."

Bit #	Value	Description
0	0x0000000000001	LEC_Invalid
1	0x0000000000002	LEC_Overflow
2	0x0000000000004	LEC_Underflow
3	0x0000000000008	LEC_ContainsUndefinedValues
4	0x0000000000010	LEC_LessThan
5	0x0000000000020	LEC_GreaterThan
6	0x0000000000040	LEC_NotAPulse
7	0x0000000000080	LEC_NotCyclic
8	0x0000000000100	LEC_Averaged
9	0x0000000000200	LEC_UnlockedPLL
10	0x0000000000400	LEC_OtherError
11	0x0000000000800	LEC_OtherWarning
12	0x0000000001000	LEC_OtherInfo
32	0x0000100000000	LEC_InputsIncompatible
33	0x0000200000000	LEC_AlgorithmLimitsReached
34	0x0000400000000	LEC_BadDefinition
35	0x0000800000000	LEC_TooFewData
36	0x0001000000000	LEC_TooManyData
37	0x0002000000000	LEC_UniformHorizIntervalRequired
38	0x0004000000000	LEC_BadUnits
39	0x0008000000000	LEC_DataRangeTooLow
40	0x0010000000000	LEC_DataUndersampled
41	0x0020000000000	LEC_PoorStatistics
42	0x0040000000000	LEC_SlowTransitionTime
43	0x0080000000000	LEC_DataResampled
44	0x0100000000000	LEC_DataInterpolated
45	0x0200000000000	LEC_MeasurementScaleImprecise
46	0x0400000000000	LEC_NoDataAvailable
47	0x0800000000000	LEC_SomeCummulatedResultsInvalid
48	0x1000000000000	LEC_InsufficientMemory
49	0x2000000000000	LEC_ChannelNotActive
50	0x4000000000000	LEC_UseStatusDescription

Copying Waveform Data to Excel

This Excel macro reads the number of samples in a waveform and places it in cell B1 of the spreadsheet, then reads all waveform sample values and copies them into column A (A1...Axx). The example is coded in VBA, and would be launched by a button in a spreadsheet.

```
Sub Button1_Click()

      ' Connect to the oscilloscope
      Set app = CreateObject("LeCroy.XStreamDSO")

      ' Query the number of samples in C1 and store in cell "B1"
      numSamples = app.Acquisition.C1.Out.Result.Samples
      Cells(1, 2)
      Value = numSamples

      ' Access waveform data array, fill first column of the spreadsheet
      wave = app.Acquisition.C1.Out.Result.DataArray
      For i = 0 To numSamples - 1
             Cells(i + 1, 1).Value = wave(i)
      Next i

      End Sub
```

Note: Ensure that the record length is < 64 k samples, since Excel has a limit on the number of rows in a spreadsheet. Ideally, start experimenting with short (500 point) records.

Storing Waveform Data in a Text File

This VBScript example is very similar to the VBA macro example above, the most notable difference being the use of a standard system ActiveX control, **Scripting.FileSystemObject**, to enable the creation of files containing waveform data in ASCII format.

```
' Connect to the oscilloscope
Set app = CreateObject("LeCroy.XStreamDSO")

' Code to take acquisition and generate FFT in F1
. . .

' Readout the FFT
numSamples = app.Math.F1.Out.Result.Samples

' Write the FFT power spectrum into the file, sample by sample
Set fso = CreateObject("Scripting.FileSystemObject")
Set MyFile= fso.CreateTextFile("c:\XStreamFFT.txt", True)

      wave = app.Math.F1.Out.Result.DataArray
      For i = 0 To numSamples - 1
              MyFile.WriteLine(wave(i))
      Next

' Clean up
MyFile.Close
Set fso = Nothing
Set app = Nothing
```

Exposing Measurements

Measurement results are read similar to Waveforms, using the appropriate **app.Measure.P*n*.Out.Result** object.

The Value is the default property of all Out.Results, so getting the above result delivers the last measured value in the acquisition for that parameter.

Statistics

In addition to the last measured value, statistics are available for each parameter using two different calls:

```
result = app.Measure.P1.mean.Result.Value
result = app.Measure.P1.max.Result.Value
result = app.Measure.P1.min.Result.Value
result = app.Measure.P1.num.Result.Value
result = app.Measure.P1.sdev.Result.Value

result = app.Measure.P1.Statistics("mean").Result.Value
result = app.Measure.P1.Statistics("max").Result.Value
result = app.Measure.P1.Statistics("min").Result.Value
result = app.Measure.P1.Statistics("num").Result.Value
result = app.Measure.P1.Statistics("sdev").Result.Value
```

The data used to display the Histicon is available using the “histo” statistic. For example:

```
Set app = CreateObject("LeCroy.XStreamDSO")
bins = app.Measure.P5.Statistics("histo").Result.BinPopulations
numBins = app.Measure.P5.Statistics("histo").Result.bins

For i = 0 To numBins - 1
       Cells(i + 1, 4).Value = bins(i)
Next I

Set app = Nothing
```

Measurements on Sequence Mode Waveforms

In MAUI firmware version 7.7.x.x and later, the segment index is supported as an argument to the app.Measure.P*n*.Out.Result property. For example:

```
set myResult = app.Measure.P1.Out.Result(1)
```

returns the result of the measurement on segment 1 of the P1 source waveform (which is a Sequence Mode acquisition).

Zero (0) or no argument returns the result related to last segment. A segment index greater than the total number of segments also returns the result related to last segment.

The following code from the sample file **D:\Scripts\Automation\ExampleMeasureSeg.vbs** loops over each parameter specified, returning the result for each segment:

```
numSegs = 10
for iSeg = 1 to numSegs
        set p1Result = app.Measure.P1.Out.Result(iSeg)
        set p2Result = app.Measure.P2.Out.Result(iSeg)
        set p3Result = app.Measure.P3.Out.Result(iSeg)
        outputFile.Write iSeg & "," & p1Result.Value & "," & p2Result.Value & "," &
p3Result.Value & "," & VbCrLf

next
```

Tip: To see how this works, recall the MeasureSegs entry from D:\Scripts\Automation\AutomationExamplesLabNotebook.lnb. This will set up P1-P3 and copy a segment trace into measurement source C1.

Reading from the Measure Table

The sample file **D:\Scripts\Automation\ExampleTableMeasure.vbs** contains code for iterating over the Measure table to read results for all active parameters.

Similar code is available for iterating over the Pass/Fail table in **D:\Scripts\Automation\ExampleTablePassFail.vbs**, and the WaveScan table in **D:\Scripts\Automation\ExampleTableWaveScan.vbs**.

Tip: To see how these work, recall the Table WaveScan, Measure, PassFail entry from D:\Scripts\Automation\AutomationExamplesLabNotebook.lnb. This will copy a source trace into C1, set up P1-P6, a Pass/Fail test, and the WaveScan table view.

Copying Measurements to Excel

The following Excel macro enables the Standard Vertical parameters, then transfers the eight measurement values into cells C1 to C8. The example is coded in VBA, and would be launched by a button in a spreadsheet.

```
' Create Button in Excel

Sub Button1_Click()

' Connect to the oscilloscop
Set app = CreateObject("LeCroy.XStreamDSO")

            ' Enable Standard Vertical Parameters
             app.Measure.MeasureMode = "StdVertical"

            ' Transfer the 8 parameter values into the spreadsheet
             Cells(1, 3).Value = app.Measure.P1.Out.Result.Value
              Cells(2, 3).Value = app.Measure.P2.Out.Result.Value
              Cells(3, 3).Value = app.Measure.P3.Out.Result.Value
              Cells(4, 3).Value = app.Measure.P4.Out.Result.Value
              Cells(5, 3).Value = app.Measure.P5.Out.Result.Value
              Cells(6, 3).Value = app.Measure.P6.Out.Result.Value
              Cells(7, 3).Value = app.Measure.P7.Out.Result.Value
              Cells(8, 3).Value = app.Measure.P8.Out.Result.Value

' Clean up
Set app = Nothing

End Sub
```

Exposing Table Data

Tables are data arrays that may be one- or two-dimensional, and this is impossible to tell from looking at the table as it is presented in MAUI.

Many tables have Variant cell types, which may contain other tables that also need to be indexed in order to see the correct values. For example, were you to send this simple VBS query to get results from the Spectrum Analyzer table:

```
vbs? 'return =app.SpecAnalyzer.SpecAnTable.Out.Result.CellValue(3,2)'
```

(3,2) represents the table (row,column) to return, but to specifically return the frequency *value*, you'd have to send something like:

```
vbs? 'return =app.SpecAnalyzer.SpecAnTable.Out.Result.CellValue(3,2)(0,0)'
```

The first index indicates the row of table data wanted (3) from the Frequency column (2), but that single cell contains an array of the Amplitude value (0,0), Start Frequency (1,0) and Stop Frequency (2,0). You have to index first the principle table *then* the array inside that particular cell, hence the extra (0,0) to get the amplitude value.

Likewise, the table that presents the results of any serial decoder software, app.SerialDecode.Decode***n***.Out.Result, is a table with a table in each cell that you need to index at (line,col). However, it only has a *numeric value* in (0,0) that needs to be indexed, as well.

Note: If the data in a cell of the Serial Decoder Result table is a string, there is no (datatype,dataidx); if it is a number, there is an array to be indexed and it is always at (0,0).

The Serial Decode table presents a number of challenges in exposing results. See the sample script **D:\Scripts\Automation\ExampleTableSerialDecode.vbs**, which iterates over the Serial Decode table and dumps the data to a text file.

Tip: To see how this works, recall the Table Serial Decode entry from D:\Scripts\Automation\AutomationExamplesLabNotebook.lnb. This will copy two waveforms into M1 and M2 and apply the USB2 decoder to them.

Handling Different Cell Types

There are four cell "types" that may appear in a table. Each type must be handled differently in code.

- CellType 0 is a Variant (as in the Spectrum Analyzer and Serial Decoder tables). These cells may hold different things, such as other table arrays, which may be either one- or two-dimensional.
- CellType 2 is a Param result (as in the Measure table). These are cells with single values.
- CellType 3 is a Boolean result. These are cells containing single, Boolean values, either 1|0 or True|False.
- CellType 4 is the histicon cell of the Measure table. This not commonly used.

Each of the D:\Scripts\Automation\ExampleTable*.vbs scripts contain code used to iterate over a table to determine its actual structure and cell types. We recommend that you adapt this code to your programs whenever accessing results from table objects.

Tip: The file D:\Scripts\TableExport.lss also includes code for determining whether CellType 0 cells contain an array and uses the appropriate method for reading the data.

Error Handling for Table Results

Error handling is especially important for tables with Parameter and Boolean cell types, as an error is generated if a cell has no data. The following snippet shows the use of VBS function "on error resume next" applied to table data:

```
' get the Parameter or Boolean Value property (handle error case if no data in the
value)
strThisVal = "-"
on error resume next
set cellVal = myResult.CellValue(rowIdx, columnIdx)
strThisVal = cellVal.value
on error goto 0  ' Reset Error handling state
strRowData = strRowData & strThisVal
```

Discovering Number of Array Dimensions

You can discover the number of dimensions in a table array by adding the following helper function to VBScripts:

```
function getArrayDims(arr1)
        dimensions = 0
        if IsArray(arr1) then

                on error resume next
                Err.clear
                do while Err.number = 0
                        dimensions = dimensions + 1
                        UBound arr1, dimensions
                loop
                Err.clear
                dimensions = dimensions - 1

        end if

        getArrayDims = dimensions
end function
```

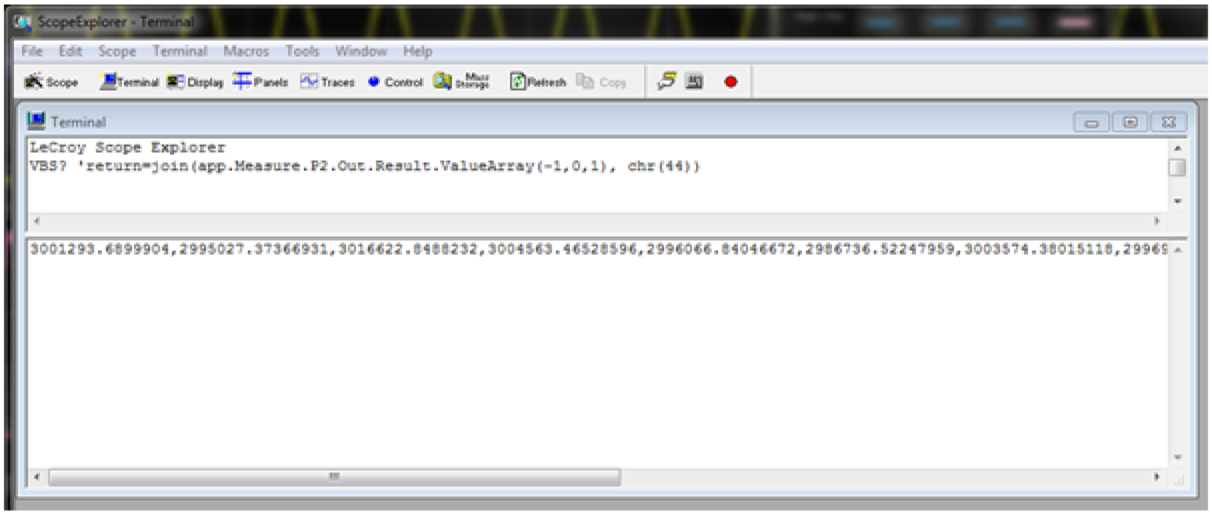
Tip: This function appears at the end of the sample scripts D:\Scripts\Automation\ExampleTable*.vbs, from which you can copy it.

Note: This function will not work in VBA scripts.

Using Join to Read from Tables

The VBS query Join can be used to read table value arrays into a comma-delimited list of values. For example, sending the following command from the terminal in WaveStudio returns a list of all the specified values for the measurement parameter P2:

```
VBS? 'return=join(app.Measure.P2.Out.Result.ValueArray(-1,0,1), chr(44))
```


ScopeExplorer - Terminal
File Edit Scope Terminal Macros Tools Window Help
Scope Terminal Display Panels Traces Control Mass Storage Refresh Copy
Terminal

```
LeCroy Scope Explorer
VBS? 'return=join(app.Measure.P2.Out.Result.ValueArray(-1,0,1), chr(44))
```

```
3001293.6899904,2995027.37366931,3016622.8488232,3004563.46528596,2996066.84046672,2986736.52247959,3003574.38015118,29965
```

Synchronization

Synchronization—or, more specifically, knowing when to read results—is critical when operating a digital oscilloscope remotely (it is just as important for Automation as for GPIB remote control). This is especially true when working with an oscilloscope that uses a multithreaded architecture.

A classic problem seen in the majority of custom applications that control Teledyne LeCroy oscilloscopes is that the scope is left to free-run in Auto-trigger mode, while simultaneously (and asynchronously) results are queried.

Several techniques can be used to guarantee the synchronization and consistency of results, whether they be waveform or parameter measurements, when using the Automation interface.

Synchronizing Triggers Using Timeouts

The **Acquire** method arms the acquisition system and waits a user-specified time for a trigger. The second argument, an optional Boolean, specifies whether or not to force a trigger then return the value if a trigger doesn't arrive within the allotted time period.

Note: The Acquire method is equivalent to setting the Trigger Mode to “Single”, then executing WaitUntilIdle.The return of the Boolean causes the method to function logically like a query and requires it to be read into a variable, whether or not the returned value is actually displayed.

The following Excel VBA macro example demonstrates the use of a timeout, a useful technique for ensuring synchronization.

```
Sub Button1_Click()

      ' Connect to the oscilloscope
      Set app = CreateObject("LeCroy.XStreamDSO")

      ' Enable Standard Vertical parameters
      app.Measure.MeasureMode = "StdVertical"

      ' Stop the free-running trigger and take a single acquisition
      ' Use a 10 second timeout in case the acquisition is not complete
      app.Acquisition.TriggerMode = "Stopped"

      Dim Acquired as Boolean
      Acquired = app.Acquisition.Acquire (10, True)

      ' Read the first parameter value and transfer into the spreadsheet
       ' Display the Acquired value to show the oscilloscope has triggered
      Cells(1, 3).Value = app.Measure.P1.Out.Result.Value
      MsgBox Acquired

End Sub
```

Synchronizing Setups

Another scenario where synchronization is necessary is between changing settings and reading results, even when no acquisition took place. For this the **WaitUntilIdle** method is used. This method is a “blocking” mechanism and will not return control until the setup request has completed.

An example of WaitUntilIdle usage follows.

Note: WaitUntilIdle is not for use when in Normal or Auto trigger mode.

```
Sub Button1_Click()

      ' Connect to the oscilloscope
      Set app = CreateObject("LeCroy.XStreamDSO")

      ' Enable Standard Vertical parameters
      app.Measure.MeasureMode = "StdVertical"

      ' Wait for the change to take place for a max. of 5 seconds
      app.WaitUntilIdle(5)

      ' Read the value of P1 (pkpk) and transfer into the spreadsheet
      Cells(1, 2).Value = app.Measure.P1.Out.Result.Value

      ' Enable Standard Horizontal parameters
      app.Measure.MeasureMode = "StdHorizontal"

      ' Wait for the change to take place for a max. of 5 seconds
      app.WaitUntilIdle(5)

      ' Read the value of P1 and transfer into the spreadsheet
      Cells(1, 3).Value = app.Measure.P1.Out.Result.Value

End Sub
```

Best Practices for Synchronization

- In almost all Automation applications, it is highly recommended that you stop acquisitions before accessing result data. Most synchronization problems are caused by failure to follow this practice.
- Use the **app.SetToDefaultSetup** action to restore the instrument to its default state before setting the controls required by an application. This eliminates any dependency on the previous configuration of the instrument. Teledyne LeCroy strives to ensure that the default state of the instrument is constant from one software release to the next.
- When using a result object, verify that the status is valid to ensure that the acquisition and/or processing was valid.

Application Interactions

It is not possible to run two simultaneous instances of the oscilloscope application. More than one simultaneous *connection* to the instrument via Automation will be accepted, but simultaneous connections are not recommended. When the final client has been disconnected from the instrument (server), the oscilloscope application will remain running and will accept further client connections.

Operations that cause Modal Dialogs to appear in the instrument’s display will, by default, disrupt access from Automation. This behavior can be changed using the controls:

- app.SystemControl.ModalDialogTimeout
- app.SystemControl.EnableMessageBox

The instrument application can be minimized in order to allow the controlling application to take over the display and touch panel by means of the app.Minimize control. It can also be resized and repositioned on the display by means of the app.Top, app.Left, app.Bottom, and app.Right controls.

When an application is running *locally* on the instrument and requests a connection to the oscilloscope via Automation, one of two things will happen:

- If the oscilloscope application is already running, the object returned will be a “pointer” to the running application.
- If the oscilloscope application is *not* running, it will be started.

Early and Late Binding

The COM standard on which Automation is built supports two kinds of “binding” between client and server: early (static), and late (dynamic, dispatch). Static binding usually involves a type library and is used primarily by compiled languages such as C++. In this case, function entry points are resolved at compile time. Dynamic binding (also known as late binding) involves resolving method and property calls at run time, as opposed to compile time.

The Automation interfaces in XStreamDSO based instruments use primarily dynamic binding. From many programming languages (VB, VBScript, etc.) this is transparent. But when you are developing applications in C++, which does not provide late-binding natively, the use of a “helper” class is required. This is demonstrated below:

```
#include "stdafx.h"
#include "AtlBase.h" CComModule _Module;
#include "AtlCom.h"

CComPtr<IDispatch> spDso;
// dispatch ptr. to root of object model (app)
CComDispatchDriver ddDso;

int main(int argc, char* argv[])
{
      printf("Hello XStream World!\n");

      ::CoInitialize(NULL);

      HRESULT hr = spDso.CoCreateInstance(L"LeCroy.XStreamDSO");
      if(SUCCEEDED(hr))
      {
            ddDso = spDso;

            // perform an Auto-Setup (app.Autosetup)
            hr = ddDso.Invoke0(L"AutoSetup");

            // retrieve a Dispatch ptr. to the app.Display object
            CComVariant displayPtr;
            hr = ddDso.GetPropertyByName(L"Display", &displayPtr);
            CComDispatchDriver ddDisplay(displayPtr.pdispVal);

            // enter Dual-grid mode(app.Display.GridMode = "Dual")
            hr = ddDisplay.PutPropertyByName(L"GridMode", &CComVariant("Dual"));
      }
      return 0;
}
```

Automation Programming Conventions

Follow these guidelines when writing Automation programs for remote control. See Control Variables and Result Interfaces for more information about the types and supported methods.

Variables are indicated by italicized placeholder text in the examples below.

Values

Enum, String, and Color type values must have double quotes around them, for example:

```
app.Display.GridMode = "Quad"
```

Integer, Double, DoubleLockstep, and Bool values do not require quotes:

```
app.Display.Persisted = false
app.Acquisition.Horizontal.NumSegments = 10
```

Where objects take multiple arguments, values are given in comma-delimited lists:

```
app.Acquisition.Acquire(5,true)
app.Acquisition.C1.LabelsText = "Hello,World"
```

The first Acquisition object above is a Method with both Integer and Bool type arguments; the second is a CVAR with a multi-value String argument.

To see the correct format and syntax, query the object's current setting. This command can be sent very easily using the WaveStudio Terminal with a remote connection to the oscilloscope:

```
VBS? 'return = object'
```

Units

Generally, units are optional when giving Automation commands, as units are already determined by the input trace and type of any math functions applied to the trace. An exception is the Rescale math function, which creates a second trace that explicitly changes the vertical units in which the source trace is calculated, and therefore requires that a unit be specified:

```
app.Math.Fn.Equation = rescale(trace)
app.Math.Fn.Operator1Setup.Unit = "menemonic"
```

See the list of acceptable mnemonics in Units.

The vertical unit of analog and sensor input channels (C*n* and SE*n*) can be changed by setting the CVAR Unit to "Other":

```
app.Acquisition.Cn.Unit = "OTHER"
app.AcquisitionPMU.SEn.Unit = "OTHER"
```

Then, follow with the unit Type (category) and displayed Units. For example:

```
app.Acquisition.Cn.Type = "MASS"
app.Acquisition.Cn.Units = "SLUG"
```

Note: You can only select Units from the list of values that appears following the Type selection.

Equations

CVARs **app.Math.F*n*.Equation**, **app.Math.F*n*.EquationRemote**, and **app.Measure.P*n*.Equation** are text Strings containing the summary of the math or measure operation. They can be used to query the current settings, but not to set the function or parameter.

To set up a Math function, use the CVARs app.Math.F*n*.Source*n* and app.Math.F*n*.Operator*n*, and any objects in the app.Math.F1.Operator*n*Setup folders.

To set up a Parameter, use the CVARs app.Measure.P*n*.Source*n* and app.Measure.P*n*.ParamEngine, plus any objects in the app.Measure.P*n*.Operator subfolder.

Labels

The CVARs **LabelsText** and **LabelsPosition** (which appear in the hierarchy for any waveform object) specify the text and position of custom labels placed on a waveform. LabelsText takes a single String argument for which you can specify a comma-delimited list of values each representing a separate label:

```
app.Acquisition.C1.LabelsText = "Hello,World"
```

The above control creates two labels, "Hello" and "World." Note that later sending the same control with only a single value will erase all but the first label in the list (which will remain at its current position), changing it to the new text string.

LabelsPosition is also a String where each list value is a pipe-delimited pair specifying the horizontal and vertical position of the corresponding label in the LabelsText string. Placing parentheses around the vertical value in the pair turns on "Use Trace Vertical Position". The following control would position both labels "Hello" and "World", placing "Hello" adjacent to the trace, and "World" at the vertical position specified:

```
app.Acquisition.C1.LabelsPosition = "0.000002|(0.02),0.000002|0.01"
```

Colors

Color type CVARs set/query the color of traces and other display objects, using a number in the range 0 to FFFFFF in hexadecimal. The possible colors are made from any combination of the primary colors, which are set in hexadecimal as Blue = &HFF0000, Green = &HFF00, Red = &HFF. For example:

```
app.Display.C1Color = "255,255,0"
```

The value may be entered in decimal or in hexadecimal, though hexadecimal is usually more convenient. Note that if the intensity of a color is to be reduced or increased by a numerical factor, an AND operation must be used afterwards, to prevent corruption of other primary colors.

File Names

CVARs of the Filename type generally do not require the full path to be given as part of the value, but in most cases, the directory in which the files will be saved is set using a separate CVAR, which does require the full path. Check the parent objects within the subsystem in XStreamBrowser to find the CVAR for setting the file path.

Persistence

When applied to any trace, the CVARs **Persisted**, **PersistDotJoined**, **Persistence3D**, **Persist3DQuality**, **PersistenceMonochrome**, and **PersistenceSaturation** determine the status and appearance of the persistence display.

Persistence sets/queries the persistence state. If the Display.LockPersistence CVAR is set to 'AllLocked' then the persisted state of all displayed waveforms will be the same. If the Display.LockPersistence control is set to 'PerTrace' then the persisted state of each waveform may be independently controlled.

If **PersistDotJoined** is False (the default state), samples are put into the persistence map as dots. The advantage of that is that any lit pixel in the pmap actually corresponds to a sample of the data taken at that time. The disadvantage of dots is that there is no way to associate a dot with any other dot; there is no history of which dots were part of the same acquisition. If this control is set True, then each acquisition draws lines into the persistence map that connect the dots at the sample positions. Clearly the advantage of that is that it is now possible to see if some outlier samples were all part of the same acquisition, or not. The disadvantage is that lit points in the persistence map no longer correspond to actual samples, the lines between the samples are also lit.

If the persistence map is going to be analyzed it is probably preferable to leave Dot Joined off so that only actual samples are considered in the analysis. If there are very few points in a persistence map, there may columns with no points, that is, there are gaps horizontally between points. In that case, Dot Joined will connect them starting with the last trace, and for all subsequence traces accumulated.

The action of turning on or off Dot Joined clears the accumulated persistence map.

Persistence3D puts the persistence display into a 3D surface map.

Persistence3DQuality selects the 3D quality, which determines how the display is rendered. This CVAR is only relevant when Persistence3D is True.

If **PersistenceMonoChrome** is set True, the display will be monochromatic, regardless of whether 2D or 3D.

Placeholders

In some cases, the value that appears in XStreamBrowser is only a placeholder that will appear on the oscilloscope GUI until you make an actual setting. Placeholders will usually be indicated by angle brackets surrounding the text string. For example, the Value of app.Utility.Remote.AllowControlFrom is <ipAddr, or dnsName>, which appears inside the control on the GUI indicating you should substitute the remote client IP address or DNS name. If you provided an actual IP address or DNS name, that node would have exclusive remote control of the oscilloscope.

Visible Serial Decoder Table Columns

The CVAR app.SerialDecode.Decode*x*.Decode.ColumnState contains a pipe-delimited list of all the table columns that are selected for display. For example:

```
app.SerialDecode.Decode1.Decode.ColumnState = "Idx=On|Time=On|Data=On|..."
```

If you wish to change the table configuration by hiding or displaying columns, send the full string with the state changed from "on" to "off", or vice versa, rather than remove any column from the list.

Note: Even though columns are hidden, they are still calculated in the decoding, and any time you access the Out.Result objects of serial decode tables, all the columns are returned. If you seek to access a specific column, use the getDataArray function to first determine the depth and order of the table and the actual number of the column.

Using Programming Variables

One way to increase the readability and simplicity of your source code is to use variables to reference objects that are at each level of the hierarchy. For example, here is the VB code to read out the Sweeps property for C1:

```
Dim numSweeps as Long
numSweeps = app.Acquisition.C1.Out.Result.Sweeps
```

If you are reading out more than just the Sweeps property, you might find it easier to read the following:

```
Dim C1Res as Object
Dim C1 as Object
Dim numSweeps as Long
Dim HorizontalOffset As Double
Dim HorizontalPerStep As Double
Dim VerticalOffset As Double
Dim VerticalPerStep As Double
Dim wform

C1 = app.Acquisition.C1
C1.AverageSweeps = 200 numSweeps = C1
Res.Sweeps HorizontalOffset = C1
Res.HorizontalOffset HorizontalPerStep = C1
Res.HorizontalPerStep VerticalOffset = C1
Res.VerticalOffset VerticalPerStep = C1
Res.VerticalPerStep
```

The panel setup files make heavy use of object variables, making them far more readable and editable:

```
Set Acquisition = XStreamDSO.Acquisition
Set C1 = Acquisition.C1
C1.View = True
C1.UseGrid = "YT1"
C1.Persisted = False
C1.PersistenceSaturation = 50
C1.PersistenceMonoChrome = True
C1.Persistence3d = False
. . .
```

Automation in MATLAB

On instruments equipped with the CustomDSO (XDEV) option, MATLAB applications can use Automation to control and exchange data with the oscilloscope application. For more information, see *Lab 831: X-Stream COM Object Programming with MATLAB* and *Using LeCroy Digital Oscilloscopes with MATLAB*.

Note: An installation of MATLAB is required on the controller for remote execution of MATLAB scripts. An installation of MATLAB is required *both on the controller and oscilloscope* when implementing custom MATLAB math and measurements in the processing of remote control programs. If you have a site license, the oscilloscope will occupy one seat when connected. For individual licenses, the oscilloscope can be one of the three allowed installations.

Connecting and Disconnecting

The LeCroy-MATLAB interface is based on Active X technology and is greatly assisted by using the ActiveDSO library. MATLAB applications use the **actxserver** keyword to connect to the instrument over TCP/IP, for example:

```
app = actxserver('LeCroy.XstreamDSO.1', '<IP address>')
```

Note: Use address 127.0.0.1 when the MATLAB application accessing the oscilloscope application is running locally on the oscilloscope, rather than remotely.

To disconnect, end with:

```
Set app = Nothing
```

Creating Object Variables

Given the complexity of MATLAB's syntax for handling multi-tiered Automation objects, it is highly recommended to create object variables ("handles") at each level of the hierarchy. For example:

```
% creation of object variables 1 level down from top-level
acq = app.Object.Item('Acquisition');
math = app.Object.Item('Math');
meas = app.Object.Item('Measure');
PF = app.Object.Item('PassFail');

% creation of object variables 1 level further
c1 = acq.Object.Item('C1');
f1 = math.Object.Item('F1');
p1 = meas.Object.Item('P1');
p1Operator = p1.Object.Item('Operator')

% creation of object variables to results
c1_results = c1.Out.Result;
f1_results = f1.Out.Result;
p1_results = p1.Out.Result;
```

Accessing Control Variables (CVARs)

These instructions apply to CVARs (object selected from a yellow folder in XStreamBrowser).

Using the syntax:

```
<handle> = Object.Item('<object>')
```

Create an object variable for each level in the object hierarchy. For example, the following lines of code drill into the hierarchy of the VerScale CVAR:

```
acq = app.Object.Item('Acquisition');
c1 = acq.Object.Item ('C1');
```

The result is a convenient set of handles to use rather than long and clumsy lines of code. Note that each line above uses the object variable created in the line above it.

For CVARs that you can read or write, use the **get** and **set** functions to access properties of the CVAR. The Value property is most frequently used, but others are available, including Range. Here are examples of getting and setting the VerScale CVAR:

```
% read the value of the VerScale CVAR
C1VDiv = get(c1.Item('VerScale'), 'Value')

% read the Range and Type properties of the VerScale CVAR
range = get(c1.Item('VerScale'), 'Range')
type = get(c1.Item('VerScale'), 'Type')

% set VerScale to 0.789 V/div
set(c1.Item('VerScale'), 'Value', 0.789)
```

For CVARs that are Actions, use the **invoke** function:

```
% execute an application-level Clear Sweeps action
app.invoke('ClearSweeps','ActNow');

% execute an AutoSetup action
app.invoke('AutoSetup','ActNow');

% execute the ResetAll action for the Math system (only)
math.invoke('ResetAll','ActNow');
```

Action CVARs have an interface called **ActNow** that can be referenced, but this isn't required.

For CVARs that are Methods, use the **invoke** function and include the arguments required to perform the method:

```
% execute the Acquire method with 5s timeout, no forced trigger
acq.invoke('Acquire', 5, false);
```

Accessing Out.Result Objects

These instructions apply to items that appear when selecting an object from a Result Interface folder in XStreamBrowser.

For each level of the object hierarchy *up to but not including the item's parent object*, create an object variable using the syntax:

```
<handle> = Object.Item('<object>')
```

For example, the following lines of code drill into the P1 object hierarchy up to the parent "Out.Result":

```
meas = app.Object.Item('Measure');
p1 = meas.Object.Item('P1');
```

Create an object variable for "Out.Result" using this syntax:

```
p1_results = p1.Out.Result
```

To read properties within the Out.Result object, use either of the following:

```
p1_<handle> = p1_results.<property>
p1 = get(p1_results,'<property>')
```

For example, to read the Value property:

```
p1_val = p1_results.Value
```

Or

```
p1 = get(p1_results,'Value')
```

To read back multi-valued items such as ValueArray and DataArray, use the **get** function:

```
P1_array = get(p1_results, 'ValueArray', -1, 0, 1)
C1_data = get(c1_results, 'DataArray', -1, -1, 0, 1)
```

ValueArray, which returns all measured values for a parameter, and DataArray, which returns waveform data, are actually interfaces that require several arguments to determine the number of values to return, what kind of values, etc. See ValueArray and DataArray.

Automation in Python

The oscilloscope can be controlled by Automation from applications written in the Python language. Python programs may be designed to execute locally using COM, or remotely using either the ActiveDSO driver or a VISA driver. See the Python example in Remote Control Program Using VISA.

You will need the Python for Windows Extensions and Python installed wherever the program is to run. If it runs locally, the libraries must be installed on the oscilloscope; if it connects remotely, they must be installed on the controller. The version of Python for Windows Extensions should match your version of Python.

For remote control, you will also need an installation of ActiveDSO or a VISA driver on the controller.

With COM

COM is the most direct way to send Automation commands to the oscilloscope in Python.

Note: Any COM program should be able to run from a remote computer that has a DCOM connection to the oscilloscope.

Connecting

The initial connection imports the win32com.client, needed for any COM Automation, and any Python extensions to be used. It then connects to the oscilloscope application, "LeCroy.XStreamDSO," here aliased as "h":

```
import win32com.client
import matplotlib.pyplot as plt
h = win32com.client.Dispatch("LeCroy.XStreamDSO")
```

Accessing Control Variables

The current value of any CVARs (yellow folder objects) can be read by placing the object into a variable. This example gets the current sample period of the variable "deltat", then prints it following the string "Sample Period":

```
deltat = h.Acquisition.Horizontal.TimePerPoint
print "Sample Period = ", deltat
```

Shortcuts can be created to simplify references to any Automation object. This gets the vertical scale of C1, using the shortcut c1 to refer to the full object path "h.Acquisition.C1":

```
c1 = h.Acquisition.C1
vdiv = c1.VerScale
print "Channel 1 Volts per Division Setting = ", vdiv
```

To change the setup of a CVAR, set the object (or its shortcut) equal to the new value:

```
c1.VerScale = .1
```

Accessing Out.Result Objects

To read a single measured property of a waveform, place the object (or its shortcut) into a variable:

```
numsamples = h.Acquisition.C1.Out.Result.Samples
print(numsamples)
```

To access the entire waveform, use the DataArray object. For example, to plot the C1 waveform:

```
wave = h.Acquisition.C1.Out.Result.DataArray
plt.plot(wave)
plt.show()
```

With ActiveDSO

For more examples, see the *Technical Brief: Using Python with ActiveDSO for Remote Communication*.

Connect and Disconnect

Connecting to the oscilloscope using ActiveDSO similarly calls the win32com.client then instantiates the ActiveDSO control "LeCroy.ActiveDSOCtrl.1", here aliased as "scope". The MakeConnection string makes the remote connection to the oscilloscope:

```
import win32com.client
scope=win32com.client.Dispatch("LeCroy.ActiveDSOCtrl.1")
scope.MakeConnection("<connection string>")
```

The <*connection string*> is whatever you would normally enter in the ActiveDSO MakeConnection method to specify the interface, for example "IP: 172.0.0.31".

To disconnect, send:

```
scope.Disconnect()
```

Accessing Control Variables

For CVARs that you can read or write (yellow folder objects), use WriteString to send commands. The <*command string*> is the remote command, either in the legacy 488.2 format, or an Automation control sent within the VBS command.

```
scope.WriteString("<command string>", <Boolean EOI>)
```

For example, to set the C1 V/div to 20 mV using Automation, you would send:

```
scope.WriteString("""VBS 'app.Acquisition.C1.VDIV=".02 V" ' """, 1)
```

Note: The triple quotes around the command string are required because the double quotes around the value ".02 V" are part of the Automation control embedded within the VBS command. Otherwise, Python would interpret the first double quote as the end of the command string.

Accessing Out.Result Objects

To read Out.Result objects, use WriteString with the VBS? query (to access the result value) followed by the ReadString method to return it in the desired format. The following code queries the result of the P1 parameter, reading a maximum of 80 bytes, and prints the results to the Interactive Window:

```
scope.WriteString("VBS? 'return=app.Measure.P1.Out.Result.Value' ",1)
value = scope.ReadString(80)
print(value)
```

Automation in C#

Newer programming languages like C# are not supported by the ActiveDSO control or the VICP protocol. We recommend that those writing Automation programs in C# should do the following:

- Connect to the oscilloscope over ENET, either through your LAN or a direct connection.
- On the oscilloscope, choose the **LXI (VXI-11)** remote control setting.
- On the controller, install an VISA-compliant driver and the IVI C# VISA API to decouple your Automation program from the driver.

The following C# program uses the above configuration to make a remote connection to the oscilloscope and perform the same tasks as the Python script in Program Using VISA.

Note: Characters in angle brackets are placeholders. Omit the brackets from your code.

```
using System;
using Ivi.Visa;

namespace LeCroy.ScopeVisaExample
{
   public class ScopeExample
   {
      public void DoExample()
      {
      // Open session to scope
      var session = (IMessageBasedSession)GlobalResourceManager.Open
        ("TCPIP0::<hostname|IP address>::INSTR");
      session.TimeoutMilliseconds = 5000;
      session.Clear();
      // Don't return command header with query result
      session.FormattedIO.WriteLine("COMM_HEADER OFF");
      // Recall default setup
      session.FormattedIO.WriteLine("vbs 'app.settodefaultsetup'");
      // Wait until scope is done with recall default
      session.FormattedIO.WriteLine("vbs? 'return=app.WaitUntilIdle(5)'");
      session.FormattedIO.ReadString();
      // Set up acquisition trigger and timebase
      session.FormattedIO.WriteLine("vbs 'app.acquisition.triggermode =
        \"stopped\"'");
      session.FormattedIO.WriteLine("vbs 'app.acquisition.trigger.edge.level =
        1.0'");
      session.FormattedIO.WriteLine("vbs 'app.acquisition.triggermode =
        \"Single\"'");
      session.FormattedIO.WriteLine("vbs 'app.acquisition.horizontal.maximize =
        \"FixedSampleRate\"'");
      // Clear all current measurement definitions and set up new measurement

      session.FormattedIO.WriteLine("vbs 'app.measure.clearall'");
      session.FormattedIO.WriteLine("vbs 'app.measure.showmeasure = true'");
      session.FormattedIO.WriteLine("vbs 'app.measure.statson = true'");
      session.FormattedIO.WriteLine("vbs 'app.measure.p1.view = true'");
      session.FormattedIO.WriteLine("vbs 'app.measure.p1.paramengine = \"mean\"'");
      session.FormattedIO.WriteLine("vbs 'app.measure.p1.source1 = \"C1\"'");

      // Reset the parameter statistics

      session.FormattedIO.WriteLine("vbs 'app.measure.clearsweeps'");

      // Arm acquisition, forcing a trigger if there is none after 0.1 seconds.
      // Take 10 acquisitions, find the mean value and print it to the console.

      for (int i = 0; i < 10; ++i)
      {

         session.FormattedIO.WriteLine("vbs? 'return=app.acquisition.acquire
           ( 0.1 , True )'");

         // Wait until all processing is done; check if timed out

         session.FormattedIO.WriteLine("vbs? 'return=app.WaitUntilIdle(5)'");
         var success = session.FormattedIO.ReadInt64();

         if (success == 0)
         {
         throw new TimeoutException($"Time out from WaitUntilIdle, return =
           {success}");
         }

         // Read result in P1 measurement parameter, write it to the console

         session.FormattedIO.WriteLine("vbs?
           'return=app.measure.p1.out.result.value'");
         var mean = session.FormattedIO.ReadDouble();
         Console.WriteLine($"Mean = {mean}");
      }

      // Close session and disconnect from scope

      session.Dispose();

      }

   }

}
```

Part 3: Automation Control Variable Reference

This section describes the Actions and Methods that may be applied to XStreamDSO standard objects.

Many more CVARs are available in the XStreamDSO application than are documented here. Use XStreamBrowser to view the entire app object hierarchy of your oscilloscope and the acceptable value ranges for other types of CVARs. Also see the various software option manuals.

app

app is the root of the XStreamDSO automation hierarchy; all other nodes are accessed from this point.

Nested within the app object are the principal XStreamDSO subsystems. Standard and optional subsystems are arranged alphabetically.

Child Objects

Object	Description
app.Acquisition	Subsystems related to the acquisition and digitization of signal: all inputs, Timebase (Horizontal), and Trigger.
app.Cursors	Cursor (measure) subsystem.
app.CustomDSO	Custom DSO (XDEV) option. Standard on WavePro, WaveMaster, and LabMaster oscilloscopes and equivalent DDA/SDA models.
app.Display	Display subsystem.
app.DriveAnalysis	Disk Drive Analyzer option. Standard on DDA model oscilloscopes.
app.EyeDr	Eye Doctor II option. Standard on SDA model oscilloscopes with SDA III.
app.HardCopy	Hardcopy (Print) subsystem.
app.Help	Online Help subsystem.
app.History	History Mode subsystem.
app.LabNotebook	LabNotebook subsystem.
app.Math	Math (Function) subsystem.
app.MotorDriveAnalysis	Motor Drive Analyzer option. Standard on MDA800 oscilloscopes.
app.Measure	Measure (Parameter) subsystem.
app.Memory	Internal memory (storage) subsystem.
app.OMA	Optical Modulation Analysis option. Standard on OMA systems.
app.PassFail	Pass/Fail testing subsystem.
app.Preferences	Application preferences subsystem.
app.ProbesCal	Probe calibration subsystem.
app.SaveRecall	Save Recall (File) subsystem.
app.SDA2 or app.SDA3	SDA II and SDA III options. Standard on SDA model oscilloscopes.
app.SpecAnalyzer	Spectrum Analyzer option. Standard on HDO6000, HDO8000, and MDA800 oscilloscopes.
app.SystemControl	Mouse/pointer control subsystem.
app.TriggerScan	TriggerScan subsystem.
app.Utility	Utilities subsystem.
app.VirtualProbe	Virtual Probe option. Standard on SDA model oscilloscopes with SDA III.
app.WaveScan	WaveScan subsystem.

Object	Description
app.WebEditor	WebEditor subsystem.
app.XPort	Report output subsystem.
app.Zoom	Zoom ("expansion trace") subsystem.

Actions

Action	Description
app.AutoSetup	Starts an AutoSetup operation. When input channels are visible, AutoSetup operates only on those visible channels. If no channels are visible, all channels are affected by AutoSetup. With more than one channel visible, the first visible channel in numerical order that has a detectable signal applied to it is automatically set up for edge triggering.
app.ClearSweeps	Clears all accumulated sweeps for all subsystems. These include Channel Pre-Processing, Math,Measure, and Display Persistence. Note that subsystem-specific ClearSweeps controls affect only the individual subsystem.
app.Exit	Equivalent to app.Quit() method.
app.FindAllVerScaleAtCurrentTimebase	Rescales all channel traces to occupy most of the full vertical scale range, but without changing the timebase. A better adjustment will be made if Var Gain is also enabled, in which case the traces will be adjus-ted to occupy +/- 3.3 divisions.
app.Maximize	Maximizes window to fill desktop. Equivalent to app.WindowState = 1.
app.Minimize	Minimizes window to reveal underlying desktop. It will display a small window in the corner of the display that when clicked restores the window to full-screen mode. To programmatically restore the window, refer to app.WindowState.
app.ResetPreferences	Resets all application preferences to their default states. This includes the remote communications port, the color palette settings, etc. but does not include controls such as V/Div, T/Div, etc. These main instrument controls can be reset using the SetToDefaultSetup control.
app.Restore	Restores the instrument display to its position and size before the last minimize request.
app.SetToDefaultSetup	Restores all instrument panel setups to the factory default state. User preference settings such as the remote communications port, color palette, etc. will not be restored to the default state. These may be reset using the ResetPreferences action.
app.Shutdown	Powers off the instrument.
app.Windowed	Places the application window in the upper-part of the display screen with a sizable border.

Methods

app.Quit

Closes the XStreamDSO application. User will be prompted to confirm. Until the user responds, control via Automation is blocked.

app.Sleep([in] double timeoutMilliseconds)

Causes the main execution thread of the instrument application to sleep for the specified time period, defined in milliseconds.

```
' Sleep for ten seconds

app.Sleep(10000)
```

WaitUntilIdle([in] double timeoutSeconds)

Waits until either the application is idle or the specified timeout expires, specified in seconds. This evaluates to True if the application completes before the timeout expires, and to False if a timeout occurs.

When Trigger mode is Auto or Run, the application is never Idle. In this case the call to WaitUntilIdle returns after the next acquisition and any configured processing.

```
' Wait with a timeout of five seconds

app.WaitUntilIdle(5)
```

app.Acquisition

CVARs related to inputs C1-C*n* and Aux In, the timebase, the trigger, and the Aux Output.

app.AcquisitionPMU contains equivalent CVARs for SAM40 sensor acquisition modules.

Child Objects

Object	Description
app.Acquisition.AuxIn	Aux In settings.
app.Acquisition.AuxOutput	Aux Out settings.
app.Acquisition.C*n*	Channel inputs C1 to C*n*. The number depends on your oscilloscope model.
app.Acquisition.Horizontal	Acquisition timebase settings.
app.Acquisition.Trigger	Acquisition trigger settings.

Actions

Action	Description
app.Acquisition.Calibrate	Initiates a full calibration of the acquisition system of the instrument.
app.Acquisition.ClearSweeps	Resets any accumulated average data or persistence data for channel waveforms. Valid only when one or more channels have waveform averaging or persistence enabled in their pre-processing settings. Note that channel counters may be reset on an individual basis using app.Acquisition.C*n*.ClearSweeps control.
app.Acquisition.CopyChannelSetup	Launches the Copy Channel Setup modal dialog for making the copy selections. Equivalent to clicking Copy Channel Setup button.
app.Acquisition.ShowChannelSetup	Opens the Channel Setup dialog, which summarizes all the channel Vertical settings.
app.Acquisition.AuxOutput.SetToDefault	Sets the Aux Output controls to their default values.

Methods

app.Acquisition Acquire([in] double timeoutSeconds, [in] long bForceTriggerOnTimeout)

Takes a single acquisition. The first of the two arguments specifies a timeout; the second, which is optional, specifies whether or not to force a trigger when the timeout occurs. Evaluates to True if a trigger occurred, or False if a timeout occurred.

Note: Adding the Boolean ForceTrigger argument to the method requires that it be dimensioned into a variable. Here, "triggerDetected" is used.

```
' Start acquisition, wait 5 seconds for trigger, force trigger if  not detected
within 5 seconds

Dim triggerDetected as Boolean

triggerDetected = app.Acquisition.Acquire(5, true)
```

app.Acquisition.C*n*

CVARs related to input channels C1 through C*n*.

app.AcquisitionPMU.SE*n* contains equivalent CVARs for SAM40 sensor acquisition module channels.

Names of the form app.Acquisition.Channels.*xxxx* are an alias Collection. For example:

- app.Acquisition.Channels("C*n*") is equivalent to app.Acquisition.C*n*
- app.Acquisition.Channels(*n*) is equivalent to app.Acquisition.C*n*
- app.Acquisition.Channels("C*n*").Out.Result is equivalent to app.Acquisition.C*n*.Out.Result

Child Objects

Object	Description
app.Acquisition.C*n*.InputB	On WaveMaster, LabMaster, and equivalent DDA/SDA oscilloscopes, settings related to the "B" row inputs.

Actions

Action	Description
app.Acquisition.C*n*.ClearSweeps	Clears all accumulated sweeps for channel.
app.Acquisition.C*n*.FindScale	Automatically adjusts channel's V/div and Offset such that the signal is visible on the screen within +/- 3 div.
app.Acquisition.C*n*.HorScaleToggle	Toggles Horizontal Offset control between (1, 2, 5) stepped and fine increment input. Var. checkbox is cleared or checked.
app.Acquisition.C*n*.VerScaleToggle	Toggles Vertical Scale control between (1, 2, 5) stepped and fine increment input. Var. checkbox is cleared or checked.

app.Acquisition.Trigger

CVARs related to acquisition trigger.

Child Objects

Object	Description
app.Acquisition.Trigger.<*Type*>	Currently selected acquisition trigger type (e.g., app.Acquisition.Trigger.Edge). The settings within the <*Type*> object will change depending on what is selected. Most trigger types support the Action FindLevel.
app.Acquisition.SoftwareAssistedTrigger	Settings related to Software Assisted Trigger feature. Not available on WaveSurfer and HDO4000 oscilloscopes.

Actions

Action	Description
app.Acquisition.Trigger.<*Type*>.FindLevel	Automatically sets trigger level to signal mean.

app.Cursors

CVARs related to the selection and placement of measurement cursors.

Child Objects

Object	Description
app.Cursors.XYCursorsMgr	Settings related to the placement and tracking of relative cursors.

app.CustomDSO

CVARs related to the CustomDSO (XDEV) option. Standard on WavePro, WaveMaster, and LabMaster oscilloscopes, available as an option on WaveRunner and most HDO oscilloscopes. Not available on HDO4000 and WaveSurfer 3000 oscilloscopes.

Actions

Action	Description
app.CustomDSO.PlugIn1Install	Installs custom program
app.CustomDSO.PlugIn1Remove	Removes custom program

app.Display

CVARs related to the oscilloscope touch screen display and the appearance of waveform traces.

Actions

Action	Description
app.Display.ClearSweeps	Clears sweeps only for persistence traces.
app.Display.DisableExternalMonitor	Exit external monitor display; resume default touch screen display.
app.Display.EnableExternalMonitor	Enter external monitor display.
app.Display.FactoryDefault	Equivalent to SetToDefault.
app.Display.OpenMonitorControls	Opens dialog for external monitor setup.
app.Display.PreviewPrintColors	Shows the instrument display in the currently selected print color palette.
app.Display.ResetAll	Turns off display persistence on any trace where it has been set.

app.Hardcopy

CVARs related to the oscilloscope Print function. This includes hardcopy print as well as print to file, send to email, and copy to clipboard.

Note: In the 64-bit XStreamDSO v.8.4.0.0 and later, many former Hardcopy CVARs have been moved to the File > Print and File > Save Screen Image dialogs. There is no longer a Hardcopy Preferences dialog in MAUI. See app.SaveRecall.

Actions

Action	Description
app.Hardcopy.EjectPaper	Sends eject command to connected printer. This action is only relevant if app.Hardcopy.Destination is set to Printer.
app.Hardcopy.Print	Initiates the print action; opens modal dialog for completing print selections.
app.Hardcopy.PrintToRemote	Performs the same action as the above command, but useful for programming languages where ending a command with the word "print" is problematic.
app.Hardcopy.ShowEmailMenu	Displays dialog for configuring Email settings.

app.History

CVARs related to the oscilloscope History Mode feature. Not available on Zi series oscilloscopes.

Child Objects

Object	Description
app.History.HistoryTable	Settings related to the History Mode tabular display.

Actions

Action	Description
app.History.Next	Displays next acquisition in history.
app.History.Previous	Displays previous acquisition in history.
app.History.HistoryTable.ClearSweeps	Clears history buffer.

app.LabNotebook

CVARs related to the LabNotebook documentation tool.

Note: In MAUI, LabNotebook CVARS have been moved to the File > Save and File > Recall dialogs. See app.SaveRecall.

Actions

Action	Description
app.LabNotebook.CreateReport	Outputs selected Notebook Entries in report format.
app.LabNotebook.DeleteAll	Deletes all Notebook Entries.
app.LabNotebook.DeleteRecord	Deletes selected Notebook Entries.
app.LabNotebook.DeviceChanged	Used internally by MAUI to propagate Windows "Device Changed" notifications to LabNotebook. Do not use.
app.LabNotebook.EmailRecord	Emails selected Notebook Entries.
app.LabNotebook.ExtractAttachmentsNow	Extracts external files attached to selected LabNotebook to path set in app.LabNotebook.ExtractFilepath.
app.LabNotebook.ExtractFilesNow	Extracts screen capture (.PNG), setup (.LSS) and trace (.TRC) files that make up the Notebook Entry into separate files.
app.LabNotebook.FilterRecords	Applies search filters to list of Notebook Entries.
app.LabNotebook.FlashBackToRecord	Invokes Flashback Recall of selected Notebook Entry. The flashback restores the screen image, waveforms, and setups saved with the entry.
app.LabNotebook.InternalView	Opens the Labnotebook Report Viewer, displaying the selec-ted entry in the report format.
app.LabNotebook.NextRecord	Displays the next Notebook Entry
app.LabNotebook.PreviousRecord	Displays the previous Notebook Entry
app.LabNotebookPrintRecord	Sends selected Notebook Entry to connected printer.
app.LabNotebook.Refresh	Refreshes the list of Notrbook Entries for the selected LabNote-book file. Primarily used by legacy LabNotebook for WaveSurfer and WaveRunner Xi oscilloscopes.
app.LabNotebook.ReportGenRefreshFromCurrentState	Generates report using current state of oscilloscope (all setups, visible waveforms, visible table data, etc.).
app.LabNotebook.Save	Saves current state of oscilloscope to new Notebook Entry.
app.LabNotebook.SaveReport	Saves contents of report window to file using current app.LabNotebook.Report* settings.
app.LabNotebook.ShowEditDescription	Displays pop-up of Notebook Entry Description for editing.
app.LabNotebook.ShowEMailMenu	Displays Email & Report Settings dialog.
app.LabNotebook.ShowScreenImageSettings	Displays pop-up of Screen Image settings for editing (linked to Area/Color Preferences button).
app.LabNotebook.ViewRecord	Displays selected Notebook Entry in report window.

app.LogicAnalyzer

CVARs related to digital logic analyzer functions. Standard on -MS/MSO model oscilloscopes, or with an optional external Mixed-Signal input device.

Child Objects

Object	Description
app.LogicAnalyzer.Digital*x*	Digital logic group settings.
app.LogicAnalyzer.Pattern	Custom logic pattern settings.

app.Math

CVARs related to Math functions F1-F*n*.

Names of the form app.Math.Functions("Fn").xxxx are an alias Collection. For example:

- app.Math.Functions("F*n*") is equivalent to app.Math.F*n*
- app.Math.Functions("F*n*").Out.Result is equivalent to app.Math.F*n*.Out.Result
- app.Math.Functions("F*n*").Zoom is equivalent to app.Math.Zoom.F*n*

Child Objects

Object	Description
app.Math.F*n*	Math functions F1 to F*n*.
app.Math.XY	CVARs controlling the display of data in X vs. Y mode. Only Valid when the instrument is in XY, XYSingle, or XYDual display modes.

Actions

Action	Description
app.Math.ClearSweeps	Clears sweeps for history functions such as average, histogram and trend.
app.Math.ResetAll	Resets all math functions to default state; all function definitions are cleared.
app.Math.ShowZoomMenu	Displays the Zoom dialog for rescaling functions.

app.Math.F*n* and app.Math.XY

CVARs related to individual math functions F1-F*n* and XY trace.

Child Objects

Object	Description
app.Math.F*n*.Operator*n*Setup	This node is dynamically created and will contain the controls for the operator currently selected into Operator*n*.
app.Math.F*n*.Zoom	Function zoom scale settings.

Actions

Action	Description
app.Math.F*n*.ClearSweeps **app.Math.XY.ClearSweeps**	Clears accumulated data for single function trace. Clears persistence X-Y plot.
app.Math.F*n*.DoResetZoom	Resets scale of F*n* trace to 1:1.
app.Math.F*n*.DoStoreToMemoryTrace	Stores F*n* trace to corresponding internal memory (e.g., F1 to M1).
app.Math.F*n*.FPHit	Opens/closes the F*n* dialog display. Each successive invocation of the command acts like a toggle.
app.Math.F*n*.ShowProcessingWeb	Open WebEditor window to create processing web to run in function. Not available on WaveSurfer and HDO4000 oscilloscopes.
app.Math.F*n*.Operator*n*Setup.DownFactor	For those operators that involve a sampling factor (such as Interpolation), decreases the sample value by one step.
app.Math.F*n*.Operator*n*Setup.UpFactor	For those operators that involve a sampling factor (such as Interpolation), increases the sample value by one step.

app.Measure

CVARs related to Measure parameters P1-P*n* (MyMeasure mode) and the statistical results and histicons which depend on them.

Names of the form app.Measure.Measure("P*n*").xxxx are an alias Collection. For example:

- app.Measure.Measure("P*n*").OutResult is equivalent to app.Measure."P*n*".OutResult
- app.Measure.Measure("P*n*").Statistics is equivalent to app.Measure.P*n*.Statistics

Child Objects

Object	Description
app.Measure.P*n*	User-defined measure parameters P1 to P*n*.
app.Measure.Premote	Used internally by MAUI for handling legacy remote commands. Do not use.

Actions

Action	Description
app.Measure.ClearAll	Resets all parameter setups, turning each of the parameters view to "off", the MeasurementType to "measure"and the selected paramEngine to "Null".
app.Measure.ClearAllHelpMarkers	Force off all 'HelpMarkers'. HelpMarkers are the on-trace annotation of measurement setup and results.
app.Measure.ClearSweeps	Clears the accumulated statistics for parameters P1 to P*n* as well as the acumulated statistics for their associated histicons.
app.Measure.SetGateToDefault	Sets the measure gate to its default state(-5 to 5 Div). Valid only when in either Std. Vertical or Std. Horizontal measurement modes. For MyMeasure, see the equivalent controls under app.Measure.P*n*.
app.Measure.ShowAllHelpMarkers	Force on all 'HelpMarkers'.

app.Measure.P*n*

CVARs related to individual measure parameters P1-P*n*.

Child Objects

Object	Description
app.Measure.P*n*.Accept	Measurement result filter settings.
app.Measure.P*n*.Operator	Settings related to selected measurement.

Actions

Action	Description
app.Measure.P*n*.HistogramThis	Draws histogram plot of measurement results.
app.Measure.P*n*.ShowProcessingWeb	Opens Web Editor window to create processing web to run in parameter. Not available on WaveSurfer and HDO4000 oscilloscopes.
app.Measure.P*n*.TrackThis	Draws track plot of measurement results.
app.Measure.P*n*.TrendThis	Draws trend plot of measurement results.
app.Measure.P*n*.Accept.FindLevel	Automatically sets filter level based on signal characteristics.
app.Measure.P*n*.Accept.FindRange	Automatically sets filter level range based on signal characteristics.
app.Measure.P*n*.Operator.FindLevel	Automatically finds measurement level based on signal characteristics.

app.Memory

CVARs related to the internal memories M1 through M*n*.

Names of the form app.Memory.Memories("M*n*").xxxx are an alias Collection. For example:

- app.Memory.Memories("M*n*").Out.Result is equivalent to app.Memory.M*n*.Out.Result
- app.Memory.Memories("M*n*").Zoom is equivalent to app.Memory.M*n*.Zoom

Child Objects

Object	Description
app.Memory.M*n*	Internal memories M1 to M*n*.

Actions

Action	Description
app.Memory.ClearAllMem	Clears the contents of all trace memories.

app.Memory.M*n*

CVARs related to memories M1-M*n*.

Child Objects

Object	Description
app.Memory.M*n*.Zoom	Memory zoom scale settings.

Actions

Action	Description
app.Memory.M*n*.ClearMem	Clears contents of memory.
app.Memory.M*n*.ClearSweeps	Clears accumulated sweeps.
app.Memory.M*n*.Copy	Copies the trace specified by the Source1 control into this memory.
app.Memory.M*n*.FPHit	Used internally by MAUI to toggle open/closed Memory Setup dialog when front panel Mem button is pressed. Not recommended for use.

app.PassFail

CVARs related to Pass/Fail testing and test Qualifiers Q1-Q*n*.

Names of the forms app.PassFail.PassFail("Qremote").xxxx and app.PassFail.PassFail("Q*n*").xxxx are alias Collections. For example:

- app.PassFail.PassFail("Qremote").Operator is equivalent to app.PassFail.Qremote.Operator
- app.PassFail.PassFail("Q*n*").Out.Result is equivalent to app.PassFail.Q*n*.Out.Result

Child Objects

Object	Description
app.PassFail.Q*n*	Settings related to test qualifier.
app.PassFail.LastPass	Returns last passed result. See Result Interface reference.
app.PassFail.NumPass	Returns number of results passed. See Result Interface reference.
app.PassFail.Rate	Returns Pass Fail rate. See Result Interface reference.

Actions

Action	Description
app.PassFail.ClearSweeps	Clears accumulated data for single function trace.

app.PassFail.Q*n*

CVARs related to individual Pass/Fail test qualifiers Q1-Q*n*. Not available on WaveSurfer and HDO4000 oscilloscopes.

Child Objects

Object	Description
app.PassFail.Q*n*.Operator	Settings related to test operator.

Actions

Action	Description
app..PassFail.Q*n*.ClearSweeps	Clears sweeps.
app..PassFail.Q*n*.Operator.ClearSweeps	Clears sweeps.
app.PassFail.Q*n*.Operator.FindLimit	When qualifier is performing a parameter comparison (Condition = Param compare), sets the maximum value in Operator Limit field.
app.PassFail.Q*n*.Operator.FindLimitUsing*n*Sigma	When qualifier is performing a parameter comparison (Condition = Param compare), sets the value in Operator Limit field using *n* Sigma. *n*:= {1, 3, 5}

app.Preferences

This set of CVARs controls user preferences for the instrument setup and operation.

Note: In MAUI, many email CVARs have been moved to the File > File Sharing and Email & Reports Settings dialogs. There is no longer an Email Preferences dialog. See app.SaveRecall.

Child Objects

Object	Description
app.Preferences.Display	Touch screen display and color preferences.
app.Preferences.Email	Email preferences.

Actions

Action	Description
app.Preferences.LanguageIcon	Displays language selection icon. This action is only valid on oscilloscope models that allow language selection.
app.Preferences.Display.ClearSweeps	Same as app.Display.ClearSweeps. Clear accumulated sweeps if Persistence display is enabled.
app.Preferences.Display.FactoryDefault	Restores all Display color CVARs to factory default settings. Linked to Preferences > Color > Factory default colors button.
app.Preferences.Display.OpenMonitorControls	Open Windows display panel for external monitor configuration.
app.Preferences.Display.PreviewPrintColors	Opens preview window of image using print color palette.
app.Preferences.Display.ResetAll	Returns all display settings to factory default.
app.Preferences.Email.ComposeMail	Launches dialog to compose cover email when file "printed" to email.
app.Preferences.Email.SendMail	Sends email message.
app.Preferences.Email.SendTestMail	Sends a message by e-mail to test the system.

app.ProbesCal

CVARs related to probe calibration feature. Not available on WaveSurfer and HDO4000 oscilloscopes.

Actions

Action	Description
app.ProbesCal.CalibrateAll*n*	Initiates full calibration of corresponding channel *n*, which includes Gain/Offset, and deskew.
app.ProbesCal.Clear*n*	Clears all calibration coefficients for corresponding channel *n*.
app.ProbesCal.DcCal*n*	Initiates a DC calibration (Gain/Offset) of corresponding channel *n*.
app.ProbesCal.Deskew*n*	Initiates a deskew calibration of corresponding channel *n*.
app.ProbesCal.RecallCalSetup	Whenever a probe calibration is applied, the scope saves the information in a file on the disk. If the scope must be rebooted for any reason, the probe calibration information is always cleared, but can be recalled using this control.

app.SpecAnalyzer

CVARs related to the Spectrum Analyzer option. Standard on HDO6000, HDO8000, and MDA800 series oscilloscopes.

Child Objects

Object	Description
app.SpecAnalyzer.SpecAn	Post-processing spectrum trace.
app.SpecAnalyzer.SpecAnTable	Spectrum measurement table.
app.SpecAnalyzer.Spectro	Spectrogram plot.
app.SpecAnalyzer.SpecWindow	Spectrum Analyzer window.
app.SpecAnalyzer.SpIn	Spectrum source trace.

Actions

Action	Description
app.SpecAnalyzer.AllMarkersOff	Turns off all markers.
app.SpecAnalyzer.MarkerToCenterFreq	Moves marker to center frequency.
app.SpecAnalyzer.MarkerToRefLevel	Moves marker to reference level.
app.SpecAnalyzer.SetDefaultMarkers	Places default markers on SpecAn trace.
app.SpecAnalyzer.SetHarmonicsMarkers	Places harmonic frequency markers on SpecAn trace.
app.SpecAnalyzer.SetPeaksMarkers	Places peaks markers on SpecAn trace.
app.SpecAnalyzer.SpecAn.ClearSweeps	Clears any accumulated result data for SpecAn trace.
app.SpecAnalyzer.SpecAnTable.ClearSweeps	Clears any accumulated result data used in computation of SpecAn table.
app.SpecAnalyzer.Spectro.ClearSweeps	Clears any accumulated result data for spectrogram plot.
app.SpecAnalyzer.SpecWindow.ClearSweeps	Clears any accumulated result data for "window" of gated spectrum trace.
app.SpecAnalyzer.SpIn.ClearSweeps	Clears any accumulated result data for spectrum source trace.

app.SaveRecall

CVARs related to saving or recalling setups, waveforms, and tabular data.

Child Objects

Object	Description
app.SaveRecall.Remote	Controls defining the scope and format of exported waveform data.
app.SaveRecall.Setup	Controls related to setup panel data.
app.SaveRecall.Table	Controls related to table data.
app.SaveRecall.Utilities	Controls related to the file directory structure.
app.SaveRecall.Waveform	Controls related to waveform data.

Actions

Action	Description
app.SaveRecall.DisableAutoSave	Turn OFF AutoSave feature/confirm disable AutoSave. (Turn ON AutoSave by setting Enum app.SaveRecall.AutoSave to Wrap or Fill.
app.SaveRecall.ShowAutoSave	Display AutoSave dialog.
app.SaveRecall.ShowDiskUtilities	Display Disk Utilities dialog.
app.SaveRecall.ShowEmailReportSettings	Display Email & Report Settings dialog.
app.SaveRecall.ShowLSIBExport	Display LSIB export dialog. (Only works when LSIB option installed.)
app.SaveRecall.ShowPrint	Display Print dialog.
app.SaveRecall.ShowRecall	Display Recall dialog.
app.SaveRecall.ShowRecallLabNotebook	Display LabNotebook settings on Recall dialog.
app.SaveRecall.ShowRecallSetup	Display Setup settings on Recall dialog.
app.SaveRecall.ShowRecallWaveform	Display Waveform settings on Recall dialog.
app.SaveRecall.ShowReportGenerator	Display Report Generator dialog.
app.SaveRecall.ShowSave	Display Save dialog.
app.SaveRecall.ShowSaveLabNotebook	Display LabNotebook settings on Save dialog.
app.SaveRecall.ShowSaveScreenImage	Display Screen Image settings on Save dialog.
app.SaveRecall.ShowSaveSetup	Display Setup settings on Save dialog.
app.SaveRecall.ShowSaveTable	Display Table settings on Save dialog.
app.SaveRecall.ShowSaveWaveform	Display Waveform settings on Save dialog.
app.SaveRecall.ShowSharing	Display File Sharing dialog.

app.SaveRecall.Remote

CVARs defining the scope and format of exported waveform data.

Actions

Action	Description
app.SaveRecall.Remote.DoExport	Used internally by MAUI to implement legacy style remote waveform transfer. Do not use.
app.SaveRecall.Remote.DoImport	Used internally by MAUI to implement legacy style remote waveform transfer. Do not use.

app.SaveRecall.Setup

CVARs related to saving or recalling setup data.

Actions

Action	Description
app.SaveRecall.Setup.DoRecallDefaultNvlPanel	Recalls the factory set NVL (preference) panel settings. These are controls which are not affected when the default panel is recalled, and includes items such as the color preferences, remote control preferences, etc. Use with care, especially when invoking over a remote connection, as it could result in the controller being disconnected when the default port is selected.
app.SaveRecall.Setup.DoRecallDefaultPanel	Recalls factory default panel settings. Equivalent to pressing Default Setup or Recall Default button.
app.SaveRecall.Setup.DoRecallPanel	Recalls setup from internal panel.
app.SaveRecall.Setup.DoRecallSetupFileDoc2	Recalls setup from selected .LSS file.
app.SaveRecall.Setup.DoSavePanel	Saves setup to internal panel.
app.SaveRecall.Setup.DoSavePanelWithPrompt	Saves setup to .LSS file with prompt for file name.
app.SaveRecall.Setup.DoSaveSetupFileDoc2	Saves setup to autogenerated .LSS file.
app.SaveRecall.Setup.NotifyRecallDefaultHook	Used internally by MAUI. Do not use.
app.SaveRecall.Setup.RecallInternal*n*	Recall setups in corresponding internal panel.
app.SaveRecall.Setup.SaveInternal*n*	Save current setup to corresponding internal panel.

app.SaveRecall.Table

CVARs related to saving table data.

Actions

Action	Description
app.SaveRecall.Table.DoSave	Saves displayed table(s) to file using app.SaveRecall.Table settings. File name is formatted <source prefix><filename string><counter>.csv
app.SaveRecall.Table.SaveFile	Saves displayed table(s) to file using app.SaveRecall.Table settings, inserting a two-character separator ("--") between the source prefix, filename string and counter, if selected (e.g., Decode1--USB3Decoding--0001.csv).

app.SaveRecall.Utilities

CVARs related to file directory structure.

Actions

Action	Description
app.SaveRecall.Utilities.CopyDir	Copies all files from path set in app.SaveRecall.Utilities.Directory
app.SaveRecall.Utilities.CopyFile	Copies file in path app.SaveRecall.Utilities.SelectedFiles
app.SaveRecall.Utilities.CreateDir	Creates path set in app.SaveRecall.Utilities.DestDirectory
app.SaveRecall.Utilities.DeleteAll	Deletes all files from path set in app.SaveRecall.Utilities.Directory
app.SaveRecall.Utilities.DeleteFile	Deletes file from path set in app.SaveRecall.Utilities.SelectedFiles
app.SaveRecall.Utilities.EmailSelectedFilesNow	Emails files from path set in app.SaveRecall.Utilities.SelectedFiles
app.SaveRecall.Utilities.NextFile	Shows next file in path set in app.SaveRecall.Utilities.Directory
app.SaveRecall.Utilities.PrevFile	Shows prev. file in path set in app.SaveRecall.Utilities.Directory
app.SaveRecall.Utilities.SaveSelectedFilesToZipNow	Zips files in path set in app.SaveRecall.Utilities.SelectedFiles

app.SaveRecall.Waveform

CVARs related to saving waveform data to external files and recalling waveform files.

Actions

Action	Description
app.SaveRecall.Waveform.DoRecall	Recall waveform from internal Memory. (Use app.SaveRecall.Remote.DoImport to import from remote directory.)
app.SaveRecall.Waveform.NextFile	Display next waveform file in directory.
app.SaveRecall.Waveform.PrevFile	Display previous waveform file in directory.
app.SaveRecall.Waveform.SaveFile	Save active waveform to file using app.SaveRecall.Waveform settings, inserting a two-character separator ("--") between the source prefix, filename string and counter, if selected (e.g.,C1--MyTrace--0001.trc). (Use app.SaveRecall.Remote.DoExport to save to remote directory.)

app.TriggerScan

CVARs related to the TriggerScan feature. Not available on WaveSurfer and HDO4000 oscilloscopes.

Actions

Action	Description
app.TriggerScan.AddNewSetup	Appends the current trigger setup to the list of TriggerScan triggers.
app.TriggerScan.DeleteAll	Deletes all stored trigger setups from the trigger list.
app.TriggerScan.DeleteSelected	Deletes the selected trigger setup from the trigger list.
app.TriggerScan.LoadSelected	Loads the trigger setup selected in the trigger list into the current trigger setup.
app.TriggerScan.LoadSetup	Loads the trigger list from the file specified in the SetupFileName control.
app.TriggerScan.SaveSetup	Saves the current trigger list into the file specified in the SetupFileName control.
app.TriggerScan.StartScan	Starts scanning. Places the scope in Normal trigger mode, and starts walking down the list of trigger setups.
app.TriggerScan.StartTraining	Starts training. This will take an acquisition on the channel specified in the TrainerSource control, and depending upon the state of the TrainEdges, TrainGlitches, TrainIntervals, TrainRunts, TrainWidths controls, creates a list of trigger setups.
app.TriggerScan.StopScan	Stops scanning.
app.TriggerScan.UpdateSelected	Updates the currently selected TriggerScan setup with the current trigger setup.

app.Utility

CVARs related to oscilloscope Utilities dialog settings.

Child Objects

Object	Description
app.Utility.DateTimeSetup	Data/Time controls.
app.Utility.Options	Option key installation/activation controls.
app.Utility.Remote	Remote control settings.

Actions

Action	Description
app.Utility.DateTimeSetup.AddOneHour	Adds one hour to current time.
app.Utility.DateTimeSetup.BackOneHour	Removes one hour from current time.
app.Utility.DateTimeSetup.SetFromSNTP	Sets the real time clock from the simple network time protocol.
app.Utility.DateTimeSetup.ShowProperties	Launches modal dialog showing current date/time settings.
app.Utility.DateTimeSetup.Validate	Validates any new settings. This action is equivalent to clicking 'Validate Changes' on the Date/Time page.

app.WaveScan

CVARs related to the WaveScan feature.

Child Objects

Object	Description
app.WaveScan.ScanDecode	Scan Decode table view controls.
app.WaveScan.ScanHisto	Scan Histogram view controls.
app.WaveScan.ScanOverlay	Scan Overlay (marker) view controls.

Actions

Action	Description
app.WaveScan.FindRare*n*Sigma	Presets the filter limit and delta to find rare events. Uses the history of measurements since the last Clear Sweeps, or control change, to set the limit and delta to capture +/- *n* sigma events. *n*:= {1,3,5}
app.WaveScan.FindSelectRarest	Presets the filter to find rarest event in acquisition.
app.WaveScan.FindUseMean	Setup the filter to find measurements with values > the current statistical mean.
app.WaveScan.ScanDecode.ClearSweeps	Clears any accumulated result data.
app.WaveScan.ScanHisto.ClearSweeps	Clears any accumulated result data.
app.WaveScan.ScanHisto.Histogram.ClearSweeps	Clears any accumulated result data.
app.WaveScan.ScanHisto.Histogram.FindScale	Automatically determine an appropriate horizontal scale for the histogram, using the values currently in the histogram buffer.
app.WaveScan.ScanHisto.Zoom.ResetZoom	Resets the zoom settings to their default values.
app.WaveScan.ScanOverlay.ClearSweeps	Clears any accumulated result data.

app.WebEditor

CVARs related to the WebEditor, which is used to create custom processing chains ("webs") associated with a single function, parameter, or Pass/Fail qualifier.

Tip: The easiest way to determine the proper syntax for WedEditor objects is to set up the WebEditor on the oscilloscope as you would like, then save a setup file. The .lss file will embed the Automation objects for that WebEditor function. This tip can be applied to any type of setup you wish to perform remotely.

Actions

Action	Description
app.WebEditor.ClearSweeps	Clears any accumulated data for nodes such as Average, Persistence, etc. that reside in the processing web.

Methods

app.WebEditor.AddConnection([in] VARIANT destProcessor, [in] VARIANT destInputPin, [in] VARIANT sourceProcessor, [in] VARIANT sourceOutputPin)

Adds a connection between two 'pins' of nodes placed within the Web Editor. Pins are described by the name of the node, and the zero-based index of the pin on that node.

app.WebEditor.AddPreview([in] VARIANT sourceProcessor, [in] VARIANT sourcePin, [in] BSTR previewName, [in] double xPosition, [in] double yPosition, [in] BSTR associatedExecName)

Adds a Preview to the specified pin of the specified node. The coordinates specify where the preview will appear on the Web, with 0,0 being the top left-hand corner.

app.WebEditor.AddProcessor([in] VARIANT processorOrClassId, [in] BSTR requestedName, [in] double xPosition, [in] double yPosition)

Adds a named 'processor' to the web. To determine the name of a processor just place it on the web using the GUI and hover the mouse over the node. The 'ProgID' of the node, in the format LeCroy.<procName>' will appear. Note that when adding processors from automation there is no distinction between Measure, Math, and Pass/Fail processors.

```
' Create a Waveform Averager, name it "MyAvg", and place it at x=200, y=30

app.WebEditor.AddProcessor "LeCroy.Average", "MyAvg", 200, 30
```

app.WebEditor.GetProcessor([in] VARIANT processor)

Retrieves a reference to a processor that has been added to the Web. This reference may then be used to access the processor's controls.

```
' Retrieve a pointer to the MyAvg averager and set it's number of sweeps
 to the value 1234

set myAverager = app.WebEditor.GetProcessor("MyAvg")
myAverager.Sweeps = 1234
```

app.WebEditor.RemoveAll()

Removes all processors from the web.

```
' Show the WebEditor and remove all processors from it

app.ActiveView = "WebEdit"
app.WebEditor.RemoveAll
```

app.WebEditor.RemoveConnection([in] VARIANT destProcessor, [in] VARIANT destInputPin)

Removes a connection between two pins on the web.

app.WebEditor.RemovePreview([in] VARIANT processor)

Removes the named preview display.

app.WebEditor.RemoveProcessor([in] VARIANT processor)

Removes the named processor from the Web.

app.Zoom

CVARs related to Zoom (Z*n*) traces.

Child Objects

Object	Description
app.Zoom.Z*n*	Zooms Z1 to Z*n*. The number depends on your oscilloscope model.

Actions

Action	Description
app.Zoom.GoToEnd	When in MultiZoom mode, scroll to the end of the source waveform, whose last point will be centered on the graticule.
app.Zoom.GoToStart	When in MultiZoom mode, scroll to the start of the source waveform, whose first point will be centered on the graticule.
app.Zoom.HorZoomIn	Horizontally zoom in all the traces included in MultiZoom.
app.Zoom.HorZoomOut	Horizontally zoom out all the traces included in MultiZoom.
app.Zoom.ResetAll	Reset all zoom traces to their default settings.
app.Zoom.ResetZoom	Resets the general zoom settings to their default values.
app.Zoom.Z*n*.ClearSweeps	Clears any accumulated result data for individual zoom trace Z*n*.
app.Zoom.Z*n*.DoStoreToMemoryTrace	Stores the content of Z*n* into the corresponding memory (M*n*).

Part 4: Automation Result Interface Reference

The following result interfaces (Out.Result objects) appear throughout the XStreamDSO object hierarchy. Their properties will generally be the same regardless of the subsystem to which they apply.

Base

Horizontal coordinate of the leftmost of the two most populated histogram peaks. It is equivalent to the paramater hbase.

Applies to: Histogram

```
Dim hbase as Double
hbase = app.Math.F1.Out.Result.Base
```

BinPopulations

Variant array containing the populations of each bin. Bin 0 is the first bin. Index the array to retrieve the number of counts in a given bin.

Applies to: Histogram

Read out BinPopulations by indexing the array using the FirstPopulatedBin and LastPopulatedBin properties as boundaries Also shows code for determining coordinate of bin centers.

```
Const STARTROW = 5
Dim i As Integer
Dim BinPops
Dim FirstPopulatedBin, LastPopulatedBin As Integer
Dim OffsetAtLeftEdge As Double
Dim BinWidth As Double

BinPops = app.Math.F1.Out.Result.BinPopulations
FirstPopulatedBin = app.Math.F1.Out.Result.FirstPopulatedBin
LastPopulatedBin = app.Math.F1.Out.Result.LastPopulatedBin
OffsetAtLeftEdge = app.Math.F1.Out.Result.OffsetAtLeftEdge
BinWidth = app.Math.F1.Out.Result.BinWidth

For i = FirstPopulatedBin To LastPopulatedBin
Cells(i - FirstPopulatedBin + STARTROW + 1, 7) = i
Cells(i - FirstPopulatedBin + STARTROW + 1, 8) = OffsetAtLeftEdge +
(BinWidth / 2) + BinWidth * i
Cells(i - FirstPopulatedBin + STARTROW + 1, 9) = BinPops(i)
Next i
```

Bins

Number of bins in the histogram.

Applies to: Histogram

```
Dim Bins as Integer
Bins = app.Math.F1.Out.Result.Bins
```

BinWidth

Width of each bin in the histogram.

Applies to: Histogram

```
Dim BinWidth as double
BinWidth = app.Math.F1.Out.Result.BinWidth
```

BusName

Name of the bus, which can be configured via the user interface or by the automation property app.LogicAnalyzer.Digital1.BusName.

Applies to: Digital

```
Dim BusName As String
BusName = app.LogicAnalyzer.Digital1.Out.Result.BusName
```

CellType

Datatype for the selected cell in a table. This is used in order to properly read out the CellValue. Variant type cells usually contain a second DataArray (i.e., table within a table) that must be indexed *in addition to* the principal table in order to return the correct value. See Exposing Table Data for examples and helper scripts.

Applies to: Table

Arguments

Row	Long	0 = first row, usually header with column descriptors	0-based index of the row containing the cell. Use the Rows property to determine the maximum number of rows.
Column	Long	0 = first column, usually row index number	0-based index of the column containing the cell. Use the Columns property to determine the maximum number of columns.
Result	Enum	0 = variant 2 = parameter 3 = Boolean 4 = histicon	Result type. Other values exist but do not apply to the Table interface.

Example

```
Dim CellType As Integer
CellType = app.SerialDecode.Decode1.Out.Result.CellType(1, 1)
```

The example above returns the CellType for row 1, column 1.

CellValue

The value for the selected cell in a table. The method for reading back CellValue depends on the cell's CellType property:

CellType = 0 (Variant), CellValue is probably an array with the last sample value plus other results, which must be indexed *in addition to* the principal table. See Exposing Table Data.

CellType = 2, CellValue is Parameter result with a discrete value.

CellType = 3, CellValue is a Boolean result.

CellType = 4, CellValue is a histicon.

Applies to: Table

Arguments

Row	Long	0 = first row	0-based index of the row containing the cell. Use the Rows property to determine the maximum number of rows.
Column	Long	0 = first column	0-based index of the column containing the cell. Use the Columns property to determine the maximum number of columns.

Example

When the CellType = 0, read out the value of a numeric cell by adding (0,0) to the cell index, as in:

```
Dim CellValue
CellValue = app.SerialDecode.Decode1.Out.Result.CellValue(3,2)(0, 0)
```

The above would return the value shown in row 3, column, 2 of the Serial Decode table.

Tip: Oscilloscopes that have a serial decoder option installed include the file D:\Scripts\TableExport.lss, a VBScript for determining the decoder table structure and outputting the decoded values.

When the CellType = 2, read out the value as follows:

```
Dim DecoderTableResult As Object
Set DecoderTableResult = app.SerialDecode.Decode1.Out.Result
Dim CellValueOb As Object
Set CellValueOb = DecoderTableResult.CellValue(1, 2)
CellValue = CellValueOb.Value
```

Columns

Number of columns in the DataArray. Typically equal to 1000 for Persist waveforms. For Tables, the result can vary depending on the application.

Applies to: Persist, Table

Persist Example

```
Dim Columns As Integer
Columns = app.SDA.Eye.Out.Result.Columns
```

Table Example

```
Dim Columns As Integer
Columns = app.SerialDecode.Decode1.Out.Result.Columns
```

DataArray

Variant array containing data for a trace. The implementation depends on the type of waveform.

Applies to: Digital, Persist, Waveform, XY

XY Interface

Arguments (optional)

arrayValuesScaled	Boolean	1 (TRUE) = data is scaled 0 (FALSE) = data is raw	Determines whether returned values are scaled or raw. Passing TRUE indicates scaled data; FALSE indicates raw data. Default is TRUE. Scaled values are double precision; raw values are 16-bit signed integers. See the properties XVerticalPerStep, XVer-ticalResolution and XVerticalOffset(and the cor-responding Y coordinate) for more information.
numSamples	Long	-1 = retrieve all data	Number of samples to retrieved. Default is -1.
startIndex	Long	0 = first sample	Index of the first sample to be retrieved. Default is 0.
sparsingFactor	Long	1 = no sparsing	Determines the sparsing factor to use. Default is 1. A sparsing factor of 5 means to retrieve every 5th point. Use the math function Sparse to configure sparsing offset.

Example

Reads values to use for DataArray arguments from a spreadsheet, then loops through the retrieved array, saving the data to the spreadsheet along with sample index and sample time.

```
Const ROWOFFSET = 10
Const COLOFFSET = 7
Dim HorizontalPerStep As Double
Dim HorizontalOffset As Double
Dim ScaleArray As Boolean
Dim nSamples As Long
Dim startIndex As Long
Dim sparseFactor As Long
Dim XYwform

ScaleArray = Cells(9, 5) nSamples = Cells(10, 5) startIndex = Cells(11, 5)
sparseFactor = Cells(12, 5)
XYwform = app.Math.XY.Out.Result.DataArray
HorizontalPerStep = app.Math.XY.Out.Result.HorizontalPerStep
HorizontalOffset = app.Math.XY.Out.Result.HorizontalOffset

For i = 0 To UBound(XYwform)
For j = 0 To 1 Cells(i + ROWOFFSET, COLOFFSET) = i
Cells(i + ROWOFFSET, COLOFFSET + 1) = HorizontalPerStep * i HorizontalOffset
Cells(i + ROWOFFSET, COLOFFSET + 2) = XYwform(i, 0)
Cells(i + ROWOFFSET, COLOFFSET + 3) = XYwform(i, 1)
Next j
Next i
```

Waveform Interface

Arguments (optional)

arrayValuesScaled	Boolean	1 (TRUE) = data is scaled 0 (FALSE) = data is raw	Determines whether returned values are scaled or raw. Passing TRUE indicates scaled data; FALSE indicates raw data. Default is TRUE. Scaled values are double precision; raw values are 16-bit signed integers. See the properties VerticalPerStep, VerticalResolution and VerticalOffset for more information.
numSamples	Long	-1 = retrieve all data	Number of samples to retrieve. Default is -1.
startIndex	Long	0 = first sample	Index of the first sample to be retrieved. Default is 0.
sparsingFactor	Long	1 = no sparsing	Determines the sparsing factor to use. Default is 1. For example, a sparsing factor of 5 means to retreive every 5th point. Use the math function Sparse in order to configure sparsing offset.

Example

Reads values to use for DataArray arguments from a spreadsheet, then loops through the retrieved array, saving the data to the spreadsheet along with sample index and sample time.

```
Const ROWOFFSET = 10
Const COLOFFSET = 7
Dim HorizontalPerStep As Double
Dim HorizontalOffset As Double
Dim ScaleArray As Boolean
Dim nSamples As Long
Dim startIndex As Long
Dim sparseFactor As Long
Dim wform

ScaleArray = Cells(9, 5) nSamples = Cells(10, 5) startIndex = Cells(11, 5)
sparseFactor = Cells(12, 5)
wform = app.Acquisition.C1.Out.Result.DataArray
HorizontalPerStep = app.Acquisition.C1.Out.Result.HorizontalPerStep
HorizontalOffset = app.Acquisition.C1.Out.Result.HorizontalOffset

For i = 0 To UBound(wform)
Cells(i + ROWOFFSET, COLOFFSET) = i
Cells(i + ROWOFFSET, COLOFFSET +1) = HorizontalPerStep * i +HorizontalOffset
Cells(i + ROWOFFSET, COLOFFSET+2) = wform(i)
Next i
```

Persist Interface

Retrieves a 2D array containing hits in each cell of the rectangle selected via the input arguments.

Arguments (optional)

numColumns	Long	-1 = retrieve all columns	Number of columns to retrieve. Default is -1.
numRows	Long	-1 = retrieve all rows	Number of rows to retrieve. Default is -1.
startColumn	Long	0 = first sample	Index of the first column to be retrieved. Default is 0.
startRow	Long	0 = first row	Index of the first row to be retrieved. Default is 0.

Example

Reads values to use for DataArray arguments from a spreadsheet, then loops through the retrieved array, saving the data to the spreadsheet.

```
Const ROWOFFSET = 10
Const COLOFFSET = 7
Dim numColumns As Long
Dim numRows As Long
Dim startColumn As Long
Dim startRow As Long
Dim wform

numColumns = Cells(9, 5) numRows = Cells(10, 5) startColumn = Cells(11, 5) startRow
= Cells(12, 5)
wform = app.SDA.Eye.Out.Result.DataArray(numColumns, numRows, startColumn,
startRow)
For i = 0 To numRows - 1
For j = 0 To numColumns - 1
Cells(i + ROWOFFSET, j + COLOFFSET) = wform(i, j)
Next j
Next i
```

Digital Interface

Retrieves a 2D array containing the state of each sample on each line. The value 1 is returned if he sample was above the threshhold, 0 if below.

Arguments (optional)

numSamples	Long	-1 = retrieve all data	Number of samples to retrieve. Default is -1.
numLines	Long	-1 = retrieve all digital lines	Number of lines to retrieve. Default is -1.
startIndex	Long	0 = first index	Index of the first sample to be retrieved. Default is 0.
startLine	Long	0 = first digital line	Index of the first line to be retrieved. Default is 0. The user selects which lines to enable; only data from enabled lines are included in the DataArray

Example

Reads values to use for DataArray arguments from a spreadsheet, then loops through the retrieved array, saving the data to the spreadsheet.

```
Const ROWOFFSET = 10
Const COLOFFSET = 7
Dim nSamples As Long
Dim nLines As Long
Dim startIndex As Long
Dim startLine As Long
Dim wform
```

```
nSamples = Cells(9, 5) nLines = Cells(10, 5) startIndex = Cells(11, 5) startLine =
Cells(12, 5)
wform = app.LogicAnalyzer.Digital1.Out.Result.DataArray(nSamples, nLines,
startIndex, startLine)
```

Saves the retrieved samples to a spreadsheet, with each digital line in a column:

```
For j = 0 To UBound(wform, 2)
For i = 0 To UBound(wform, 1)
Cells(i + ROWOFFSET, j + COLOFFSET) = wform(i, j)
Next j
Next i
```

ExtendedStatus

Reserved for future use.

Applies to: all Result Interfaces.

FirstEventTime

Absolute trigger time of the acquisition, or the time of the first trigger in an acquisition that utilizes multiple sweeps. Examples of multi-sweep acquisitions are Sequence Mode and when a source channel is configured for pre-processor averaging. Times are returned encoded as a currency value (VT_CY) within a variant, which allows the use of the full 64-bit resolution of the timestamp value. Values are referenced to 1st Jan 2000, with 1ns resolution. Note that VT_CY values are stored as 64-bit (8 byte) two's complement integers, scaled by 10,000 to give a fixed-point number with 15 digits to the left of the decimal point, and 4 digits after. See the example for details on decoding FirstEventTime as well as other properties that return times, such as LastEventTime and UpdateTime.

Applies to: all Result Interfaces

```
Dim FirstEventTime
Dim TimeString as String
FirstEventTime = app.Acquisition.C1.Out.Result.FirstEventTime
timeString = DecodeTimeProperty(FirstEventTime)

' Decode the FirstEventTime, LastEventTime and UpdateTime properties.

Function DecodeTimeProperty(ByVal EventTime) As String

Dim days, thedate, hours, thehour, minutes, theminute, seconds
Dim outstring As String
days = EventTime / (86400 * 100000#)
thedate = DateAdd("d", days, "1-Jan-00")
hours = (days - Int(days)) * 24
thehour = Int(hours)
minutes = (hours - thehour) * 60
theminute = Int(minutes)
seconds = (minutes - theminute) * 60

' Format output string:

DecodeTimeProperty = thedate & " " & thehour & ":" & theminute & ":" &seconds

End Function
```

FirstPopulatedBin

Index of the first populated bin. (The first bin of the histogram is bin 0).

Applies to: Histogram

```
Dim FirstPopulatedBin as Integer
FirstPopulatedBin = app.Math.F1.Out.Result.FirstPopulatedBin
```

HorizontalFrameStart

Coordinate of the left edge of the graticule containing the trace relative to the trigger time, which is at time = 0.

Applies to: Digital, Histogram, Persist, Waveform, XY

```
Dim XFrameStart As Double
XFrameStart = app.Acquisition.C1.Out.Result.HorizontalFrameStart
```

HorizontalFrameStop

Coordinate of the right edge of the graticule containing the trace relative to the trigger time, which is at time = 0.

Applies to: Digital, Histogram, Persist, Waveform, XY

```
Dim XFrameStop As Double
XFrameStop = app.Acquisition.C1.Out.Result.HorizontalFrameStop
```

HorizontalOffset

Time of the first sample. Note that the first sample is typically just off screen, to the left of the grid. Use this value when calculating the time for each sample.

Applies to: Digital, Histogram, Persist, Waveform, XY

```
Dim HorizontalOffset As Double
HorizontalOffset = app.Acquisition.C1.Out.Result.HorizontalOffset

Dim HorizontalPerStep As Double
HorizontalPerStep = app.Acquisition.C1.Out.Result.HorizontalPerStep

Dim SampleTime as Double
Dim i as Long
For i = 0 to numPoints-1
SampleTime = HorizontalPerStep * i + HorizontalOffset
Next
```

For a more complete example, see the Waveform example in DataArray as well as the function GetDataArray_Click.

HorizontalPerColumn

Difference in the horizontal coordinate of adjacent columns (typically in seconds). Use HorizontalPerColumn to determine the timing information for each column of the DataArray.

Applies to: Persist

```
Dim HorizontalPerColumn As Double
HorizontalPerColumn = app.SDA.Eye.Out.Result.HorizontalPerColumn
```

HorizontalPerStep

Time between samples, otherwise known as the sample interval. This is the inverse of the SampleRate.

Applies to: Digital, Histogram, Persist, Waveform, XY

```
Dim HorizontalPerStep As Double
HorizontalPerStep = app.Acquisition.C1.Out.Result.HorizontalPerStep
```

HorizontalResolution

Resolution of the readout of horizontal values. Not directly related to the sample period.

Applies to: Digital, Histogram, Persist, Waveform, XY

```
Dim HorizontalResolution As Double
HorizontalResolution = app.Acquisition.C1.Out.Result.HorizontalResolution
```

HorizontalUnits

Resolution of the readout of horizontal values. Not directly related to the sample period.

Applies to: Digital, Histogram, Persist, Waveform, XY

```
Dim HorizontalUnits As String
HorizontalUnits = app.Acquisition.C1.Out.Result.HorizontalUnits
```

HorizontalVarianceArray

Variant array with the variances from the nominal sample times. Used on WaveExpert oscilloscopes.

Applies to: Waveform, XY

```
Dim HorizontalUnits As Double
HorizontalUnits = app.Acquisition.C1.Out.Result.HorizontalUnits
```

HorizontalVariances

Number of elements in HorizontalVarianceArray. Used on WaveExpert oscilloscopes.

Applies to: Waveform, XY

```
Dim HorizontalVarianceArray
HorizontalVarianceArray =
app.Acquisition.C1.Out.Result.HorizontalVarianceArray
```

IndexOfFirstSampleInFrame

Index of the first sample that appears in the graticule. This is typically index 1, since index 0 is off- grid to the left when traces are zoomed.

Applies to: Waveform

```
Dim IndexOfFirstSampleInFrame as Long
IndexOfFirstSampleInFrame =
app.Acquisition.C1.Out.Result.IndexOfFirstSampleInFrame
```

LastEventTime

Time of the last contributing event in a set. Useful only when the result includes data produced by a sequence acquisition, or a cumulative operation such as averaging. Times are returned encoded as a currency value (VT_CY) within a variant; see description for FirstEventTime for decoding details.

Applies to: All Result interfaces.

```
Dim LastEventTime
Dim TimeString as String
LastEventTime = app.Acquisition.C1.Out.Result.FirstEventTime
TimeString = DecodeTimeProperty(LastEventTime)
```

See FirstEventTime for an example of decoding LastEventTime.

LastPopulatedBin

Index of the last populated bin. (The first bin of the histogram is bin 0).

Applies to: Histogram

```
Dim LastPopulatedBin as Long
LastPopulatedBin = app.Math.F1.Out.Result.LastPopulatedBin
```

Levels

Returns the value 2, corresponding to the number of levels possible.

Applies to: Digital

```
Dim Levels As Integer
Levels = app.LogicAnalyzer.Digital1.Out.Result.Levels
```

LineAliasName

Alias of the line name based on the input index. The alias for the line is displayed on the right side of the grid, and have values of the form "D0", "D1", etc.

Applies to: Digital

```
Dim LineAliasName0
LineAliasName0 = app.LogicAnalyzer.Digital1.Out.Result.LineAliasName(0)
```

LineName

Name of the line. This can be modified via the user interface or via the property app.LogicAnalyzer.Digital1.LineNames.

Applies to: Digital

```
Dim LineName0

LineName0 = app.LogicAnalyzer.Digital1.Out.Result.LineName(0)
```

Lines

Number of lines in the digital bus.

Applies to: Digital

```
Dim Lines

Lines = app.LogicAnalyzer.Digital1.Out.Result.Lines
```

Max

Horizontal coordinate of the left edge of the last populated bin. It is equivalent to the hmax parameter.

Applies to: Histogram

```
Dim Max as double
Max = app.Math.F1.Out.Result.Max
```

MaxPopulation

Mode of the histogram (population of the bin with the most hits).

Applies to: Histogram

```
Dim MaxPopulation as Long
MaxPopulation = app.Math.F1.Out.Result.MaxPopulation
```

MaxPopulationBin

Index of the bin with the highest population. (The first bin of the histogram is bin 0).

Applies to: Histogram

```
Dim MaxPopulationBin as Integer
MaxPopulationBin = app.Math.F1.Out.Result.MaxPopulationBin
```

MaxPopulationInRectangle

Population of the largest element in the selected rectangle.

Applies to: Persist

Arguments

numColumns	Long	-1 = use all columns	Number of columns to use. Default is -1.
numRows	Long	-1 = use all rows	Number of rows to use. Default is -1.
startColumn	Long	0 = first sample	Index of the first column. Default is 0.
startRow	Long	0 = first row	Index of the first row. Default is 0.

Example

Determining the maximum population in the rectangle.

```
Dim numColumns As Long
Dim numRows As Long
Dim startColumn As Long
Dim startRow As Long
Dim MaxPopulationInRectangle As Long

numColumns = Cells(9, 5)
numRows = Cells(10, 5)
startColumn = Cells(11, 5)
startRow = Cells(12, 5)
MaxPopulationInRectangle =
app.SDA.Eye.Out.Result.MaxPopulationInRectangle
(numColumns,numRows,startColumn,startRow)
```

Use no arguments to select the full rectangle:

```
MaxPopulationInRectangle = app.SDA.Eye.Out.Result.MaxPopulationInRectangle
```

Mean

Returns the mean value of the histogam. It is equivalent to the hmean parameter.

Applies to: Histogram

```
Dim hmean as double
hmean = app.Math.F1.Out.Result.Mean
```

Min

Horizontal coordinate of the left edge of the first populated bin. It is equivalent to the hmin parameter.

Applies to: Histogram

```
Dim hmin as double
hmin = app.Math.F1.Out.Result.Min
```

NumFrameDimensions

Number of dimensions in the current result. For waveforms, this is typically = 2, (Voltage and time) dimensions). For X-Y mode the result is 3.

Applies to: all Result Interfaces.

```
Dim NumFrameDimensions as Integer
NumFrameDimensions = app.Acquisition.C1.Out.Result.NumFrameDimensions
```

NumSamplesInFrame

Number of samples within the graticule.

Applies to: Waveform

```
Dim NumSamplesInFrame as Long
NumSamplesInFrame = app.Acquisition.C1.Out.Result.NumSamplesInFrame
```

OffsetAtLeftEdge

Horizontal coordinate of left edge of the first bin (either populated or unpopulated) displayed on the grid. Use OffsetAtLeftEdge as an offset for calculating the position of each bin.

Applies to: Histogram

Read out BinPopulations by indexing the array using the FirstPopulatedBin and LastPopulatedBin properties as boundaries Also shows code for determining coordinate of bin centers.

```
Const STARTROW = 5
Dim i As Integer
Dim BinPops
Dim FirstPopulatedBin, LastPopulatedBin As Integer
Dim OffsetAtLeftEdge As Double
Dim BinWidth As Double

BinPops = app.Math.F1.Out.Result.BinPopulations
FirstPopulatedBin = app.Math.F1.Out.Result.FirstPopulatedBin
LastPopulatedBin = app.Math.F1.Out.Result.LastPopulatedBin
OffsetAtLeftEdge = app.Math.F1.Out.Result.OffsetAtLeftEdge
BinWidth = app.Math.F1.Out.Result.BinWidth

For i = FirstPopulatedBin To LastPopulatedBin
Cells(i - FirstPopulatedBin + STARTROW + 1, 7) = i

' Calculate Bin Center:

Cells(i - FirstPopulatedBin + STARTROW + 1, 8) = OffsetAtLeftEdge +
(BinWidth / 2) + BinWidth * i
Cells(i - FirstPopulatedBin + STARTROW + 1, 9) = BinPops(i)
Next
```

Peaks

Number of peaks in the histogram.

Applies to: Histogram

```
Dim NumPeaks as Integer
NumPeaks = app.Math.F1.Out.Result.Peaks
```

PeakInfo

Variant array returning information about the peak selected in the input argument. Sending 0 returns information for the entire histogram; input values from 1 to Peaks+1 returns information about the requested peak.

Applies to: Histogram

Arguments (optional)

peakIndex	Long	0 = mean 1 = sigma 2 = unused 3 = unused 4 = FirstPopulatedBin 5 = LastPopulatedBin 6 = MaxPopulationBin 7 = MaxPopulation 8 = PopulationInside	Selects the peak of interest. 0 requests information about the entire histogram; > 0 requests information about a single peak. Default is 0.

Example

```
' Read out complete PeakInfo arrays for each peak.

Const STARTROW = 10
Const STARTCOL = 13
Dim PeakInfo
Dim i, j As Integer
Dim NumPeaks as Integer

NumPeaks = app.Math.F1.Out.Result.Peaks
For i = 0 To NumPeaks

' Index out a peak (index 0 is the entire histogram):

PeakInfo = app.Math.F1.Out.Result.PeakInfo(i)
Cells(STARTROW, STARTCOL + i) = i

' Loop through each element of the selected PeakInfo array (there are nine
elements):

For j = 0 To 8
Cells(STARTROW + j + 1, STARTCOL + i) = PeakInfo(j)
Next
Next
```

PopulationInside

Population of the histogram for events contained within the number of bins configured.

Applies to: Histogram

```
Dim PopInside as Long
PopInside = app.Math.F1.Out.Result.PopulationInside
```

PopulationOfRectangle

Population of the selected rectangle.

Applies to: Persist

Arguments

numColumns	Long	-1 = retrieve all columns	Number of columns to retrieve. Default is -1.
numRows	Long	-1 = retrieve all rows	Number of rows to retrieve. Default is -1.
startColumn	Long	0 = first sample	Index of the first column to be retrieved. Default is 0.
startRow	Long	0 = first row	Index of the first row to be retrieved. Default is 0.

Example

```
Dim numColumns As Long
Dim numRows As Long
Dim startColumn As Long
Dim startRow As Long
Dim PopulationOfRectangle As Long

numColumns = Cells(9, 5)
numRows = Cells(10, 5)
startColumn = Cells(11, 5)
startRow = Cells(12, 5)

PopulationOfRectangle =
app.SDA.Eye.Out.Result.PopulationOfRectangle
(numColumns,numRows,startColumn,startRow)
PopulationOfRectangle = app.SDA.Eye.Out.Result.PopulationOfRectangle
(numColumns,numRows,startColumn,startRow)
```

PopulationOver

Population of the events greater than the last bin.

Applies to: Histogram

```
Dim PopOver as Long
PopOver = app.Math.F1.Out.Result.PopulationOver
```

PopulationUnder

Population of the events less than the first bin.

Applies to: Histogram

```
Dim PopUnder as Long
PopUnder = app.Math.F1.Out.Result.PopulationUnder
```

RMS

RMS value of the histogram. Equivalent to the parameter hrms.

Applies to: Histogram

```
Dim hRMS as Double
hRMS = app.Math.F1.Out.Result.RMS
```

Rows

Number of rows in the DataArray (Persist) or in the table. Typically equal to 256 for Persist waveforms. For Tables, the result can vary depending on the application.

Applies to: Persist, Table

```
Dim Rows As Integer
Rows = app.SDA.Eye.Out.Result.Rows
```

Samples

Number of samples in the waveform. For the Waveform and XY interface, this is typically the number of samples configured for the acquisition (e.g. 500) plus 2. The additional two points are off-grid, one on each side. For the Digital interface, this is the number of samples in each digital line + 1.

Applies to: Digital, Waveform, XY

```
Dim Samples as Long
Samples = app.Acquisition.C1.Out.Result.Samples
```

Sdev

Standard deviation of the histogram. Equivalent to the parameter hsdev.

Applies to: Histogram

```
Dim hsdev as Double
hsdev = app.Math.F1.Out.Result.Sdev
```

Status

Result status. Status is returned as a decimal value, but should be treated like a register with the following bit values. See the example for decoding the Status result.

64-bit Hex	VT_Decimal	Status	Description
Value shown in XStreamBrowser	Value returned from Status property		
0x1	0.0001	Invalid result	Indicate that this Result cannot be used for any calculation.
0x2	0.0002	Data overflow	Result contains Overflow data or is calculated from a Result containing Overflows.
0x4	0.0004	Data underflow	Result contains Underflow data or is calculated from a Result containing Underflows.
0x8	0.0008	Some values are undefined	Result contains some values or data that are undefined.
0x10	0.0016	Less than	Actual value is likely to be less than the calculated value. Mostly used for parameter measurements.
0x20	0.0032	Greater than	Actual value is likely to be greater than the calculated value. Mostly used for parameter measurements.
0x40	0.0064	Not a pulse	Analyzed signal is not recognized as a pulse; mostly used for pulse parameter measurements.
0x80	0.0128	Not cyclic	Contains some values measured on non-cyclic signal.
0x100	0.0256	Data averaged	Calculated value is the result of an average of multiple measurements.
0x200	0.0512	Unlocked PLL	Unlocked PLL
0x400	0.1024	Other error	Indicates some other error condition, usually accompanied by a processor-specific status description.
0x800	0.2048	Other warning	Indicates some other warning condition, usually accompanied by a processor-specific status description.
0x1000	0.4096	Other info	Indicates some other informative condition, usually accompanied by a processor-specific status description.
0x2000	0.8192	Cumulative result	Cumulative processing somewhere in the chain
0x4000 to 0x200000	1.6384 to 209.7152		Reserved
0x400000	419.4304	Not an NRZ Eye	Not an NRZ Eye
0x800000	838.8608	Not an RZ Eye	Not an RZ Eye
0x1000000 to 0x80000000	1677.7216 to 214748.3648		Reserved

64-bit Hex	VT_Decimal	Status	Description
0x100000000	429496.7296	Inputs incompatible	Some incompatibility exists between inputs (e.g. units, frame, sample rate)
0x200000000	858993.4592	Algorithm limits reached	Algorithm couldn't converge or some other algorithmic limitation reached.
0x400000000	1717986.918	Bad settings	Combination of settings isn't correct.
0x800000000	3435973.837	Too little data	Not enough data to accurately perform calculation.
0x1000000000	6871947.674	Too much data	Too much data to perform calculation.
0x2000000000	13743895.35	Requires uniform horizontal interval	Uniform horizontal interval required.
0x4000000000	27487790.69	Bad units	Incorrect or invalid units
0x8000000000	54975581.39	Data range too low	Range of data values is too close to the resolution (e.g. bad signal to noise ratio).
0x10000000000	109951162.8	Data undersampled	Sample rate too low
0x20000000000	219902325.6	Poor statistics	Too few samples (e.g., to populate a data histogram to have enough statistics).
0x40000000000	439804651.1	Slow transition time	Transition time too slow (e.g., JTA time measurement accuracy for clock that requires fast edges).
0x80000000000	879609302.2	Data resampled	Data is resampled
0x100000000000	1759218604	Data interpolated	Data is interpolated (e.g., interpolating missing points in RIS).
0x200000000000	3518437209	Measurement scale imprecise	If all the data falls in the same histogram bin, one line for trend, one pixel for XY, etc.
0x400000000000	7036874418	No data available	Data not available (e.g., processing inputs disconnected or clear sweeps on cumulative processing).
0x800000000000	14073748836	Some accumulated results invalid	One or more results or values within the accumulated result were invalid and were skipped.
0x1000000000000	28147497671	Insufficient Memory	Memory limitations reached, attempted allocations failed.
0x2000000000000	56294995342	Channel not active	Source channel inactive.
0x4000000000000	1.1259E+11		Use status description (custom string)
0x8000000000000 to 0x8000000000000000			Reserved

StatusDescription

Description for each status code. See the above table.

Sweeps

Number of sweeps used for results that are based on multiple sweeps, such as averages, histograms, eye diagrams, etc.

Applies to: Digital, Histogram, Persist, Waveform, XY

```
Dim Sweeps as Long
Sweeps = app.Acquisition.C1.Out.Result.Sweeps
```

Top

Horizontal coordinate of the rightmost of the two most populated histogram peaks. It is equivalent to the paramater htop.

Applies to: Histogram

```
Dim htop as Double
htop = app.Math.F1.Out.Result.Top
```

UniformInterval

Returns if the samples are evenly spaced in time. Currently always true.

Applies to: Digital

UpdateTime

Indicates the time that particular result was most recently updated. Often, this property will show the same value as LastEventTime, but for traces such as memories (M1, M2, etc) this will be the time that the waveform was stored to the memory trace. Times are returned encoded as a currency value (VT_CY) within a variant; see description for FirstEventTime for decoding details.

Applies to: all Result Interfaces.

```
Dim UpdateTime
Dim TimeString as String
UpdateTime = app.Memory.M1.Out.Result.UpdateTime
TimeString = DecodeTimeProperty(UpdateTime)
```

See FirstEventTime for the code for the function DecodeTimeProperty, which is the example of decoding UpdateTime.

Value

Value of a parameter or of a statistic in the measurement system. When the scope has no result, it will show "---" in the measure table. When this is displayed, the Value property is not accessible. Error handling should be employed to catch errors that may occur.

Use the On Error Resume Next statement to handle situations where a measurement is not available, such as attempting to read back the frequency of a DC level, or trying to read the Sdev statistic when there is only 1 measurement.

Applies to: Param

```
' Readout all elements of the measurement parameter for P1
On Error Resume Next
Dim Value, Mean, Min, Max, Sdev, Num As Double
Value = app.measure.p1.out.Result.Value
Mean = app.measure.p1.Mean.Result.Value
Min = app.measure.p1.Min.Result.Value
Max = app.measure.p1.Max.Result.Value
Sdev = app.measure.p1.Sdev.Result.Value
Num = app.measure.p1.Num.Result.Value
```

ValueArray

Applies to: Param

Description: Retrieves a 1D array of values, typically used to return measurement results for multi-value parameters such as Period, Frequency, TIE@level, etc. ValueArray can also return the start time, stop time, and status (edge polarity) of each measurement taken in the sweep.

Arguments

numSamples	Long	-1 = retrieve all data	Number of results to be retrieved. Default is -1.
startIndex	Long	0 = first result	Index of the first result to be retrieved. Default is 0.
valueType	Integer (enum)	1 = parameter value 2 = measurement start time 4 = measurement stop time 8 = status value	Determines the value to read back. Default is 1. Use Status (8) to determine if edge measurements are of positive or negative polarity.

Example

To return multiple properties for a given parameter, set the valueType argument to the sum of the desired properties. For example, to return both the parameter value (1) and the stop time (4), set valueType to 5.

Use the On Error Resume Next statement to handle situations where no measurements were taken. The scope will show "---" when there is no result to read back.

```
Const ROWOFFSET = 16
Const COLOFFSET = 2
Dim numValues As Long
Dim startIndex As Long
Dim valueType As Integer
Dim valArray

numValues = Cells(9, 5) startIndex = Cells(10, 5)

valArray = app.measure.p1.out.Result.ValueArray(numSamples,startIndex,1)

startTimes = app.measure.p1.out.Result.ValueArray(numSamples,startIndex,2)

stopTimes = app.measure.p1.out.Result.ValueArray(numSamples,startIndex,4)

statusVals = app.measure.p1.out.Result.ValueArray(numSamples,startIndex,8)

Dim Value, Mean, Min, Max, Sdev, Num As Double
For i = 0 To UBound(valArray)
Cells(i + ROWOFFSET, COLOFFSET) = i
Cells(i + ROWOFFSET, COLOFFSET + 1) = valArray(i)
Cells(i + ROWOFFSET, COLOFFSET + 2) = startTimes(i)
Cells(i + ROWOFFSET, COLOFFSET + 3) = stopTimes(i)
Cells(i + ROWOFFSET, COLOFFSET + 4) = statusVals(i)
Next i
```

VerticalFrameStart

Vertical coordinate of the bottom edge of the graticule containing the trace.

Applies to: Digital, Histogram, Persist, Waveform, XY

```
Dim YFrameStart As Double
YFrameStart = app.Acquisition.C1.Out.Result.VerticalFrameStart
```

VerticalFrameStop

Vertical coordinate of the top edge of the graticule containing the trace.

Applies to: Digital, Histogram, Persist, Waveform, XY

```
Dim YFrameStop As Double
YFrameStop = app.Acquisition.C1.Out.Result.VerticalFrameStop
```

VerticalMaxPossible

Returns the maximum voltage that can be returned.

Applies to: Waveform

```
Dim VerticalMaxPossible As Double
VerticalMaxPossible = app.Acquisition.C1.Out.Result.VerticalMaxPossible
```

VerticalMinPossible

Returns the minimum voltage that can be returned.

Applies to: Waveform

```
Dim VerticalMinPossible As Double
VerticalMinPossible = app.Acquisition.C1.Out.Result.VerticalMinPossible
```

VerticalOffset

Potential difference between ground and the center of the screen. With VerticalOffset = +50 mV, the center of the screen represents -50 mV: with an offset of -21mV, the center represents +21 mV. (i.e., centerline voltage + VerticalOffset = 0)

Applies to: Persist, Waveform

```
Dim VerticalOffset As Double
VerticalOffset = app.Acquisition.C1.Out.Result.VerticalOffset
```

VerticalPerRow

Returns the increment of the vertical coordinate between rows (typically in volts). Use VerticalPerRow to determine the voltage information for each row of the DataArray.

Applies to: Persist

```
Dim VerticalPerRow As Double
VerticalPerRow = app.SDA.Eye.Out.Result.VerticalPerRow
```

VerticalPerStep

Smallest step size in the numerical values that can be read out from the DataArray, which utilizes 16-bit signed integer values. Note that the vertical range is almost exactly 65536 * VerticalPerStep. (See VerticalMaxPossible and VerticalMinPossible.)

Applies to: Waveform

```
Dim VerticalPerStep as Double
VerticalPerStep = app.Acquisition.C1.Out.Result.VerticalPerStep
```

VerticalResolution

Vertical resolution of the Y coordinate, which is the actual smallest difference that can be practically resolved. Using averaging can improve the resolution by the square root of the number of sweeps in the average. For example, if 16 averages are set via pre-processor averaging or by using the Average math function, the resolution is improved by a factor of 4. For 100 sweeps it improves by a factor of 10.

Applies to: Param, Waveform

```
Dim VerticalResolution as Double
VerticalResolution = app.Acquisition.C1.Out.Result.VerticalResolution
```

VerticalUnits

Units used for the vertical axis. Typically V for Volts, but other units are possible.

Applies to: Histogram, Param, Persist, Waveform

```
Dim VerticalUnits as String
VerticalUnits = app.Acquisition.C1.Out.Result.VerticalUnits
```

XFrameStart

Coordinate of the left edge of the XY graticule.

Applies to: XY

```
Dim XFrameStart As Double
XFrameStart = app.Math.XY.Out.Result.XFrameStart
```

XFrameStop

Coordinate of the right edge of the XY graticule.

Applies to: XY

```
Dim XFrameStop As Double
XFrameStop = app.Math.XY.Out.Result.XFrameStop
```

XMaxPossible

Maximum possible value of the X coordinate

Applies to: XY

```
Dim XMaxPossible As Double
XMaxPossible = app.Math.XY.Out.Result.XMaxPossible
```

XMinPossible

Minimum possible value of the X coordinate

Applies to: XY

```
Dim XMinPossible As Double
XMinPossible = app.Math.XY.Out.Result.XMinPossible
```

XOffset

Potential difference between ground and the horizontal center of the XY grid. For example, with VerticalOffset of the X coordinate's source trace = +50 mV, the center of the screen represents -50 mV: with an offset of -21mV, the center represents +21 mV. (I.e. centerline voltage + VerticalOffset = 0)

Applies to: XY

```
Dim XOffset As Double
XOffset = app.Math.XY.Out.Result.XOffset
```

XPerStep

Smallest step size in the numerical values that can be read out from the DataArray utilzing 16 bit signed integer values. Note that the X range is just about 65536 * XPerStep. (See XMaxPossible and XMinPossible.)

Applies to: XY

```
Dim XPerStep As Double
XPerStep = app.Math.XY.Out.Result.XPerStep
```

XResolution

Vertical resolution of the X coordinate, which is the actual smallest difference that can be practically resolved. Using averaging can improve the resolution by the square root of the number of sweeps in the average. For example, if 16 averages are set via pre-processor averaging or by using the Average math function, the resolution is improved by a factor of 4. For 100 sweeps it improves by a factor of 10.

Applies to: XY

```
Dim XResolution As Double
XResolution = app.Math.XY.Out.Result.XResolution
```

XUnits

Units of the X coordinate. Typically V for Volts, unless a current probe is in use, in which case it is A for Amperes.

Applies to: XY

```
Dim XUnits As String
XUnits = app.Math.XY.Out.Result.XUnits
```

YFrameStart

Coordinate of the bottom edge of the XY graticule.

Applies to: XY

```
Dim YFrameStart As Double
YFrameStart = app.Math.XY.Out.Result.YFrameStart
```

YFrameStop

Coordinate of the top edge of the XY graticule.

Applies to: XY

```
Dim YFrameStart As Double
YFrameStart = app.Math.XY.Out.Result.YFrameStart
```

YMaxPossible

Minimum possible value of the Y coordinate.

Applies to: XY

```
Dim YMaxPossible As Double
YMaxPossible = app.Math.XY.Out.Result.YMaxPossible
```

YMinPossible

Minimum possible value of the Y coordinate.

Applies to: XY

```
Dim YMinPossible As Double
YMinPossible = app.Math.XY.Out.Result.YMinPossible
```

YOffset

Potential difference between ground and the vertical center of the XY grid. For example, with VerticalOffset of the Y coordinate's source trace = +50 mV, the center of the screen represents -50 mV: with an offset of -21mV, the center represents +21 mV. (centerline voltage + VerticalOffset = 0)

Applies to: XY

```
Dim YOffset As Double
YOffset = app.Math.XY.Out.Result.YOffset
```

YPerStep

Smallest step size in the numerical values that can be read out from the DataArray utilzing 16 bit signed integer values. Note that the Y range is just about 65536 * YPerStep. (See YMaxPossible and YMinPossible.)

Applies to: XY

```
Dim YPerStep As Double
YPerStep = app.Math.XY.Out.Result.YPerStep
```

YResolution

Vertical resolution of the Y coordinate, which is the actual smallest difference that can be practically resolved. Using averaging can improve the resolution by the square root of the number of sweeps in the average. If 16 sweeps are averaged via pre-processor averaging or by using the Average math function, the resolution is improved by a factor of 4; over 100 sweeps, it improves by a factor of 10.

Applies to: XY

```
Dim YResolution As Double
YResolution = app.Math.XY.Out.Result.YResolution
```

YUnits

Units of the Y coordinate. Typically V for Volts, Typically V for Volts, unless a current probe is in use, in which case it is A for Amperes.

Applies to: XY

```
Dim YUnits As String
YUnits = app.Math.XY.Out.Result.YUnits
```

Part 5: IEEE 488.2 Programming Reference

Teledyne LeCroy implemented a subset of the IEEE 488.2 General Purpose Interface Bus (GPIB) for remote control of oscilloscopes from a PC or other controller device. The original implementation utilized a GPIB interface, and subsequently drivers and utilities were added for sending encapsulated GPIB commands over ENET and other interfaces.

The examples in this reference are intended to show IEEE 488.2 command syntax, rather than to detail how to program a GPIB interface. However, where examples are given, they assume the use of a National Instruments GPIB card and some form of the BASIC programming language:

- Variables ending with % are integers.
- Variables ending with $ are strings.
- Where INCLUDES are mentioned, this points to the need to couple the program to the GPIB by including some drivers.

Note: It is not necessary to use a GPIB interface in order to use the legacy 488.2 commands with Teledyne LeCroy oscilloscopes. The remote interface to the oscilloscope can be made over a LAN using NI-VISA, ActiveDSO, etc. If you *are* using the GPIB interface, any programming language can be used provided it can be linked to GPIB.

GPIB Overview

The IEEE 488.2 General Purpose Interface Bus (GPIB) is similar to a standard computer bus. While the computer interconnects circuit cards by means of a backplane bus, the GPIB interconnects independent devices (oscilloscopes and computers, for example) by means of a cable bus.

The GPIB carries both interface and program messages.

- **Interface messages** manage the bus itself. They perform functions such as the initialization, addressing and unaddressing of devices, and the setting of remote and local modes.
- **Program messages** (often called device-dependent messages) contain programming instructions, status information, and data–such as oscilloscope set up instructions and measurement data.

Devices connected by GPIB can be listeners, talkers, or controllers. A talker sends program messages to one or more listeners, while a controller manages the flow of information on the bus by sending interface messages to the devices.

When GPIB is implemented with Teledyne LeCroy oscilloscopes, the oscilloscope can be a talker or listener, but *not* a controller. The controller functions are handled by another instrument, usually a PC. The host computer must be able to play all three roles.

The details of how the controller configures the GPIB for different functions is specific to each GPIB interface and can be found in the GPIB interface manufacturer's manual.

Note: VISA and ActiveDSO drivers perform all GPIB interface functionality, so you do not need to learn the lower-level details of the GPIB bus to use the IEEE 488.2 commands.

Interface Definitions

Teledyne LeCroy oscilloscope interface capabilities include the following IEEE 488.1 definitions:

- **AH1** - Complete Acceptor Handshake
- **SH1** - Complete Source Handshake
- **L4** - Partial Listener Function
- **T5** - Complete Talker Function
- **SR1** - Complete Service Request Function
- **RL1** - Complete Remote/Local Function
- **DC1** - Complete Device Clear Function
- **DT1** - Complete Device Trigger
- **PP1** - Parallel Polling: remote configurable
- **C0** - No Controller Functions
- **E2** - Tri-state Drivers

IEEE 488.1 Standard Messages

The IEEE 488.1 standard (of which IEEE 488.2 can be considered an extension) specifies not only the mechanical and electrical aspects of the GPIB, but also the low-level transfer protocol. For instance, it defines how a controller addresses devices, turns them into talkers or listeners, resets them, or puts them in the remote state. Such interface messages are executed through the interface management lines of the GPIB, usually with ATN true. All these messages except GET are executed immediately upon receipt.

The Command Reference in this manual does not contain a command for clearing the input or output buffers or for setting the oscilloscope to the remote state because such commands are already specified as IEEE 488.1 standard messages. Refer to the GPIB interface manual of the host controller as well regarding its support programs, which should contain special calls for the execution of these messages.

Note: In addition to the IEEE 488.1 interface message standards, the IEEE 488.2 standard specifies certain standardized program messages (or command headers). They are identified in the Command Reference section with a leading asterisk ***** .

Remote Enable, RWLS

Teledyne LeCroy oscilloscopes do not lock out any local controls when placed in the remote state, or in RWLS. They always accept remote and local control inputs (unless the remote control capability is turned off).

Device Clear, DCL

In response to a universal Device CLear (DCL) or a Selected Device Clear message (SDC), the oscilloscope clears the input or output buffers, cancels the interpretation of the current command (if any) and clears pending commands. However, status registers and status-enable registers are not cleared. Although DCL will have an immediate effect, it can take several seconds to execute if the oscilloscope is busy.

Group Execute Trigger

The Group Execute Trigger message (GET) causes the oscilloscope to arm the trigger system, and is functionally identical to the *TRG command.

Interface Clear, IFC

The Interface Clear message (IFC) initializes the GPIB but has no effect on the operation of the oscilloscope.

Program Message Format

GPIB program messages are composed of commands and/or queries separated by semicolons and ending with a terminator:

```
<command/query>; . . . ;<command/query> <terminator>
```

Note: A terminator is required but is not shown in examples because usually it is automatically added by the interface driver routine writing to GPIB.

The general form of a command or a query consists of an optional **header path**, followed by a command **header**, followed by one or several **parameters**:

```
[header path:]<header>[?] [<parameter>,...,<parameter>]
```

The following rules apply:

- There is a space between the header and the first parameter.
- Commas separate parameters.
- The question mark [?] is optional and turns the command into a query.
- You can use uppercase or lowercase characters, or both, in program messages; the oscilloscope does not distinguish between them. An exception is the MESSAGE command, which can faithfully transmit strings containing both lowercase and uppercase letters.

Commands and queries are executed in the order in which they are received through remote transmission.

Commands and Queries

Program messages are made up of one or more commands or queries:

- **Commands** direct the oscilloscope to change its state, for example, its timebase or vertical sensitivity.
- **Queries** ask the oscilloscope to return data, such as a measurement, register value or state information. They are recognized by **?** following the header.

Usually, you will use the same characters for a command and a query, the query being identified by "?" as the final character. The portion of the header preceding the question mark is repeated as part of the response message.

For example, to change the timebase to 2 ms/div, send this command to the oscilloscope:

```
TIME_DIV 2E-3
```

To ask the oscilloscope about its timebase setting, send this query:

```
TIME_DIV?
```

You will receive a response like:

```
TIME_DIV 2E-3 S
```

Tip: Querying can be a useful way of generating a command that is known to be correct, and the response copied straight into your program. The repeated header text can be suppressed with the command COMM_HEADER.

Header path

Certain commands or queries apply to a subsection of the oscilloscope, such as a single input channel or trace. These commands must have their headers prefixed with a path name indicating the recipient of the command.

The header path normally consists of a two-letter path name followed by a colon **:** immediately preceding the command header.

EXAMPLE: C1:OFST -300 MV is a command to set the offset of Channel 1 to -300 mV.

The target waveform trace is specified using the following header path names:

Header Path Name	Waveform Trace
C1 to C*n*	Channels
M1 to M*n*	Memory traces
F1 to F*n*	Math function traces
TA, TB, TC, TD	Equivalent to F1 through F4, for backward compatibility with legacy instruments
EX, EX10, EX5	External trigger
LINE	LINE source for trigger

Note: When older trace names are used, such as TC, the oscilloscope response shows the new label equivalent. So, a TC header path query would return as an F3 header path response.

Header paths need only need be specified once until the path changes. Subsequent commands without header paths are assumed to refer to the most recently defined path.

Although optional, it's recommended to always use header paths to minimize the risk of error if the command order changes.

Header

The header is the mnemonic form of the operation to be performed by the oscilloscope, what we usually think of as the command or query. Most command and query headers have a long form, which allows them to be read more easily by people, and a short form for better transfer and decoding speed. The two are fully equivalent and can be used interchangeably.

EXAMPLE: TRIG_MODE AUTO and TRMD AUTO are two separate but equivalent commands for switching to the automatic trigger mode.

Some command or query mnemonics are imposed by the IEEE 488.2 standard. They are standardized so different oscilloscopes present the same programming interface for similar functions. All these mnemonics begin with an asterisk `*`.

Parameters

Whenever a command or query uses additional parameter values, the values are expressed as ASCII characters.

ASCII data can take the form of character, numeric, string, or block data. See Data Types.

There is a single exception: the transfer of waveforms with the WAVEFORM command/query, where the waveform can be expressed as a sequence of binary data values. Refer to the Waveform Transfer topic for details.

Terminator

The oscilloscope does not decode an incoming program message before receiving its terminator unless the message is longer than the 256 byte input buffer (at which point the oscilloscope starts analyzing the message once the buffer is full).

Most interface driver software will send the program message with the required terminators. You do not have to include them in your programs. See I/O Buffers for more information.

Data Types

ASCII data can have the form of **character**, **numeric**, **string**, or **block** data.

Character Data

These are simple words or abbreviations indicating a specific action.

```
F3:TRA ON
```

The data value ON commands the trace F3 to be turned on (the data value OFF has the opposite effect).

This example can become more complex. In some commands, where you can specify as many as a dozen different parameters, or where not all the parameters are applicable at the same time, the format requires pairs of data values. The first value names the parameter to be modified, while the second gives its value. *Only the parameter pairs to be changed must be specified.*

```
HARDCOPY_SETUP DEV,EPSON,PORT,GPIB
```

Here, two pairs of parameters are used. The first specifies the device as an EPSON (or compatible) printer, while the second indicates the GPIB port.

The command HARDCOPY_SETUP allows many more parameters other than the ones specified here. Either they are not relevant for printers or they are left unchanged.

Numeric Data

The numeric data type is used to enter quantitative information. Numbers can be entered as integers, fractions, or exponents:

- **`F1:VPOS -5`** - Move the display of Trace A downward by five divisions.
- **`C2:OFST 3.56`** - Set the DC offset of Channel 2 to 3.56 V.
- **`TDIV 5.0E-6`** - Adjust the timebase to 5 µsec/div.

There are many ways to set the oscilloscope's timebase to 5 µsec/div, such as:

- **`TDIV 5E-6`** - Exponential notation, without any suffix.
- **`TDIV 5 US`** - with multiplier U (1E-6) and (optional) unit S for seconds

String Data

This data type enables you to transfer a (long) string of characters as a single parameter. Simply enclose any sequence of ASCII characters between single or double quotation marks:

```
MESSAGE 'Connect probe to point J3'
```

Note: The oscilloscope displays this message in the message bar at the bottom of the touch screen display.

Block Data

These are binary data values coded in hexadecimal ASCII: four-bit nibbles translated into the digits 0 through 9 or A through F, and transmitted as ASCII characters. They are used only for the transfer of waveforms from the oscilloscope to the controller (WAVEFORM) and for instrument panel setups (PANEL_ SETUP).

Response Messages

The oscilloscope sends a response message to the controller in answer to a query. The format of such messages is the same as that of program messages: individual responses in the format of commands, separated by semicolons ; and ending in terminators (not shown in these examples). These messages can be sent back to the oscilloscope in the form in which they were received as valid commands.

For example, when the controller sends the program message:

```
TIME_DIV?;TRIG_MODE NORM;C1:COUPLING?
```

The oscilloscope might respond with:

```
TIME_DIV 50 NS;C1:COUPLING D50
```

The response message refers only to the queries: the TRIG_MODE command is left out. If this response is sent back to the oscilloscope, it is a valid program message for setting its timebase to 50 ns/div and the input coupling of Channel 1 to 50 Ω.

This table outlines syntactical variations between program messages and response messages. The oscilloscope keeps to stricter rules for response messages than for acceptance of program messages.

Program	Response
Uppercase or lowercase characters	Always uppercase characters
May contain extraneous spaces or tabs (white space)	No extraneous spaces or tabs (white space)
May contain a mixture of short and long command or query headers	Use short headers by default Can use COMM_HEADER command to force the oscilloscope to use long headers, or none at all

Tip: Many drivers set up COMM_HEADER in an Initialization function. COMM_HEADER need only be set up once, typically in the configuration stage of your application. There may be programmatic advantages to removing the headers from responses, especially if the return data will be read into another program.

Waveforms you obtain from the oscilloscope using the query WAVEFORM? are a special kind of response message. Control their exact format by using the COMM_FORMAT and COMM_ORDER commands.

Whenever you expect a response from the oscilloscope, you must have the control program instruct the bus to read from the oscilloscope. If the controller sends another program message without reading the response to the previous one, the response message in the output buffer of the oscilloscope is discarded. Depending on the state of the oscilloscope and the computation to be done, several seconds may pass before a response to a query is received.

Note: Remote command interpretation does *not* have priority over other oscilloscope activities. Set the controller I/O timeout conditions to three or more seconds to give the oscilloscope time to respond. An incorrect query will not get a response, but a beep will sound if the Remote Control Assistant is enabled.

I/O Buffers

The oscilloscope has 256-byte input and output buffers. An incoming program message is not decoded before a message terminator has been received.

Valid GPIB terminators are:

- **<NL> -** New line character, meaning, the ASCII new-line character (decimal value is 10).
- **<NL><EOI> -** New Line character with a simultaneous <EOI> signal.
- **<EOI><EOI> -** Signal together with the last character of the program message.

Note: Terminators are often not shown in examples because they are handled by the driver software, although they are required. The **<NL> <EOI>** terminator is always used in response messages sent by the oscilloscope to the controller.

However, if the input buffer becomes full (because the program message is longer than the buffer), the oscilloscope starts analyzing the message. In this case, data transmission is temporarily halted, and the controller may generate a timeout if the limit was set too low.

Making Service Requests

When the oscilloscope is used in a remote application, events often occur asynchronously; meaning, at unpredictable times for the host computer. The most common example of this is a trigger wait after the oscilloscope is armed. In such a case, the controller must wait until the acquisition is finished before it can read the acquired waveform.

The simplest way of checking if a certain event has occurred is by either continuously or periodically reading the status bit associated with it until the required transition is detected.

A more efficient way of detecting events occurring in the oscilloscope is to use Service Request (**SRQ**). This GPIB interrupt line can be used to interrupt program execution in the controller. The controller can then execute other programs while waiting for the oscilloscope.

The SRQ bit is latched until the controller reads the Status Byte Register (STB). The action of reading the STB with the command *STB? clears the register contents except the MAV bit (bit 4) until a new event occurs. Service requesting can be disabled by clearing the SRE register with the *SRE 0 command.

Unfortunately, not all interface manufacturers support the programming of interrupt service routines. In particular, National Instruments supports only the SRQ bit within the ISTA% status word. This requires you to continuously or periodically check this word, either explicitly or with the function call IBWAIT.

Enabling SRQ

In the default state, SRQ is disabled. To enable SRQ, set the Service Request Enable register with the *SRE command, specifying which event should generate an SRQ.

The oscilloscope then interrupts the controller when the selected event(s) occur by asserting the SRQ interface line. If several devices are connected to the GPIB, you may be required to identify which oscilloscope caused the interrupt by serial polling the various devices.

INR and INB

This event is tracked by the INR register, which is reflected in the SRE register as the INB summary bit in position 0. Since bit position 0 has the value 1, the command *SRE 1 enables the generation of SRQ whenever the INB summary bit is set.

In addition, the events of the INR register that may be summarized in the INB bit must be specified. The event "new signal acquired" corresponds to INE bit 0 (value 1) while the event "return-to-local" is assigned to INE bit 2 (value 4). The total sum is 1 + 4 = 5. So, the command INE 5 is needed:

```
CMD$ = "INE 5 ; *SRE 1" : CALL IBWRT (SCOPE%, CMD$)
```

Taking Instrument Polls

You can regularly monitor state transitions within the oscilloscope by polling selected internal status registers.

Four basic polling methods are used to detect the occurrence of a given event: **continuous**, **serial**, **parallel**, and ***IST**. The simplest of these is continuous polling while the others are appropriate only when interrupt-service routines (servicing the SRQ line) are supported, or multiple devices on GPIB require constant monitoring.

The following examples accomplish the same goal (determining whether a new acquisition has taken place) in order to emphasize the differences between the polling methods. The examples use board-level GPIB function calls. It is assumed that the controller (board) and the oscilloscope (device) are located at addresses 0 and 4, respectively.

The listener and talker addresses for the controller and the oscilloscope are:

Logic Device	Listener Address	Talker Address
External Controller	32 (ASCII<space>)	64 (ASCII @)
Oscilloscope	32 + 4 = 36 (ASCII $)	64 + 4 = 68 (ASCII D)

Continuous Polling

A status register is continuously monitored until a transition is observed. This is the most straightforward method for detecting state changes, but may not be practical in certain situations, especially with multiple device configurations.

In the following example, the event "new signal acquired" is observed by continuously polling the Internal State Change Register (INR) until the corresponding bit (in this case bit 0, or value 1) is non-zero, indicating a new waveform has been acquired. Reading INR clears this at the same time, so there is no need for an additional clearing action after a non-zero value is detected. The CHDR OFF command instructs the oscilloscope to omit any command headers when responding to a query, simplifying the decoding of the response. The oscilloscope then sends "1" instead of "INR 1" as follows:

Example: Continuous Polling

```
CMD$ = "CHDR OFF"
CALL IBWRT (SCOPE%, CMD$)
MASK% = 1  ' New Signal Bit has value 1
DO
CMD$ = "INR?"
CALL IBWRT (SCOPE%, CMD$)
CALL IBRD (SCOPE%, RD$)
NEWSIG% = VAL (RD$) AND MASK%
LOOP UNTIL NEWSIG% = MASK%
```

Serial Polling

Serial polling takes place once the SRQ interrupt line has been asserted, and is only advantageous when you are using several oscilloscopes at once. The controller finds which oscilloscope has generated the interrupt by inspecting the SRQ bit in the STB register of each. Because the service request is based on an interrupt mechanism, serial polling offers a reasonable compromise in terms of servicing speed in multiple-device configurations.

The following example uses the command INE 1 to enable the event "new signal acquired" for reporting the INR to the INB bit of the status byte STB. The command *SRE 1 enables the INB of the status byte to generate an SRQ whenever it is set. The function call IBWAIT instructs the computer to wait until one of three conditions occurs:

- &H8000 in the mask (MASK%) corresponds to a GPIB error.
- &H4000 to a timeout error.
- &H0800 to the detection of RQS (ReQuest for Service) generated by the SRQ bit.

Whenever IBWAIT detects RQS, it automatically performs a serial poll to find out which oscilloscope generated the interrupt. It only exits if a timeout occurs or if the oscilloscope (SCOPE%) generated SRQ. The additional function call IBRSP fetches the value of the status byte, which may be further interpreted. To work properly, the value of "Disable Auto Serial Polling" must be set to "off" in the GPIB handler (use IBCONF.EXE to check).

Example: Serial Polling

```
CMD$ = "*CLS ; INE 1;*SRE 1"
CALL IBWRT (SCOPE%, CMD$)
MASK% = &HC800
CALL IBWAIT (SCOPE%, MASK%)
IF (IBSTA% AND &HC000) <> 0 THEN PRINT "GPIB or Timeout Error" : STOP
CALL IBRSP (SCOPE%, SPR%)
PRINT "Status Byte =.", SPR%
```

After the serial poll is completed, the RQS bit in the STB status register is cleared. Note that the other STB register bits remain set until they are cleared by means of a *CLS command or the oscilloscope is reset. If these bits are not cleared, they cannot generate another interrupt.

Parallel Polling

Like serial polling, this is only useful when several oscilloscopes are connected. The controller simultaneously reads the Individual STatus bit (IST) of all oscilloscopes to determine which one needs service. This method allows up to eight different oscilloscopes to be polled at the same time.

When a parallel poll is initiated, each oscilloscope returns a status bit over one of the DIO data lines. Devices may respond either individually, using a separate DIO line, or collectively on a single data line. Data-line assignments are made by the controller using a Parallel Poll Configure (PPC) sequence.

The following example uses the INE 1 command to enable the event "new signal acquired" in the INR for reporting to the INB bit of the status byte STB. The PaRallel poll Enable register (PRE) determines which events are summarized in the IST status bit. The command *PRE 1 enables the INB bit (when first set itself) to set the IST bit. Once parallel polling is established, the parallel-poll status is examined until a change on data bus line DIO2 takes place.

Example: Parallel Polling, Stage 1

Enable the INE and PRE registers; configure the controller for parallel poll; instruct the oscilloscope to respond on data line 2 (DIO2) using these commands:

```
CMD1$ = DSOListenPCTalk$          'As defined earlier
CALL IBCMD (BRD0%, CMD1$)
CMD$ = "INE 1;*PRE 1"
CALL IBWRT (BRD0%, CMD$)
PPE$ = Chr$ (&H5)                 'GPIB Parallel Poll Enable
MSA9$ = Chr$ (&H69)               'GPIB Secondary Address 9
CMD4$ = PPE$ + MSA9$ + UnListen$
CALL IBCMD (BRD0%, CMD4$)
```

Example: Parallel Polling, Stage 2

Parallel poll the oscilloscope until DIO2 is set using these commands:

```
Do
CALL IBRPP (BRD0%, PPR%)
Loop Until (PPR% AND &H2) = 2
```

Example: Parallel Polling, Stage 3

Disable parallel polling (hex 15) and clear the parallel poll register using these commands:

```
PPU$ = Chr$ (&H15)               'GPIB Parallel Poll Unconfigure
CALL IBCMD (BRD0%, PPU$)
CALL IBCMD (BRD0%, CMD1$)        'As defined earlier
CMD$ = "*PRE 0" : CALL IBWRT(BRD0%,CMD$):
```

*IST Polling

Read the state of the Individual STatus bit (IST) returned during parallel polling by sending the *IST? query. Enable this poll mode, by initializing the oscilloscope for parallel polling by writing into the PRE register. Since *IST emulates parallel polling, apply this method wherever parallel polling is not supported by the controller.

In the following example, the command INE 1 enables the event "new signal acquired" in the INR for reporting to the INB bit of the status byte STB. The command *PRE 1 enables the INB bit (when first set itself) to set the IST bit. The command CHDR OFF suppresses the command header in the oscilloscope's response, simplifying the interpretation. The status of the IST bit is then continuously monitored until set by the oscilloscope:

*Example: *IST Polling*

```
CMD$ = "CHDR OFF; INE 1; *PRE 1"
CALL IBWRT (SCOPE%, CMD$)
DO
CMD$ = "*IST?"
CALL IBWRT (SCOPE%, CMD$)
CALL IBRD (SCOPE%, RD$)
LOOP UNTIL VAL (RD$) = 1
```

Timing and Synchronization

Depending on how your remote program is written, it may be affected by timing changes between different oscilloscopes. Most timing and synchronization problems are related to changing acquisitions, or the completion of analysis after an acquisition occurs.

Say that you change the Offset of C1 while the oscilloscope is in Auto trigger mode, and then use the PAVA? query to read a parameter computed on C1. In newer oscilloscopes, the processing is overlapped with the next acquisition and, as a consequence, the PAVA? result may have come from the acquisition prior to the offset change.

There are several ways to ensure your program provides correct results when remotely controlling the oscilloscope.

Control the Trigger Mode

When in Single trigger mode, acquisitions do not overlap. You can use the status registers available in the instrument, or the *OPC? query and the WAIT command to detect acquisition and processing completion.

When you arm the oscilloscope by sending the TRMD SINGLE command, the instrument automatically performs any necessary calibrations before it acquires any data. These calibrations may take several seconds, so if you query the status immediately after sending the TRMD SINGLE command, set the GPIB (or remote) timeout to least 10 seconds and prevent a timeout before receiving the correct results.

A case where you may need to use Normal or Auto trigger mode involves the accumulation of many acquisitions for averaging or histogramming functions. In this case, it is best to stop the acquisitions, set up the oscilloscope, and then set the trigger mode to Normal when acquiring the data.

A possible alternative would be to use Sequence trigger mode. It is faster, but does require knowing how many acquisitions to accumulate. This number can be specified and captured using sequence mode.

Reduce Calibrations

When operating in Dynamic Calibration mode, the default on older MAUI oscilloscopes, calibrations are performed whenever your program changes some acquisition settings such as Volts/Div or the number of active channels. Calibrations are also performed if the oscilloscope temperature significantly changed. The calibrations may be disabled by sending the AUTO_CALIBRATE OFF command. While oscilloscope performance may be degraded if the temperature changes and does not self-calibrate, a calibration can always be forced by issuing the *CAL? command.

Using this forced calibration technique allows you to control their timing so they do not interfere while acquiring important data.

Use Status Registers

Status registers store a record of events and conditions occurring inside the oscilloscope. Some of the events recorded include:

- The acquisition of new data
- When processing completes
- When printing (hardcopy) completes
- When an error occurs

Programmers can use the registers to sense the instrument's condition by polling until the desired status bit is set. A status register can be polled by querying its associated remote command (*STB, INR?, *ESR). Alternatively, the oscilloscope can request service from the controller by using the mask registers to select the events of interest.

The following procedure shows the steps necessary for acquiring data using the status registers for synchronization.

1. STOP the acquisition.
2. (Commands to) set up the oscilloscope.
3. Clear status registers.
4. Set up mask register (if needed).
5. ARM or TRMD SINGLE to start the acquisition.
6. Poll status registers or wait for service request.

(Various commands/queries) to read data, cursors, and parameter measurements.

If the data has already been acquired and you want to perform further analysis (math, parameters, cursors), you can proceed as follows:

1. Clear status registers.
2. Set up mask register (if needed).
3. (Commands to) change math functions, parameters, cursors, etc. as required for analysis.
4. Poll status registers or wait for service request.
5. (Commands/queries to) read data, cursors, and parameter measurements.

Use *OPC? and WAIT

The acquisition WAIT command (not to be confused with the IEEE 488.2 standard *WAI command):

- Waits for the acquisition to complete, but does not wait for the processing.
- Allows you to specify an optional timeout so that if the oscilloscope does not trigger, your program does not hang.

Note: If you use the timeout method, it is strongly advised to then check the status registers with *OPC? to ensure the oscilloscope actually triggered and any processing has completed.

The *OPC? query returns a 1 when the previous commands have finished. This means you can use this query with the WAIT command to synchronize the oscilloscope with your controller, using the procedure shown here:

1. STOP the acquisition.
2. (Commands to) set up the oscilloscope.
3. ARM or TRMD SINGLE to start the acquisition.
4. WAIT for trigger and acquisition to complete.
5. *OPC? to ensure processing is complete.
6. (Commands/queries to) read data, cursors, and measurement parameters.

Waveform Transfer

A waveform can be said to have two main parts:

- Its basic data array: raw data values from the oscilloscope's ADCs (Analog-to-Digital Converters) obtained during the waveform capture.
- The description accompanying this raw data: vertical and horizontal scale or time of day, for example, necessary for a full understanding of the information contained in the waveform.

When these parts are transmitted together, the descriptor comes first. You can access the waveform descriptive information by remote control using the INSPECT? query, which interprets it in ASCII text form.

Waveform data can then be either:

- Read off the oscilloscope using the WAVEFORM? query
- Written back into the oscilloscope with the WAVEFORM command

Using the STORE and STORE_SETUP commands, you can also store waveform data in preformatted ASCII output for popular spreadsheet and math processing packages.

Analog Waveform Template

Your instrument contains a commented waveform template that provides a detailed description of how analog waveform data is organized. Use the TEMPLATE? query to access the template file used by the oscilloscope. This can be done locally on the oscilloscope, with no need for a remote connection, using these steps:

1. Choose **File > Minimize** to show the Windows desktop.
2. Launch the **WaveStudio** software.
3. **Add Scope** using the **Network** connection. Enter "**localhost**" in the address field.
4. Open the **Terminal** and enter the query **TEMPLATE?**.
5. To save the contents of the window to a file:
   - Open Notepad.
   - In the WaveStudio Terminal window, right-click (touch-and-hold) and Select All.
   - Right-click again and Copy.
   - Paste the contents into NotePad and save as a .txt file.

Tip: If you have WaveStudio installed on a PC, the same can be done remotely using whatever connection type is configured on the oscilloscope and the appropriate address.

Note: An older version of the waveform template file is installed on the oscilloscope in C:\Program Files\LeCroy\XStream\93XX.tpl. Despite the .TPL extension, this is an ASCII file that can be viewed with any text editor.

Logical Data Blocks

Each waveform normally contains at least a Waveform Descriptor block and one data array block. Additional blocks may also be present in more complex waveforms.

- **Waveform Descriptor block (WAVEDESC) -** This includes all the information necessary to reconstitute the display of the waveform from the data, including hardware settings at the time of acquisition, the exact time of the event, kinds of processing performed, your oscilloscope name and serial number, the encoding format used for the data blocks, and miscellaneous constants.
- **Sequence Acquisition Times block (TRIGTIME) -** This is needed for sequence mode acquisitions to record the exact timing information for each segment. It contains the time of each trigger relative to the trigger of the first segment, along with the time of the first data point of each segment relative to its trigger.
- **Random Interleaved Sampling times block (RISTIME) -** This is required for RIS acquisitions to record the exact timing information for each segment.
- **First Data Array block (SIMPLE or DATA_ARRAY_1) -** This is the basic integer data of the waveform. It can be raw or corrected ADC data or the integer result of waveform processing.
- **Second Data Array block (DATA_ARRAY_2) -** This is a second data array, needed to hold the results of processing functions such as the following Extrema of FFT math functions.

Array	Extrema	FFT
Data_Array_1	Roof trace	Real part
Data_Array_2	Floor trace	Imaginary part

Note: The waveform template may also describe an array named DUAL, but this is simply a way to allow the INSPECT? query to examine two data arrays together.

Inspecting Waveform Contents

Use the INSPECT? query to examine the contents of your waveform.

The waveform template explains the WAVEDESC block and other logical blocks that may be returned by the INSPECT? query.

Tip: Use the TMPL? query to get a copy of the full waveform template on your oscilloscope.

You can access a readable translation of single entities in the Waveform Descriptor block by using the query INSPECT? "<WAVEDESC variable>". A typical exchange might be:

Query: `C1:INSPECT? "VERTICAL_OFFSET"`

Response: `"VERTICAL_OFFSET: -4.0000e-002"`

Query: `C1:INSPECT? "TRIGGER_TIME"`

Response: `"TRIGGER_TIME: Date = APR 8, 2016, Time = 10:29: 0.311462573"`

Also, use INSPECT? "SIMPLE" to examine the measured data values of a waveform. For example, the reply to an acquisition with 52 points would look like the following:

INSPECT? "SIMPLE"					
C1:INSP "					
0.0005225	0.0006475	**-0.00029**	-0.000915	**2.25001E-05**	0.000835
0.0001475	-0.0013525	**-0.00204**	-4E-05	**0.0011475**	0.0011475
-0.000915	-0.00179	**-0.0002275**	0.0011475	**0.001085**	-0.00079
-0.00179	-0.0002275	**0.00071**	0.00096	**-0.0003525**	-0.00104
0.0002725	0.0007725	**0.00071**	-0.0003525	**-0.00129**	-0.0002275
0.0005225	0.00046	**-0.00104**	-0.00154	**0.0005225**	0.0012725
0.001335	-0.0009775	**-0.001915**	-0.000165	**0.0012725**	0.00096
-0.000665	-0.001665	**-0.0001025**	0.0010225	**0.00096**	-0.0003525
-0.000915	8.50001E-05	**0.000835**	0.0005225		

"

The numbers in the previous table are the fully-converted measurements in volts.

Depending on the application, you may prefer the to see the data using either a BYTE (8 bits) or a WORD (16 bits) for each data value. In that case, use either:

```
 INSPECT? "SIMPLE",BYTE
INSPECT? "SIMPLE",WORD
```

The examination of data values for waveforms with two data arrays can be performed as follows:

`INSPECT? "DUAL"` to get pairs of data values on a single line
`INSPECT? "DATA_ARRAY_1"` to get the values of the first data array
`INSPECT? "DATA_ARRAY_2"` to get the values of the second data array

INSPECT? has its limitations; it is useful, but wordy. INSPECT? cannot be used to quickly transfer an entire waveform to and from the oscilloscope. To do this, use the WAVEFORM? query and WAVEFORM command, instead. With WAVEFORM_SETUP, you can inspect a sparse form of the waveform.

If you are a BASIC user, you might also find it convenient to use INSPECT? and WAVEFORM? together to construct files containing a version of the Waveform Descriptor that both you and BASIC can read. Stored waveforms can be read in a format suitable for retransfer to the instrument using:

```
C1:INSPECT? "WAVEDESC";WAVEFORM?
```

Place the response directly into a file.

Using the Waveform Query

The WAVEFORM? query is an effective way to transfer waveform data in block formats defined by the IEEE 488.2 standard. The resulting files can be downloaded back into the instrument by using the WAVEFORM command.

All logical blocks in a waveform can be read with the simple query:

```
<trace>:WAVEFORM?
```

For example:

```
C1:WAVEFORM?
```

Your can also query for a single block by adding the block name as a parameter, for example:

```
C1:WAVEFORM? DAT1
```

The waveform template lists all the logical block names.

The response to the WAVEFORM? query of an oscilloscope in its default state will show the waveform data in hexadecimal format with an ASCII translation.

Note: Waveform data read using the WF? query can only be loaded back into oscilloscope internal memory (M1 to M*n*), from where it can be recalled to the display. It may be beneficial to remove headers from the readout using the COMM_HEADER command so that the data in memory is ready to be copied to a .TRC file and recalled as is. The response to a WF? query can easily contain over 16 million bytes if in binary form and twice as much if the HEX option is used.

The WAVEFORM query can be used to read digital, as well as analog, waveforms simply by naming the digital group to be accessed by the command, as in (the short form shown here):

```
DIGITAL1:WF?
```

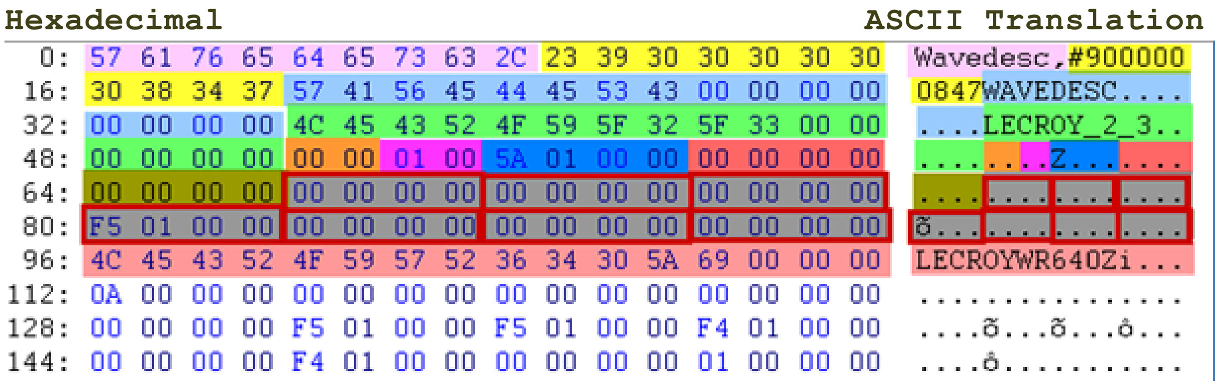
While there is no digital waveform template file, the data can be interpreted as shown in Digital Waveforms. There is also a DigTraceUtility available for download from the Teledyne LeCroy website at:

http://teledynelecroy.com/support/softwaredownload/digtrace.aspx?capid=106&mid=533&smid=

This tool will allow you to view *.digXML files created using the WF? query (or the WaveML option on the oscilloscope GUI) and resave the data in several formats.

WF? Response Compared to the Template

This example uses the result of the WAVEFORM? "WAVEDESC" query to show how the hexadecimal response to a WAVEFORM? query maps to the WAVEDESC block description in the waveform template (the response to TMPL?). Each element is numbered by raw byte and by offset, which is how it is identified in the waveform template (which starts at byte 0), and color keyed to match the ASCII translation.



```
Hexadecimal                                                   ASCII Translation
  0: 57 61 76 65 64 65 73 63 2C 23 39 30 30 30 30 30    Wavedesc,#900000
 16: 30 38 34 37 57 41 56 45 44 45 53 43 00 00 00 00    0847WAVEDESC....
 32: 00 00 00 00 4C 45 43 52 4F 59 5F 32 5F 33 00 00    ....LECROY_2_3..
 48: 00 00 00 00 00 00 01 00 5A 01 00 00 00 00 00 00    ........Z.......
 64: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00    ................
 80: F5 01 00 00 00 00 00 00 00 00 00 00 00 00 00 00    õ...............
 96: 4C 45 43 52 4F 59 57 52 36 34 30 5A 69 00 00 00    LECROYWR640Zi...
112: 0A 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00    ................
128: 00 00 00 00 F5 01 00 00 F5 01 00 00 F4 01 00 00    ....õ...õ...ô...
144: 00 00 00 00 F4 01 00 00 00 00 00 00 01 00 00 00    ....ô...........
```

Bytes	Offset	Color	Contain
0 to 8		pink	Simple beginning of a query response, translated into ASCII.
9 to 19		yellow	String #9002000348, signaling the beginning of a binary block where nine ASCII integers are used to give the length of the block (2000348 bytes).
20 to 35	0	light blue	Actual beginning of the waveform: 16-character block DESCRIPTOR_NAME string, in this case WAVEDESC.
36 to 51	16	green	TEMPLATE_NAME string, translated to LECROY_2_3.
52 to 53	32	orange	COMM_TYPE byte, byte (0) or word (1), in this case byte.
54 to 55	34	magenta	COMM_ORDER byte, which gives the order of subsequent bytes in the file, high byte first (0) or low byte first (1), in this case low first. All subsequent readings of the file must use the information given by this byte.
56 to 59	36	dark blue	Length in bytes of WAVEDESC block.
60 to 63	40	red	Length in bytes of USERTEXT block.
64 to 67	44	olive	Reserved.
68 to 97	48	grey	Length in bytes of forthcoming data BLOCKS and ARRAYS.
96 to 111	76	salmon	16-character INSTRUMENT_NAME string, translated to LECROYWR640Zi.

In this way you can use the waveform template to interpret the WAVEFORM? query readout.

Tip: Be sure to get the waveform template from your oscilloscope using the TMPL? query before beginning to make the mapping.

Interpreting Vertical Data

Knowing now how to decipher the data, you may wish to convert it to the appropriate measured values. The vertical reading for each data point depends on the vertical gain and the vertical offset given in the descriptor. For acquisition waveforms, this corresponds to the volts/div and voltage offset selected after conversion for the data representation being used.

The template tells us that the vertical gain and offset can be found at Bytes 156 and 160 and are stored as floating point numbers in the IEEE 32-bit format. An ASCII string giving the vertical unit is found in **VERTUNIT**, byte 196 of the WAVEDESC block. The vertical value is given by the relationship:

value = VERTICAL_GAIN x data - VERTICAL_OFFSET

If the computer or the software available is not able to understand the IEEE floating point values, use the description in the template.

The data values in a waveform may not correspond to measured points. FIRST_VALID_PNT and LAST_VALID_PNT give the necessary information. The descriptor also records the SPARSING_FACTOR, the FIRST_POINT, and the SEGMENT_INDEX to aid interpretation if the options of the WAVEFORM_SETUP command have been used.

For sequence acquisitions, the data values for each segment are given in their normal order and the segments are read out one after the other. The important descriptor parameters are the WAVE_ARRAY_COUNT and the SUBARRAY_COUNT, giving the total number of points and the number of segments.

For waveforms such as the extrema and the complex FFT there are two arrays (one after the other) for the two of the result.

Calculating the Horizontal Position of Data Points

Each vertical data value has a corresponding horizontal position, usually measured in time or frequency units. The calculation of this position depends on the type of waveform. Each data value has a position, *i*, in the original waveform, with *i* = 0 corresponding to the first data point acquired. The descriptor parameter HORUNIT gives a string with the name of the horizontal unit.

Single Sweep Waveforms

```
x[i] = HORIZ_INTERVAL * i + HORIZ_OFFSET
```

For acquisition waveforms this time is from the trigger to the data point in question. Its different from acquisition to acquisition since the HORIZ_OFFSET is measured for each trigger.

Sequence Waveforms

These are really many independent acquisitions, so each segment has its own horizontal offset. These can be found in the TRIGTIME array.

For the *n*th segment:

```
x[i,n] = HORIZ_INTERVAL * i + TRIGGER_OFFSET[n]
```

The TRIGTIME array can contain up to 200 segments of timing information with two eight-byte double precision floating point numbers for each segment.

RIS Waveforms

These are composed of many acquisitions interleaved together. The descriptor parameter, RIS_SWEEPS, gives the number of acquisitions. The *i*th point belongs to the *m*th segment where:

```
m = i modulo (RIS_SWEEPS)
```

Has a value between 0 and RIS_SWEEPS -1.

Then with:

```
j = i - m
x[i] = x[j,m] = HORIZ_INTERVAL * j + RIS_OFFSET[m]
```

where the RIS_OFFSET can be found in the RISTIME array. There can be up to 100 eight-byte double precision floating point numbers in this block. The instrument tries to acquire segments such that:

```
RIS_OFFSET[i] ≈ PIXEL_OFFSET + (i - 0.5) * HORIZ_INTERVAL
```

Decoding Floating Point Numbers

Single precision values are held in four bytes. If these are arranged in decreasing value order, we get the following bits:

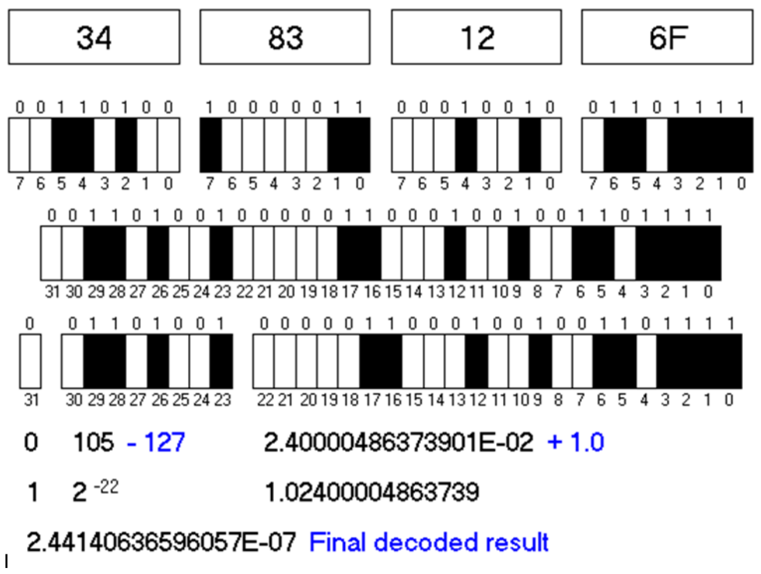
bit 31, bit 30, bit 29, bit 28 . . . . . bit 3, bit 2, bit 1, bit 0

Note: If the byte order command CORD is set for low byte first, the bytes as received in a waveform descriptor are received in reverse order. However, within a byte the bits keep their order, highest at the left, as expected.

From these bits we are to construct three numbers that are to be multiplied, S x E x F:

$S = (-1)^s E = 2^{(e - 127)}$ $F = 1 + f$

S, E, and F are calculated directly from the 32 bits. The following diagram illustrates the calculation of the vertical gain example:



In a way not following the byte boundaries, bits are then segregated as follows:

31, 30, 29 . . . . .24, 23, 22, 21 . . . . 2, 1, 0

sign exponent bits . . . . fractional bits . . . . bit 0.5, 0.25, 0.125 . . .

The sign bit s is 1 for a negative number and 0 for a positive number, so it is easy to construct the sign from this:

S = (-1)^s

The eight exponent bits have the following values:

Bit 23 is worth 1, bit 24 is worth 2 . . . bit 29 is worth 64, bit 30 is worth 128, so the resulting number can range from 0 to 28 -1, which is 255.

127 is then subtracted from this value e creating a range from -127 to +128. This is then used as an exponent to raise two to a power that is 2^e, to create a value E.

Then we have to create the multiplying number. The values of the 23 bits are as follows:

Bit 22 is worth 0.5, 21 is worth 0.25, 20 is worth 0.125, 19 is worth 0.0625 . . . .

When all the bits are added together, we obtain a positive number f that can be very close to one, differing from it only by the value of the smallest bit, if all the bits are ones. (Generally the value will be much less than one.) Then we add one to the result, obtaining 1 + f = F. The use of the added one extends the dynamic range of the data. Another way of calculating f is to take the 23-bit number at face value, and divide it by 2^24.

Finally we multiply together the sign, the value E, and the value F to create the final result:

Result = (-1)^s x 2^(e-127) x (1 + f) = S x E x F

Using the Waveform Command

Waveforms read with the WAVEFORM? query can be loaded back into the instrument using WAVEFORM and related commands. Since the descriptor contains all of the necessary information, you don't need to be concerned with communication format parameters. The oscilloscope learns all it needs to know from the waveform.

Tip: Waveforms can only be sent back to the instrument internal memories (M1 to M*n*). Consider using the COMM_HEADER command to remove prefixes in the WFM? query response.

When synthesizing waveforms for display or comparison, always read out a waveform of the appropriate size, and then replace the data with the desired values. This ensures the descriptor is coherent.

Here are some of the many ways to use WAVEFORM and its commands to simplify your work:

Partial Waveform Readout

Use WAVEFORM_SETUP to specify a short part of a waveform for readout and to select a sparsing factor for reading only every *n*th data point.

Byte Swapping

The COMM_ORDER command allows you to swap two bytes of data presented in 16-bit word format, in the descriptor or in the data/time arrays, when sending the data via GPIB or LAN ports. Depending on the computer system used, this allows easier data interpretation.

For Intel-based computers, you should send the data with the LSB first; the command should be CORD LO. For Motorola-based computers, send the data with the MSB first (CORD HI), the default at power-up.

Note: Data written to the instrument's hard disk, USB, or floppy always remain in LSB first format (the default DOS format). You cannot use the CORD command in these cases, since it is only meant for data sent using GPIB and RS-232-C ports.

Data Length, Block Format, and Encoding

COMM_FORMAT gives you control over these parameters. If you do not need the extra precision of the lower order byte of the standard data value, the BYTE option enables you to save the amount of data transferred or stored by a factor of two. If the computer you are using cannot read binary data, the HEX option allows a response form where the value of each byte is given by a pair of hexadecimal digits.

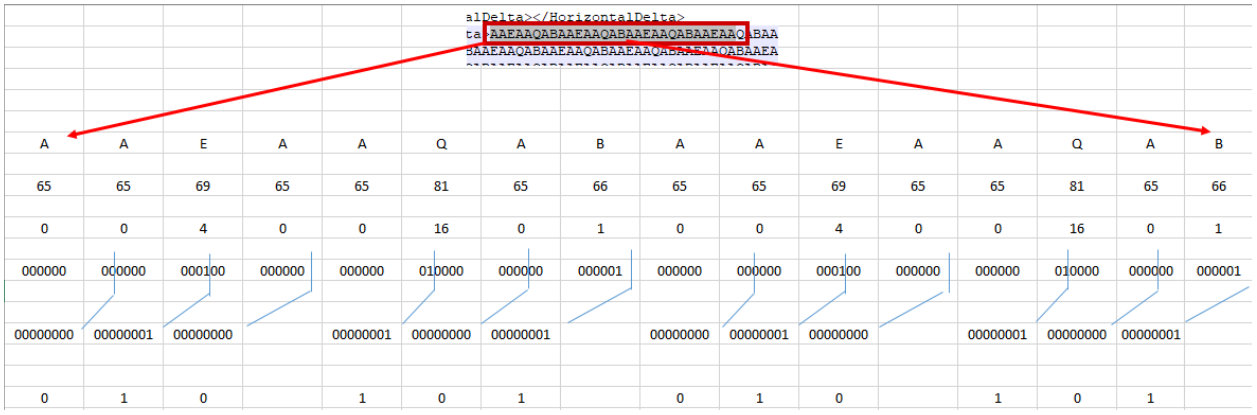
Data-Only Transfers

COMM_HEADER OFF enables a response to WF? DAT1 with data only (the C1:WF DAT1 disappears). If you have also specified COMM_FORMAT OFF,BYTE,BIN, the response is in binary bytes only (the #90000nnnnn translation disappears). Refer to Using the Waveform Query for more information.

Digital Waveforms

While there is no corresponding template file for digital waveforms, they are organized similarly to analog waveforms, with a text-based description of the header, followed by a Base64 encoding of the waveform binary data.

In Base64 encoding, 4 ASCII characters (6 bits per character) are used to represent 3 bytes, which, in the case of the digital waveforms, correspond to the value of 3 bits in the waveform. For example, the initial 4 bytes “AAEA” in the XML data field map to the 3 bits “010”. The following image shows how a small section of the waveform data would translate.



```
alDelta></HorizontalDelta>
ta>AAEAAQABAAEAAQABAAEAAQABAAEAAQABAA
BAAEAAQABAAEAAQABAAEAAQABAAEAAQABAAEA
```

A	A	E	A	A	Q	A	B	A	A	E	A	A	Q	A	B
65	65	69	65	65	81	65	66	65	65	69	65	65	81	65	66
0	0	4	0	0	16	0	1	0	0	4	0	0	16	0	1
000000	000000	000100	000000	000000	010000	000000	000001	000000	000000	000100	000000	000000	010000	000000	000001
00000000	00000001	00000000		00000001	00000000	00000001		00000000	00000001	00000000		00000001	00000000	00000001	
0	1	0		1	0	1		0	1	0		1	0	1	

Digital waveforms saved from the oscilloscope GUI are in text-based format, either Excel or WaveML, a proprietary XML format (*.digXML). When saving multiple digital groups ("All Displayed"), the default selection is ASCII, and the output will be separate XML files for each digital bus. Digital waveforms saved using remote commands (e.g., the WF? query) are always in .digXML format.

Transferring High-Speed Waveforms

Several important factors must be considered to achieve maximum, continuous data transfer rates from your instrument to the external controller.

The single most important of these is to **limit the amount of work done by the computer**, meaning:

- Avoid writing data to disk wherever possible
- Minimize operations such as per-data-point computations
- Reduce the number of calls to the I/O system

To do this, try the following:

- **Reduce the number of points to be transferred and the number of data bytes per point**. The pulse parameter capability and the processing functions can save a great deal of computing and a lot of data transfer time if employed creatively.
- **Attempt to overlap waveform acquisition with waveform transfer**. The oscilloscope is capable of transferring an already acquired or processed waveform after a new acquisition has been started. The total time the instrument takes to acquire events is considerably increased if it is set to wait for triggers (live time).
- **Minimize the number of waveform transfers by using Sequence mode** to accumulate many triggers for each transfer. This is preferable to using WAVEFORM_SETUP to reduce the number of data points for transfer. It also significantly reduces oscilloscope transfer overhead. For example, you could use ARM; WAIT;C1:WF? to wait for the event, transfer the data, and then start a new acquisition. You could also loop this line in the program as soon as it has finished reading the waveform.

Part 6: IEEE 488.2 Command Reference

Throughout this reference, the full command header is listed first, followed by the short form, as in **DOT_JOIN**, **DTJN**. Either form may be used in commands and queries.

The solution to unavailable legacy commands is to use Automation commands integrated into a remote control program using the VBS command.

Commands and Queries by Short Form

Short	Long	Subsystem	What The Command or Query Does
3DB	DD_CTAF_3DB	DDA	Sets the CTAF parameter, 3 dB.
ACAL	AUTO_CALIBRATE	MISC	Enables and disables automatic calibration.
ALST?	ALL_STATUS?	STATUS	Reads and clears the contents of all status registers.
ARM	ARM_ACQUISITION	ACQUISITION	Changes acquisition mode from Stopped to Single.
ASET	AUTO_SETUP	ACQUISITION	Adjusts vertical, timebase and trigger parameters.
ATTN	ATTENUATION	ACQUISITION	Selects the vertical attenuation factor of the probe.
BUZZ	BUZZER	MISC	Controls the buzzer in the instrument.
BWL	BANDWIDTH_LIMIT	ACQUISITION	Enables/disables bandwidth-limiting low-pass filter.
*CAL?	*CAL?	MISC	Performs a complete internal calibration of the instru-ment.
CFMT	COMM_FORMAT	COMM	Selects the format for sending waveform data.
CHDR	COMM_HEADER	COMM	Controls formatting of query responses.
CHL	COMM_HELP_LOG	COMM	Returns the contents of the RC Assistant log.
CHLP	COMM_HELP	COMM	Controls operational level of the RC Assistant.
CLM	CLEAR_MEMORY	FUNCTION	Clears the specified memory.
*CLS	*CLS	STATUS	Clears all status data registers.
CLSW	CLEAR_SWEEPS	FUNCTION	Restarts the cumulative processing functions.
CMR?	CMR?	STATUS	Reads and clears the CoMmand error Register (CMR).
COMB	COMBINE_CHANNELS	ACQUISITION	Controls the channel interleaving function.
CORD	COMM_ORDER	COMM	Controls the byte order of waveform data transfers.
COUT	CAL_OUTPUT	MISC	Sets signal type put out at the CAL connector.
CPL	COUPLING	ACQUISITION	Selects the specified input channel's coupling mode.
CRMS	CURSOR_MEASURE	CURSOR	Specifies the type of cursor/parameter measurement.
CRS	CURSORS	CURSOR	Sets the cursor type.
CRST	CURSOR_SET	CURSOR	Allows positioning of any cursor.
CRVA?	CURSOR_VALUE?	CURSOR	Returns trace values measured by specified cursors.
CUAP	CUSTOM_APPLICATION	ET-PMT	Toggles between Mask Tester and oscilloscope mode.
CU_OPT?	CUSTOM_OPTIONS?	ET-PMT	Returns installed custom options.
DACT	DD_ANALOG_COMP_THRESH	DDA	Sets the analog threshold value for Analog Compare.
DARD	DD_ANALYZE_REGION_DISABLE	DDA	Disables the use of the analyze region markers.
DARL	DD_ANALYZE_REGION_LENGTH	DDA	Selects the length of a region to be analyzed.
DARS	DD_ANALYZE_REGION_START	DDA	Selects the start of a region to be analyzed.
DATE	DATE	MISC	Changes the date/time of the internal real-time clock.

Short	Long	Subsystem	What The Command or Query Does
DBIT	DD_BITCELL	DDA	Enters the bit cell time of the head signal.
DBST	DD_CTAF_BOOST	DDA	Sets the CTAF parameter, boost.
DBYT	DD_BYTE_OFFSET	DDA	Moves the head trace to show the specified byte.
DDFC	DD_CTAF_FC	DDA	Sets the CTAF parameter, cut-off frequency fc.
DDFM	DD_FIND_METHOD	DDA	Selects the error-finding method.
DDR?	DDR?	STATUS	Reads, clears the Device Dependent Register (DDR).
DDSI	DD_SIGNAL_INPUT	DDA	Sends or reads out the association of a source with a particular Disk Drive signal.
DEF	DEFINE	FUNCTION	Specifies math expression for function evaluation.
DELF	DELETE_FILE	STORAGE	Deletes a file from the currently selected directory.
DENC	DD_ENCODING	DDA	Allows selection of the data-encoding ratio for locating the bytes by byte offset.
DERI?	DD_ERR_INFO	DDA	Returns the measured value associated with the last error position selected, and a code specifying what the value contains.
DERR	DD_ERR_NUM	DDA	Displays the section of waveform containing the specified error number.
DFBIT	DD_FIND_BITCELL	DDA	Looks at the head signal and attempts to determine the bit-cell time.
DFEN	DD_FIR_ENABLE	DDA	Enables the FIR filter for PRML channel emulation.
DFER	DD_FIND_ERROR	DDA	Commands the DDA to find errors.
DFGD	DD_CTAF_GROUP_DELAY	DDA	Sets the CTAF parameter, group delay.
DFIR	DD_FIR	DDA	Stores the setup that will be used if the FIR filter is enabled for use in the channel emulation.
DHSC	DD_HEADSIGNAL_CHANNEL	DDA	Specifies the head signal source channel or memory for channel emulation and servo analysis.
DIGS	DD_IGNORE_SAMPLES	DDA	Defines the number of samples to be ignored at the Read Gate signal end for channel emulation and analog compare.
DISP	DISPLAY	DISPLAY	Controls the display screen.
DNER?	DD_NUM_ERRORS	DDA	Returns the number of errors found.
DOVL	DD_OVERLAP_REF	DDA	sets a state variable which determines re-establishing the overlap of the head signal
DPA	DD_PES_ANALYSIS	DDA	Starts or aborts PES analysis.
DPD?	DD_PES_DATA	DDA	Reads out results of PES Analysis.
DPSD?	DD_PES_SUMMARY_DATA	DDA	Summarizes PES Analysis results.
DPSU	DD_PES_SETUP	DDA	Command sets parameters for PES Analysis. The query responds with the current state of specified keywords.

Short	Long	Subsystem	What The Command or Query Does
DRAV	DD_RESET_AVERAGE	DDA	Resets the averaged data and all sweeps; clears histograms and parameters; allows the start of a fresh analysis.
DRCC	DD_READCLOCK_CHANNEL	DDA	Specifies the input channel to which Read Clock is connected or the memory in which it is stored.
DRGC	DD_READGATE_CHANNEL	DDA	Specifies the input channel to which Read Gate is connected or the memory in which it is stored.
DRGP	DD_READ_GATE_POLARITY	DDA	Selects the polarity of the Read Gate signal.
DRLE	DD_ML_RUN_LENGTH_LIMIT	DDA	Limits the run length, the number of “0” values in a row for the head/analog signal when channel emulation is active.
DRLM	DD_ML_MIN_SPACING	DDA	When channel emulation is active, this sets the minimum allowed spacing of transitions.
DSAV	DD_START_AVERAGING	DDA	Changes the state of the “Avg. Samples” switch on the Graph menu.
DSEG	DD_BYTE_OFFSET_SEGMENT	DDA	Moves the head trace to show the specified segment.
DSF	DD_SHOW_FILTERED	DDA	Enables and disables the filtering of the head signal.
DSIG	DD_SIGNAL_TYPE	DDA	Specifies Peak Detect or a particular PRML format for the head signal.
DSLV	DD_SHOW_LEVELS	DDA	Displays the level markers indicating the Viterbi levels of the ML samples when channel emulation is active.
DSML	DD_SHOW_ML	DDA	Displays/hides ML markers
DSPH	DD_SAMPLE_PHASE	DDA	Adjusts the phase between the DDFA PLL sample points and an external clock reference (when RCLK is connected).
DSST	DD_SHOW_SAMPLE_TIMES	DDA	Shows vertical-line cursors on the grid at each sample time corresponding to the read clock.
DST	DD_SAM_THRESH	DDA	Sets the SAM threshold value for channel emulation.
DSTR	DD_STORE_REFERENCE	DDA	Stores the head signal to one of the DDA’s available memories for analog compare and channel emulation with reference.
DTF?	DD_TRAIN_FILTER	DDA	Commands the DDA to determine reasonable values for each filter parameter.
DTJN	DOT_JOIN	DISPLAY	Controls the interpolation lines between data points.
DVSP	DD_VCO_SYNCH_PATTERN	DDA	Defines the number of bits per half-period in the synchronization field.
DVTD	DD_VCOSYNCH_TO_DATA	DDA	Specifies the number of bytes on the analog head signal waveform between the end of the VCO sync field and the actual data.
*ESE	*ESE	STATUS	Sets the Standard Event Status Enable register (ESE).
*ESR?	*ESR?	STATUS	Reads, clears the Event Status Register (ESR).
EXR?	EXR?	STATUS	Reads, clears the EXecution error Register (EXR).

Short	Long	Subsystem	What The Command or Query Does
FCR	FIND_CENTER_RANGE	FUNCTION	Automatically sets the center and width of a histogram.
FRST	FUNCTION_RESET	FUNCTION	Resets a waveform-processing function.
FRTR	FORCE_TRIGGER	ACQUISITION	Forces the instrument to make one acquisition.
GRID	GRID	DISPLAY	Specifies single-, dual- or quad-mode grid display.
HCSU	HARDCOPY_SETUP	HARD COPY	Configures the hard-copy driver.
HMAG	HOR_MAGNIFY	DISPLAY	Horizontally expands the selected expansion trace.
HPOS	HOR_POSITION	DISPLAY	Horizontally positions intensified zone's center.
*IDN?	*IDN?	MISC	Causes instrument to respond with identifiers.
INE	INE	STATUS	Sets the Internal state change Enable register (INE).
INR?	INR?	STATUS	Reads, clears Internal state change Register (INR).
INSP?	INSPECT?	WAVEFORM TRANSFER	Allows acquired waveform parts to be read.
ILVD	INTERLEAVED	ACQUISITION	Enables/disables Random Interleaved Sampling (RIS).
INTS	INTENSITY	DISPLAY	Controls the brightness of the grid.
IST?	IST?	STATUS	Reads the current state of the IEEE 488.
MSG	MESSAGE	DISPLAY	Displays a character string on the instrument screen.
MSIZ	MEMORY_SIZE	ACQUISITION	Selects max. memory length.
MTFA	MT_FAIL_ACTION	ET-PMT	Sets fail actions.
MTOF	MT_OFFSET	ET-PMT	Sets the offset for STM-1E, STS-3E, and 139M.
MTOP?	MT_OPC?	ET-PMT	Returns state of last operation.
MTPC?	MT_PF_COUNTERS?	ET-PMT	Returns pass/fail result.
MTST	MT_SELECT_TEST	ET-PMT	Selects Electrical Telecomm testing standard.
MTSY?	MT_SYMBOL?	ET-PMT	Returns 1 or 0 symbol, or pos or neg.
MTTS	MT_TEST_STATE	ET-PMT	Controls testing status: RUN, STOP, PAUSE, CONTINUE.
MTVA	MT_VERTICAL_ALIGN	ET-PMT	Performs offset alignment for STM-1E, STS-3E, and 139M.
OFCT	OFFSET_CONSTANT	CURSOR	Sets offset to be fixed in either divisions or volts.
OFST	OFFSET	ACQUISITION	Allows output channel vertical offset adjustment.
*OPC	*OPC	STATUS	Sets the OPC bit in the Event Status Register (ESR).
*OPT?	*OPT?	MISC	Identifies oscilloscope options.
PACL	PARAMETER_CLR	CURSOR	Clears all current parameters in Custom, Pass/Fail.
PACU	PARAMETER_CUSTOM	CURSOR	Controls parameters with customizable qualifiers.
PADL	PARAMETER_DELETE	CURSOR	Deletes a specified parameter in Custom, Pass/Fail.
PARM	PARAMETER	CURSOR	Controls the parameter mode.
PAST?	PARAMETER_STATISTICS?	CURSOR	Returns parameter statistics results.

Short	Long	Subsystem	What The Command or Query Does
PAVA?	PARAMETER_VALUE?	CURSOR	Returns current parameter, mask test values.
PECL	PERSIST_COLOR	DISPLAY	Controls color rendering method of persistence traces.
PECS	PER_CURSOR_SET	CURSOR	Positions one of the six independent cursors.
PELT	PERSIST_LAST	DISPLAY	Shows the last trace drawn in a persistence data map.
PERS	PERSIST	DISPLAY	Enables or disables the persistence display mode.
PESA	PERSIST_SAT	DISPLAY	Sets the color saturation level in persistence.
PESU	PERSIST_SETUP	DISPLAY	Selects display persistence duration.
PF	PASS_FAIL	CURSOR	Sets up pass fail system.
PFDO	PASS_FAIL_DO	CURSOR	Defines outcome and actions for Pass/Fail
PNSU	PANEL_SETUP	SAVE/RECALL	Complements the *SAV/*RST commands.
*PRE	*PRE	STATUS	Sets the PaRallel poll Enable register (PRE).
*RCL	*RCL	SAVE/RECALL	Recalls one of five non-volatile panel setups.
RCLK	REFERENCE_CLOCK	ACQUISITION	Toggles between internal clock and external clock.
RCPN	RECALL_PANEL	SAVE/RECALL	Recalls a front panel setup from mass storage.
*RST	*RST	SAVE/RECALL	Initiates a device reset.
*SAV	*SAV	SAVE/RECALL	Stores current state in non-volatile internal memory.
SCDP	SCREEN_DUMP	HARD COPY	Initiates a screen capture.
SCLK	SAMPLE_CLOCK	ACQUISITION	Toggles between internal clock and external clock.
SEQ	SEQUENCE	ACQUISITION	Controls the sequence mode of acquisition.
*SRE	*SRE	STATUS	Sets the Service Request Enable register (SRE).
*STB?	*STB?	STATUS	Reads the contents of the IEEE 488.
STO	STORE	WAVEFORM TRANSFER	Stores a trace in internal memory or mass storage.
STOP	STOP	ACQUISITION	Immediately stops signal acquisition.
STPN	STORE_PANEL	SAVE/RECALL	Stores front panel setup to mass storage.
STST	STORE_SETUP	WAVEFORM TRANSFER	Sets up waveform storage.
TDIV	TIME_DIV	ACQUISITION	Modifies the timebase setting.
TMPL?	TEMPLATE?	WAVEFORM TRANSFER	Produces a complete waveform template copy.
TRA	TRACE	DISPLAY	Enables or disables the display of a trace.
TRCP	TRIG_COUPLING	ACQUISITION	Sets the coupling mode of the specified trigger source.
TRFL	TRANSFER_FILE	WAVEFORM TRANSFER	Transfers ASCII files to and from storage media, or between scope and computer.
TRDL	TRIG_DELAY	ACQUISITION	Sets the time at which the trigger is to occur.
*TRG	*TRG	ACQUISITION	Executes an ARM command.
TRLV	TRIG_LEVEL	ACQUISITION	Adjusts the trigger level of the specified trigger source.

Short	Long	Subsystem	What The Command or Query Does
TRMD	TRIG_MODE	ACQUISITION	Specifies the trigger mode.
TRPA	TRIG_PATTERN	ACQUISITION	Defines a trigger pattern.
TRSE	TRIG_SELECT	ACQUISITION	Selects the condition that will trigger acquisition.
TRSL	TRIG_SLOPE	ACQUISITION	Sets the trigger slope of the specified trigger source.
*TST?	*TST?	MISC	Performs internal self-test.
VBS	VBS	AUTOMATION	Sends an automation command.
VDIV	VOLT_DIV	ACQUISITION	Sets the vertical sensitivity.
VMAG	VERT_MAGNIFY	DISPLAY	Vertically expands the specified trace.
VPOS	VERT_POSITION	DISPLAY	Adjusts the vertical position of the specified trace.
*WAI	*WAI	STATUS	WAIt to continue - required by the IEEE 488.
WAIT	WAIT	ACQUISITION	Prevents new analysis until current is completed.
WF	WAVEFORM	WAVEFORM TRANSFER	Transfers a waveform from controller to scope.
WFSU	WAVEFORM_SETUP	WAVEFORM TRANSFER	Specifies amount of waveform data to go to controller.

Commands and Queries by Subsystem

ACQUISITION - Controlling Waveform Captures

Short	Long	What The Command or Query Does
ARM	ARM_ACQUISITION	Changes acquisition state from stopped to single.
ASET	AUTO_SETUP	Adjusts vertical, timebase and trigger parameters.
ATTN	ATTENUATION	Selects the vertical attenuation factor of the probe.
BWL	BANDWIDTH_LIMIT	Enables/disables bandwidth-limiting low-pass filter.
COMB	COMBINE_CHANNELS	Controls the channel interleaving function.
CPL	COUPLING	Selects the specified input channel's coupling mode.
FRTR	FORCE_TRIGGER	Forces the instrument to make one acquisition.
ILVD	INTERLEAVED	Enables/disables Random Interleaved Sampling (RIS).
MSIZ	MEMORY_SIZE	Selects max. memory length.
OFST	OFFSET	Allows output channel vertical offset adjustment.
RCLK	REFERENCE_CLOCK	Toggles between internal clock and external clock.
SCLK	SAMPLE_CLOCK	Toggles between internal clock and external clock.
SEQ	SEQUENCE	Controls the sequence mode of acquisition.
STOP	STOP	Immediately stops signal acquisition.
TDIV	TIME_DIV	Modifies the timebase setting.
TRCP	TRIG_COUPLING	Sets the coupling mode of the specified trigger source.
TRDL	TRIG_DELAY	Sets the time at which the trigger is to occur.
*TRG	*TRG	Executes an ARM command.
TRLV	TRIG_LEVEL	Adjusts the trigger level of the specified trigger source.
TRMD	TRIG_MODE	Specifies the trigger mode.
TRPA	TRIG_PATTERN	Defines a trigger pattern.
TRSE	TRIG_SELECT	Selects the condition that will trigger acquisition.
TRSL	TRIG_SLOPE	Sets the trigger slope of the specified trigger source.
VDIV	VOLT_DIV	Sets the vertical sensitivity.
WAIT	WAIT	Prevents new analysis until current is completed.

AUTOMATION - Sending Automation Commands

Short	Long	What The Command or Query Does
VBS	VBS	Sends Automation commands.

COMMUNICATION - Setting Communication Characteristics

Short	Long	What The Command or Query Does
CFMT	COMM_FORMAT	Selects the format for sending waveform data.
CHDR	COMM_HEADER	Controls formatting of query responses.
CHL	COMM_HELP_LOG	Returns the contents of the RC Assistant log.
CHLP	COMM_HELP	Controls operational level of the RC Assistant.
CORD	COMM_ORDER	Controls the byte order of waveform data transfers.

CURSOR - Performing Measurements

Short	Long	What The Command or Query Does
CRMS	CURSOR_MEASURE	Specifies the type of cursor/parameter measurement.
CRS	CURSORS	Sets the cursor type.
CRST	CURSOR_SET	Allows positioning of any cursor.
CRVA?	CURSOR_VALUE?	Returns trace values measured by specified cursors.
OFCT	OFFSET_CONSTANT	Sets offset to be fixed in either divisions or volts.
PACL	PARAMETER_CLR	Clears all current parameters in Custom, Pass/Fail.
PACU	PARAMETER_CUSTOM	Controls parameters with customizable qualifiers.
PADL	PARAMETER_DELETE	Deletes a specified parameter in Custom, Pass/Fail.
PARM	PARAMETER	Controls the parameter mode, Standard, Custom, etc.
PAST?	PARAMETER_STATISTICS?	Returns parameter statistics results.
PAVA?	PARAMETER_VALUE?	Returns current parameter, mask test values.
PECS	PER_CURSOR_SET	Positions one of the six independent cursors.
PF	PASS_FAIL	Sets up pass fail system.
PFDO	PASS_FAIL_DO	Defines outcome and actions for Pass/Fail tests.

DISPLAY - Displaying Waveforms

Short	Long	What The Command or Query Does
DISP	DISPLAY	Controls the display screen.
DTJN	DOT_JOIN	Controls the interpolation lines between data points.
GRID	GRID	Specifies single-, dual- or quad-mode grid display.
HMAG	HOR_MAGNIFY	Horizontally expands the selected expansion trace.
HPOS	HOR_POSITION	Horizontally positions intensified zone's center.
INTS	INTENSITY	Controls the brightness of the grid.
MSG	MESSAGE	Displays a character string on the instrument screen.
PECL	PERSIST_COLOR	Controls color rendering method of persistence traces.

Short	Long	What The Command or Query Does
PELT	PERSIST_LAST	Shows the last trace drawn in a persistence data map.
PERS	PERSIST	Enables or disables the persistence display mode.
PESA	PERSIST_SAT	Sets the color saturation level in persistence.
PESU	PERSIST_SETUP	Selects display persistence duration.
TRA	TRACE	Enables or disables the display of a trace.
VMAG	VERT_MAGNIFY	Vertically expands the specified trace.
VPOS	VERT_POSITION	Adjusts the vertical position of the specified trace.

FUNCTION - Performing Waveform Mathematical Operations

Short	Long	What The Command or Query Does
CLM	CLEAR_MEMORY	Clears the specified memory.
CLSW	CLEAR_SWEEPS	Restarts the cumulative processing functions.
DEF	DEFINE	Specifies math expression for function evaluation.
FCR	FIND_CENTER_RANGE	Automatically sets the center and width of a histogram.
FRST	FUNCTION_RESET	Resets a waveform-processing function.

HARDCOPY - Printing the Display/Screen Capture

Short	Long Form	What The Command or Query Does
HCSU	HARDCOPY_SETUP	Configures the hard-copy driver.
SCDP	SCREEN_DUMP	Initiates a screen dump.

MISCELLANEOUS

Short	Long	What The Command or Query Does
ACAL	AUTO_CALIBRATE	Enables and disables automatic calibration.
BUZZ	BUZZER	Controls the buzzer in the instrument.
*CAL?	*CAL?	Performs a complete internal calibration of the DSO.
COUT	CAL_OUTPUT	Sets signal type put out at the CAL connector.
DATE	DATE	Changes the date/time of the internal real-time clock.
*IDN?	*IDN?	For identification purposes.
*OPT?	*OPT?	Identifies oscilloscope options.
*TST?	*TST?	Performs internal self-test.

PROBES - Using Probes

Short	Long	What The Command or Query Does
PRIT?	PROBE_INFOTEXT?	Returns attributes of a connected probe.
PRNA?	PROBE_NAME	Identifies a probe connected to the instrument.
PRx:AZ	PRx:AUTOZERO	Initiates an AutoZero cycle in an ADP30x probe.
PRx:BWL	PRx:BANDWIDTH_LIMIT	Sets the upper (HF) -3 dB bandwidth limit of an ADP305 probe.
PRx:CPL	PRx:COUPLING	Selects the coupling mode of an ADP30x probe.
PRx:OFST	PRx:OFFSET	Sets the probe offset value of an ADP30x probe.
PRx:VDIV	PRx:VOLT_DIV	Sets the vertical sensitivity at an ADP30x probe input.

SAVE/RECALL SETUP - Perserving and Restoring Panel Settings

Short	Long	What The Command or Query Does
PNSU?	PANEL_SETUP?	Returns panel setups in ASCII format.
*RCL	*RCL	Recalls one of five non-volatile panel setups.
RCPN	RECALL_PANEL	Recalls a panel setup from mass storage.
*RST	*RST	Initiates a device reset.
*SAV	*SAV	Stores current state in non-volatile internal memory.
STPN	STORE_PANEL	Stores a panel setup to mass storage.

STATUS - Obtaining Status Information and Setup Service Requests

Short	Long	What The Command or Query Does
ALST?	ALL_STATUS?	Reads and clears the contents of all status registers.
*CLS	*CLS	Clears all status data registers.
CMR?	CMR?	Reads and clears the CoMmand error Register (CMR).
DDR?	DDR?	Reads and clears the Device Dependent Register (DDR).
*ESE	*ESE	Sets the Standard Event Status Enable register (ESE).
*ESR?	*ESR?	Reads and clears the Event Status Register (ESR).
EXR?	EXR?	Reads and clears the EXecution error Register (EXR).
INE	INE	Sets the INternal state change Enable register (INE).
INR?	INR?	Reads and clears INternal state change Register (INR).
IST?	IST?	Reads the current state of the IEEE 488.
*OPC	*OPC	Sets the OPC bit in the Event Status Register (ESR).
*PRE	*PRE	Sets the PaRallel poll Enable register (PRE).
*SRE	*SRE	Sets the Service Request Enable register (SRE).
*STB?	*STB?	Reads the contents of the IEEE 488.
*WAI	*WAI	WAIt to continue - required by the IEEE 488.

STORAGE

Short	Long	What The Command or Query Does
DELF	DELETE_FILE	Deletes files from mass storage directory.
TRFL	TRANSFER_FILE	Allows for transferring files to and from storage media, or between oscilloscope and computer.

WAVEFORM TRANSFER - Preserving and Restoring Waveforms

Short	Long	What The Command or Query Does
INSP?	INSPECT?	Allows acquired waveform parts to be read.
REC	RECALL	Recalls waveform from mass storage to internal memory.
STO	STORE	Stores a waveform in internal memory or mass storage.
STST	STORE_SETUP	Controls the way in which waveforms are stored.
TMPL?	TEMPLATE?	Produces a copy of the template describing a complete waveform.
WF	WAVEFORM	Query transfers a waveform from oscilloscope to controller in re-load-able format; command transfers a waveform read using WF? from controller to scope.
WFSU	WAVEFORM_SETUP	Specifies amount of waveform data to go to controller.

DISK DRIVE ANALYSIS (Option) – Specialized Disk Drive Measurements

Short	Long	What The Command or Query Does
3DB	DD_CTAF_3DB	Sets the CTAF parameter, 3 dB.
DACT	DD_ANALOG_COMP_THRESH	Sets the analog threshold value for DDA analog compare.
DARD	DD_ANALYZE_REGION_DISABLE	Disables the use of the DDA analyze region markers.
DARL	DD_ANALYZE_REGION_LENGTH	Selects the length of a region to be analyzed by DDA.
DARS	DD_ANALYZE_REGION_START	Selects the start of a region to be analyzed by DDA.
DBIT	DD_BITCELL	Enters the bit cell time of the drive head signal.
DBST	DD_CTAF_BOOST	Sets the DDA CTAF parameter, boost.
DBYT	DD_BYTE_OFFSET	Moves the head trace to show the specified byte in DDA.
DDFC	DD_CTAF_FC	Sets the DDA CTAF parameter, cut-off frequency fc.
DDFM	DD_FIND_METHOD	Selects the DDA error-finding method.
DDSI	DD_SIGNAL_INPUT	Sends or reads out the association of a particular Disk Drive signal with a source.
DENC	DD_ENCODING	Allows selection of the data-encoding ratio for locating the bytes by byte offset in DDA.
DERI?	DD_ERR_INFO?	Returns the measured value associated with the last DDA error pos-ition selected, and a code specifying what the value contains.

Short	Long	What The Command or Query Does
DERR	DD_ERR_NUM	Displays the section of waveform containing the specified DDA error number.
DFBIT?	DD_FIND_BITCELL?	Looks at the head signal and attempts to determine the bit-cell time.
DFEN	DD_FIR_ENABLE	Enables the FIR filter for PRML channel emulation.
DFER	DD_FIND_ERROR	Commands the DDA to find errors.
DFGD	DD_CTAF_GROUP_DELAY	Sets the DDA CTAF parameter, group delay.
DFIR	DD_FIR	Stores the setup that will be used if the FIR filter is enabled for use in the channel emulation.
DHSC	DD_HEADSIGNAL_CHANNEL	Specifies the head signal source channel or memory for channel emulation and servo analysis.
DIGS	DD_IGNORE_SAMPLES	Defines number of samples to be ignored at the Read Gate signal end for channel emulation and analog compare.
DNER?	DD_NUM_ERRORS	Gives the number of DDA errors found.
DOVL	DD_OVERLAP_REF	Sets a state variable that determines whether the DDA re-establishes the overlap of the reference signal whenever the head trace is moved.
DPA	DD_PES_ANALYSIS	Starts/aborts PES analysis.
DPD?	DD_PES_DATA?	Reads out results of PES Analysis.
DPSD?	DD_PES_SUMMARY_DATA?	Summarizes PES Analysis results.
DPSU	DD_PES_SETUP	Sets parameters for PES Analysis.
DRAV	DD_RESET_AVERAGE	Resets the averaged data and all sweeps; clears histograms and parameters.
DRCC	DD_READCLOCK_CHANNEL	Specifies the input channel to which Read Clock is connected or the memory in which it is stored.
DRGC	DD_READGATE_CHANNEL	Specifies the input channel to which Read Gate is connected or the memory in which it is stored.
DRGP	DD_READ_GATE_POLARITY	Selects the polarity of the read gate signal.
DRLE	DD_ML_RUN_LENGTH_LIMIT	Limits the run length.
DRLM	DD_ML_MIN_SPACING	Sets the minimum allowed transitions.
DSAV	DD_START_AVERAGING	Changes the state of the “Avg. Samples” switch on the Graph menu.
DSEG	DD_BYTE_OFFSET_SEGMENT	Moves the head trace to show the specified segment in DDA.
DSF	DD_SHOW_FILTERED	Enables and disables the filtering of the head signal.
DSIG	DD_SIGNAL_TYPE	Specifies Peak Detect or a particular PRML format for the head signal.
DSLV	DD_SHOW_LEVELS	Displays the level markers indicating the Viterbi levels of the ML samples when channel emulation is active.
DSML	DD_SHOW_ML	Displays ML markers.
DSPH	DD_SAMPLE_PHASE	Adjusts the phase between the DDFA PLL sample points and an external clock reference (when RCLK is connected).

Short	Long	What The Command or Query Does
DSST	DD_SHOW_SAMPLE_TIMES	Shows vertical-line cursors on the grid at each sample time corresponding to the read clock.
DST	DD_SAM_THRESH	Sets the SAM threshold value for channel emulation.
DSTR	DD_STORE_REFERENCE	Stores the head signal to one of the DDA's available memories for analog compare and channel emulation with reference.
DTF	DD_TRAIN_FILTER	Commands the DDA to determine reasonable values for each filter parameter.
DVSP	DD_VCO_SYNCH_PATTERN	Defines the number of bits per half-period in the synchronization field.
DVTD	DD_VCOSYNCH_TO_DATA	Specifies the number of bytes on the analog head signal waveform between the end of the VCO sync field and the actual data.

ET-PMT (Option) - Electrical Telecomm Pulse Mask Testing

Short	Long	What The Command or Query Does
CU_OPT?	CUSTOM_OPTIONS?	Returns installed custom options.
CUAP	CUSTOM_APPLICATION	Toggles between Mask Tester mode and oscilloscope mode.
MTFA	MT_FAIL_ACTION	Sets fail actions.
MTOF	MT_OFFSET	Sets the offset for STM-1E, STS-3E, and 139M.
MTOP?	MT_OPC?	Returns state of last operation.
MTPC?	MT_PF_COUNTERS?	Returns pass/fail result.
MTST	MT_SELECT_TEST	Selects Electrical Telecomm testing standard.
MTSY?	MT_SYMBOL?	Returns 1 or 0 symbol, or pos or neg.
MTTS	MT_TEST_STATE	Controls testing status: RUN, STOP, PAUSE, CONTINUE.
MTVA	MT_VERTICAL_ALIGN	Performs offset alignment for STM-1E, STS-3E, and 139M.

ACQUISITION Commands and Queries

ARM_ACQUISITION, ARM

Description

The ARM_ACQUISITION command arms the scope and forces a single acquisition if it is already armed.

Command Syntax

```
ARM_ACQUISITION
```

Example (GPIB)

The following instruction enables signal acquisition:

```
CMD$="ARM": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

STOP, *TRG, TRIG_MODE, WAIT, FRTR

AUTO_SETUP, ASET

Description

The AUTO_SETUP command attempts to display the input signal(s) by adjusting the vertical, timebase and trigger parameters. AUTO_SETUP operates only on the channels whose traces are currently turned on. If no traces are turned on, AUTO_SETUP operates on all channels.

If signals are detected on several channels, the lowest numbered channel with a signal determines the selection of the timebase and trigger source.

If only one input channel is turned on, the timebase will be adjusted for that channel.

The AUTO_SETUP FIND command adjusts gain and offset only for the specified channel.

Command Syntax

```
<channel>:AUTO_SETUP [FIND]
```

```
<channel>:= <C1 to Cn>
```

If the FIND keyword is present, gain and offset adjustments are performed only on the specified channel. If no <channel> prefix is added, an auto-setup is performed on the channel used on the last ASET FIND remote command.

In the absence of the FIND keyword, the normal auto-setup is performed, regardless of the <channel> prefix.

Example (GPIB)

The following instructs the oscilloscope to perform an auto-setup:

```
CMD$="C1:ASET": CALL IBWRT(SCOPE%,CMD$)
```

ATTENUATION, ATTN

Description

The ATTENUATION command selects the vertical attenuation factor of the probe. Values up to 10000 can be specified.

The ATTENUATION? query returns the attenuation factor of the specified channel.

Command Syntax

```
<channel>:ATTENUATION <attenuation>

<channel>:= <C1 to Cn, EX, EX10>

<attenuation>:= {1, 2, 5, 10, 20, 25, 50, 100, 200, 500, 1000, 10000}
```

Query Syntax

```
<channel>:ATTENUATION?
```

Response Format

```
<channel>:ATTENUATION <attenuation>
```

Example (GPIB)

The following instruction sets the attenuation factor of C1to 100:

```
CMD$="C1:ATTN 100": CALL IBWRT(SCOPE%,CMD$)
```

BANDWIDTH_LIMIT, BWL

Description

The BANDWIDTH_LIMIT command enables or disables the bandwidth-limiting low-pass filter on a per-channel basis. When the <channel> argument is omitted, the BWL command applies to all channels.

The response to the BANDWIDTH_LIMIT? query shows the bandwidth filter setting for each channel.

Command Syntax

```
BANDWIDTH_LIMIT [<channel>,]<mode>[,<channel>,<mode>...]
```

```
<channel>:= <C1 to Cn>
```

```
<mode>:= {OFF, 20MHZ, 200MHZ, 500MHZ, 1GHZ, 2GHZ, 3GHZ, 4GHZ, 6GHZ}
```

Per channel bandwidth may be set incrementally.

The <mode> setting is limited to the bandwidth filters available on your oscilloscope model. 500MHZ and 2GHZ filters available on HDO9000 models only. More settings are available for WaveMaster and LabMaster models. See the product datasheet for specifications.

Query Syntax

```
BANDWIDTH_LIMIT?
```

Response Format

```
BANDWIDTH_LIMIT <channel>,<mode>[,<channel>,<mode>...]
```

Example (GPIB)

The following turns off bandwidth limit filters for all channels:

```
CMD$="BWL OFF": CALL IBWRT(SCOPE%, CMD$)
```

The following turns on the 200 MHz bandwidth filter for C1 only:

```
CMD$="BWL C1,200MHZ": CALL IBWRT(SCOPE%, CMD$)
```

The following is the response to the BWL? query following the last two commands:

```
BWL C1,200MHZ,C2,OFF,C3,OFF,C4,OFF
```

COMBINE_CHANNELS, COMB

Description

The COMBINE_CHANNELS command controls the channel interleaving function of the acquisition system. The COMBINE_CHANNELS? query returns the channel interleaving function's current status.

Command Syntax

```
COMBINE_CHANNELS <state>
```

```
<state> : = {1, 2, AUTO}
```

Where 1 = no interleaving; 2 = two interleaved pairs; AUTO = oscilloscope determines based on the active channels.

Query Syntax

```
COMBINE_CHANNELS?
```

Response Format

```
COMB <state>
```

Example (GPIB)

The following instruction engages channel interleaving of C1 and C2, and C3 and C4:

```
CMD$="COMB 2": CALL IBWRT(SCOPE%,CMD$)
```

The following instruction sets Auto-Combine mode:

```
CMD$="COMB AUTO": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

TDIV

COUPLING, CPL

Description

The COUPLING command selects the coupling mode of the specified input.

The COUPLING? query returns the coupling mode of the specified channel.

Command Syntax

```
<channel>:COUPLING <coupling>
```

```
<channel>:= <C1 to Cn, EX, EX10, ETM10>
```

```
<coupling>:= {A1M, D1M, D50, GND}
```

The selected coupling value must be one that is available on the oscilloscope. Not all values are supported by all instruments.

A1M and D1M attenuation pertains only to instruments with a probe connected.

Query Syntax

```
<channel>:COUPLING?
```

Response Format

```
<channel>:COUPLING <coupling>
```

```
<coupling>:= {A1M, D1M, D50, GND, OVL}
```

OVL is returned in the event of signal overload while in DC 50 Ω coupling. In this condition, the oscilloscope will disconnect the input.

Example (GPIB)

The following instruction sets the coupling of C2 to 50 Ω DC:

```
CMD$="C2:CPL D50": CALL IBWRT(SCOPE%,CMD$)
```

The following instruction sets of the coupling of the EXT input to DC 1 Mohm:

```
CMD$="EX:CPL D1M": CALL IBWRT(SCOPE%,CMD$)
```

FORCE_TRIGGER, FRTR

Description

Causes the instrument to make one acquisition.

Command Syntax

```
FORCE_TRIGGER
```

Example (GPIB)

Either of the following programs forces the oscilloscope to make one acquisition:

```
CMD$="TRMD SINGLE;ARM;FRTR"

CALL IBWRT(Scope%, CMD$)


CMD$ = "TRMD STOP;ARM;FRTR"

CALL IBWRT(Scope%, CMD$)
```

INTERLEAVED, ILVD

Description

The INTERLEAVED command enables or disables random interleaved sampling (RIS) for timebase settings where both single shot and RIS mode are available.

RIS is not available for sequence mode acquisitions. If sequence mode is on, ILVD ON turns it off.

The response to the INTERLEAVED? query indicates whether the oscilloscope is in RIS mode.

Command Syntax

```
INTERLEAVED <mode>
```

```
<mode>:= {ON, OFF}
```

Query Syntax

```
INTERLEAVED?
```

Response Format

```
INTERLEAVED <mode>
```

Example (GPIB)

The following instructs the oscilloscope to use RIS mode:

```
CMD$="ILVD ON": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

TIME_DIV, TRIG_MODE, MEMORY_SIZE, SEQUENCE

MEMORY_SIZE, MSIZ

Description

On most models where this command/query is available, MEMORY_SIZE allows selection of the memory length used for acquisition. Refer to the product datasheet at teledynelecroy.com for maximum memory specifications.

The MEMORY_SIZE? query returns the current maximum memory length used to capture waveforms.

Command Syntax

```
MEMORY_SIZE <size>
```

```
<size>:= <500, 1e+3, …, 2.5e+6, 5e+6, 1e+7, etc.>
```

Or, alternatively:

```
<size>: = <500, 1000, 2500, 5000, 10K, 25K, 50K, 100K, 250K, 500K, 1MA, 2.5MA, 5MA,
10MA, 25MA, etc.>
```

Values other than those listed here are recognized by the oscilloscope as numeric data. For example, the oscilloscope recognizes 1.0M as 1 millisample. However, it recognizes 1MA as 1 megasample.

Note: The oscilloscope adapts to the closest valid memory size according to available channel memory. Reducing the number of data points results in faster throughput.

Query Syntax

MSIZ?

Response Format

MEMORY_SIZE <size>

Example (GPIB)

The following instruction sets the oscilloscope to acquire at most 10,000 data samples per single-shot or RIS acquisition:

```
CMD$="MSIZ 10K": CALL IBWRT(SCOPE%,CMD$)
```

```
CMD$="MSIZ 10e+3": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

TDIV

OFFSET, OFST

Description

The OFFSET command allows adjustment of the vertical offset of the specified input channel at the probe tip.

Note: The offset takes into the account the attenuation factor (set by command ATTN, default 1.0) and the sensitivity of the probe attached to the channel input, if any.

The maximum ranges depend on the fixed sensitivity setting. Refer to the product datasheet at teledynelecroy.com for maximum offset specifications.

If an out-of-range value is entered, the oscilloscope is set to the closest possible value and the VAB bit (bit 2) in the STB register is set.

The OFFSET? query returns the DC offset value of the specified channel at the probe tip.

Command Syntax

```
<channel>:OFFSET <offset>[V]
```

```
<channel>:= <C1 to Cn>
```

```
<offset>:= <any valid value>
```

The unit V is optional.

Query Syntax

```
<channel>:OFFSET?
```

Response Format

```
<channel>:OFFSET <offset>
```

Example (GPIB)

The following instruction sets the offset of C2 to -3 V:

```
CMD$="C2:OFST -3V": CALL IBWRT(SCOPE%,CMD$)
```

REFERENCE_CLOCK, RCLK

Description

The REFERENCE_CLOCK command allows for selection of either internal or external reference clock.

Command Syntax

```
REFERENCE_CLOCK <state>
```

```
<state>:= {INTERNAL, EXTERNAL}
```

Query Syntax

```
REFERENCE_CLOCK?
```

Response Format

```
REFERENCE_CLOCK <state>
```

Example (GPIB)

The following instruction sets the instrument to use an external reference clock:

```
CMD$="RCLK EXTERNAL":CALL IBWRT(SCOPE%,CMD$)
```

SAMPLE_CLOCK, SCLK

Description

The SAMPLE_CLOCK command selects for an internal or external sample clock.

Command Syntax

```
SAMPLE_CLOCK <state>
```

```
<state>:= {INTERNAL, EXTERNAL}
```

Query Syntax

```
SAMPLE_CLOCK?
```

Response Format

```
SAMPLE_CLOCK <state>
```

Example (GPIB)

The following instruction sets the instrument to use an external sample clock:

```
CMD$="SCLK EXTERNAL":CALL IBWRT(SCOPE%,CMD$)
```

SEQUENCE, SEQ

Description

The SEQUENCE command sets the conditions for the sequence mode acquisition. The response to the SEQUENCE? query gives the conditions for the sequence mode acquisition.

When Sequence mode is turned by using this command, SMART memory is automatically enabled and the memory length is set to the user-supplied <max_size> value. The argument <max_size> can be expressed either as numeric fixed point, exponential, or using standard suffixes.

Sequence mode cannot be used at the same time as random interleaved sampling (RIS). If RIS is on, the command SEQ ON turns RIS off.

Refer to the product datasheet at teledynelecroy.com for Sequence mode specifications.

Command Syntax

SEQUENCE <mode>[,<number segments>[,<max_size>]]

<mode> : = {OFF, ON}

<number segments> : = <any valid value>

<max_size> : = <any valid value, e.g., 10e+3 , 5K, 1M, etc.>

Note: The oscilloscope adapts the requested <max_size> to the closest valid value.

Query Syntax

SEQUENCE?

Response Format

```
SEQUENCE <mode>,<number segments>,<max_size>
```

Example (GPIB)

The following instruction sets the segment count to 43, the maximum segment size to 250 samples, and turns the sequence mode on:

```
CMD$="SEQ ON,43,250": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

TRIG_MODE

STOP

Description

The STOP command immediately stops the acquisition of a signal. If the trigger mode is AUTO or NORM, STOP places the oscilloscope in Stopped trigger mode to prevent further acquisition.

Command Syntax

```
STOP
```

Example (GPIB)

The following instruction stops the acquisition process:

```
CMD$ ="STOP": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

ARM_ACQUISITION, TRIG_MODE, WAIT, FORCE_TRIGGER

TIME_DIV, TDIV

Description

The `TIME_DIV` command modifies the timebase setting. The timebase setting can be specified with units: NS for nanoseconds, US for microseconds, MS for milliseconds, S for seconds, or KS for kiloseconds. Alternatively, you can use exponential notation: 10E-6, for example. An out-of-range value causes the VAB bit (bit 2) in the STB register to be set. Refer to the STB table in the ***STB?- *STB?** topic for more information.

The `TIME_DIV?` query returns the current timebase setting.

Refer to the product datasheet at teledynelecroy.com for timebase specifications.

Command Syntax

```
TIME_DIV <value>[KS,S,MS,US,NS]
```

```
<value>:= <any valid value>
```

The unit is optional.

Query Syntax

```
TIME_DIV?
```

Response Format

```
TIME_DIV <value>
```

Example (GPIB)

The following instruction sets the timebase to 500 µs/div:

```
CMD$="TDIV 500US": CALL IBWRT(SCOPE%,CMD$)
```

The following instruction sets the timebase to 2 msec/div:

```
CMD$="TDIV 0.002": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

TRIG_DELAY, TRIG_MODE

TRIG_COUPLING, TRCP

Description

The TRIG_COUPLING command sets the coupling mode of the specified trigger source.

The TRIG_COUPLING? query returns the trigger coupling of the selected source.

Note: The TRCP command affects only the coupling of the signal path to the trigger circuit, regardless of input impedance or coupling settings. To set the coupling on the input, use the COUPLING command.

Command Syntax

```
<trig_source>:TRIG_COUPLING <trig_coupling>

<trig_source>:= <C1 to Cn, EX, EX10, ETM10>

<trig_coupling>:= {AC, DC, HFREJ, LFREJ}
```

Query Syntax

```
<trig_source>:TRIG_COUPLING?
```

Response Format

```
<trig_source>:TRIG_COUPLING <trig_coupling>
```

Example (GPIB)

The following instruction sets the trigger coupling of the trigger source C2 to AC:

```
CMD$="C2:TRCP AC": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

COUPLING, TRIG_DELAY, TRIG_LEVEL, TRIG_MODE, TRIG_SELECT, TRIG_SLOPE

TRIG_DELAY, TRDL

Description

The TRIG_DELAY command sets the time at which the trigger is to occur with respect to the nominal zero delay position, which defaults to the center of the grid. This is also referred to as Horizontal Delay.

The response to the TRIG_DELAY? query indicates the trigger time with respect to the first acquired data point. Setting a trigger delay value of zero places the trigger indicator at the center of the grid.

Note: MAUI oscilloscopes support programming the trigger delay in units of time; the legacy argument PCT (of grid) is no longer supported. Positive values move the trigger position to the right of the nominal zero delay position, and increase the portion of the waveform before the trigger point. Negative values move the trigger point in the opposite direction.

Command Syntax

```
TRIG_DELAY <value>
```

The <value> is given in time and may be anywhere in the ranges:

Negative delay: (0 to -10,000) x Time/div

Postive delay: (0 to +10) x Time/div

If a value outside these ranges is specified, the trigger time is set to the nearest limit and the VAB bit (bit 2) is set in the STB register.

Query Syntax

```
TRIG_DELAY?
```

Response Format

```
TRIG_DELAY <value>
```

Example (GPIB)

The following instruction sets a post-trigger delay of -20 S:

```
CMD$="TRDL -20S": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

TIME_DIV, TRIG_COUPLING, TRIG_LEVEL, TRIG_MODE, TRIG_SELECT, TRIG_SLOPE

*TRG

Description

The *TRG command executes an ARM command. *TRG is the equivalent of the 488.1 GET (Group Execute Trigger) message.

Command Syntax

```
*TRG
```

Example (GPIB)

The following instruction enables signal acquisition:

```
CMD$="*TRG": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

ARM_ACQUISITION, STOP, WAIT, FORCE_TRIGGER

TRIG_LEVEL, TRLV

Description

The TRIG_LEVEL command adjusts the trigger level of the specified trigger source. An out-of-range value will be adjusted to the closest legal value and will cause the VAB bit (bit 2) in the STB register to be set.

The TRIG_LEVEL? query returns the current trigger level.

Command Syntax

```
<trig_source>:TRIG_LEVEL <trig_level>V
```

```
<trig_source>:= <C1 to Cn, EX, EX10, ETM10>
```

The <trig_source> value is optional.

Query Syntax

```
<trig_source>:TRIG_LEVEL?
```

Response Format

```
<trig_source>:TRIG_LEVEL <trig_level>
```

Example (GPIB)

The following instruction adjusts the trigger level of C2 to -3.4 V:

```
CMD$="C2:TRLV -3.4V": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

TRIG_COUPLING, TRIG_DELAY, TRIG_MODE, TRIG_SELECT, TRIG_SLOPE

TRIG_MODE, TRMD

Description

The TRIG_MODE command specifies the trigger mode.

The TRIG_MODE? query returns the current trigger mode.

Command Syntax

```
TRIG_MODE <mode>
```

```
<mode>:= {AUTO, NORM, SINGLE, STOP}
```

Note: Some older model oscilloscopes force an acquisition by sending the command TRMD SINGLE with the oscilloscope armed. You can achieve the same effect on current oscilloscope models by sending the FORCE_TRIGGER command.

Query Syntax

```
TRIG_MODE?
```

Response Format

```
TRIG_MODE <mode>
```

Example (GPIB)

The following instruction selects the normal mode:

```
CMD$="TRMD NORM": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

ARM_ACQUISITION, FORCE_TRIGGER, STOP, TRIG_SELECT, SEQUENCE, TRIG_COUPLING, TRIG_LEVEL, TRIG_SLOPE

TRIG_PATTERN, TRPA

Description

The TRIG_PATTERN command defines a trigger pattern. The command specifies the logic level of the sources C1 to C4 and External, and the states under which logic pattern a trigger can occur. This command can be used even if the Pattern trigger is not activated.

The TRIG_PATTERN? query returns the current trigger pattern.

Command Syntax

```
TRIG_PATTERN [<source>,<state>,...<source>,<state>],STATE,<condition>
```

```
<source>:= <C1 to Cn, EX>
```

```
<state>:= {L, H}
```

```
<condition>:= {AND, OR, NAND, NOR}
```

While optional, at least one source state parameter should be set, otherwise there will be no meaningful pattern. If a source state is not specified in the command, the source is set to the "X" (Don't Care) state.

Query Syntax

```
TRIG_PATTERN? [<source>,<state>,...<source>,<state>],STATE,<condition>
```

Response Format

```
TRIG_PATTERN [<source>,<state>,...<source>,<state>],STATE,<condition>
```

The response sends back only L (Low) or H (High) source states and ignores the X states.

Example (GPIB)

The following instruction configures the triggering logic pattern as CH 1 = H, CH 2 = L, CH 3 = X, CH 4 = H and defines the condition binding them as NOR.

```
CMD$="TRPA C1,H,C2,L,C4,H,STATE,NOR": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

TRIG_COUPLING, TRIG_DELAY, TRIG_LEVEL, TRIG_MODE, TRIG_SELECT, TRIG_SLOPE

TRIG_SELECT, TRSE

Description

The TRIG_SELECT command selects the conditions that trigger the acquisition of waveforms. Depending on the trigger type, additional parameters may need to be specified. These additional parameters are grouped in pairs. The first in the pair names the variable for modification, while the second gives the new value for assignment. Pairs may be given in any order and restricted only to the variables to be changed.

The oscilloscope interprets the "Hold Type" (HT) parameter as instruction to hold the trigger for a given amount of time or number of events, or until a certain trigger source or qualifier source condition is achieved (e.g., a pulse of a given width). The "Hold Value" (HV) parameter provides the value that satisfies the HT condition; they are always used together.

State Qualified and Edge Qualified triggers should use the Qualifier Source (QL) parameter and include any HT conditions to be observed on the qualifying signal.

The level used for the Edge and Edge Qualified trigger types is supplied with the TRIG_LEVEL command, and the slope with the TRIG_SLOPE command. These are not set using the HT parameter.

To set logic pattern triggers, use the Automation commands or the GPIB command TRIG_PATTERN. The receipt of the TRIG_PATTERN command overrides the TRIG_SELECT settings until another TRIG_SELECT is sent.

Use the Automation commands to set any trigger not shown here. See the product datasheet for the triggers supported by your model.

Command Syntax

For all but the TV trigger, the command syntax for standard triggers is:

```
TRIG_SELECT <trig_type>,SR,<source>[,QL,<source>,HT,<hold_type>,HV,<hold_
value>,HV2,<hold value>]
```

See table below for valid parameter values.

The trigger sources available depend on your oscilloscope model. See the product datasheet for specifications.

When specifying <hold_value>, the unit S (seconds) is optional; other units should be specified using the notation shown in Units and Multipliers.

The following table shows the command notation used to create the parameter-value pairs.

Parameters	Mnemonic	Values	Mnemonic	Notes
Trigger Type		**Dropout**	DROP	
		Edge	EDGE	
		Glitch	GLIT	
		Interval	INTV	
		Pattern	PA	
		Runt	RUNT	
		Slew Rate	SLEW	
		State Qualified	SQ	Add Qualifier Source parameter
		Edge Qualified	TEQ	
		Qualified First	TEQ1	
		TV	TV	Unique syntax, see below
		Single-source	SNG	For backward compatibility with legacy oscilloscopes
		Standard	STD	
Trigger Source	SR	**C1 through Cn**	C1...Cn	For best results, use C1 through C4 only. Use C2 and C3 for DBI acquisitions.
		Auxilliary Line In	LINE	
		External Trigger	EX , EX5, EX10, ETM10	See product datasheet for available external trigger inputs.
Qualifier Source	QL	**See Trigger Source**		
Hold Type	HT	**Time greater than**	TI	Holdoff is not available for SNG and STD triggers.
		Time less than	TL	
		Events	EV	
		Pulse larger than	PL	
		Pulse smaller than	PS	
		Pulse width	P2	Add HV and HV2
		Interval larger than	IL	
		Interval smaller than	IS	
		Interval width	I2	Add HV and HV2
		No hold-off on wait	OFF	
First Hold Value	HV		<value><unit>	Holdoff is not available for SNG and STD triggers.
Second Hold Value	HV2		<value><unit>	

TV Trigger Syntax

TV trigger syntax is:

```
TRIG_SELECT TV,SR,<source>,FLDC,<field_count>,FLD,<trigger_field>,
CHAR,<characteristics>,LPIC,<lpic>,ILAC,<ilace>,LINE,<trigger_line>
```

```
<source>:= <C1 to Cn, LINE, EX, EX5, EX10, ETM10>

<field_count>:= {1, 2, 4, 8}

<trigger_field>:= 1 to field_count

<characteristics>:= {NTSC, PALSEC, CUST50, CUST60}

<lpic>:= 1 to 1500

<ilace>:= {1, 2, 4, 8}

<trigger_line>:= 1 to 1500, or 0 for any line
```

DDA Trigger Syntax

DDA models and oscilloscopes with the DDA software option installed include the following disk drive analysis trigger types:

Read Gate Trigger

```
TRIG_SELECT READ,SR,<read gate source>,WIDTH,<min. read gate pulse width>
```

Sector Pulse Trigger

```
TRIG_SELECT SECTOR,SR,<sector source>,QL,<index source>NUM,<sector number>
```

Servo Gate Trigger

```
TRIG_SELECT SERVO,SR,<servo gate source>,QL,<index source>,FIRST,<servo burst after
index for first trigger>,SKIP,<skip number of bursts before next trigger>
```

PES Window Trigger

```
TRIG_SELECT PESWIN,SR,<PES source>,QL,<servo gate source>,WINDOW,<window size>
```

See the *DDA Reference Manual* for more information about the operation of these triggers.

Query Syntax

```
TRIG_SELECT?
```

Response Format

```
TRIG_SELECT <trig_type>,SR,<source>,HT,<hold_type>,HV,<hold_value>
```

The HV2 value is returned only if <hold_type> is P2 or I2.

Example (GPIB)

The following instruction selects the Single-Source trigger with C1 as trigger source. Hold type condition is the occurrence of a "pulse smaller than" the hold value of 20 ns:

```
CMD$="TRSE SNG,SR,C1,HT,PS,HV,20NS": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

TRIG_LEVEL, TRIG_SLOPE, TRIG_PATTERN

TRIG_SLOPE, TRSL

Description

The TRIG_SLOPE command sets the slope/polarity of the selected trigger source.

The TRIG_SLOPE? query returns the trigger slope/polarity of the selected source.

Command Syntax

```
<trig_source>:TRIG_SLOPE <trig_slope>

<trig_source>:= {C1, C2, C3, C4, LINE, EX, EX10, ETM10}

<trig_slope>:= {NEG, POS}
```

Query Syntax

```
<trig_source>:TRIG_SLOPE?
```

Response Format

```
<trig_source>:TRIG_SLOPE <trig_slope>
```

Example (GPIB)

The following instruction sets the trigger to the negative slope of C2:

```
CMD$="C2:TRSL NEG": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

TRIG_COUPLING, TRIG_DELAY, TRIG_LEVEL, TRIG_MODE, TRIG_SELECT, TRIG_SLOPE

VOLT_DIV, VDIV

Description

The VOLT_DIV command sets the vertical sensitivity in Volts/div. Refer to the product datasheet at teledynelecroy.com for a list of valid ranges.

The vertical sensitivity includes the attenuation factor (set by the command ATTN, default 1.0) and the sensitivity of the probe attached to the channel input, if any.

If an out-of-range value is entered, the VAB bit (bit 2) in the STB register is set. Refer to the STB table in the *STB? topic for more information.

The VOLT_DIV? query returns the vertical sensitivity of the specified channel at the probe tip.

Command Syntax

```
<channel>:VOLT_DIV <v_gain>

<channel>:= <C1 to Cn>

<v_gain>:= <any valid value><unit>
```

When specifying <v_gain>, the unit V is optional. Other units should be specified using the notation in Units and Multipliers.

Query Syntax

```
<channel>:VOLT_DIV?
```

Response Format

```
<channel>:VOLT_DIV <v_gain>
```

Example (GPIB)

The following instruction sets the vertical sensitivity of channel 1 to 50 mV/div:

```
CMD$="C1:VDIV 50MV": CALL IBWRT(SCOPE%,CMD$)
```

WAIT

Description

The WAIT command prevents your instrument from analyzing new commands until the current acquisition has been completed. The optional argument specifies the timeout (in seconds) after which the scope stops waiting for new acquisitions. If a timeout value (<t>) is not given, or if <t> = 0.0, the scope waits indefinitely.

Command Syntax

```
WAIT [<t>]

<t>:= time in seconds
```

Example (GPIB)

```
send: "TRMD SINGLE"

loop {send:"ARM;WAIT;*OPC;C1:PAVA? MAX"

read response

process response

}
```

This example finds the maximum amplitudes of several signals acquired one after another. ARM starts a new data acquisition. The WAIT command ensures that the maximum is evaluated for the newly acquired waveform.

The query `"C1:PAVA? MAX"` instructs the oscilloscope to evaluate the maximum data value in the Channel 1 waveform.

Related Commands

*TRG, TRIG_MODE, ARM

AUTOMATION Commands and Queries

VBS, VBS

Description

The VBS command allows Automation commands to be sent in the context of an existing program.

The Automation command must be placed within single quotation marks.

The equal sign (=) within the automation command may be flanked by optional spaces for clarity.

Tip: See XStreamBrowser for instructions on accessing the Automation hierarchy.

Command Syntax

VBS '<automation command>'

Query Syntax

VBS? 'Return=<automation command>'

Examples

The following examples show the use of the VBS command to send an automation command. The second column shows the equivalent GPIB-only command.

Command	VBS with Embedded Automation	Equivalent GPIB-only Command
Set C1 vertical scale to 50 mV/div	VBS 'app.Acquisition.C1.VerScale=0.05'	C1:VDIV 50 MV
Set horizontal scale to 500 ns/div	VBS 'app.Horizontal.HorScale = 500e-9'	TDIV 0.5e-6
Change grid mode to Dual	VBS 'app.Display.GridMode = Dual'	GRID DUAL
Query the vertical scale of C1	VBS? 'Return-n=app.Acquisition.C1.VerScale'	C1:VDIV?

COMMUNICATION Commands and Queries

COMM_FORMAT, CFMT

Description

The COMM_FORMAT command selects the format the oscilloscope uses to send waveform data. The available options allow the block format, the data type and the encoding mode to be modified from the default settings.

Initial settings (after power-on) are: block format DEF9; data type WORD; encoding BIN.

The COMM_FORMAT? query returns the currently selected waveform data format.

Command Syntax

```
COMM_FORMAT <block_format>,<data_type>,<encoding>

<block_format>:= {DEF9, OFF}

<data_type>:= {BYTE, WORD}

<encoding>:= {BIN}
```

Block Format

The IEEE 488.2 definite length arbitrary block response data format is specified using DEF. The digit 9 indicates that the byte count consists of 9 digits. The data block directly follows the byte count field.

For example, a data block consisting of three data bytes would be sent as:

```
WF DAT1,#9000000003<DAB><DAB><DAB><NL^END>
```

<DAB> represents an eight-bit binary data byte.

<NL^END> (new line with EOI) signifies the block transmission has ended.

Note: The block format OFF does not conform to the IEEE 488.2 standard and is only provided for special applications where the absolute minimum of data transfer may be important.

Data Type

BYTE transmits the waveform data as 8-bit signed integers (one byte).

WORD transmits the waveform data as 16-bit signed integers (two bytes).

Note: The data type **`BYTE`** transmits only the high-order bits of the internal 16-bit representation. The precision contained in the low-order bits is lost.

Encoding

BIN specifies Binary encoding. This is the only type of waveform data encoding supported by Teledyne LeCroy oscilloscopes.

Query Syntax

```
COMM_FORMAT?
```

Response Format

```
COMM_FORMAT <block_format>,<data_type>,<encoding>
```

Example (GPIB)

The following instruction redefines the transmission format of waveform data as a block of definite length, 9-digit data count field, data encoded in binary and represented as 8-bit signed integers.

```
CMD$="CFMT DEF9,BYTE,BIN": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

WAVEFORM

COMM_HEADER, CHDR

Description

The COMM_HEADER command controls the way the oscilloscope formats responses to queries. There are three response formats; unless you request otherwise, the short response format is used.

This command does not affect the interpretation of messages sent to the oscilloscope, only responses to queries. Headers can be sent in long or short form regardless of the COMM_HEADER setting.

Command Syntax

```
COMM_HEADER <mode>
```

```
<mode>:= {SHORT, LONG, OFF}
```

Format		Example Response
LONG	Responses start with the long form of the header word	`C1:VOLT_DIV 200E-3 V`
SHORT	Responses start with the short form of the header word	`C1:VDIV 200E-3 V`
OFF	Headers are omitted from the response and units are suppressed	`200E-3`

Query Syntax

```
COMM_HEADER?
```

Response Format

```
COMM_HEADER <mode>
```

Example (GPIB)

The following code sets the response header format to LONG:

```
CMD$="CHDR LONG": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

COMM_HELP_LOG

COMM_HELP_LOG?, CHL?

Description

The COMM_HELP_LOG query returns the current contents of the log generated by the Remote Control Assistant. If the optional parameter CLR is specified, the log is cleared after the transmission; otherwise, its kept.

Query Syntax

```
COMM_HEADER_LOG? [CLR]
```

Response Format

COMM_HEADER_LOG <string containing the logged text>

Example (GPIB)

The following instruction reads and prints the remote control log:

```
CMD$="CHL?": CALL IBWRT(SCOPE%,CMD$)PRINT
```

Related Commands

COMM_HELP

COMM_HELP, CHLP

Description

The COMM_HELP command controls the level of operation of the Remote Control Assistant, which assists in debugging remote control programs. This diagnostics utility is selected on the instrument's Utilities dialog. Remote Control Assistant can log all message transactions occurring between the external controller and the oscilloscope (full dialog), or errors only. You can view the log at any time on-screen.

Command Syntax

```
COMM_HELP <level>,<reset at power on>
```

```
<level>:= {OFF, EO, FD}
```

```
<reset at power on>:= {NO, YES}
```

LEVELS	OPERATION
OFF	Don't assist at all
EO	Log detected Errors Only
FD	Log the Full Dialog between the controller and the oscilloscope

If <reset at power on> is set to YES, at power-on the logging level is set to EO and the log is cleared. If set to NO, the user-set logging level is preserved and the log is not cleared.

Setting <reset at power on> to NO is useful when logging command sequences to include rebooting the oscilloscope.

The default level is EO, and reset at power on is YES.

Query Syntax

```
COMM_HELP?
```

Response Format

```
COMM_HELP<level>,<reset at power on>
```

Example (GPIB)

After sending this command, all the following commands and responses are logged:

```
CMD$="CHLP FD": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

COMM_HELP_LOG

COMM_ORDER, CORD

Description

The COMM_ORDER command controls the byte order of waveform data transfers. Waveform data can be sent with the most significant byte (MSB) or the least significant byte (LSB) in the first position. The default mode is to send the MSB first. COMM_ORDER applies equally to the waveform's descriptor and time blocks. In the descriptor some values are 16 bits long (word), 32 bits long (long or float), or 64 bits long (double). In the time block all values are floating values, meaning, 32 bits long. When COMM_ORDER HI is specified, the MSB is sent first; when COMM_ORDER LO is specified, the LSB is sent first.

The COMM_ORDER ? query returns the byte transmission order in current use.

Command Syntax

```
COMM_ORDER <mode>
```

```
<mode>:= {HI, LO}
```

Query Syntax

```
COMM_ORDER?
```

Response Format

```
COMM_ORDER <mode>
```

Example (GPIB)

The order of transmission of waveform data depends on the data type. The following table illustrates the different possibilities:

Data Type	COMM ORDER HI	COMM ORDER LO
Word	<MSB><LSB>	<LSB><MSB>
Long or Float	<MSB><byte2><byte3><LSB>	<LSB><byte3><byte2><MSB>
Double	<MSB><byte2>...<byte7><LSB>	<LSB><byte7>...<byte2><MSB>

Related Commands

WAVEFORM

CURSOR Commands and Queries

CURSOR_MEASURE, CRMS

Description

The CURSOR_MEASURE command specifies the type of cursor or parameter measurements to be displayed and is the main command for displaying parameters and Pass/Fail test results.

The CURSOR_MEASURE? query indicates which cursors or parameter measurements are currently displayed.

Command Syntax

```
CURSOR_MEASURE <mode>[,<submode>]

<mode>:= {CUST, FAIL, HABS, HPAR, HREL, OFF, PASS, VABS, VPAR, VREL}

<submode>:= {STAT, ABS, DELTA, SLOPE}
```

Where:

- CUST[,STAT] shows user-defined (My Measure) parameters.
- FAIL shows measurements failing Pass/Fail test.
- HABS shows Horizontal Absolute cursors.
- HPAR[,STAT] shows Standard Horizontal parameters.
- HREL[,ABS,DELTA,SLOPE] shows Horizontal Relative cursors.
- OFF turns off cursor and parameter display.
- PASS shows measurements passing Pass/Fail test.
- VABS shows Vertical Absolute cursors.
- VPAR[,STAT]shows Standard Vertical parameters.
- VREL[,ABS,DELTA] shows Vertical Relative cursors.

The submode STAT is optional with modes CUST, HPAR, and VPAR. If present, STAT turns on parameter statistics display. Absence of STAT turns off parameter statistics.

The submodes ABS and DELTA are optional with modes HREL or VREL. If present, ABS reads absolute position of relative cursors, whereas DELTA reads the delta of the two cursors. Absence of keyword selects the DELTA.

The modes PARAM, SHOW DASH, and LIST used with some legacy LeCroy instruments are not available on MAUI instruments.

Query Syntax

```
CURSOR_MEASURE?
```

Response Format

```
CURSOR_MEASURE <mode>
```

Example (GPIB)

The following instruction switches on the Vertical relative cursors:

```
CMD$="CRMS VREL": CALL IBWRT(SCOPE%,CMD$)
```

The following instruction determines which cursor is currently turned on:

```
CMDS$="CRMS?": CALL IBWRT(SCOPE%,CMD$): CALL IBRD(SCOPE%,RD$): PRINT RD$
```

Example response message:

```
CRMS OFF
```

Related Commands

CURSOR_SET, PARAMETER_STATISTICS, PARAMETER_VALUE, CURSORS, PARAMETER, PASS_FAIL

CURSORS, CRS

Description

Sets the type of cursor to be used and the readout. Unlike CRMS, this command does not change the state of parameters or pass/fail.

Command Syntax

```
CURSORS <type>[,<readout>]

<type>:=  {OFF, HREL, HABS, VREL, VABS}

<readout>:= {ABS, SLOPE, DELTA}
```

The SLOPE argument is used with the Horizontal Relative (HREL) cursor only.

Query Syntax

```
CURSORS? or CRS?
```

Example (GPIB)

The following instruction sets the cursors to horizontal relative, and readout to the difference between them.

```
CMD$="CRS HREL,DELTA": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

CURSOR_MEASURE

CURSOR_SET, CRST

Description

The CURSOR_SET command allows you to position any one of the independent cursors at a given grid location.

When setting a cursor position, you must specify the trace on which the cursor is positioned. This means the trace must be turned on, a requirement not applicable to all legacy LeCroy instruments.

The legacy commands PREF and PDIF are not supported on MAUI instruments.

The CURSOR_SET? query indicates the current position of the cursor(s). The values returned depend on the type selected.

Command Syntax

```
<trace>:CURSOR_SET <cursor>,<position>[. . .,<cursor>,<position>]

<trace>:= C1 to Cn, F1 to Fn, M1 to Mn, TA, TB, TC, TD

<cursor>:= {HABS, HREF, HDIF, VABS, VREF, VDIF}

<position>:= 0 to 10 DIV horizontal or -3.99 to 3.99 DIV vertical
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

Parameters are grouped in pairs. The first parameter specifies the cursor to be modified and the second one indicates its new value. Parameter pairings can be listed in any order and restricted to those items to be changed.

Cursor types are:

- HABS - Horizontal Absolute cursor
- HREF - Reference cursor of Horizontal Relative cursor pair
- HDIF - Difference cursor of Horizontal Relative cursor pair
- VABS - Vertical Absolute cursor
- VREF - Reference cursor of Vertical Relative cursor pair
- VDIF - Difference cursor of Vertical Relative cursor pair

The unit DIV is optional when specifying the position.

Tip: You can change the trace on which cursors are placed without repositioning the cursors by using the CURSOR_SET command with no arguments (for example, F2:CRST).

Query Syntax

```
CURSOR_SET? [<cursor>]
```

```
<cursor>:= {HABS, HREF, HDIF, VABS, VREF, VDIF, ALL}
```

Response Format

```
<trace>:CURSOR_SET <cursor>,<position>[...,<cursor>,<position>]
```

If <cursor> is not specified, ALL will be assumed. If the position of a cursor cannot be determined in a particular situation, its position will be indicated as UNDEF.

Example (GPIB)

The following instruction positions the VREF and VDIF cursors at +3 DIV and -2 DIV respectively on trace F1:

```
CMD$="F1:CRST VREF,3DIV,VDIF,-2DIV" :CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

CURSOR_MEASURE, CURSOR VALUE, PARAMETER_VALUE

CURSOR_VALUE?, CRVA?

Description

The CURSOR_VALUE? query returns the values measured by the specified cursors for a given trace.

There are important differences in the function of this query between MAUI instruments and legacy LeCroy instruments:

- The keyword ALL should not be used; neither should multiple keywords. If they are used, the word UNDEF is returned.
- The specified trace must be visible (turned on), and the cursor mode currently set on that trace must be the same as in the query. If it is not the same, UNDEF is returned.

Tip: Use the PARAMETER_VALUE? query to obtain measurement parameter values.

Query Syntax

```
<trace>:CURSOR_VALUE? [<mode>]

<trace>:= C1 to Cn, F1 to Fn, M1 to Mn, TA to TD

<mode>:= {HABS, HREL, VABS, VREL}
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

Cursor modes are:

- HABS - Horizontal Absolute cursor
- HREL - Horizontal Relative cursors
- VABS - Vertical Absolute cursor
- VREL - Vertical Relative cursors

Response Format

```
<trace>:CURSOR_VALUE HABS,<abs_hor>

<trace>:CURSOR_VALUE HREL,<delta_hor>,<abs hor_ref>,<abs hor_dif>,<slope>

<trace>:CURSOR_VALUE VABS,<abs_vert>

<trace>:CURSOR_VALUE VREL,<delta_vert>,<abs vert_ref>,<abs vert_dif>
```

Note: The dV/dt value <slope> is displayed in the appropriate trace descriptor box.

For horizontal cursors, both horizontal and vertical values are given. For vertical cursors only vertical values are given.

Example (GPIB)

The following query reads the measured value of the Horizontal Absolute cursor (HABS) on Channel 2:

```
CMD$="C2:CRVA? HABS": CALL IBWRT(SCOPE%,CMD$)
```

Response message:

```
C2:CRVA HABS,34.2E-6 S,244 E-3 V
```

OFFSET_CONSTANT, OFCT

Description

As you change the gain, this command allows for keeping the vertical offset level indicator stationary (when DIV is selected) or to have it move with the actual voltage level (when VOLTS is selected). The advantage of selecting DIV is that the waveform remains on the grid as the gain is increased; whereas, with VOLTS selected, the waveform could move off the grid.

Regardless of which is selected, the Offset value shown on the oscilloscope Channel setup dialog is always given in volts. However, DIV is selected for the Offset Control, the offset in volts is scaled proportional to the change in gain, thereby keeping the grid placement constant.

Command Syntax

```
OFFSET_CONSTANT <constant>

<constant>:= {VOLTS, DIV}
```

Query Syntax

```
OFCT?
```

Response Format

```
OFCT VOLTS
```

Example (GPIB)

```
CMD$ = "OFCT VOLTS": CALL IBWRT(SCOPE%, CMD$)
```

PARAMETER_CLR, PACL

Description

The PARAMETER_CLR command clears all the current parameters in the user-defined (My Measure) and Pass/Fail sets.

Command Syntax

```
PARAMETER_CLEAR
```

Related Commands

PARAMETER_DELETE, PARAMETER_VALUE

PARAMETER_CUSTOM, PACU

Description

The PARAMETER_CUSTOM command configures user-defined parameters (My Measure) in locations P1 through P*n*.

Tip: Use PAVA? to read the measured value of a parameter that was set up with PACU. The best way to learn the required command syntax is to set up the measurement as desired on the oscilloscope and run the P*n*: PACU? query. The response will be formatted exactly as required, especially if you have set the oscilloscope to suppress command headers using COMM_HEADER.

Command Syntax

```
PARAMETER_CUSTOM <parameter>,<measurement>,<qualifier>[,<qualifier>,...]

<parameter>:= 1 to n, CUST1 to CUST8

<measurement>:= mnemonic from table below or listed by the PAVA? query

<qualifier>:= qualifier(s) for each parameter shown in the tables below
```

Note: *n* represents the highest number parameter slot on your instrument. CUST1 through CUST8 are included for backward compatibility; they are accepted but not returned by queries.

Query Syntax

```
PACU? <parameter>
```

Response Format

```
PACU <parameter>,<measurement>,<qualifier>[,<qualifier>,...]
```

Related Commands

PARAMETER_DELETE, PARAMETER_VALUE

Measurements

Note: Measurements listed here may not be available on all instruments. If you do not already have access to the measurement on the oscilloscope (Measure Setup selector), you will not have it via remote control. See the product datasheet at teledynelecroy.com for a list of available measurements.

Qualifiers shown in the tables below may take the following values and units. Notate the units as shown (V, PCT, DIV, HZ, etc.).

<source>:= Header Paths and Sources. For histogram measurements, use histogram function F*n*.

<level>:= value PCT *or* V

<slope>:= {POS, NEG}

<hysteresis>:= 0.01 to 8 DIV

<frequency>:= 10 to 1e9 HZ (Narrow Band center frequency)

<signaltype>:= {CLOCK, DATA}

<outputin>:= {TIME, UI}

<referencetype>:= {STANDARD, CUSTOM}

All MAUI Oscilloscopes

These measurements are standard on all MAUI oscilloscopes running XStreamDSO v. 8.0.0 or higher.

Measurement	Mnemonic	Qualifiers
Amplitude	AMPL	<source>
Area	AREA	<source>
Base	BASE	<source>
Delay	DLY	<source>
Duty cycle	DUTY	<source>
Fall time 90% to 10%	FALL	<source>
Fall time 80% to 20%	FALL82	<source>
Frequency	FREQ	<source>
Maximum value	MAX	<source>
Mean value	MEAN	<source>
Minimum value	MIN	<source>
None/cleared	NULL	<source>
Overshoot negative	OVSN	<source>
Overshoot positive	OVSP	<source>

Measurement	Mnemonic	Qualifiers
Peak to peak	PKPK	<source>
Period	PER	<source>
Phase difference	PHASE	<source>
Rise time 10% to 90%	RISE	<source>
Rise time 20% to 80%	RISE28	<source>
Root mean square	RMS	<source>
Time clock to clock edge	SKEW	<clocksource1>,<clockslope1>,<clocklevel1 PCT | V>, <clocksource2>,<clockslope2>,<clocklevel2 PCT | V>, <clockhysteresis1>,<clockhysteresis2>
Standard deviation	SDEV	<source>
Top	TOP	<source>
Width 50% positive slope	WID	<source>
Width 50% negative slope	WIDN	<source>

HDO4000 and Higher Bandwidth Oscilloscopes

These measurements are standard on all HDO, MDA, WaveRunner, WavePro, WaveMaster and LabMaster oscilloscopes running XStreamDSO v. 8.0.0 or higher.

Measurement	Mnemonic	Qualifiers
Delta period @ level	DPLEV	<signaltype>,<slope>,<level PCT | V>,<hysteresis DIV>, <referencetype>,<-3dBfrequency HZ>,<frequency HZ>
Delta time @ level	DTLEV	<source1>,<slope1>,<level1 PCT | V>,<hysteresis1 DIV> <source2>,<slope2>,<level2 PCT | V>,<hysteresis2 DIV>
Duty cycle @ level	DULEV	<source>
Edge @ level	EDLEV	<source>,<slope>,<level PCT | level V>,<hysteresis DIV>
Frequency @ level	FREQLEV	<signaltype>,<slope>,<level PCT | V>,<hysteresis DIV>, <referencetype>,<-3dBfrequency HZ>,<frequency HZ>
Period @ level	PLEV	<signaltype>,<slope>,<level PCT | V>,<hysteresis DIV>,<refer-encetype>,<-3dBfrequency HZ>,<frequency HZ>
Time @ level	TLEV	<source>,<slope>,<level PCT | V>,<hysteresis DIV>

HDO6000 and Higher Bandwidth Oscilloscopes

These measurements are standard on HDO6000 and higher, MDA, WaveRunner, WavePro, WaveMaster and LabMaster series oscilloscopes running XStreamDSO v. 8.0.0 or higher.

Measurement	Mnemonic	Qualifiers
Histogram Mean	AVG	<source>
Math on Parameters	CALCx	<measure1>,<source1>,<operator>,<measure2>,<source2> <operator>:= {ADD, SUB, MUL, DIV}
Cycles on screen	CYCL	<source>
Delta delay	DDLY	<source>
Delta trigger time	DTRIG	<source>
Delta width @ level	DWIDLEV	<source>,<slope>,<level PCT | level V>,<hysteresis DIV>
Duration of acquisition	DUR	<source>
Excel parameter	EXCELPARAM	<source1var>,<source2var>,<outputvar>,<source1headervar>, <source2headervar>,<outputheadervar>,<withheader>, <outputenable>,<source1enable>,<source2enable>, <newsheet>,<advanced>,'<worksheetfilename>'
Fall @ level	FLEV	<source>,<highlevel PCT | V>,<lowlevel PCT | V>
First (left-most) sample in measure gate	FRST	<source>
Histogram FWHM	FWHM	<source>
Histogram peak FW @ level	FWxx	<source>,<%maxpopulation PCT> <%maxpopulation>:= value PCT of max population at which to measure Full-Width
Half Period	HPER	<source>,<slope>,<level PCT | V>,<hysteresis DIV>
Histogram amplitude	HAMPL	<source>
Histogram base level	HBASE	<source>
Histogram right bin; same as Histogram maximum	HIGH	<source>
Histogram mean	HMEAN	<source>
Histogram median	HMEDI	<source>
Time clock edge to data edge @ level	HOLDLEV / HOLDTIME	<clocksource>,<clockslope>,<clocklevel PCT | V>, <datasource>,<dataslope>datalevel PCT | V>, <clockhysteresis DIV>,<datahysteresis DIV>
Histogram rms	HRMS	<source>
Histogram top level	HTOP	<source>
Last (right-most) sample in measure gate	LAST	<source>
Histogram left bin; same as Histogram minimum.	LOW	<source>

Measurement	Mnemonic	Qualifiers
Mathcad parameter	MATHCADPARAMARITH	<source>,'<function>'
MATLAB parameter	MATLABPARAM	<source>,'<function>'
Histogram maximum population	MAXP	<source>
Median	MEDI	<source>
Histogram mode	MODE	<source>
Narrow Band phase	NBPH	<source><frequency HZ>
Narrow Band power	NBPW	<source><frequency HZ>
N cycle jitter	NCYCLE	<source>
VBS script parameter	PARAMSCRIPT	<source>,'<code>'
Histogram percentile	PCTL	<source>
Number of peaks	PKS	<source>
Number of points	PNTS	<source>
Population of histogram bin at *x*	POPATX	<source>,<cursorposition V> <cursorposition>:= value V representing histogram bin at which to measure population
Histogram range	RANGE	<source>
Rise time @ level	RLEV	<source>,<lowlevel PCT | V>,<highlevel PCT | V>
Data edge to clock edge	SETUP	<clocksource>,<clockslope>,<clocklevel PCT | V>, <datasource>,<dataslope>datalevel PCT | V>, <clockhysteresis DIV>,<datahysteresis DIV>
Histogram standard deviation	SIGMA	<source>
Time Interval Error @ level	TIELEV	<signaltype>,<slope>,<level PCT | V>,<outputin>,<hysteresis DIV>,<referencetype>,<-3db@frequency HZ>,<frequency HZ>
Histogram total population	TOTP	<source>
Width @ level	WIDLV	<source>,<slope>,<level PCT | V>,<hysteresis DIV>
Pos of max. data value	XMAX	<source>
Pos of min. data value	XMIN	<source>
Histogram *N*th highest peak	XAPK	<source>

XMath/SDA Option Measurements

These measurements are included on SDA 7 Zi and SDA 8 Zi series oscilloscopes running XStreamDSO v. 8.0.0 or higher, or become available with the installation of an XMath or SDA option.

Note: In these cases, you will only be able to set the measurement and source using the PACU command. Other qualifiers must be set manually or using Automation. Select an Eye Diagram as the source for eye measurements.

Measurement	Mnemonic	Qualifiers
Edge displacement	EDGEDA	<source>
Pattern time	PATTERNTIME	<source>
Ring back high/low	RING	<source>
Lane-to-lane skew	SD2SKEW	<source>
Strip DDj from source	STRIPDDJ	<source>
Eye diagram zero level	ZEROLVL	<source>

SDA Option Measurements

These measurements are included on SDA 7 Zi and SDA 8 Zi series oscilloscopes running XStreamDSO v. 8.0.0 or higher, or become available with the installation of an SDA option. As with the measurements in the table above, you may not be able to set all necessary qualifiers using the PACU command.

Measurement	Mnemonic	Qualifiers
Eye AC rms	EYEACRMS	<source>
Eye power level ratio	EXTRATIO	<source>
Eye amplitude	EYEAMPL	<source>
Eye bit error rate estimate	EYEBER	<source>
Eye bit rate	EYEBITRATE	<source>
Eye bit time	EYEBITTIME	<source>
Eye crossing	EYECROSSING	<source>
Eye negative crossing	EYECROSSN	<source>
Eye positive crossing	EYECROSSP	<source>
Eye cyc area	EYECYCAREA	<source>
Eye delay	EYEDELAY	<source>
Eye delta delay	EYEDELTDLY	<source>
Eye fall time	EYEFALLTIME	<source>
Eye height	EYEHEIGHT	<source>
Eye mean	EYEMEAN	<source>
Eye one level	EYEONE	<source>

Measurement	Mnemonic	Qualifiers
Eye opening factor	EYEOPENFAC	<source>
Eye negative overshoot	EYEOVERN	<source>
Eye positive overshoot	EYEOVERP	<source>
Eye peak noise	EYEPKNOISE	<source>
Eye peak-to-peak jitter	EYEPKPKJIT	<source>
Eye pulse width	EYEPULSEWID	<source>
Eye Q factor	EYEQ	<source>
Eye rise time	EYERISETIME	<source>
Eye RMS jitter	EYERMSJIT	<source>
Eye std. deviation noise	EYESDNOISE	<source>
Eye signal to noise	EYESGTONOISE	<source>
Eye suppression ratio	EYESUPRATIO	<source>
Eye width	EYEWIDTH	<source>
Jitter per duty-cycle distortion	PERDCD	<source>
Persistence duty-cycle	PERDUTYCYC	<source>
Per pulse symmetry	PERPULSESYM	<source>
PCIe misc. measurements	PCIEMISC	<source> **Note:** This measurement will need additional setup to return anything but the default min. pulse time measurement.
PCIe min. pulse width	TMNPLS	<source>
PCIe uncorrelated pulse width DJ	UPWJDD	<source>
PCIe uncorrelated pulse width TJ	UPWTJ	<source>

Note: For a description of other measurements installed by option key, download the software option manual from our website (see Resources). The best test of compatibility is to set up the measurement as desired on the oscilloscope, then run the PACU? query on that parameter. Whatever qualifiers are returned by the PACU? query are what can be set using the PACU command. These may not be sufficient to fully configure the measurement. Use Automation with the VBS command to set missing qualifiers.

PARAMETER_DELETE, PADL

Description

The PARAMETER_DELETE command deletes a parameter/qualifier from the table of results shown for custom measurements or Pass/Fail testing.

Command Syntax

```
PARAMETER_DELETE <column>
```

```
<column>:= 1 through x
```

x represents the highest number parameter slot on your instrument.

Example (GPIB)

The following instruction deletes the third parameter in the set:

```
CMD$="PADL 3": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

PARAMETER_CLR, PARAMETER_VALUE

PARAMETER, PARM

Description

This command turns statistics and histicons on or off.

Unlike CRMS, the PARM command does not change the state of cursors or pass/fail.

Command Syntax

```
PARM <type>,[readout]
```

```
Type:= {CUST, HPAR, VPAR, OFF}
```

```
Readout:= {STAT, HISTICON, BOTH, OFF}
```

Without argument, the state of histograms and statistics is unchanged.

Query Syntax

```
PARAMETER? or PARM?
```

Response Format

```
PARM <type>,<readout>
```

Example (GPIB)

The following instruction turns on histicons:

```
CMD$="PARM CUST,HISTICON";CALL IBWRT(SCOPE%,CMD$)
```

PARAMETER_STATISTICS?, PAST?

Description

The PARAMETER_STATISTICS? query returns all current measurement statistics for the specified parameter set. By using the optional <statistic> and <param> arguments, the query returns either the single specified statistic for all measurements in the parameter set, or all statistics for the single specified parameter.

Query Syntax

```
PARAMETER_STATISTICS? <mode>[,<statistic>][,<param>]
```

```
<mode>:= {CUST, HPAR, VPAR}
```

```
<statistic>:= {AVG, LOW, HIGH, SIGMA, SWEEPS, LAST, PARAM}
```

```
<param>:= P1 to Px
```

The <mode> must correspond to the currently configured mode on the oscilloscope. Use:

- CUST when the measure mode is set to My Measure
- VPAR when set to Std Vertical
- HPAR when set to Std Horizontal

If the <mode> does not match the one set on the oscilloscope, the query returns UNDEF.

If the <statistics> keyword PARAM is specified when in CUST mode, the query returns the list of the <parameter_name>,<source> pairs configured in the custom set, along with the statistical values.

Note: The <statistics> and <param> arguments should not be used together.

Mnemonics	
CUST	Custom parameters. Use when measure mode is My Measure.
HPAR	Horizontal standard parameters. Use when measure mode is Std Horizontal.
VPAR	Vertical standard parameters. Use when measure mode is Std Vertical.
AVG	Average value (mean row in statistics table)
HIGH	highest value (max row in statistics table)
LOW	lowest value (min row in statistics table)
PARAM	parameter definition for each line
SIGMA	sigma (standard deviation)
SWEEPS	number of measurements accumulated for each line

Example A (GPIB)

The following instruction reads the average values for all custom parameters:

```
CMD$ = "PAST? CUST,AVG" CALL IBWRT (SCOPE%,CMD$) CALL IBRD(SCOPE%,RD$)
```

The oscilloscope responds with:

```
PAST CUST,AVG,290.718E-3 V,389.25E-12 V.S,-144.589E-3 V,93.76604E-9 S,
290.725E-3 V,389.25E-12 V.S,-144.589E-3 V,229E-9 V
```

Example B (GPIB)

The following instruction reads all statistical values for parameter P2:

```
CMD$ = "PAST? CUST,P2" CALL IBWRT (SCOPE%,CMD$) CALL IBRD(SCOPE%,RD$)
```

The oscilloscope responds with:

```
PAST CUST,P1,AMPL,C1,AVG,290.718E-3 V,HIGH,297.5E-3 V,LAST,294.2E-3 V,
LOW,278.2E-3 V,SIGMA,3.047E-3 V,SWEEPS,182
```

PARAMETER_VALUE?, PAVA?

Description

The PARAMETER_VALUE query returns the current values of the waveform parameters for the specified trace. Traces do not need to be displayed to obtain the values reported by PAVA?.

Query Syntax

To query measurement parameters:

```
<trace>:PAVA? [<parameter>...,<parameter>]
```

```
<parameter>:= any standard or user-defined parameter set with PACU
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

Response Format

```
<trace>:PAVA? <parameter>,<value>,<state>
```

Note: If <parameter> is not specified, or is equal to ALL, all standard voltage and time parameters are returned followed by their values and states.

In addition to the standard and user-defined parameter values, the following states may be returned:

State	Description
AV	Averaged over several periods
GT	Greater than given value
IV	Invalid value (insufficient data provided)
LT	less than given value
NP	No pulse waveform
OF	Signal partially in overflow
OK	Deemed to be determined without problem
OU	Signal partially in overflow and underflow
PT	Window has been period truncated
UF	Signal partially in underflow

Example (GPIB)

The following instruction reads the rise time of trace C1:

```
CMD$="C1:PAVA? RISE": CALL IBWRT(SCOPE%,CMD$):
```

```
CALL IBRD (SCOPE%,RD$): PRINT RD$
```

Response message:

```
RISE,3.6E-9S,OK
```

Related Commands

CURSOR_MEASURE, CURSOR_SET, PARAMETER_CUSTOM, PARAMETER_STATISTICS

PER_CURSOR_SET, PECS

Description

The PER_CURSOR_SET command allows you to position one or more of the six independent cursors at a given grid location. Cursors must be turned on for the PECS command or query to work.

Command Syntax

```
<trace>:PER_CURSOR_SET <cursor>,<position>[…,<cursor>,<position>]
```

```
<trace>:= C1 to Cn, F1 to Fn, M1 to Mn, TA to TD
```

```
<cursor>:= {HABS, HDIF, HREF, VABS, VDIF, VREF}
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

*x*REF and *x*DIF are the left and right cursors in a relative cursor pair (HREL or VREL). The readout will show the absolute position of each and the delta between them.

Query Syntaxj

```
<trace>:PER_CURSOR_SET?
```

Example (GPIB)

The following instruction positions the HREF and HDIF cursors at +2.6 DIV and +7.4 DIV respectively on the C2 trace:

```
CMD$="C2:PECS HREF,2.6 DIV,HDIF,7.4 DIV" CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

CURSOR_MEASURE, CURSOR_SET, PER_CURSOR_VALUE

PASS_FAIL, PF

Description

The PASS_FAIL command sets up the Pass/Fail test system.

The PASS_FAIL? query returns the Pass/Fail setup.

Command Syntax

```
PASS_FAIL <state>,<logic>[,<stop after>]
```

```
<state>:= {ON, OFF}
```

```
<logic>:= {AllTrue, AllFalse, AnyTrue, AnyFalse, AllQ1ToQ4, AllQ5ToQ8, AllQ9ToQ12,
AnyQ1ToQ4, AnyQ5ToQ8, AnyQ9TOQ12}
```

```
<stop after>:= 1 to 1,000,000,000 sweeps
```

The <logic> argument specifies which set of conditions must be satisfied to constitute a "pass."

Note: The logic accepted by this command depends on the Pass/Fail functionality available on your instrument. WaveSurfer and HDO4000 oscilloscopes that do not allow you to define individual PF qualifier conditions do not support the arguments AllQ*x*ToQ*y* and AnyQ*x*ToQ*y*. These instruments only support the logic AllTrue.

Query Syntax

```
PASS_FAIL?
```

Example (GPIB)

The following instruction sets the test to pass only if all qualifier conditions are false, and to stop after 20 acquisitions:

```
CMD$="PF ON,ALLFALSE,20": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

CRMS

PASS_FAIL_DO, PFDO

Description

The PASS_FAIL_DO command defines the actions to be performed in the event of the specified outcome of a Pass/Fail test.

The PASS_FAIL_DO? query indicates which actions are currently selected. If none, no parameters are returned.

Command Syntax

```
Pass_Fail_DO <outcome>,<act>[,<act> …]
```

```
<outcome>:= {PASS, FAIL}
```

```
<act>:= {ALARM, BEEP, PRINT, SCDP, PULSE, PULS, SAVE, STO, STOP}
```

Where:

ALARM or BEEP = sound a beep.

PRINT or SCDP = send to printer.

PULSE or PULS = emit a pulse from the Aux Out connector.

SAVE or STO = store in currently selected mass storage.

STOP = stop acquisition.

Note: BEEP, SCDP, PULS and STO are provided for backward compatibility. Only the new formats are returned in queries.

Query Syntax

```
Pass_Fail_DO?
```

Response Format

```
Pass_Fail_DO [<pass_fail>,<act>[,<act> …]]
```

Example (GPIB)

The following instruction forces the instrument to stop acquiring when the test passes:

```
CMD$="PFDO PASS,STOP" CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

BUZZER, CURSOR_MEASURE, CURSOR_SET, INR, PARAMETER_VALUE, PASS_FAIL_MASK

DISPLAY Commands and Queries

DISPLAY, DISP

Description

The DISPLAY command controls the display screen of the oscilloscope. When remotely controlling the oscilloscope, and if you do not need to use the display, it can be useful to switch off the display via the DISPLAY OFF command. This improves oscilloscope response time, since the waveform graphic generation procedure is suppressed.

In addition, when the oscilloscope is in the DISPLAY OFF mode, certain LEDs and the periodic backup of the oscilloscope settings are disabled to avoid unnecessary interruptions.

The response to the DISPLAY? query indicates the display state of the oscilloscope.

Note: When you set the display to OFF, the screen does not actually go blank. Instead, the real-time clock and the message field are continuously updated. but waveforms and associated text are frozen.

Command Syntax

```
DISPLAY <state>

<state>:=  ON or OFF
```

Query Syntax

```
DISPLAY?
```

Response Format

```
DISPLAY <state>
```

Example (GPIB)

The following instruction turns off the display:

```
CMD$="DISP OFF": CALL IBWRT(SCOPE%,CMD$)
```

DOT_JOIN, DTJN

Description

The DOT_JOIN command controls the interpolation lines between data points. Setting DOT_JOIN ON selects a continuous Line; DOT_JOIN OFF selects a series of Points.

Command Syntax

```
DOT_JOIN <state>
```

```
<state>:= {ON, OFF}
```

Query Syntax

```
DOT_JOIN?
```

Response Format

```
DOT_JOIN <state>
```

Example (GPIB)

The following instruction turns off the interpolation lines:

```
CMD$="DTJN OFF": CALL IBWRT(SCOPE%,CMD$)
```

GRID

Description

The GRID command defines the style of the grid used in the display.

The GRID? query returns the grid style currently in use.

The grid value must correspond to a grid style available on your oscilloscope. See your product datasheet, XStreamBrowser, or the oscilloscope Display Setup dialog for options.

Command Syntax

```
GRID <grid>
```

```
<grid>:= {AUTO, SINGLE, DUAL, QUAD, OCTAL, XY, XYSINGLE, XYDUAL, TANDEM, QUATTRO,
TWELVE, SIXTEEN, TRIPLE, HEX}
```

Query Syntax

```
GRID?
```

Response Format

```
GRID <grid>
```

Example (GPIB)

The following instruction sets the screen display to dual grid mode:

```
CMD$="GRID DUAL": CALL IBWRT(SCOPE%,CMD$)
```

HOR_MAGNIFY, HMAG

Description

The HOR_MAGNIFY command horizontally expands a zoom math function trace (a.k.a., expansion trace) by the specified factor. Magnification factors not within the range of permissible values will be rounded off to the nearest legal value.

The VAB bit (bit 2) in the STB register table is set when a factor outside the legal range is specified.

The HOR_MAGNIFY? query returns the current magnification factor for the specified expansion function.

Command Syntax

```
<trace>:HOR_MAGNIFY <factor>
```

```
<trace>:= F1 to Fn, TA to TD
```

```
<factor>: = 1 to 20000
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

Query Syntax

```
<exp_source>:HOR_MAGNIFY?
```

Response Format

```
<exp_source>:HOR_MAGNIFY <factor>
```

Example (GPIB)

The following instruction horizontally magnifies trace F1 by a factor of 5:

```
CMD$="F1:HMAG 5": CALL IBWRT(SCOPE%,CMD$)
```

HOR_POSITION, HPOS

Description

The HOR_POSITION command horizontally positions the geometric center of the intensified (zoomed) zone represented by a zoom math function trace. Allowed positions range from division 0 through 10. If the source trace was acquired in sequence mode, horizontal shifting will only apply to a single segment at a time.

If multi-zoom is enabled, the difference in horizontal position (or segment viewed for sequence mode acquisitions) is applied to all zoom traces. The VAB bit (bit 2) in the STB register table is set if a value outside the legal range is specified.

The HOR_POSITION? query returns the position of the geometric center of the intensified zone.

Command Syntax

```
<trace>:HOR_POSITION <hor_position>,<segment>

<trace>:= F1 to Fn, M1 to Mn, TA to TD

<hor_position>:= 0 to 10 [DIV]

<segment>:= 0 to max segments
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

The segment number is only relevant for waveforms acquired in sequence mode; it is ignored in single waveform acquisitions. When segment number is 0, all segments are shown at default magnification.

Query Syntax

```
<trace>:HOR_POSITION?
```

Response Format

```
<trace>:HOR_POSITION <hor_position | segment>
```

Note: The segment number is only returned for sequence waveforms.

Example (GPIB)

The following instruction positions the center of the intensified zone on trace F1 at division 3:

```
CMD$="F1:HPOS 3": CALL IBWRT(SCOPE%,CMD$)
```

INTENSITY, INTS

Description

The INTENSITY command sets the intensity level of the grid. The argument "TRACE,<value>" is accepted for backward compatibility, but the actual trace intensity is always 100%.

Command Syntax

```
INTENSITY GRID,<value>,TRACE,<value>
```

Query Syntax

```
INTENSITY?
```

Response Format

```
INTENSITY TRACE,<value>,GRID,<value>
```

Example (GPIB)

The following example sets the grid intensity to 70%.

```
CMD$="INTS GRID,70" : CALL IBWRT(SCOPE%,CMD$)
```

MESSAGE, MSG

Description

The MESSAGE command displays a string of characters in the message field at the bottom of the instrument screen.

Command Syntax

```
MESSAGE "<string>"
```

```
<string>:= up to 49 characters
```

Longer strings are truncated to 49 characters, but the original string is retained and returned by the MSG? Query. The quotation mark delimiters are required.

Query Syntax

```
MESSAGE?
```

Response Format

```
MESSAGE "<string>"
```

Example (GPIB)

The following command causes the message 'Touch Probe 2 to Test Point 7' to appear in the oscilloscope message bar.

```
CMD$=MSG "'Touch Probe 2 to Test Point 7'": CALL IBWRT(SCOPE%, CMD$)
```

PERSIST_COLOR, PECL

Description

The PERSIST_COLOR command controls the color rendering method of persistence traces: ANALOG, COLOR_GRADED, or 3D. Refer to the datasheet specification for your instrument for availability.

The response to the PERSIST_COLOR? query indicates the color rendering method in use.

Command Syntax

```
PERSIST_COLOR <state>
```

```
<state> : = {ANALOG, COLOR_GRADED, 3D}
```

Query Syntax

```
PERSIST_COLOR?
```

Response Format

```
PERSIST_COLOR <state>
```

Example (GPIB)

The following instruction sets the persistence trace color to an intensity-graded range of the selected trace color:

```
CMD$="PECL ANALOG": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

PERSIST, PERSIST_LAST, PERSIST_SAT, PERSIST_SETUP

PERSIST_LAST, PELT

Description

The PERSIST_LAST command controls whether or not the last trace drawn in a persistence data map is shown. This command marks or un-marks the "Show Last Trace" checkbox on the Persistence dialog.

Command Syntax

```
PERSIST_LAST <state>
```

```
<state>:= {ON, OFF}
```

Query Syntax

```
PERSIST_LAST?
```

Response Format

```
PERSIST_LAST <state>
```

Example (GPIB)

The following instruction ensures the last trace is visible within its persistence data map:

```
CMD$="PELT ON": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

PERSIST, PERSIST_COLOR, PERSIST_SAT, PERSIST_SETUP

PERSIST, PERS

Description

The PERSIST command enables or disables the persistence display mode.

Command Syntax

```
PERSIST <mode>
```

```
<mode>:= {ON, OFF}
```

Query Syntax

```
PERSIST?
```

Response Format

```
PERSIST <mode>
```

Example (GPIB)

The following instruction turns the persistence display ON:

```
CMD$="PERS ON": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

PERSIST_COLOR, PERSIST_LAST, PERSIST_SAT, PERSIST_SETUP

PERSIST_SAT, PESA

Description

The PERSIST_SAT command sets the saturation level of the persistence color spectrum. The level is specified in terms of percentage (PCT) of the total persistence data map population. A level of 100 PCT corresponds to the color spectrum being spread across the entire depth of the persistence data map. At lower values, the spectrum saturates (brightest value) at the specified percentage value. The unit PCT is optional.

The response to the PERSIST_SAT? query indicates the saturation level of the persistence maps.

Command Syntax

```
PERSIST_SAT <trace>,<value>[...,<trace>,<value>]

<trace>:= C1 to Cn, F1 to Fn, TA to TD

<value>:= 0 to 100
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

Query Syntax

```
PERSIST_SAT?
```

Response Format

```
PERSIST_SAT <trace>,<value>
```

Example (GPIB)

The following instruction sets the saturation level of the persistence data map for channel 3 to 60%. This means 60% of the data points are displayed with the color spectrum, and the remaining 40% saturated in the brightest color:

```
CMD$="PESA C3,60": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

PERSIST, PERSIST_COLOR, PERSIST_PERS, PERSIST_SETUP

PERSIST_SETUP, PESU

Description

The PERSIST_SETUP command selects the persistence duration of the display, in seconds, in persistence mode. The persistence can also be set on either all traces or only the top two shown on the screen.

The PERSIST_SETUP? query indicates the current status of the persistence.

Command Syntax

```
PERSIST_SETUP <time>,<mode>
```

```
<time>:= {0.5, 1, 2, 5, 10, 20, infinite}
```

```
<mode>:= {PERTRACE, ALL}
```

Note: This command does not support the argument Top2 of legacy instruments.

Query Syntax

```
PERSIST_SETUP?
```

Response Format

```
PERSIST_SETUP <time>,<mode>
```

Example (GPIB)

The following instruction sets the variable persistence to 10 seconds on all traces:

```
CMD$="PESU 20,ALL": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

```
PERSIST, PERSIST_COLOR, PERSIST_PERS, PERSIST_SAT
```

TRACE, TRA

Description

The TRACE command enables or disables the display of a trace. An environment error is set if an attempt is made to display more than four waveforms. Refer to the EXR table in the EXR? topic for more information.

The TRACE? query indicates whether or not the specified trace is displayed.

Command Syntax

```
<trace>:TRACE <mode>

<trace>:= C1 to Cn, F1 to Fn, TA to TD

<mode>:= {ON, OFF}
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

Query Syntax

```
<trace>:TRACE?
```

Response Format

```
<trace>:TRACE <mode>
```

Example (GPIB)

The following instruction displays Trace F1:

```
CMD$="F1:TRA ON": CALL IBWRT(SCOPE%,CMD$)
```

VERT_MAGNIFY, VMAG

Description

The VERT_MAGNIFY command vertically expands the specified trace. The command is executed even if the trace is not displayed. The maximum magnification allowed depends on the number of significant bits associated with the data of the trace.

The VERT_MAGNIFY? query returns the magnification factor of the specified trace.

Command Syntax

```
<trace>:VERT_MAGNIFY <factor>

<trace>:= F1 to Fn, TA to TD

<factor>:= 100E-3 to 181
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

Query Syntax

```
<trace>:VERT_MAGNIFY?
```

Response Format

```
<trace>:VERT_MAGNIFY <factor>
```

Example (GPIB)

The following instruction enlarges the vertical amplitude of Trace A by a factor of 3.45 with respect to its original amplitude:

```
CMD$="TA:VMAG 3.45": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

VERT_POSITION

VERT_POSITION, VPOS

Description

The VERT_POSITION command adjusts the vertical position of the specified trace on the screen. It does not affect the original offset value obtained at acquisition time.

The VERT_POSITION? query returns the current vertical position of the specified trace.

Note: The VPOS command and query can only be applied to math function and memory traces. It does not apply to channel inputs.

Command Syntax

```
<trace>:VERT_POSITION <display_offset>
```

```
<trace>:= F1 to Fn, M1 to Mn, TA to TD
```

```
<display_offset>:= -5900 to +5900 DIV
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

The unit DIV is optional. The limits depend on the current magnification factor, the number of grids on the display, and the initial position of the trace.

Query Syntax

```
<trace>:VERT_POSITION?
```

Response Format

```
<trace>:VERT_POSITION <display_offset>
```

Example (GPIB)

The following instruction shifts trace F1 upwards by +3 divisions relative to the position at the time of acquisition:

```
CMD$="F1:VPOS 3DIV": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

VERT_MAGNIFY

FUNCTION Commands and Queries

CLEAR_MEMORY, CLM

Description

The CLEAR_MEMORY command clears the specified memory. Data previously stored in this memory are erased and memory space is returned to the free memory pool.

Command Syntax

```
CLEAR_MEMORY <memory>

<memory>:= M1 to Mn
```

Example (GPIB)

The following instruction clears the memory M2.

```
CMD$="CLM M2": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

STORE

CLEAR_SWEEPS, CLSW

Description

The CLEAR_SWEEPS command restarts the cumulative processing functions: summed or continuous average, extrema, FFT power average, histogram, pulse parameter statistics, Pass/Fail counters, and persistence.

Command Syntax

```
CLEAR_SWEEPS
```

Example (GPIB)

The following example restarts the cumulative processing:

```
CMD$="CLSW": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

INR

FUNCTION - DEFINE, DEF

Description

The DEFINE command specifies the mathematical expression to be evaluated by a function. This command is used to control all math tools in the standard oscilloscope along with those in the optional math software packages.

Only functions available on your instrument may be specified as parameters.

Refer to your oscilloscope *Operator's Manual* for details regarding the standard operators. See software option manuals for other math operators.

Command Syntax

```
<function>:DEFINE <parameter>,<value>[,<parameter>,<value>,...]
```

```
<function>:= F1 to Fn
```

Parameters are specified in pairs. The first in the pair names the parameter to be modified, <param_name>, while the second one gives the new value to be assigned. As many pairs may be added as are needed. Pairs can be given in any order and restricted to the variables to be changed.

See the Equation Notation and following tables for formatting of the <equation> value and additional parameters related to each operation. Space characters inside equations are optional.

Tip: The best way to learn the required syntax is to set up the function as desired on the oscilloscope and run the Fn: DEF? query. The response will be formatted exactly as required, especially if you have set the oscilloscope to suppress command headers using COMM_HEADER.

Query Syntax

```
<function>:DEFINE?
```

Response Format

```
<function>:DEFINE EQN,'<equation>'[,<parameter>,<value>,...]
```

Function Parameters

At least one of the following parameter pairs is required for the command. Generally, this is the EQN parameter, but other parameters shown can be sent as incremental changes to current EQN.

Parameters	Values	Description
EQN	'<equation>'	Mathematical operation to perform. Enclose the operation in quotes. Follow with additional parameter pairs as needed. See table below.
BITS	<num bits>	Number of bits to interpolate in ERES equation.
CENTER	<time or div>	Horizontal center position for Histogram function.

Parameters	Values	Description
LENGTH	<length>	Number of points to use from first waveform in Correlate function.
MAXEVENTS	<#events>	Number of events computed in Histogram function. See product datasheet for maximum value.
MAXBINS	<#bins>	Number of bins used to compute Histogram.
START	<start>	Starting point in second waveform for Correlate function.
SWEEPS	<#sweeps>	Number of sweeps used to compute function. See the product datasheet for maximum value.
UNITS	<unit>	Physical unit in which to express function result. See table of unit mnemonics.
VERT	<vert_scale>	Vertical scaling type.
WEIGHT	<weight>	Continuous Average function weighting factor.
WIDTH	<width>	Width of histogram display.
WINDOW	<window_type>	FFT window function. See FFT operator for list of window types.

Equation Notation

The equation value is a string comprised of the math operator followed immediately by the source(s) in parentheses. Enclose the entire equation string in quotes. Follow the equation pair with any additional parameter pairs relevant to the operation. For example:

```
F1:DEFINE EQN,'AVG(C1)',AVERAGETYPE,SUMMED
```

Include text in caps and special characters (e.g., parentheses) as shown in the tables below. Substitute variable text shown here in angle brackets with acceptable values. Use one of the values listed in curly brackets.

All MAUI Oscilloscopes

These operators are standard on all MAUI oscilloscopes running XStreamDSO v. 8.0.0 or higher.

Operators	Additional Parameters	Description
ABS(<source>)		Absolute Value
AVG (<source>)	AVERAGETYPE, {SUMMED,CONTINUOUS} WEIGHT,<value>	Average of single waveform. Specify WEIGHT for Continuous Averaging.
DERI(<source>)	VERSCALE,<verscale> VEROFFSET,<veroffset> ENABLEAUTOSCALE,{ON, OFF}	Derivative of waveform using subtraction of adjacent samples.
<source1>-<source2>		Difference between two waveforms.

Operators	Additional Parameters	Description

FFT(<source>)	TYPE,{REAL, IMAGINARY, MAGNITUDE, PHASE, POWERSPECTRUM, POWERDENSITY }
	WINDOW,{BLACKMANHARRIS, FLATTOP, HAMMING, RECTANGULAR, VONHANN}
	ALGORITHM,{LEASTPRIME, POWER2}
	FILLTYPE,{TRUNCATE, ZEROFILL}
	SUPPRESSDC,{ON, OFF}
		Fast Fourier Transform of waveform.
		
		For FFT average of power spectrum and FFT power average of power density, use the summed average of the corresponding FFT type, e.g.: EQN,"AVG(FFT(C1))", TYPE,POWERSPECTRUM, AVERAGETYPE,SUMMED

ERES(<source>)	BITS,{0.5, 1.0, 1.5, 2.0, 2.5, 3.0 }	Smoothing function defined by extra bits of resolution.
FLOOR(<source>)	SWEEPS,<value>	Lowest vertical value at each X value in N sweeps.
INTG(<source>)	MULTIPLIER,< 0.0 to 1e15> ADDER,<0.0 to 1e15> VERSCALE,<value> VEROFFSET,<value>	Integral
INVERT(-<source>)		Inversion (negation) of waveform.
PRODUCT <source1>*<source2>		Product of two waveforms.
RATIO <source1>/<source2>		Ratio of two waveforms.
RECIPROCAL 1/<source>		Reciprocal of a waveform.
RESC(<source>)	MULTIPLIER,< 0.0 to 1e15> ADDER,<0.0 to 1e15> UNIT,{value}	Rescale waveform as Out = A*Wave(In) + B. See list of Units below for values.
ROOF(<source>)	SWEEPS,<value>	Highest Y value at each X in a set of waveforms.
SQR(<source>)		Square of waveform values.
SQRT(<source>)		Square root of waveform values.
SUM<source1>+<source2>		Sum of two waveforms.
TREND(<source>)	AUTOFINDSCALE,{ON, OFF} VERSCALE,<value> CENTER,<time or div>	Trend of the values of a parameter.
ZOOMONLY(<source>)	VERSCALE,<value> HORSCALE,<value>	Zoom of waveform

HDO6000 and Higher Bandwidth Oscilloscopes

These operators are standard on HDO6000 and higher, MDA, WaveRunner, WavePro, WaveMaster, and LabMaster series oscilloscopes running XStreamDSO v. 8.0.0 or higher.

Operators	Additional Parameters	Description
CORR(<source1>,<source2>)	LENGTH,<length> START,<start point>	Correlation of two waveforms with specified correlation length and start point in second waveform.

Operators	Additional Parameters	Description
DESKEW(<source>)	WAVEDESKEW,<value>	Shift waveform in time by a specified amount.
EXP(<source>)		Exponential (power of e).
EXP10(<source>)		Exponential (power of 10).
EXTR(<source>)	SWEEPS,<value>	Extrema (Roof and Floor) of waveform. Same as Envelope.
HIST(<source>)	BINS,<value> MAXEVENTS,<value> HORSCALE,<value> CENTER,<value> VERSCALETYPE,{LINEAR, LINCONSTMAX} AUTOFINDSCALE,{ON, OFF}	Histogram of parameter values whe using P*n* source; Histogram of waveform data when using C*n* source.

INTRP(<source>)	INTERPOLATETYPE,{LINEAR, QUADRATIC, SINXX}
	EXPAND,{ON, OFF}
		Interpolate extra points in waveform.

LN(<source>)		Natural logarithm of waveform.
LOG10(<source>)		Base 10 logarithm of waveform.
PERHIST(<source>)	VERCUTCENTER,<value> VERCUTWIDTH,<value> HORCUTCENTER,<value> HORCUTWIDTH,<value> CUTDIRECTION,<value> CUTTYPE,<value> CUTWIDTH,<value>	Phistogram: histogram of a slice through a persistence map.
PMEAN(<source>)		Waveform derived from the mean of a persistence map.
PRANGE(<source>)	PCTPOPULATION,<value>	Waveform derived from the range of a persistence map.
PSIGMA(<source>)	SIGMA,<value>	Waveform derived from the st dev of a persistence map.
PHSHIFT(<source>)	PHASE,<value>	Change the phase of a set of complex data.
SEG(<source>)	SELECTEDSEGMENT,<value>	Select one segment from a sequence acquisition.
SINX(<source>)		Ten times interpolation using sin(x)/x.
SLICE(<source1>,<source2>)	FREQUENCY,<value> PRIORPERIODS,<value> POSTPERIODS,<value>	Slices source2 waveform to make many waveforms, using wf 1.
SPACK(<source>)		Magnitude of complex result.
SPARSE(<source>)	SPARSINGFACTOR,<value> SPARSINGPHASE,<value>	Produces as waveform with fewer points than the input.
TRACK(<source>)	AUTOFINDSCALE,{ON, OFF} VERSCALE,<value> CENTER,<time or div>	Track of the values of a parameter.

Operators Available with XDEV Option

These operators are standard on DDA/SDA/WavePro 7 Zi, and DDA/SDA/WaveMaster 8 Zi, and LabMaster series oscilloscopes running XStreamDSO v. 8.0.0 or higher. They are available elsewhere with the installation of the XDEV option.

Operator	Additional Parameters	Description

EXCELMATH(<source1>,<-source2>)	SOURCE1CELL,<cell>
	SOURCE2CELL,<cell>
	OUTPUTCELL,<cell>
	SOURCE1HEADERCELL,<cell>
	SOURCE2HEADERCELL,<cell>
	OUTPUTHEADERCELL,<cell>
	WITHHEADER, {ON, OFF}
	OUTPUTENABLE, {ON, OFF}
	SOURCE1ENABLE, {ON, OFF}
	SOURCE2ENABLE, {ON, OFF}
	NEWSHEET, {ON, OFF}
	ADVANCED, {ON, OFF}
	SCALING, {AUTOMATIC, MANUAL, FROMSHEET}
	{AUTOMATIC,MANUAL,FROMSHEET}
	SPREADSHEETFILENAME,<*file*.xls>
		Produces a waveform using a custom Excel function, and outputs results to Excel spreadsheet.
		
		Use full path to spreadsheet file name.

FASTWAVEPORT(<source>)	MAXSIZE,<value SAMPLE>, TIMEOUT,<value S>, PORTNAME,FASTWAVEPORT1	Produces a waveform using an external, user-defined function.
MATLAB(<source1>,<source2>)	MATLABCODE,<formula> MATLABPLOT, {ON, OFF} MATLABZEROOFFSET,<value> MATLABSCALEPERDIV,<value>	Produces a waveform using custom MATLAB function.
MCAD(<source1>,<source2>)	SOURCE1VAR,<value> SOURCE2VAR,<value> OUTPUTVAR,<value> SOURCE1HEADERVAR,<value> SOURCE2HEADERVAR,<value> OUTPUTHEADERVAR,<value> WITHHEADER,{ON, OFF}	Produces a waveform using custom MathCad function.
SCRIPT(<source1>,<source2)	LANGUAGE,VBSCRIPT. CODE,<VBScript code>, TIMEOUT,<value>	Produces waveform from applied VBS function.

Operators Available with DFP Option

These operators are available with the installation of the Digital Filter Package option.

Operators	Additional Parameters	Description
FILTER(<source>)	FIRORIIR,{FIR, IIR} FILTERKIND,{LOWPASS, HIPASS, PASSBAND} FILTERTYPE,{BESSEL, BUTTERWORTH, CHEBYSHEV, INVCHEBYSHEV} KAISERBETA,<value> PCT GAUSSIANBT,<value> PCT COSINEBETA,<value> PCT TRANSITIONWIDTH,<value> HZ F3DBWIDTH,<value> HZ STOPBANDATTENUATION,<value> DB PASSBANDRIPPLE,<value> DB, PASSBANDATTENUATION,<value> DB LOWFREQSTOP,<value> HZ LOWFREQPASS,<value> HZ HIGHFREQSTOP,<value> HZ HIGHFREQPASS,<value> HZ F3DBFREQ,<value> HZ CORNERFREQ,<value> HZ CENTERFREQ,<value> HZ ROLLOFF,<value> NUMBEROFTAPS,<value> NUMBEROFSTAGES,<value> ADVANCED,{ON, OFF} AUTOLENGTH,{ON, OFF}	Digital filter, available with DFP option.
FIR(<source>)	FTYPE,{LOWPASS, HIPASS, BANDPASS, BANDSTOP, RAISEDCOS, RSDROOTCOS, GAUSSIAN, CUSTOM} FREQ,<lower or only corner freq. in HZ> UFREQ,<upper corner freq.≥lfreq in HZ> FWIDTH,<transition region in HZ> FBETA,<0 to 100% > MCOEFF,<M1 to M*n*>	Finite Impulse Response filter, available with DFP option. FWIDTH must be >0.3% of sample rate. <lfreq> - <fwidth> must be 0.1% of sample rate. For raised cos and raised root cos, FBETA is % of <lfreq> + and - over which transition region extends. For Guassian, % of <lfreq> at which response is 3dB down from DC.

Examples

The following instruction defines F1 to compute the summed average of C1 over 200 sweeps:

```
F1:DEF EQN,'AVG(C1)',AVRAGETYPE,SUMMED,SWEEPS,200
```

The following instruction defines F1 to compute the product of C1 and C2:

```
F1:DEF EQN,'C1*C2'
```

The following instruction defines F1 to compute the Power Spectrum of the FFT of C1. The window function is Rectangular.

```
F1:DEF EQN,'PS(FFT(C1))',WINDOW,RECT
```

The following instruction defines F2 to compute the Power Average of the Power Spectrum of C1 over 244 sweeps.

```
F2:DEF EQN,'AVG(FFT(C1)'
TYPE,POWERSPECTRUM,WINDOW,RECT,ALGORITHM,POWER2,FILLTYPE,TRUNCATE,
SUPPRESSDC,ON,AVERAGETYPE,SUMMED,SWEEPS,244
```

The following instructions define F3 to construct the histogram of the P2 rise time measurements. The histogram has a linear vertical scaling, accumulates up to 1000 parameter values, and rescales automatically. The rise time parameter values are binned into 100 bins.

```
F3:DEF EQN,'HIST(P2)',VALUES,1000,BINS,100,HORSCALE,1 S,
CENTER,0E-12 S,VERSCALETYPE,LINEAR,AUTOFINDSCALE,ON
```

The following instruction defines F1 to correlate C1 and C2 for 5 divisions starting at division

```
F1:DEF EQN,"CORR(C1,C2)",CORRLENGTH,5 DIV,CORRSTART,0E-3 DIV
```

The following instruction defines F1 to take the derivative of C1:

```
F1:DEF EQN,"DERI(C1)",VERSCALE,1E+6 V/S,VEROFFSET,48E+3 V/S,ENABLEAUTOSCALE,ON
```

The following instruction defines F1 to Enhance Resolution of the C1 trace by interpolating .5 bits between each sample point:

```
F1:DEF EQN,"ERES(C1)",BITS,0.5
```

Related Commands

FIND_CTR_RANGE, FUNCTION_RESET, INR?, PARAMETER_CUSTOM, PARAMETER_VALUE?, PASS_FAIL_CONDITION

FIND_CTR_RANGE, FCR

Description

The FIND_CTR_RANGE command automatically sets the center and width of a histogram to best display the accumulated events.

FIND_CTR_RANGE is only available with an option installed that includes Histograms.

Command Syntax

```
<function>:FIND_CTR_RANGE
```

```
<function>:= TA to TD, F1 to Fn
```

Example (GPIB)

Assuming that Trace A (TA) has been defined as a histogram of one of the custom parameters, the following example determines the best center and width, and then rescales the histogram:

```
CMD$="TA:FCR": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

DEFINE, PARAMETER_CUSTOM

FUNCTION_RESET, FRST

Description

The FUNCTION_RESET command resets a waveform processing function. The number of sweeps is reset to zero and the process restarted.

Command Syntax

```
<function>:FUNCTION_RESET
```

```
<function>:= F1 to Fn, TA to TD
```

Example (GPIB)

Assuming that Trace F1 has been defined as the summed average of Channel 1, the following will restart the averaging process:

```
CMD$="F1:FRST": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

INR

HARDCOPY Commands and Queries

HARDCOPY_SETUP, HCSU

Description

The HARDCOPY_SETUP command specifies the device type and transmission mode of the instrument's print driver. This can be the instrument clipboard, hard drive or email, as well as a printer.

One or more individual settings can be changed by specifying the appropriate keywords, together with the new values. If you send contradictory values within a command, the result is governed by the last one sent.

The HARDCOPY_SETUP query returns the oscilloscope's current print settings.

Command Syntax

```
HARDCOPY_SETUP DEV,<device>,FORMAT,<format>,BCKG,<bckg>,
DEST,<destination>,DIR,"<directory>",AREA,<hardcopyarea>
[,FILE,"<filename>",PRINTER,"<printername>",PORT,<portname>]
```

```
<device>:= {BMP, JPEG, PNG, TIFF}
```

```
<format>:= {PORTRAIT, LANDSCAPE}
```

```
<bckg>:= {BLACK, WHITE}
```

```
<destination>:= {PRINTER, CLIPBOARD, EMAIL, FILE, REMOTE}
```

```
<area>:= {GRIDAREAONLY, DSOWINDOW, FULLSCREEN}
```

```
<directory>:= legal DOS path, for FILE mode only
```

```
<filename>:= filename string, no extension, for FILE mode only
```

```
<printername>:= valid printer name, for PRINTER mode only
```

```
<portname>:= {GPIB, NET}
```

Hardcopy command parameters are grouped in pairs. The first in the pair names the variable to be modified, while the second gives the new value to be assigned. Pairs can be given in any order and can be restricted to those variables to be changed. Omitted variables remain unaffected.

The <device> types PSD and BMPCOMP are not supported on MAUI oscilloscopes.

Strings representing the names of directories, files, or printers that may contain spaces and other non-alphanumeric characters must be enclosed in quotes.

An autoincremented number is appended to the <filename> string with each successive capture.

The <portname> is included for backward compatibility and sets DEST, REMOTE regardless of what else is specified in the HCSU command.

Query Syntax

```
HCSU?
```

Response Format

If preceded, for example, by HCSU DEST,FILE with CHDR OFF:

```
DEV,PNG,FORMAT,PORTRAIT,BCKG,BLACK,DEST,REMOTE,
DIR,"C:\LECROY\XSTREAM\HARDCOPY",
FILE,"IRHCP1.PNG",AREA,GRIDAREAONLY,PRINTER,"GENEVSVRHP4050RD"
```

Example (GPIB)

The following example selects output to the printer named "Local Printer":

```
CMD$="HCSU DEST,PRINTER,PRINTER,"Local Printer"" :CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

SCREEN_DUMP

SCREEN_DUMP, SCDP

Description

The SCREEN_DUMP command causes the instrument to send the screen contents to the current hardcopy device. The time-and-date stamp corresponds to the time of the command.

Command Syntax

SCREEN_DUMP

Query Syntax

SCREEN_DUMP?

Response Format

SCREEN_DUMP <status>

Example (GPIB)

The following instruction initiates a screen dump:

```
CMD$="SCDP": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

INR, HARDCOPY_SETUP

MISCELLANEOUS Commands and Queries

AUTO_CALIBRATE, ACAL

Description

The AUTO_CALIBRATE command is used to enable or disable the automatic calibration of your XStreamDSO oscilloscope. At power-up, auto-calibration is turned ON, i.e. all input channels are periodically calibrated for the current input amplifier and timebase settings, whether the instrument has been adjusted or not.

Whenever you adjust a gain or offset, however, the instrument performs a calibration. This action occurs whatever the current state of ACAL, and it does not change the state of ACAL.

Automatic calibration can be disabled by means of the command ACAL OFF. But whenever convenient, you can issue a *CAL? query to fully calibrate the oscilloscope. When the oscilloscope is returned to local control, periodic calibrations are resumed if the last ACAL value was ON. That is, the command *CAL? has no effect on the ACAL status.

The response to the AUTO_CALIBRATE? query indicates whether auto-calibration is enabled or disabled.

Command Syntax

```
AUTO_CALIBRATE <state>
```

```
<state> : = {ON, OFF}
```

Query Syntax

```
AUTO_CALIBRATE?
```

Response Format

```
AUTO_CALIBRATE <state>
```

Example (GPIB)

The following instruction disables auto-calibration:

```
CMD$="ACAL OFF": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

*CAL?

BUZZER, BUZZ

Description

The buzzer command controls the built-in buzzer. By means of the BEEP argument, the buzzer can be activated for short beeps. The value ON has the same effect as BEEP, unlike the behavior with earlier instruments. ON and OFF are accepted only for compatibility. OFF has no effect.

Command Syntax

```
BUZZer <state>

<state>:= {BEEP, ON, OFF}
```

Example (GPIB)

Sending the following will cause the instrument to sound two short tones:

```
CMD$="BUZZ BEEP;BUZZ BEEP":

CALL IBWRT(SCOPE%<CMD$)
```

*CAL?

Description

The *CAL? query causes the oscilloscope to perform an internal self-calibration and generates a response that indicates whether or not the calibration completed without error. This internal calibration sequence is the same as that which occurs at power-up. At the end of the calibration, after the response, the oscilloscope returns to the state it was in just prior to the calibration cycle. This includes the AUTO_CALIBRATE status, which is not affected by the use of *CAL?; the *CAL? query may be used whether AUTO_CALIBRATE has been set on or off.

Query Syntax

```
*CAL?
```

Response Format

```
*CAL? <diagnostics>
```

```
<diagnostics>:= diagnostic code 0 through 512
```

Code	4-CH Oscilloscope	8-CH Oscilloscope
0	Calibration successful	Calibration successful
1	C1 calibration error	C1 calibration error
2	C2 calibration error	C2 calibration error
4	C3 calibration error	C3 calibration error
8	C4 calibration error	C4 calibration error
16	TDC failure	C5 calibration error
32	Trigger failure	C6 calibration error
64	Other	C7 calibration error
128	N/A	C8 calibration error
256	N/A	TDC failure
512		Trigger failure

Example (GPIB)

The following instruction forces a self-calibration:

```
CMD$="*CAL?": CALL IBWRT(SCOPE%,CMD$): CALL IBRD(SCOPE%,RD$): PRINT RD$
```

Response message if no failure:

```
*CAL 0
```

Related Commands

AUTO_CALIBRATE

CAL_OUTPUT, COUT

Description

The CAL_OUTPUT command is used to set the type of signal put out through the instrument front panel's CAL BNC connector.

Command Syntax

```
CAL_OUTPUT <mode>[,<level>[,<rate>]]
```

```
CAL_OUTPUT  PULSE[,<width>]
```

<mode> : = {OFF, CALSQ, PF, TRIG, LEVEL, ENABLED}

<level> : = 50 mV to 1 V into 1 MΩ

<rate> : = 500 Hz to 1 MHz.

CALSQ provides a square signal; PF sets the pulse for Pass/Fail mode; TRIG sets the pulse for trigger output; LEVEL provides a DC signal at the requested level; PULSE provides a single pulse

Query Syntax

```
CAL_OUTPUT?
```

Response Format

```
CAL_OUTPUT <mode>,<level>[,<rate>]
```

Example (GPIB)

The following instruction sets the calibration signal to give a 0 to 0.2 volt 10 kHz square wave:

```
CMD$="COUT CALSQ,0.2 V,10 kHz":
```

```
CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

PASS_FAIL_DO

DATE

Description

The command sets the date and time of the real-time clock in the instrument. The query reads back the instrument timestamp.

Command Syntax

Using this command to set the clock from the Internet will work on MAUI oscilloscopes that have an internet connection, but you must Validate Changes on the oscilloscope itself for them to take effect. To set the date and the time from the internet:

```
DATE SNTP
```

Query Syntax

```
DATE?
```

*IDN?

Description

The *IDN? query causes the instrument to identify itself. The response comprises manufacturer, oscilloscope model, serial number, and firmware revision level.

Query Syntax

```
*IDN?
```

Response Format

```
*IDN LECROY,<model>,<serial_number>,<firmware_level>

<model>:= A six- or seven-character model identifier

<serial_number>:= A nine- or 10-digit decimal code

<firmware_level>:= version number
```

The version number is in dotted decimal format: two digit major release number, one digit minor release number, one digit update number (xx.y.z).

Example (GPIB)

This issues an identification request to the oscilloscope:

```
CMD$="*IDN?": CALL IBWRT(SCOPE%,CMD$):

CALL IBRD(SCOPE%,RSP$): PRINT RSP$
```

Response message:

```
*IDN LECROY,WAVEMASTER,WM01000,3.3.0
```

*OPT?

Description

The *OPT? query identifies oscilloscope options: installed software or hardware that is additional to the standard instrument configuration. The response consists of a series of response fields listing all the installed options.

Query Syntax

```
*OPT?
```

Response Format

```
*OPT <option_1>,<option_2>,..,<option_N>
```

```
<option_n>:= A three- or four-character ASCII string
```

Note: If no option is present, the character 0 is returned.

Example (GPIB)

The following instruction queries the installed options:

```
CMD$="*OPT?": CALL IBWRT(SCOPE%,CMD$):
```

```
CALL IBRD(SCOPE%,RSP$): PRINT RSP$
```

If, for example, the waveform processing options DFP2, SDM, JTA2, and GPIB are installed, the response is returned as:

```
* DFP2,SDM,JTA2,GPIB
```

Response message if no options are installed:

```
*OPT 0
```

*TST?

Description

The *TST? query performs an internal self-test, the response indicating whether the self-test has detected any errors. The self-test includes testing the hardware of all channels, the timebase and the trigger circuits.

Hardware failures are identified by a unique binary code in the returned <status> number. A status of 0 indicates that no failures occurred.

Query Syntax

```
*TST?
```

Response Format

```
*TST <status>
```

Example (GPIB)

The following causes a self-test to be performed:

```
CMD$="*TST?": CALL IBWRT(DDA%,CMD$):

CALL IBRD(DDA%,RD$): PRINT RD$
```

Response message (if no failure):

```
*TST 0
```

Related Commands

*CAL

PROBE Commands

PROBE_INFOTEXT?, PRIT?

Description

The PROBE_INFOTEXT query returns informative text about a probe connected to the oscilloscope.

Query Syntax

<channel>:PROBE_INFOTEXT?

<channel>:= C1 to C*n*, EX, EX5

Response Format

<channel>:PRIT "<info>"

Related Commands

PROBE_CAL?, PROBE_DEGAUSS?

PROBE_NAME?, PRNA?

Description

The PROBE_NAME? query returns the name of a probe connected to the instrument. Passive probes are identified by their attenuation factor.

Query Syntax

<channel>:PROBE_NAME?

<channel>:= C1 to C*n*, EX, EX5

Response Format

<channel>:PROBE_NAME <name>

Related Commands

PROBE_CAL?, PROBE_DEGAUSS?

PRx:AUTOZERO, PRx:AZ

Description

The PRx:AUTOZERO command initiates an auto zero cycle in the ADP30x probe to remove any offset drift. The probe input can remain connected to the test circuit during the auto zero cycle.

Command Syntax

```
<channel>:AUTOZERO
```

```
<channel>:= {PR1, PR2, PR3, PR4}
```

Example (GPIB)

The following command initiates an AutoZero of an ADP30x probe attached to channel 1:

```
CMD$= "PR1:AZ" : CALL IBWRT(SCOPE%,CMD$)
```

PRx:BANDWIDTH_LIMIT, PRx:BWL

Description

The PRx:BANDWIDTH_LIMIT command sets the upper (HF) -3 dB bandwidth limit of the ADP305 probe. The arguments are in Hz.

The PRx:BANDWIDTH_LIMIT query returns the upper bandwidth limit setting for the differential probe connected to the specified channel.

The PRx:BANDWIDTH_LIMIT command/query is not available with model ADP300.

Command Syntax

```
<channel>:BWL <upper bandwidth>

<channel>:= {PR1, PR2, PR3, PR4}

<upper bandwidth>:= {OFF, 20M}
```

Query Syntax

```
<channel>:BWL?
```

Response Format

```
<channel>:BWL <upper bandwidth>
```

Example (GPIB)

The following instruction sets the upper bandwidth of an ADP305 connected to channel 1 to 20 MHz.

```
CMD$= "PR1:BWL 20M" :CALL IBWRT(SCOPE%,CMD$)
```

PRx:COUPLING, PRx:CPL

Description

The PRx:COUPLING command selects the coupling mode of the ADP30x probe.

The PRx:COUPLING? query returns the coupling mode of the selected channel.

Command Syntax

```
<channel>:COUPLING <coupling>

<channel>:= {PR1, PR2, PR3, PR4}

<coupling>:= {DC, GND}
```

Query Syntax

```
<channel>:CPL?
```

Response Format

```
<channel>:CPL <coupling>
```

Example

The following instruction sets the coupling to DC in a ADP30x probe connected to channel 2.

```
CMD$= "PR2:CPL DC" : CALL IBWRT(SCOPE%,CMD$)
```

PRx:OFFSET, PRx:OFST

Description

When an ADP30x probe is connected to a channel, the OFFSET command sets the probe offset value. The maximum range and resolution is determined by the V/DIV setting. If an out-of-range value is entered, the differential probe will set the offset to the closest valid value, and the VAB bit (bit 2) in the STB register will be set.

The OFFSET? query returns the offset voltage of the differential probe connected to the specified channel.

Command Syntax

```
<channel>:OFFSET <offset>[V]
```

```
<channel>:= {PR1, PR2, PR3, PR4}
```

ADP305	200-499 mV/div (LC series)	-40V to 40V
	200-499 mV/div (LT series)	-100V to 100V
	500 mV/div to 9.9 V/div	-100V to 100V
	10V/div to 99 V/div	-1000V to 1000V
	100 V/div to 350 V/div	-1400V-(4*V/div setting) to 1400V-(4*V/div setting)
ADP300	1 to 9.9 V/div	-100V to 100V
	10 to 99 V/div	-1000V to 1000V
	100 V/div to 350 V/div	-1400V-(4*V/div setting) to 1400V-(4*V/div setting)

Query Syntax

```
<channel>:OFST?
```

Response Format

```
<channel>:OFST <offset>
```

Example (GPIB)

The following command sets the offset at the probe tip of the ADP30x differential probe connected to channel 1 to 5 volts:

```
CMD$= "PR1:OFST 5" : CALL IBWRT(SCOPE%,CMD$)
```

PRx:VOLT_DIV, PRx:VDIV

Description

The PRx:VOLT_DIV command sets the vertical sensitivity at the ADP30x input. The effective gain of the differential probe is factored into the vertical sensitivity.

The valid range of arguments is fixed by the probe type. If an out-of-range value is entered, the oscilloscope will set the vertical sensitivity to the closest value and set the VAB bit (bit 2) in the STB register.

The PRx:VOLT_DIV? query returns the vertical sensitivity at the probe input of the specified channel.

Command Syntax

```
<channel>:VOLT_DIV <sensitivity> [V]

<channel>:= {PR1, PR2, PR3, PR4}

<sensitivity>:= 200 mV to 350 V for ADP350; 1 V to 350 V for ADP300.
```

The suffix V is optional.

Query Syntax

```
<channel>:VOLT_DIV?
```

Response Format

```
<channel>:VDIV <sensitivity>
```

Example (GPIB)

The following command sets the vertical sensitivity at the probe tip of an ADP30x probe connected to channel 3 to 2 Volts/div:

```
CMD$= "PR3:VDIV 2" :CALL IBWRT(SCOPE%,CMD$)
```

SAVE/RECALL SETUP Commands and Queries

PANEL_SETUP, PNSU

Description

The PANEL_SETUP command sends a data buffer to the scope that is a panel setup file. The oscilloscope loads the <data> (see below) as it would when recalling a panel setup file locally on the scope.

The PANEL_SETUP query returns all oscilloscope setups in ASCII format, which can be saved to an .LSS file to be recalled to the oscilloscope using RECALL_SETUP.

Only setup data previously read by the PNSU? query or saved using the STORE_PANEL command can be recalled into the oscilloscope. A panel setup error is generated if the setup data block contains invalid data. See the Execution Error Status Register (EXR) table in EXR? for more information.

Note: The communication parameters (modified by commands CFMT, CHDR, CHLP, CORD and WFSU) and the enable registers associated with the status reporting system (SRE, PRE, ESE, INE) are not saved by this command.

Command Syntax

```
PANEL_SETUP #9<nnnnnnnn><data><crc>

<nnnnnnnnn>:= size in bytes (<data> size + <crc> size)

<data>:= panel setup file contents (arbitrary data block)

<crc>:= reserved for 32-bit CRC plus 8-byte CRC trailer
```

Note: Command syntax is not checked by the oscilloscope, however, the 8-byte CRC trailer string is required when sending a file to the oscilloscope, and supplied when receiving a file from the oscilloscope. The ASCII string 'ffffffff' is normally used as the trailer string.

Query Syntax

```
PANEL_SETUP?
```

Response Format

```
PANEL_SETUP <setup>
```

The PNSU? query returns data that includes both a prefix and suffix that are required when seeking to transmit the panel setup when using the PNSU command.

The prefix is the communications header and the DEF9 string, which are the characters #9 followed by the number of bytes contained in the panel setup file. This byte count includes the CRC trailer, which is the eight 'ffffffff' characters.

If you wish to save the data received by the PNSU? query to disk as a setup file that can be used with the oscilloscope's “Recall Setup” feature, be sure to strip the DEF9 header and CRC trailer.

PNSU? Query Example

The <setup> contents shown below are shortened for brevity, and replaced by “…contents omitted…”

The data uses ‘\ codes’ for the whitespace characters: \s is a space character, \n = newline, \r = return

COMM_HEADER programmed to OFF:

```
<setup>: #9001243634'\sXStreamDSO\sConfigurationVBScript\s...\r\n'\sLECROY,MCM-Zi-A,
…contents omitted…ffffffff
```

COMM_HEADER programmed to SHORT:

```
<setup>:
PNSU\s#9001243634'\sXStreamDSO\sConfigurationVBScript\s...\r\n'\sLECROY,MCM-Zi-A,
…contents omitted…ffffffff
```

Note: You can interpret from the DEF9 header that the panel setup file size is 1243634 bytes, including the ffffffff CRC trailer.

Related Commands

*RCL, *SAV

*RCL (Recall Setup)

Description

The *RCL command sets the instrument state by recalling one of the non-volatile setup panels (Setup 0 to Setup *x*).

The *RCL command produces an effect the opposite of the *SAV command.

If the specified setup is not acceptable, the Execution Error Status Register (EXR) is set and the EXE bit of the standard Event Status Register (ESR) is set.

Command Syntax

```
*RCL <panel_setup>
```

```
<panel_setup>:= 0 to x
```

0 is the factory default panel setup.

1 to *x* are the corresponding setup panels available on your oscilloscope. The maximum value of *x* will be the highest number setup (e.g., 6 indicating Setup 6).

Example (GPIB)

The following instruction recalls the instrument setup previously stored in Setup 3:

```
CMD$="*RCL 3": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

RECALL_PANEL, PANEL_SETUP, *SAV, ESR, EXR

RECALL_PANEL, RCPN

Description

The RECALL_PANEL command recalls panel setups from a file saved (using PNSU? or STORE_PANEL) on the instrument data drive (D:) or a connected mass storage device. The device and the file name are given as two-value parameter pairs.

Command Syntax

```
RECALL_PANEL DISK,<device>,FILE,'<file name>'
```

```
<device>:= {HDD, USB, MICRO}
```

```
<file name>:= full path to file with the extension .LSS
```

The file name string may be up to eight characters. Use the full path to the directory, including the drive letter, enclosed in single quotes. Be sure there are no spaces before the directory string.

Note: The hard drive selection (HDD) always points to drive D, which is the data drive on MAUI oscilloscopes. An external USB drive is usually named drive E; check your oscilloscope file system. The device type MICRO applies only to instruments that utilize Micro-SD card data storage, such as WaveSurfer 3000.

Example (GPIB)

The following instruction recalls the panel setup from file CHIRP_MEAS.LSS on the instrument D: drive:

```
CMD$="RCPN DISK,HDD,FILE,'D:\Applications\USB2\Setups\CHIRP_MEAS.LSS'": CALL IBWRT
(SCOPE%,CMD$)
```

The following instruction recalls the panel setup from file CHIRP_MEAS.LSS on a USB drive connected to the instrument, where the file is stored in the \USB2\Setups subfolders:

```
CMD$="RCPN DISK,USB,FILE,'E:\USB2\Setups\CHIRP_MEAS.LSS'": CALL IBWRT(SCOPE%,CMD$)
```

The following instruction recalls the panel setup from file P012.LSS on a USB drive:

```
CMD$="RCPN DISK,USB,FILE,'P012.LSS'": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

PANEL_SETUP, *SAV, STORE_PANEL, *RCL

*RST (Reset)

Description

The *RST command initiates a device reset. *RST sets all traces to the GND line and recalls the factory default panel setup (0), with the trigger in STOP mode (0).

Note: The Recall Default button on the oscilloscope GUI will recall the factory default panel in AUTO trigger mode. To replicate this functionality via remote control, use the Automation command: app.SaveRecall.Setup.DoRecallDefaultPanelWithTriggerModeAuto. You may send this command nested within the VBS command when using a legacy 488.2 script.

Command Syntax

```
*RST
```

Example (GPIB)

The following instruction resets the oscilloscope:

```
CMD$="*RST": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

*CAL, *RCL

*SAV (Save Setup)

Description

The *SAV command stores the current state of your instrument one of the non-volatile setup panels (Setup 0 to Setup *x*). The *SAV command stores the complete setup of the oscilloscope at the time the command is issued.

Note: The communication parameters (modified by commands CFMT, CHDR, CHLP, CORD and WFSU) and the enable registers associated with the status reporting system (SRE, PRE, ESE, INE) are not saved by this command.

Command Syntax

```
*SAV <panel_setup>
```

```
<panel_setup>:= 1 to x
```

1 to *x* are the corresponding setup panels available on your oscilloscope. The maximum value of *x* will be the highest number setup (e.g., 6 indicating Setup 6).

Example (GPIB)

The following instruction saves the current instrument setup in Setup 3:

```
CMD$="*SAV 3": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

PANEL_SETUP, *RCL

STORE_PANEL, STPN

Description

The STORE_PANEL command stores the complete panel setup of the oscilloscope in a file on the instrument data drive (D:) or a connected mass storage device. The device and the file name are given as two-value parameter pairs.

Note: The communication parameters (modified by commands CFMT, CHDR, CHLP, CORD and WFSU) and the enable registers associated with the status reporting system (SRE, PRE, ESE, INE) are not saved by this command.

If no file name (or an empty string) is supplied, the oscilloscope generates a file name according to its internal rules. Autogenerated file names are numbered sequentially.

This command is the complement of RECALL_PANEL.

Command Syntax

```
STORE_PANEL DISK,<device>,FILE,'<filename>'

<device>:= {HDD, USB, MICRO}

<filename>:= full path to file
```

The file name string may be up to eight characters. Use the full path to the directory, including the drive letter, enclosed in single quotes. Be sure there are no spaces before the directory string. The file extension .LSS will be appended automatically.

Note: The hard drive selection (HDD) always points to drive D, which is the data drive on most Teledyne LeCroy oscilloscopes. An external USB drive is usually named drive E; check your oscilloscope file system. The device type MICRO applies only to instruments that utilize Micro-SD card data storage, such as WaveSurfer 3000.

Example (GPIB)

The following instruction saves the current oscilloscope setup to USB drive in a file called DIODE.LSS:

```
CMD$="STPN DISK,USB,FILE,'DIODE.LSS'": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

PNSU, *SAV, RECALL_PANEL, *RCL

STATUS Commands and Queries

ALL_STATUS?, ALST?

Description

The ALL_STATUS? query reads and clears the contents of all status registers: STB, ESR, INR, DDR, CMR, EXR and URR except for the MAV bit (bit 6) of the STB register. For an interpretation of the contents of each register, refer to the appropriate status register.

The query is useful to obtain a complete overview of the state of your oscilloscope.

Query Syntax

```
ALL_STATUS?
```

Response Format

```
ALL_STATUS STB,<n>,ESR,<n>,INR,<n>,DDR,<n>,CMR,<n>,EXR,<n>,URR,<n>
```

```
<n> : = 0 to 65535
```

Example

The following instruction reads the contents of all the status registers:

```
CMD$="ALST?": CALL IBWRT(SCOPE%,CMD$):

CALL IBRD(SCOPE%,RSP$): PRINT RSP$
```

Response message:

```
ALST F2,000000,ESR,000052,INR,000005,DDR,000000,CMR,000004,EXR,000024,URR,000000
```

Related Commands

*CLS, CMR?, DDR?, *ESR?, EXR?, *STB?, URR?

*CLS

Description

The *CLS command clears all status data registers.

Command Syntax

```
*CLS
```

Example (GPIB)

The following instruction causes all the status data registers to be cleared:

```
CMD$="*CLS": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

ALL_STATUS, CMR, DDR, *ESR, EXR, *STB, URR

CMR?

Description

The CMR? query reads and clears the contents of the Command Error Register (refer to the following table for details), which specifies the last syntax error type detected by your oscilloscope.

Query Syntax

```
CMR?
```

Response Format

```
CMR <code>
```

```
<code>:= 0 to 13
```

Example (GPIB)

The following instruction reads the contents of the CMR register:

```
CMD$="CMR?": CALL IBWRT(SCOPE%,CMD$):

CALL IBRD(SCOPE%,RSP$): PRINT RSP$
```

Related Commands

ALL_STATUS?, *CLS

CMR (Command Error) Status Register Structure

Code	Message
1	Unrecognized command/query header.
2	Illegal header path.
3	Illegal number.
4	Illegal number suffix.
5	Unrecognized keyword.
6	String error.
7	GET embedded in another message.
10	Arbitrary data block expected.
11	Non-digit character in byte count field of arbitrary data block.
12	EOI detected during definite length data block transfer.
13	Extra bytes detected during definite length data block transfer.

DDR?

Description

The DDR? query reads and clears the contents of the Device Dependent or Device Specific Error Register (DDR). In the case of a hardware failure, the DDR register specifies the origin of the failure.

Query Syntax

```
DDR?
```

Response Format

```
DDR <value>

<value>:= 0 to 65535
```

DDR (Device Dependent) Status Register Structure

Bit	Value	Meaning
15...14		Reserved.
13	8192	Timebase hardware failure detected.
12	4096	Trigger hardware failure detected.
11	2048	Channel 4 hardware failure detected.
10	1024	Channel 3 hardware failure detected.
9	512	Channel 2 hardware failure detected.
8	256	Channel 1 hardware failure detected.
7	128	External input overload condition detected.
6...4		Reserved.
3	8	Channel 4 overload condition detected.
2	4	Channel 3 overload condition detected.
1	2	Channel 2 overload condition detected.
0	1	Channel 1 overload condition detected.

*ESE

Description

The *ESE command sets the standard Event Status Enable Register (ESE). This command allows one or more events in the ESR register to be reflected in the ESB summary message bit (bit 5) of the STB register. For an overview of the ESB defined events, refer to the ESR table.

The *ESE? query reads the contents of the ESE register.

Command Syntax

```
*ESE <value>
```

```
<value>:= 0 to 255
```

Query Syntax

```
*ESE?
```

Response Format

```
*ESE <value>
```

Example (GPIB)

The following instruction allows the ESB bit to be set if a user request (URQ bit 6, decimal 64) and/or a device dependent error (DDE bit 3, decimal 8) occurs. Summing these values yields the ESE register mask 64+8=72.

```
CMD$="*ESE 72": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

*ESR

*ESR?

Description

The *ESR? query reads and clears the contents of the Event Status Register (ESR). The response represents the sum of the binary values of the register bits 0 to 7. The following table provides an overview of the ESR register structure.

Query Syntax

```
*ESR?
```

Response Format

```
*ESR <value>
```

```
<value> : = 0 to 255
```

Example (GPIB)

The following instruction reads and clears the contents of the ESR register:

```
CMD$="*ESR?": CALL IBWRT(SCOPE%,CMD$):
```

```
CALL IBRD(SCOPE%,RSP$): PRINT RSP$
```

Response message:

```
*ESR 0
```

Related Commands

ALL_STATUS, *CLS, *ESE

ESR (Standard Events) Status Register Structure

Bit	Value	Name	Meaning	Notes
15...8			Reserved by IEEE 488.2.	
7	128	PON	Power Off-to-On occurred.	The PON bit is always turned on (1) when the unit is powered up.
6	64	URQ	User request.	On legacy LeCroy oscilloscopes, this bit reports softkey inputs. It does not apply to MAUI oscilloscopes.
5	32	CME	Command parser error detected.	The CME bit is set true (1) whenever a command syntax error is detected. The CME bit has an associated Command Parser Register (CMR) which specifies the error code. Refer to CMR?
4	16	EXE	Execution error detected.	The EXE bit is set true (1) when a command cannot be executed due to some device condition (for example, the oscilloscope in local state) or a semantic error. The EXE bit has an associated Execution Error Register (EXR) that specifies the error code. Refer to EXR?
3	8	DDE	Device dependent error occurred.	The DDE bit is set true (1) whenever a hardware failure has occurred at power-up or at execution time, such as a channel overload condition, or a trigger or timebase circuit defect. The origin of the failure can be localized with the DDR? query.
2	4	QYE	Query error occurred.	The QYE bit is set true (1) whenever (a) an attempt is made to read data from the Output Queue when no output is either present or pending, (b) data in the Output Queue has been lost, (c) both output and input buffers are full (deadlock state), (d) an attempt is made by the controller to read before having sent an <END>, (e) a command is received before the response to the previous query was read (output buffer flushed).
1	2	RQC	Requests bus control.	The RQC bit is always false (0), as the oscilloscope has no GPIB controlling capability and never requests control.
0	1	OPC	Operation complete.	The OPC bit is set true (1) whenever *OPC has been received, since commands and queries are strictly executed in sequential order. The oscilloscope starts processing a command only when the previous command has been entirely executed.

EXR?

Description

The EXR? query reads and clears the contents of the Execution Error Register (EXR). The EXR register specifies the type of the last error detected during execution. Refer to the following table for more information.

Query Syntax

```
EXR?
```

Response Format

```
EXR? <code>
```

```
<code>:= 21 to 64
```

Example (GPIB)

The following instruction reads the contents of the EXR register:

```
CMD$="EXR?": CALL IBWRT(SCOPE%,CMD$):
```

```
CALL IBRD(SCOPE%,RSP$): PRINT RSP$
```

Response message (if no fault):

```
EXR 0
```

Related Commands

ALL_STATUS, *CLS

EXR (Execution Error) Status Register Structure

The following table lists the error codes that may be returned with the EXR query. Codes marked with an asterisk (*) are valid only on instruments with a removable hard drive or memory card.

Code	Description
21	Permission error. The command cannot be executed in local mode.
22	Environment error. The oscilloscope is not configured to correctly process a command. For instance, the oscilloscope cannot be set to RIS at a slow timebase.
23	Option error. The command applies to an option which has not been installed.
24	Unresolved parsing error.
25	Parameter error. Too many parameters specified.
26	Non-implemented command.
27	Parameter missing. A parameter was expected by the command.
30	Hex data error. A non-hexadecimal character has been detected in a hex data block.
31	Waveform error. The amount of data received does not correspond to descriptor indicators.
32	Waveform descriptor error. An invalid waveform descriptor has been detected.
33	Waveform text error. A corrupted waveform user text has been detected.
34	Waveform time error. Invalid RIS or TRIG time data has been detected.
35	Waveform data error. Invalid waveform data have been detected.
36	Panel setup error. An invalid panel setup data block has been detected.
50*	No mass storage present when user attempted to access it.
51*	Mass storage not formatted when user attempted to access it.
53*	Mass storage was write protected when user attempted to create a file, to delete a file, or to format the device.
54*	Bad mass storage detected during formatting.
55*	Mass storage root directory full. Cannot add directory.
56*	Mass storage full when user attempted to write to it.
57*	Mass storage file sequence numbers exhausted (999 reached).
58*	Mass storage file not found.
59*	Requested directory not found.
61*	Mass storage file name not DOS compatible, or illegal file name.
62*	Cannot write on mass storage because file name already exists.

INE

Description

The INE command sets the Internal State Change Enable register (INE). This command allows one or more events in the INR register to be reflected in the INB summary message bit (bit 0) of the STB register. For an overview of the INR defined events, refer to the Internal State Register Structure (INR) table in the INR? topic for more information.

The INE? query reads the contents of the INE register.

Command Syntax

```
INE <value>
```

```
<value>:= 0 to 65535
```

Query Syntax

```
INE?
```

Response Format

```
INE <value>
```

Example (GPIB)

The following instruction allows the INB bit to be set whenever a screen dump has finished (bit 1, for example decimal 2), or a waveform is acquired (bit 0, for example decimal 1), or both of these. Summing these two values yields the INE mask 2+1=3.

```
CMD$="INE 3": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

INR?

INR?

Description

The INR? query reads and clears the contents of the Internal State Change Register (INR). The INR register (table below) records the completion of various internal operations and state transitions.

Query Syntax

```
INR?
```

Response Format

```
INR <state>
```

```
<state>:= 0 to 65535
```

Example (GPIB)

The following instruction reads the contents of the INR register:

```
CMD$="INR?": CALL IBWRT(SCOPE%,CMD$)
```

The response message represents the summed bit value of the internal state changes:

```
INR 1026
```

Meaning, waveform processing in math function F3 (1024) and a screen dump (2) have both terminated.

Related Commands

ALL_STATUS, *CLS, INE

INR? (Internal State Change) Status Register Structure

The following table describes the states corresponding to the returned bit values:

Bit	Value	State
15		0 - Reserved for future use.
14	16384	1 - Probe was changed.
13	8192	1 - Trigger command received; trigger armed*.
12	4096	1 - Pass/Fail test detected desired outcome.
11	2048	1 - Waveform processing has terminated in trace F4.
10	1024	1 - Waveform processing has terminated in trace F3.
9	512	1 - Waveform processing has terminated in trace F2.
8	256	1 - Waveform processing has terminated in trace F1.
7	128	1 - A floppy or hard disk exchange has been detected.
6	64	1 - Floppy or hard disk has become full in AutoStore Fill mode.
5	32	0 - Reserved for LeCroy use.
4	16	1 - A segment of a sequence waveform has been acquired in acquisition memory but not yet read out into the main memory.
3	8	1 - A time-out has occurred in a data block transfer.
2	4	1 - A return to the local state is detected.
1	2	1 - A screen dump has terminated.
0	1	1 - A new signal has been acquired in acquisition memory and read out into the main memory.

Note: On MAUI oscilloscopes, INR status bit 13 is set high when a trigger is armed, even though the oscilloscope may not yet be ready to acquire due to technical limitations. If you are concerned with timing a second action on the Trigger Ready state, it is safest to use the result of the command TRMD SINGLE; WAIT;*OPC?, which will be 1 when the previous acquisition is fully complete.

*IST?

Description

The *IST? (Individual STatus) query reads the current state of the IEEE 488.1-defined IST local message. The IST individual status message is the status bit sent during a parallel poll operation.

Query Syntax

```
*IST?
```

Response Format

```
*IST <value>
```

```
<value>:= 0 or 1
```

Example (GPIB)

The following instruction causes the contents of the IST bit to be read:

```
CMD$="*IST?": CALL IBWRT(SCOPE%,CMD$):
```

```
CALL IBRD(SCOPE%,RSP$): PRINT RSP$
```

Response message:

```
*IST 0
```

Related Commands

*PRE

*OPC

Description

The *OPC (Operation Complete) command sets the OPC bit (bit 0) to "true" in the standard Event Status Register (ESR).

The *OPC? query always responds with the ASCII character 1 because the oscilloscope only responds to the query when the previous commands are entirely executed. Since *OPC? executes only when processing is complete, it is recommended for synchronization purposes. See Timing and Synchronization.

Command Syntax

```
*OPC
```

Query Syntax

```
*OPC?
```

Response Format

```
1
```

Related Commands

*WAI

*PRE

Description

The *PRE command sets the PaRallel poll Enable register (PRE). The lowest eight bits of the Parallel Poll Register (PPR) are composed of the STB bits. *PRE allows you to specify which bit(s) of the parallel poll register affect the IST (Individual Status Bit).

The *PRE? query reads the contents of the PRE register. The response is a decimal number corresponding to the binary sum of the register bits.

Command Syntax

```
PRE <value>
```

```
<value>:= 0 to 65535
```

Query Syntax

```
*PRE?
```

Response Format

```
*PRE <value>
```

Example (GPIB)

The following instruction causes the IST status bit to become 1 as soon as the MAV bit (bit 4 of STB, meaning decimal 16) is set, and yields the PRE value 16:

```
CMD$="*PRE 16": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

*IST

*SRE

Description

The *SRE command sets the Service Request Enable register (SRE). This command allows you to specify which summary message bit or bits in the STB register generate a service request. Refer to the table on page 225 for an overview of the available summary messages.

A summary message bit is enabled by writing a 1 into the corresponding bit location. Conversely, writing a 0 into a given bit location prevents the associated event from generating a service request (SRQ). Clearing the SRE register disables SRQ interrupts.

The *SRE? query returns a value that, when converted to a binary number, represents the bit settings of the SRE register. Note that bit 6 (MSS) cannot be set and its returned value is always zero.

Command Syntax

```
*SRE <value>
```

```
<value>:= 0 to 255
```

Query Syntax

```
*SRE?
```

Response Format

```
*SRE <value>
```

Example (GPIB)

The following instruction allows an SRQ to be generated as soon as the MAV summary bit (bit 4, for example decimal 16) or the INB summary bit (bit 0, for example decimal 1) in the STB register, or both, are set. Summing these two values yields the SRE mask 16 + 1 = 17.

```
CMD$="*SRE 17": CALL IBWRT(SCOPE%,CMD$)
```

*STB?

Description

The *STB? query reads the contents of the 488.1 defined Status Byte Register (STB) and Master Summary Status (MSS). The response represents the values of bits 0 to 5 and 7 of the STB register and the MSS summary message.

The response to a *STB? query is identical to the response of a serial poll except that the MSS summary message appears in bit 6 in place of the RQS message.

Query Syntax

```
*STB?
```

Response Format

```
*STB? <value>
```

```
<value>:= 0 to 255
```

Example (GPIB)

The following instruction reads the Status Byte Register:

```
CMD$="*STB?": CALL IBWRT(SCOPE%,CMD$):
```

```
CALL IBRD(SCOPE%,RSP$): PRINT RSP$
```

Response message:

```
*STB 0
```

Related Commands

ALL_STATUS, *CLS, *PRE, *SRE

STB (Status Byte) Status Register Structure

Bit	Value	Name	Description	Notes
7	128	DIO7	Reserved for future use.	

6	64	MSS/RQS
		MSS = 1
		RQS = 1
			At least 1 bit in STB masked by SRE is 1, service is requested.	The Master Summary Status (MSS) indicates the oscilloscope requests service, while the Service Request status (when set) specifies the oscilloscope issued a service request. Bit position 6 depends on the polling method:
				
				MSS if an *STB? query is received
				RQS if serial polling is conducted
				
				Example:
				If SRE = 10 and STB = 10, then MSS = 1.
				If SRE = 010 and STB = 100 then MSS = 0.

5	32	ESB	An ESR enabled event has occurred.	The Event Status Bit (ESB) indicates whether or not one or more of the enabled IEEE 488.2 events occurred since the last reading or clearing of the Standard Event Status Register (ESR). ESB is set if an enabled event becomes true (1).
4	16	MAV	Output queue is not empty.	The Message AVailable bit (MAV) indicates whether or not the Output queue is empty. The MAV summary bit is set true (1) whenever a data byte resides in the Output queue.
3	8	DIO3	Reserved.	
2	4	VAB	A command data value has been adapted.	The Value Adapted Bit (VAB) is set true (1) whenever a data value in a command is adapted to the nearest legal value. For instance, the VAB bit would be set if the timebase is redefined as 2.5 µs/div since the adapted value is 2 µs/div.
1	2	DIO1	Reserved.	
0	1	INB	An enabled internal state change occurred.	The Internal State Bit (INB) is set true (1) whenever certain enabled internal states are entered. For further information, refer to the INR? query.

*WAI

Description

The *WAI (Wait to continue) command, required by the IEEE 488.2 standard, has no effect on the oscilloscope, as the instrument only starts processing a command when the previous command has been entirely executed.

Command Syntax

```
*WAI
```

STORAGE Commands and Queries

DELETE_FILE, DELF

Description

The DELETE_FILE command deletes a file from the currently selected directory.

Command Syntax

```
DELETE_FILE DISK,<medium>,FILE,'<filename>'
```

```
<medium>: = {HDD, USB, MICRO}
```

The file name must be enclosed in single quotes. Use the full path to the directory, including the drive letter. Be sure there are no spaces before the directory string.

Note: The hard drive selection (HDD) always points to drive D, which is the data drive on MAUI oscilloscopes. An external USB drive is usually named drive E; check your oscilloscope file system. The device type MICRO applies only to instruments that utilize Micro-SD card data storage, such as WaveSurfer 3000.

Example (GPIB)

The following instruction deletes a panel setup file from the hard drive:

```
CMD$="DELF DISK,HDD,FILE,'D:\SETUPS\TESTRUN.LSS'
```

```
CALL IBWRT(SCOPE%,CMD$)
```

TRANSFER_FILE, TRFL

Description

This command allows you to transfer files to and from storage media, or between oscilloscope and computer. The command format is used to transfer files from the computer to storage media. The query format is used to transfer files from storage media to computer.

Command Syntax

```
TRANSFER_FILE DISK,<device>,FILE,'<filepath>',#9<nnnnnnnnn><data><crc>

<device>:={HDD, USB, MICRO}

<filepath>:= legal DOS path to file

<nnnnnnnnn>:= file size in bytes (<data> size + <crc> size)

<data>:= file data (arbitrary data block)

<crc>:= reserved for 32-bit CRC plus 8-byte CRC trailer
```

The path name must be enclosed in single quotes. Use the full path to the directory, including the drive letter. Be sure there are no spaces before the directory string.

Note: The hard drive selection (HDD) always points to drive D, which is the data drive on MAUI oscilloscopes. An external USB drive is usually named drive E; check your oscilloscope file system. The device type MICRO applies only to instruments that utilize Micro-SD card data storage, such as WaveSurfer 3000.

Note: CRC checking is not performed by the scope, however the 8-byte CRC trailer string is required when sending a file to the scope, and supplied when receiving a file from the scope. The ASCII string 'ffffffff' is normally used as trailer string.

Query Syntax

```
TRFL? DISK,<device>,FILE,'<filepath>'
```

Response Format

```
TRFL #9nnnnnnnnn<data><crc>
```

Example (GPIB)

The following instruction reads the file FAVORITE.DSO from the hard drive:

```
CMD$=TRFL DISK,HDD,FILE,'FAVORITE.DSO' CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

DIRECTORY

WAVEFORM TRANSFER Commands and Queries

INSPECT?, INSP?

Description

The INSPECT? query allows you to read parts of an acquired waveform in intelligible form. The command is based on the explanation of the format of a waveform given by the Waveform Template (use the TEMPLATE? query to obtain an up-to-date copy of the template).

Any logical block of a waveform can be inspected using this query by giving its name enclosed in quotes as the first parameter (refer to the template itself for more details).

The special logical block named WAVEDESC can also be inspected in more detail. By giving the name of a variable in the WAVEDESC block as the first parameter, it is possible to inspect only the value of that one entity.

Query Syntax

```
<trace>:INSPECT? '<WAVEDESC variable|logical block>',[<data_type>]
```

```
<trace>:= C1 to Cn, F1 to Fn, M1 to Mn, TA to TD
```

```
<WAVEDESC_variable>:= any variable listed in the WAVEDESC block of the
oscilloscope's Waveform Template
```

```
<logical_block>:= {TRIGTIME,RISTIME,SIMPLE,DATA_ARRAY_1,DATA_ARRAY_2,
```

```
<data_type>:= {BYTE, WORD, FLOAT}
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

You may use single or double quotation marks in the query, but the reply always uses double quotes.

The optional parameter <data_type> applies only to inspection of data arrays. It selects the representation of the data. The default <data_type> is FLOAT.

Data Type Descriptions	
BYTE	Raw data as integers (truncated to 8 most significant bits).
FLOAT	Normalized data (gain, offset applied) as floating point numbers (gives measured values in volts or units).
WORD	Raw data as integers (truncated to 16 most significant bits).

Block WAVEDESC contains several variables related to scaling of data values. Values of these variables depend on the current setting of the command COMM_FORMAT (CFMT). The following example shows how the values returned by INSP? change when you modify the CFMT setting from BYTE (default) to WORD:

CFMT Set to BYTE	CFMT Set to WORD

`VERTICAL_GAIN     : 3.1250e-003`
`VERTICAL_OFFSET   : -2.0600e-001`
`MAX_VALUE         : 1.2700e+002`
`MIN_VALUE         : -1.2800e+002`
	`VERTICAL_GAIN     : 1.2207e-005`
	`VERTICAL_OFFSET   : -2.0600e-001`
	`MAX_VALUE         : 3.2512e+004`
	`MIN_VALUE         : -3.2768e+004`

Response Format

```
<trace>:INSPECT "<WAVEDESC_variable|logical_block>: <value>"
```

Examples (GPIB)

The following instruction reads the value of the timebase at which the last waveform in Channel 1 was acquired:

```
CMD$="C1:INSP? 'TIMEBASE'"

CALL IBWRT(SCOPE%,CMD$)

CALL IBRD(SCOPE%,RSP$)

PRINT RSP$
```

Response message:

```
C1:INSP "TIMEBASE: 500 US/DIV"
```

The following instruction reads the entire contents of the waveform descriptor block:

```
CMD$="C1:INSP? 'WAVEDESC'"
```

Related Commands

COMM_FORMAT, TEMPLATE, WAVEFORM_SETUP

RECALL, REC

Description

The RECALL command recalls a waveform file from the current directory on mass storage into any of the internal memories (M1 to M*n*).

Only waveforms stored in binary format (.trc) can be recalled.

Command Syntax

```
<memory>:RECALL DISK,<device>,FILE,'<file name>'

<device>:= {HDD, USB, MICRO}

<memory>:= M1 to Mn

<file name>:= full path to .trc file
```

The file path must be enclosed in single quotes. Use the full path to the directory, including the drive letter. Be sure there are no spaces before the directory string.

Note: The hard drive selection (HDD) always points to drive D, which is the data drive on MAUI oscilloscopes. An external USB drive is usually named drive E; check your oscilloscope file system. The device type MICRO applies only to instruments that utilize Micro-SD card data storage, such as WaveSurfer 3000.

Example (GPIB)

The following instruction recalls the waveform file 'C2Trace00000.trc' into Memory 1:

```
CMD$="<M1:REC DISK,HDD,FILE,'D:\Waveforms\C2Trace00000.trc'": CALL IBWRT
(SCOPE%,CMD$)
```

Related Commands

STORE, INR?

STORE, STO

Description

The STORE command stores the specified waveform data in one of the internal memories (M1 to M*n*) or in the current directory in mass storage. The files are saved in binary with the .trc extension.

The complement to the STORE command is the RECALL command, which recalls waveforms saved to external files into one of the oscilloscope internal memories.

Set the current directory (where files are stored) with the DIR command.

Command Syntax

```
STORE [<trace>,<dest>]
```

```
<trace>:= C1 to Cn, F1 to Fn, TA to TD, or ALL_DISPLAYED
```

```
<dest>:= M1 to Mn, or FILE
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

When storing traces to FILE, files are saved with the .trc extension in the directory last set with the DIR command. File names are autogenerated.

If you send the STORE command without an argument, the current Storage Setup operation will be stored. Modify this setup using STORE_SETUP.

Example (GPIB)

The following instruction stores the Channel 4 (C4) waveform into Memory 1 (M1):

```
CMD$="STO C4,M1": CALL IBWRT(SCOPE%,CMD$)
```

The following instruction stores all currently displayed waveforms onto the hard drive:

```
CMD$="STO ALL_DISPLAYED,FILE": CALL IBWRT(SCOPE%,CMD$)
```

The following instruction executes the storage operation currently defined in the Storage Setup:

```
CMD$="STO": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

DIR, RECALL, STORE_SETUP

STORE_SETUP, STST

Description

The STORE_SETUP command controls the way in which traces are stored. Any one trace or all displayed traces can be set up for storage, either by turning on AUTO store or using the STORE command.

Two modes are available when using AUTO store: FILL, which stops when the storage medium is full, and WRAP, which replaces the oldest trace by the latest one. Wrap mode overwrites any trace file, whether or not it was made during the current session or records the same trace.

Command Syntax

```
STORE_SETUP [<trace>,<dest>][,AUTO,<mode>][,FORMAT,<type>]

<trace>:= C1 to Cn, F1 to Fn, M1 to Mn, TA to TD, ALL_DISPLAYED

<dest>:= M1 to Mn, HDD

<mode>:= {OFF, FILL, WRAP}

<type>:= {ASCII, BINARY, EXCEL,MATHCAD, MATLAB}
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

Query Syntax

```
STORE_SETUP?
```

Response Format

```
STORE_SETUP <trace>,<dest>,AUTO,<mode>
```

Example (GPIB)

The following instruction enables AUTO store for Channel 1, to be performed until insufficient space remains for another file.

```
CMD$="STST C1,HDD,AUTO,FILL" CALL IBWRT("SCOPE%", CMD$)
```

Related Commands

STORE, INR

TEMPLATE?, TMPL?

Description

The TEMPLATE? query produces a copy of the template that describes the various logical entities making up a complete waveform. In particular, the template describes in full detail the variables contained in the descriptor part of a waveform.

Query Syntax

```
TEMPLATE?
```

Response Format

```
TEMPLATE? "<template>"

<template>:= Variable length string detailing the structure of a waveform.
```

Related Commands

INSPECT?

WAVEFORM, WF

Description

A WAVEFORM command transfers a waveform from the controller to an oscilloscope internal memory for future recall and display, whereas a WAVEFORM? query transfers a waveform from the oscilloscope display to the controller in file format.

WAVEFORM stores an external waveform back into the oscilloscope's internal memory. A waveform consists of several distinct entities:

- The waveform descriptor (DESC)
- The user text (TEXT)
- The time descriptor (TIME)
- The data block (DAT1)
- An optional second data block (DAT2)

The WAVEFORM? query instructs the oscilloscope to transmit a waveform to the controller. The entities can be queried independently. If the ALL parameter is specified, all four or five entities are transmitted in one block in the order shown above.

Note: Only complete waveforms transmitted with the WAVEFORM? ALL query can be restored to the oscilloscope.

The format of the waveform data depends on the current settings specified by the last WAVEFORM_SETUP, COMM_ORDER and COMM_FORMAT commands.

Command Syntax

```
<memory>:WAVEFORM ALL <waveform_data_block>

<memory>:= M1 to Mn

<waveform_data_block>:= arbitrary data block
```

Query Syntax

```
<trace>:WaveForm? <block>

<trace>:= C1 to Cn, F1 to Fn, M1 to Mn, TA to TD

<block>:= {DESC, TEXT, TIME, DAT1, DAT2, ALL}
```

Note: TA through TD are for backward compatibility. Although accepted, they are not returned by queries.

If you do not provide a <block> parameter, ALL is assumed.

Response Format

```
<trace>:WAVEFORM <block>,<waveform_data_block>
```

Tip: It may be convenient to disable the response header if the waveform is to be restored to the oscilloscope. See the COMM_HEADER topic for more information.

Examples (GPIB)

The following instruction reads the block DAT1 from Memory 1 and saves it in the file "MEM1.DAT". The path header "M1:" is saved together with the data.

```
FILE$ = "MEM1.DAT"
CMD$ = "M1:WF? DAT1"
CALL IBWRT(SCOPE%,CMD$)
CALL IBRDF(SCOPE%,FILE$)
```

In the following example, the entire contents of Channel 1 are saved in the file "CHAN1.DAT". The path header "C1:" is skipped to ensure that the data can later be recalled into the oscilloscope.

```
FILE$="CHAN1.DAT":RD$=SPACE$(3)
CMD$="CHDR SHORT; C1:WF?"
CALL IBWRT(SCOPE%,CMD$)
CALL IBRD(SCOPE%,RD$)     ' Skip first 3 characters "C1:"
CALL IBRDF(SCOPE%,FILE$) ' Save data in file "CHAN1.DAT"
```

The following instruction illustrates how the waveform data saved in the preceding example can be recalled into Memory 1:

```
FILE$ = "CHAN1.DAT"
CMD$ ="M1:"
CALL IBEOT(SCOPE%,0)      ' disable EOI
CALL IBWRT(SCOPE%,CMD$)
CALL IBEOT(SCOPE%,1)      ' re-enable EOI
CALL IBWRTF(SCOPE%,FILE$)
```

The "M1:" command ensures the active waveform is "M1". When the data file is sent to the oscilloscope, it first sees the header "WF" (the characters "C1:" having been skipped when reading the file) and assumes the default destination "M1".

Related Commands

INSPECT, COMM_FORMAT, COMM_ORDER, FUNCTION_STATE, TEMPLATE, WAVEFORM_SETUP, WAVEFORM_TEXT

WAVEFORM_SETUP, WFSU

Description

The WAVEFORM_SETUP command specifies the amount of data in a waveform to be transmitted to the controller.

The WAVEFORM_SETUP? query returns the transfer parameters currently in use.

Command Syntax

```
WAVEFORM_SETUP SP,<sparsing>,NP,<number>,FP,<first point>,SN,<segment>
```

Note: After power-on, all values are set to 0 (meaning, entire waveforms are transmitted without sparsing). Parameters are grouped in pairs. The first of the pair names which variable is modified, while the second provides the new value for assignment. Pairs can be given in any order and restricted to the variables for change.

Sparsing (SP)

The sparsing parameter defines the interval between data points. For example:

SP = 0 sends all data points.

SP = 1 sends all data points.

SP = 4 sends every 4th data point.

Number of Points (NP)

The number of points parameter indicates how many points should be transmitted. For example:

NP = 0 sends all data points.

NP = 1 sends 1 data point.

NP = 50 sends a maximum of 50 data points.

NP = 1001 sends a maximum of 1001 data points.

First Point (FP)

The first point parameter specifies the address of the first data point to be sent. For waveforms acquired in sequence mode, this refers to the relative address in the given segment. For example:

FP = 0 corresponds to the first data point.

FP = 1 corresponds to the second data point.

FP = 5000 corresponds to data point 5001.

Segment Number (SN)

The segment number parameter indicates which segment should be sent if the waveform was acquired in sequence mode. This parameter is ignored for non-segmented waveforms. For example:

SN = 0 all segments.

SN = 1 first segment.

SN = 23 segment 23.

Query Syntax

```
WAVEFORM_SETUP?
```

Response Format

```
WAVEFORM_SETUP SP,<sparsing>,NP,<number>,FP,<first point>,SN,<segment>
```

Example (GPIB)

The following instructs every 3rd data point (SP = 3) starting at address 200 for transfer:

```
CMD$="WFSU SP,3,FP,200": CALL IBWRT(SCOPE%,CMD$)
```

Related Commands

INSPECT, WAVEFORM, TEMPLATE

DISK DRIVE ANALYSIS (Option) Commands and Queries

DD_ANALOG_COMP_THRESH, DACT

Description

Sets the analog threshold value for Analog Compare.

Command Syntax

```
DD_ANALOG_COMPARE_THRESHOLD <threshold>
```

```
<threshold >:= float in range 0.0 to 1.0. Analog Compare error threshold in units of
full-scale error.
```

Query Syntax

```
DD_ANALOG_COMPARE_THRESHOLD?
```

Response Format

```
DD_ANALOG_COMPARE_THRESHOLD <threshold>
```

Related Commands

DD_FIND_ERROR, DD_FIND_METHOD

DD_ANALYZE_REGION_DISABLE, DARD

Description

Disables the use of the analyze region markers, which means the entire waveform will be analyzed in analog compare and channel emulation.

Command Syntax

```
DD_ANALYZE_REGION_DISABLE
```

The analyze region is enabled whenever DD_ANALYZE_REGION_START or DD_ANALYZE_REGION_ LENGTH are set.

Related Commands

DD_ANALYZE_REGION_START, DD_ANALYZE_REGION_LENGTH

DD_ANALYZE_REGION_LENGTH, DARL

Description

Selects the length of a region to be analyzed.

Command Syntax

```
DD_ANALYZE_REGION_LENGTH <time >

<time>:= time in seconds
```

Query Syntax

```
DD_ANALYZE_REGION_LENGTH?
```

Response Format

```
DD_ANALYZE_REGION_LENGTH <time >
```

Related Commands

DD_ANALYZE_REGION_START, DD_ANALYZE_REGION_DISABLE

DD_ANALYZE_REGION_START, DARS

Description

Selects the start of a region to be analyzed.

Command Syntax

```
DD_ANALYZE_REGION_START <time >

<time>:= time in seconds
```

Query Syntax

```
DD_ANALYZE_REGION_START?
```

Response Format

```
DD_ANALYZE_REGION_START <time >
```

Related Commands

DD_ANALYZE_REGION_LENGTH, DD_ANALYZE_REGION_DISABLE

DD_BITCELL, DBIT

Description

Enters the bit cell time of the head signal.

Command Syntax

```
DD_BITCELL <bittime>
```

```
<bittime>:= time in range 0.10–99.99 ns
```

Query Syntax

```
DD_BITCELL?
```

Response Format

```
DD_BITCELL <bittime>
```

DD_BYTE_OFFSET, DBYT

Description

Moves the head trace to show the specified byte. Channel must be configured.

Command Syntax

```
DD_BYTE_OFFSET <bytenum>
```

```
<bytenum>:= integer in range 20 to 50,000
```

Query Syntax

```
DD_BYTE_OFFSET?
```

Response Format

```
DD_BYTE_OFFSET <bytenum>
```

Related Commands

DD_BYTE_OFFSET, DD_VCOSYNCH_TO_DATA, DD_BITCELL, DD_ENCODING, DD_SIGNAL_INPUT

DD_BYTE_OFFSET_SEGMENT, DSEG

Description

Moves the head trace to show the specified segment.

Command Syntax

```
DD_BYTE_OFFSET _SEGMENT <segnum>
```

```
<segnum>:= integer in range 1 to 999
```

Query Syntax

```
DD_BYTE_OFFSET _SEGMENT?
```

Response Format

```
DD_BYTE_OFFSET _SEGMENT <segnum>
```

Related Commands

DD_BYTE_OFFSET

DD_CTAF_3DB, D3D

Description

Sets the CTAF (Continuous Time Analog Filter) parameter, 3 dB.

Command Syntax

```
DD_CTAF_3DB <3 dB point>
```

```
<3 dB point>:= frequency in range 0.1 to 1.0 * sampling frequency
```

Query Syntax

```
DD_CTAF_3DB?
```

Response Format

```
DD_CTAF_3DB <3 dB point>
```

Related Commands

DD_CTAF_FC, DD_CTAF_BOOST, DD_CTAF_GROUP_DELAY, DD_TRAIN_FILTER

DD_CTAF_BOOST, DBST

Description

Sets the CTAF (Continuous Time Analog Filter) parameter, boost.

Command Syntax

```
DD_CTAF_BOOST <boost>
```

```
<boost>:= gain (in dB) in range 0.0-13.0 dB
```

Query Syntax

```
DD_CTAF_BOOST?
```

Response Format

```
DD_CTAF_BOOST <boost>
```

Related Commands

DD_CTAF_FC, DD_CTAF_3DB, DD_CTAF_GROUP_DELAY, DD_TRAIN_FILTER

DD_CTAF_FC, DDFC

Description

Sets the CTAF (Continuous Time Analog Filter) parameter, cut-off frequency fc.

Command Syntax

```
DD_CTAF_FC <fc>

<fc>:= frequency in range 0.1 to 1.0 * sampling freq.
```

Query Syntax

```
DD_CTAF_FC?
```

Response Format

```
DD_CTAF_FC <fc>
```

Related Commands

DD_CTAF_3DB, DD_CTAF_BOOST, DD_CTAF_GROUP_DELAY, DD_TRAIN_FILTER

DD_CTAF_GROUP_DELAY, DFGD

Description

Sets the CTAF (Continuous Time Analog Filter) parameter, group delay.

Command Syntax

```
DD_CTAF_GROUP_DELAY <gdpercent>
```

```
<gdpercent>:= value in range -30.0% to +30.0%
```

Query Syntax

```
DD_CTAF_GROUP_DELAY?
```

Response Format

```
DD_CTAF_GROUP_DELAY <gdpercent>
```

Related Commands

DD_TRAIN_FILTER, DD_CTAF_FC DD_CTAF_3DB, DD_CTAF_BOOST

DD_ENCODING, DENC

Description

Allows selection of the data-encoding ratio for locating the bytes by byte offset.

Command Syntax

```
DD_ENCODING <m>,<n>

<m>:= integer in range 1 to 32

<n>:= integer in range <m> to 32
```

Query Syntax

```
DD_ENCODING?
```

Response Format

```
DD_ENCODING <m>,<n>
```

Related Commands

DD_BYTE_OFFSET

DD_ERR_INFO?, DERI?

Description

Returns the measured value associated with the last error position selected, and a code specifying what the value contains.

Query Syntax

```
DD_ERR_INFO?
```

Response Format

Shown with short header, the default query response state:

```
DERI <code>,<value>
```

The first number is the code, the second is the value. The meaning of the code is:

0 = invalid, never selected an error position yet

1 = SAM from channel emulation without reference(always greater than 0)

2 = Run Length Limit violation from channel emulation, the value is the number of bit cells without a magnetic transition.

3 = Analog Distance (normalized, proportional to Volts squared) from analog compare

4 = SAM from channel emulation with reference (can be negative, if a different path should have been taken)

Example

DERI? might return "DERI 1,1.7683".

Related Commands

DD_NUM_ERRORS, DD_FIND_ERRO, DD_ERR_NUM

DD_ERR_NUM, DERR

Description

Displays the section of waveform containing the specified error number.

Command Syntax

```
DD_ERR_NUM <errnum>
```

```
<errnum>:= integer in range 1 to #errors found
```

If there are no errors, any invocation produces error status. An <errnum> greater than #errors found produces an error.

Related Commands

DD_FIND_ERROR, DD_ERR_INFO,DD_NUM_ERRORS

DD_FIND_BITCELL?, DFBIT?

Description

Looks at the head signal and attempts to determine the bit-cell time. To be successful, the user must have positioned the Analyze Region Start cursor inside the synch field or have read gate setup.

Query Syntax

```
DD_FIND_BITCELL?
```

Response Format

```
DD_FIND_BITCELL <bool>
```

```
<bool>:= {0, 1}
```

1 if successful; 0 if not successful.

Related Commands

DD_ANALYZE_REGION_START, DD_ANALYZE_REGION_LENGTH, DD_BITCELL, DD_VCO_
SYNCH_PATTERN

DD_FIND_ERROR, DFER

Description

Commands the DDA to find errors.

Command Syntax

```
DD_FIND_ERROR <bool>
```

```
<bool>:= {OFF, ON}
```

Query Syntax

```
DD_FIND_ERROR?
```

Response Format

```
DD_FIND_ERROR <bool>
```

Related Commands

DD_FIND_METHOD

DD_FIND_METHOD, DDFM

Description

Selects the error-finding method.

Command Syntax

```
DD_FIND_METHOD <method>
```

```
<method>:= {ANALOG_COMPARE, ML_DISTANCE, ML_COMPARE}
```

ML_DISTANCE emulates a PRML channel without a reference signal, whereas ML_COMPARE uses a reference.

Query Syntax

```
DD_FIND_METHOD?
```

Response Format

```
DD_FIND_METHOD <method>
```

Related Commands

DD_FIND_ERROR, DD_SAM_THRESH, DD_ANALOG_COMP_THRESH

DD_FIR, DFIR

Description

Stores the setup that will be used if the FIR filter is enabled for use in the channel emulation.

Command Syntax

```
DD_FIR <num>,<coef_0>,<coef_1>,<coef_2>,.....,<coef_n+1>
```

Query Syntax

```
DD_FIR?
```

Response Format

```
DD_FIR <num>,<coef_0>,<coef_1>,<coef_2>,.....,<coef_n+1>
```

Where <num> can be 1 to 21. The sum of the coefficients must be greater than 0.1. If the sum of the coefficients is greater than 1.0, the coefficients will be scaled so that they sum to 1.0.

Related Commands

DD_FIR_ENABLE

DD_FIR_ENABLE, DFEN

Description

Enable/disables the FIR filter for PRML channel emulation. It is always possible to disable the FIR. Requests to enable the FIR only succeed if the following conditions are true:

- Number of coefficients is > 0 and < 21
- At least one of the coefficients is non-zero

These conditions will be met if the DD_FIR command was ever executed successfully. The setup established by DD_FIR is not affected by DD_FIR_ENABLE: the FIR filter may be enabled and disabled without having to reestablish the setup.

Command Syntax

```
DD_FIR_ENABLE <bool>

<bool>:= {YES, NO}
```

Query Syntax

```
DD_FIR_ENABLE?
```

Response Format

```
DD_FIR_ENABLE <bool>
```

Related Commands

DD_FIR

DD_HEADSIGNAL_CHANNEL, DHSC

Description

Specifies the head signal source channel or memory for channel emulation and servo analysis.

Command Syntax

```
DD_HEADSIGNAL_CHANNEL <channel>
```

```
<channel>:= {NONE, C1 to Cn, M1 to Mn}
```

Query Syntax

```
DD_HEADSIGNAL_CHANNEL?
```

Response Format

```
DD_HEADSIGNAL_CHANNEL <channel>
```

Related Commands

DD_SIGNAL_INPUT

DD_IGNORE_SAMPLES, DIGS

Description

Defines the number of samples to be ignored at the Read Gate signal end for channel emulation and analog compare.

Command Syntax

```
DD_IGNORE_SAMPLES <samples>
```

```
<samples>:= integer in range 0 to 999.
```

Query Syntax

```
DD_IGNORE_SAMPLES?
```

Response Format

```
DD_IGNORE_SAMPLES <samples>
```

Related Commands

DD_READGATE_CHANNEL

DD_ML_MIN_SPACING, DRLM

Description

When channel emulation is active, this sets the minimum allowed spacing of transitions. Minimum allowed spacing of transitions affects PR4, EPR4 and E2PR4.

Command Syntax

```
DD_ML_MIN_SPACING <d>
```

```
<d>:= integer in range 0 to 2
```

0 means adjacent transitions are allowed; 1 means there must be at least one non-transition between each transition; 2 is only valid for E2PR4.

Query Syntax

```
DD_ML_MIN_SPACING?
```

Response Format

```
DD_ML_MIN_SPACING <d>
```

Related Commands

DD_FIND_ERROR, DD_ML_RUN_LENGTH_LIMIT

DD_ML_RUN_LENGTH_LIMIT, DRLE

Description

Limits the run length, the number of “0” values in a row for the head/analog signal when channel emulation is active.

Command Syntax

```
DD_ML_RUN_LENGTH_LIMIT <k>
```

```
<k>:= integer in the range 0 to 99.
```

Maximum allowed run of non-transitions. If zero, then RLL checking is disabled.

Query Syntax

```
DD_ML_RUN_LENGTH_LIMIT?
```

Response Format

```
DD_ML_RUN_LENGTH_LIMIT <k>
```

Related Commands

DD_FIND_ERROR, DD_ML_MIN_SPACING

DD_NUM_ERRORS?, DNER?

Description

Returns the number of errors found.

Query Syntax

```
DD_NUM_ERRORS?
```

Response Format

```
DD_NUM_ERRORS <errorcount>
```

```
<errorcount>: = number of errors found
```

Related Commands

DD_FIND_EROR, DD_ERR_NUM, DD_ERR_INFO, DD_NUM_ERRORS

DD_OVERLAP_REF, DOVL

Description

This command sets a state variable which determines whether Byte Offset (when jumping to a "Worst SAM #" or an NRZ mismatch position) or other disk-drive related features re-establish the overlap of the reference signal whenever they move the head trace. To re-establish overlap, they calculate correlation over a window around the expected match position, and overlap the waveform at the sample where the correlation is highest. The size of the window is limited to the width of the head trace display or to a fixed number of bytes, whichever is smaller. If the waveform is greatly different within the window, the most correlated position may not be meaningful, and the waveforms will not appear overlapped. This should be clear on the display.

The command DD_OVERLAP_REF ON does not cause the reference to be displayed. The next change of Byte Offset, etc, causes the reference to be displayed, correctly overlapped.

The command DD_OVERLAP_REF OFF does not cause the reference trace to be turned off. It may be turned off, or repositioned as desired by the user. Subsequent changes to Byte Offset, etc, do not move the reference and do not cause it to be displayed.

Command Syntax

```
DD_OVERLAP_REF <bool>

<bool>: = {OFF, ON}
```

Query Syntax

```
DD_OVERLAP_REF?
```

Response Format

```
DD_OVERLAP_REF <bool>
```

DD_PES_ANALYSIS, DPA

Description

Starts or aborts PES analysis. The query returns status of the analysis.

Command Syntax

```
DD_PES_ANALYSIS <command>
```

```
<command>:= {START, ABORT}
```

Query Syntax

```
DD_PES_ANALYSIS?
```

Response Format

```
DD_PES_ANALYSIS <state>
```

```
<state>:= 1 = running, 0 = stopped
```

Related Commands

DD_PES_DATA, DD_PES_SETUP

DD_PES_DATA?, DPD?

Description

Reads out results of PES Analysis.

Query Syntax

```
DD_PES_DATA? [<sort order>]
```

```
<sort_order>:= {WEDGE, RRO, IRO, MAX, MIN, SIGMA}
```

<sort_order> is an optional parameter that specifies how data is sorted on output. Data can be sorted by: WEDGE, RRO (Repetitive Runout), IRO (Instantaneous Runout), MAX (Maximum Runout), MIN (Minimum Runout), or SIGMA (Runout Standard Deviation).

Response Format

```
DD_PES_DATA? "<wedge_1>,<IRO_1>,<RRO_1>,<MAX_1>,<MIN_1>,<SIGMA_1>,…,<wedge_N>,…"
```

Related Commands

DD_PES_ANALYSIS, DD_PES_SETUP, DD_PES-SUMMARY_DATA

DD_PES_SUMMARY_DATA?, DPSD?

Description

Summarizes PES Analysis results. Returns average and sigma (Runout Standard Deviation) of all wedge RROs (Repetitive Runouts), as well as the average of sigma for each wedge's RRO.

Note: IRO = instantaneous run out, from one observation of the PES signal; RRO = repeatable run out, the average of multiple IRO values at the same position.

Query Syntax

```
DD_PES_SUMMARY_DATA?
```

Response Format

```
DD_PES_SUMMARY_DATA? <avgRO>,<sigmaRO>,<avgSigma>

<avgRO> : = Average of all wedges’ RROs

<sigmaRO> : = Sigma of all wedges’ RROs in % of track separation

<avgSigma> : = Average sigma of all wedges' RROs
```

<avgRO> is the average distance of the head from the track, as a percentage of track separation.

<sigmaRO> Reflects the width of the distribution of all RRO values from all wedges. If the track is circular and the head still, this should be zero.

<avgSigma> reflects the width of the distribution of IRO values that contributed to that wedge's RRO. This value, also given as a percentage of track separation, is increased by non-repeatable runout.

Related Commands

DD_PES_ANALYSIS, DD_PES_DATA, DD_PES_SETUP

DD_READ_GATE_POLARITY, DRGP

Description

Selects the polarity of the read gate signal.

Command Syntax

```
DD_READ_GATE_POLARITY <polarity>
```

```
<polarity>:= {POS, NEG}
```

Query Syntax

```
DD_READ_GATE_POLARITY?
```

Response Format

```
DD_READ_GATE_POLARITY <polarity>
```

Related Commands

DD_READGATE_CHANNEL, DD_SIGNAL_INPUT

DD_READCLOCK_CHANNEL, DRCC

Description

Specifies the input channel to which Read Clock is connected or the memory in which it is stored.

Command Syntax

```
DD_READCLOCK_CHANNEL <channel>
```

```
<channel>:= {NONE, C1 to Cn,  M1 to Mn}
```

Query Syntax

```
DD_READCLOCK_CHANNEL?
```

Response Format

```
DD_READCLOCK_CHANNEL <channel>
```

Related Commands

DD_SIGNAL_INPUT

DD_READGATE_CHANNEL, DRGC

Description

Specifies the input channel to which Read Gate is connected or the memory in which it is stored.

Command Syntax

```
DD_READGATE_CHANNEL <channel>
```

```
<channel>:= {NONE, C1 to Cn, M1 to Mn}
```

Query Syntax

```
DD_READGATE_CHANNEL?
```

Response Format

```
DD_READGATE_CHANNEL <channel>
```

Related Commands

DD_SIGNAL_INPUT, DD_READ_GATE_POLARITY

DD_RESET_AVERAGE, DRAV

Description

Resets the averaged data and all sweeps; clears histograms and parameters; allows the start of a fresh analysis.

Command Syntax

```
DD_RESET_AVERAGE
```

DD_SAM_THRESH, DST

Description

Sets the SAM threshold value for channel emulation.

Command Syntax

```
DD_SAM_THRESH <threshold>
```

```
<threshold>:= float (range depends on signal type)
```

Channel emulation error threshold is in units of Sequenced Amplitude Margin (SAM). The minimum threshold is 0.0 channel emulation without reference and -1.0 for channel emulation with reference. Maximum allowed thresholds are:

Signal Type	Maximum SAM Threshold
PR	42.00
EPR	41.00
E2PR	41.11

Query Syntax

```
DD_SAM_THRESH?
```

Response Format

```
DD_SAM_THRESH <threshold>
```

Related Commands

DD_FIND_ERROR, DD_FIND_METHOD

DD_SAMPLE_PHASE, DSPH

Description

Adjusts the phase between the DDFA PLL sample points and an external clock reference (when RCLK is connected).

Command Syntax

```
DD_SAMPLE_PHASE <phase>
```

```
<phase>:= degrees in the range -180 to +180, where the bit cell time is 360 degrees
```

Query Syntax

```
DD_SAMPLE_PHASE?
```

Response Format

```
DD_SAMPLE_PHASE <phase>
```

Related Commands

DD_READCLOCK_CHANNEL, DD_SIGNAL_INPUT, DD_SHOW _SAMPLE_TIMES

DD_SHOW_FILTERED, DSF

Description

The DD_SHOW_FILTERED command enables and disables the filtering of the head signal. When enabled, the filtered version will be displayed in the next open function trace (F*n*).

Command Syntax

```
DD_SHOW_FILTERED <bool>
```

```
<bool>:= {OFF, ON}
```

Query Syntax

```
DD_SHOW_FILTERED?
```

Response Format

```
DD_SHOW_FILTERED <bool>
```

Related Commands

DD_TRAIN_FILTER

DD_SHOW_LEVELS, DSLV

Description

Displays the level markers indicating the Viterbi levels of the ML samples when channel emulation is active.

Command Syntax

```
DD_SHOW_LEVELS <bool>
```

```
<bool>:= {OFF, ON}
```

Query Syntax

```
DD_SHOW_LEVELS?
```

Response Format

```
DD_SHOW_LEVELS <bool>
```

Related Commands

DD_FIND_ERROR, DD_FIND_METHOD

DD_SHOW_ML, DSML

Description

Displays/hides ML markers, cursors indicating the times and levels of the Viterbi detector ML samples, which are available when channel emulation or NRZ compare is enabled.

Command Syntax

```
DD_SHOW_ML <bool>
```

```
<bool>:= {OFF, ON}
```

Query Syntax

```
DD_SHOW_ML?
```

Response Format

```
DD_SHOW_ML <bool>
```

Related Commands

DD_FIND_ERROR, DD_FIND_METHOD

DD_SHOW_SAMPLE_TIMES, DSST

Description

Shows vertical-line cursors on the grid at each sample time corresponding to the read clock.

Command Syntax

```
DD_SHOW_SAMPLE_TIMES <bool>
```

```
<bool>:= {OFF, ON}
```

Query Syntax

```
DD_SHOW_SAMPLE_TIMES?
```

Response Format

```
DD_SHOW_SAMPLE_TIMES <bool>
```

Related Commands

DD_SIGNAL_INPUT, DD_READCLOCK_CHANNEL, DD_SAMPLE_PHASE

DD_SIGNAL_INPUT, DDSI

Description

Sends or reads out the association of a source with a particular Disk Drive signal. This signal can be used by disk drive triggers, servo analysis, analog compare, and channel emulation.

Command Syntax

```
DD_SIGNAL_INPUT <signal_name>,<source>[,<polarity>]
```

```
<signal_name>:= {HEAD, READ_GATE, READ_CLOCK, INDEX, SERVO_GATE,
SECTOR_PULSE, PES, ON_TRACK, WRITE_GATE}
```

```
<source>:= {None, C1 to Cn, EX, M1 to Mn}
```

```
<polarity>:= {POS, NEG}
```

HEAD and PES have no polarity.

EX source is not valid for HEAD, READ_GATE or READ_CLOCK signals.

M1 through M*n* not valid for SERVO_GATE, SECTOR_PULSE, PES, ON_TRACK or WRITE_GATE.

Query Syntax

```
DD_SIGNAL_INPUT?
```

Response Format

```
DD_SIGNAL_INPUT <signal_name>,<source>[,<polarity>]
```

Related Commands

DD_HEADSIGNAL_CHANNEL, DD_READGATE_CHANNEL, DD_READCLOCK_CHANNEL, DD_READ_GATE_POLARITY

DD_SIGNAL_TYPE, DSIG

Description

Specifies Peak Detect or a particular PRML format for the head signal.

Command Syntax

```
DD_SIGNAL_TYPE <sigtype>
```

```
<sigtype>:= {PEAK, PR4, EPR4, EEPR4}
```

Query Syntax

```
DD_SIGNAL_TYPE?
```

Response Format

```
DD_SIGNAL_TYPE <sigtype>
```

DD_START_AVERAGING, DSAV

Description

Changes the state of the “Avg. Samples” switch on the Graph menu. When set to yes, all subsequent acquisitions will be averaged and noise analysis calculations will be carried on.

Command Syntax

```
DD_START_AVERAGING <bool>
```

```
<bool>:= {YES, NO}
```

Query Syntax

```
DD_START_AVERAGING?
```

Response Format

```
DD_START_AVERAGING <bool>
```

DD_STORE_REFERENCE, DSTR

Description

Stores the head signal to one of the DDA's available memories for analog compare and channel emulation with reference.

Command Syntax

```
DD_STORE_REFERENCE
```

Related Commands

DD_FIND_ERROR, DD_OVERLAP_REF

DD_TRAIN_FILTER?, DTF?

Description

Commands the Disk Drive Analyzer to determine reasonable values for each filter parameter. A head signal able to be analyzed is required on which to train the filter.

Query Syntax

```
DD_TRAIN_FILTER?
```

Response Format

```
DD_TRAIN_FILTER <success>

<success> : = 0 or 1
```

Related Commands

DD_CTAF_3DB, DD_CTAF_BOOST, DD_CTAF_FC, DD_CTAF_GROUP_DELAY

DD_VCO_SYNCH_PATTERN, DVSP

Description

Defines the number of bits per half-period in the synchronization field.

Command Syntax

```
DD_VCO_SYNCH_PATTERN <pattern>
```

```
<pattern>:= integer in the range 1-4 indicating type of VCO synch pattern (1T, 2T,
etc.)
```

Query Syntax

```
DD_VCO_SYNCH_PATTERN?
```

Response Format

```
DD_VCO_SYNCH_PATTERN <pattern>
```

Related Comamnds

DD_VCO_SYNCH_TO_DATA, DD_FIND_BITCELL

DD_VCOSYNCH_TO_DATA, DVTD

Description

Specifies the number of bytes on the analog head signal waveform between the end of the VCO sync field and the actual data.

Command Syntax

```
DD_VCOSYNCH_TO_DATA <numbytes>
```

```
<numbytes>:= integer in the range 1 to 32
```

Query Syntax

```
DD_VCOSYNCH_TO_DATA?
```

Response Format

```
DD_VCOSYNCH_TO_DATA <numbytes>
```

Related Commands

DD_VCO_SYNCH_PATTERN, DD_BYTE_OFFSET

ET-PMT (Option) Commands and Queries

CUSTOM_OPTIONS?, CU_OPT?

Description

The CU_OPT? query identifies ET-PMT options currently enabled due to the presence of a PP100. These options can also be enabled by the normal option key mechanism. If so, they are reported by the *OPT? query instead of CU_OPT?. The response to CU_OPT? consists of a series of response fields listing all the options enabled due to the presence of a PP100.

Query Syntax

```
CU_OPT?
```

Response Format

```
<option_1>, [<option_n>]
```

```
<option_n> := {MT01, MT02}
```

The parameter <option_n> is for compatibility with older oscilloscopes.

Related Commands

CUSTOM_APPLICATION, MT_FAIL_ACTIONS, MT_OPC?, MT_PF_COUNTERS?, MT_SELECT_ TEST, MT_SYMBOL?

CUSTOM_APPLICATION, CUAP

Description

The CUSTOM_APPLICATION command toggles the oscilloscope application between ET-PMT Mask Tester mode and standard oscilloscope mode.

The CUSTOM_APPLICATION query returns the current setting.

Command Syntax

CUAP <state>

<state> := [OFF, MASK_TESTER]

For compatibility with older oscilloscopes, either argument is acceptable.

Query Syntax

```
CUAP?
```

Response Format

```
CUAP <state>
```

Related Commands

CUSTOM_OPTIONS?, MT_FAIL_ACTIONS, MT_OPC?, MT_PF_COUNTERS?, MT_SELECT_TEST, MT_SYMBOL?

MT_FAIL_ACTION, MTFA

Description

This command sets the ET-PMT mask test actions to occur whenever a waveform does not meet the pass criteria.

The query form of this command returns the current action settings.

Command Syntax

```
MTFA <action>,[...,<action>]
```

```
<action> := {STOP, STORE, DUMP, BEEP, PULSE}
```

Query Syntax

```
MTFA?
```

Response Format

```
MTFA <action>[,...,<action>]
```

Related Commands

CUSTOM_APPLICATION, CUSTOM_OPTIONS?, MT_OPC?, MT_PF_COUNTERS?, MT_SELECT_TEST, MT_SYMBOL?

MT_OFFSET, MTOF

Description

The MT_OFFSET command sets the ET-PMT mask offset value for STM-1E, STS-3E and 139M.

The MT_OFFSET query returns the offset value.

Command Syntax

```
MTOF <offset_value>
```

```
<offset_value>:= -50 mV to +50 mV
```

Query Syntax

```
MTOF?
```

Response Format

```
MTOF <offset_value> mV
```

Related Commands

CUSTOM_APPLICATION, CUSTOM_OPTIONS?, MT_OPC?, MT_PF_COUNTERS?, MT_SELECT_TEST, MT_SYMBOL?

MT_OPC?, MTOP?

Description

This query returns the state of the last ET-PMT operation. Its functionality is similar to the *OPC? (operation complete) query.

Query Syntax

```
MTOP?
```

Response Format

```
MTOP <state>
```

```
<state> := {0, 1}
```

where 1 signifies "complete."

Related Commands

CUSTOM_APPLICATION, CUSTOM_OPTIONS?, MT_FAIL_ACTIONS, MT_PF_COUNTERS?, MT_SELECT_TEST, MT_SYMBOL?

MT_PF_COUNTERS?, MTPC?

Description

This query returns the number of passed waveforms out of the total number tested and the percent fail rate for the last ET-PMT mask test.

Query Syntax

```
MTPC?
```

Response Format

```
MT_PF_COUNTERS PASS,<value>,OF,<value>,FAIL_RATE,<percent value>
```

Related Commands

CUSTOM_APPLICATION, CUSTOM_OPTIONS?, MT_FAIL_ACTIONS, MT_OPC?, MT_SELECT_TEST, MT_SYMBOL?

MT_SELECT_TEST, MTST

Description

The MT_SELECT_TEST command selects the ET-PMT signal/test type, and performs AUTOALIGN or HORIZONTAL ALIGN actions automatically on the signal.

MT_SELECT_TEST query returns the current test settings.

Command Syntax

```
MTST <test_name>,<channel>,<averaging>

<test_name>:= {NO_TEST,E1TP,E1COAX,E2,E3,E4,STM1E,DS1,DS3,STS1,STS3E}

<channel>:= {C1, C2, C3, C4}

<averaging>:= {0 to 128}
```

Query Syntax

```
MTST?
```

Response Format

```
MTST <test_name>, <channel>, <averaging>
```

Related Commands

CUSTOM_APPLICATION, CUSTOM_OPTIONS?, MT_FAIL_ACTIONS, MT_OPC?, MT_PF_COUNTERS?, MT_SYMBOL?

MT_SYMBOL?, MTSY?

Description

For STM-1E, STS-3E and 139 M tests, returns the 1 or 0 symbol.

For DS1, DS3 and STS1, returns the POS or NEG pulse.

Query Syntax

```
MTSY?
```

Response Format

```
MTSY <bit_value>
```

```
<bit_value>:=   1 or 0, POS or NEG
```

Related Commands

CUSTOM_APPLICATION, CUSTOM_OPTIONS?, MT_FAIL_ACTIONS, MT_OPC?, MT_PF_
COUNTERS?, MT_SELECT_TEST

MT_TEST_STATE, MTTS

Description

The command controls the ET-PMT test execution: RUN/STOP or PAUSE/CONTINUE.

The query returns the current ET-PMT test state.

Command Syntax

```
MT_TEST_STATE <test_state>

<test_state>:= {RUN, STOP, CONTINUE, PAUSE}
```

Query Syntax

```
MTTS?
```

Response Format

```
MTTS <test_state>

<test_state> := {RUN, STOP, CONTINUE, PAUSE}
```

Related Commands

CUSTOM_APPLICATION, CUSTOM_OPTIONS?, MT_FAIL_ACTIONS, MT_OPC?, MT_PF_
COUNTERS?, MT_SYMBOL?

MT_VERTICAL_ALIGN, MTVA

Description

Performs offset alignment for ET-PMT masks STM-1E, STS-3E and 139M.

Command Syntax

```
MT_VERTICAL_ALIGN
```

Related Commands

CUSTOM_APPLICATION, CUSTOM_OPTIONS?, MT_FAIL_ACTIONS, MT_OPC?, MT_PF_COUNTERS?, MT_SYMBOL?

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