LECROY

X-STREAM OSCILLOSCOPES

REMOTE CONTROL MANUAL

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About this Manual

This manual explains how to control the instrument from a computer, using commands keyed or programmed into an external controller. This controller is usually a computer, but it could be a simple terminal.

The manual includes a complete list of the commands that you will need to perform remote control operations with the instrument. The manual has two main parts:

Part One, "About Remote Control," covers the principles of remote control and offers practical examples.

Part Two, "Commands," describes each of the remote control commands and queries for instrument operations. It starts with two special indexes that list the commands by short name and by category. Use these to find the command or query you want to use.

As an additional guide, each chapter is prefaced by a summary of its contents.

Watch for these icons and the information they signal:

TIPs offer additional hints on how to get the most out of instrument actions or features.

NOTEs bring to your attention important information you should know. Example -

Important Note for users of other LeCroy DSOs

Existing software: Although the X-Stream™ family of instruments makes extensive use of Automation interfacing, enabling many powerful means of control, most of the commonly used remote control commands have been retained, though in some cases there are minor changes in definitions. Automation commands can be used in existing software by using the VBS command, which is explained in Chapter 6.

Trace labels: Math traces TA, TB, TC, and TD have been replaced by F1, F2, F3 and F4, respectively. Existing software that includes the old trace labels will work with the X-Stream scopes, but new software should use the new labels unless it will be used on earlier DSOs. In addition to these four traces, the instruments include traces math functions F5, F6, F7, and F8. All eight traces are equivalent in their ability to perform zooms or math processing. Memory trace labels M1, M2, M3, and M4 are also permissible trace labels.

Parameter labels have also changed. These are now P1 . . . P8, but the older labels Cust1 . . . Cust5 will still work.

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PART ONE

ABOUT REMOTE CONTROL

Part One explains how the instrument operates under remote control. It covers GPIB and LAN interfaces, the transfer and formatting of waveforms, and the use of status bytes in reporting errors.

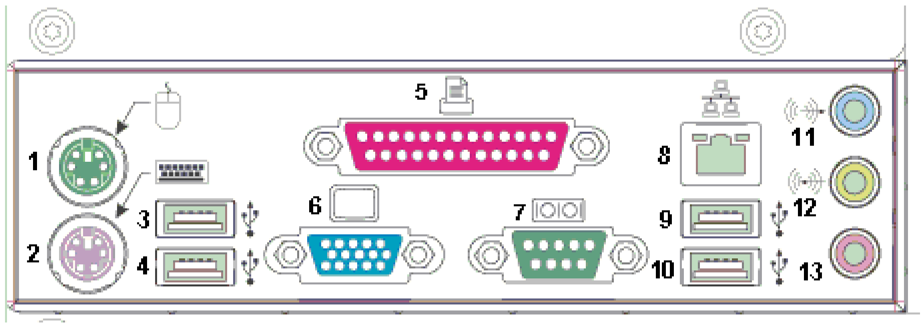
CHAPTER ONE: *Overview*

In this chapter, see how to

- ***Construct program messages***
- ***Use commands and queries***
- ***Include data, and make data strings***

Operate Your Instrument by Remote Control

You can fully control your instrument remotely by using either the optional GPIB (General Purpose Interface Bus) port, if available, or the LAN communication port on the scope's I/O panel, shown below (8). The only actions for which you must use the front panel controls are to power up the scope and to set remote control addresses.



Typical I/O panel, including the LAN port (8) used for remote control

TIP: Use the instrument's Remote Control Assistant to monitor all your remote control operations. See the COMM_HELP command in Part Two of this manual."

STANDARDS

LeCroy's remote control commands conform to the GPIB IEEE 488.2* standard. This may be considered an extension of the IEEE 488.1 standard, which deals mainly with electrical and mechanical issues.

COMPATIBILITY WITH OTHER LECROY SCOPES

Throughout LeCroy's history, the company has striven to maximize compatibility. This policy continues to operate. But the X-Stream DSOs introduce a completely new philosophy in scope communication, enabling the scopes to control powerful proprietary programs within the instrument and within the processing chain. You may find that a **few** "GPIB" commands, used for the earlier scopes, do not work on X-Stream scopes. The solution is to use the new Automation commands, which are described in Chapter 6. It is easy to integrate these commands into a GPIB program, using the command **VBS**. But you should find that for the most frequently used commands and queries, existing scopes and X-Stream scopes are compatible, apart from a few details.

*ANSI/IEEE Std. 488.2–1987, *IEEE Standard Codes, Formats, Protocols, and Common Commands.* The Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY 10017 USA

PROGRAM MESSAGES

You control the oscilloscope remotely using program messages that consist of one or more commands or queries. The program messages you send from the external controller to the X-Stream oscilloscope must conform to precise format structures. The oscilloscope will execute all program messages sent in the correct form, but will ignore those with errors.

You can use uppercase or lowercase characters, or both, in program messages; the scope does not distinguish between them. But the MESSAGE command can faithfully transmit strings containing both lowercase and uppercase letters.

Warning or error messages are normally not reported unless the controller explicitly examines the relevant status register, or if the status-enable registers have been set so that the controller can be interrupted when an error occurs. If you connect an external monitor to the instrument's LAN port, however, you will be able to observe all your remote control transactions, including error messages, as they happen. See the command COMM_HELP in Part Two, "Commands."

Program messages are separated by semicolons **;** and end in a terminator:
<command/query>;.........;<command/query> <terminator>.

The oscilloscope will not decode an incoming program message before receiving its terminator. The exception is when the program message is longer than the 256 byte input buffer; then the oscilloscope will start analyzing the message when the buffer is full. Commands and queries are executed in the order in which they are transmitted.

In GPIB mode, the following are valid terminators:

<NL>	New Line character (i.e., the ASCII new-line character, whose 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

The <NL> <EOI> terminator is always used in response messages sent by the oscilloscope to the controller.

NOTE: The <EOI> signal is a dedicated GPIB interface line, which can be set with a special call to the GPIB interface driver. Refer to the GPIB interface manufacturer's manual and support programs.

COMMANDS AND QUERIES

Program messages are made up of one or more commands or queries. While the command directs the oscilloscope to change its state (for example, its timebase or vertical sensitivity) the query asks the oscilloscope about that state. Very often, you will use the same characters for a command and a query, the query being identified by a **?** after the last character.

For example, to change the timebase to 2 ms/div, send this command to the oscilloscope:
TIME_DIV 2 M

Or, to ask the oscilloscope about its timebase, send this query: TIME_DIV?

TIP: The response to a query can be a useful way of generating a command that is known to be correct, and the response can be copied straight into your program.

A query causes the oscilloscope to send a response message. The control program should read this message with a 'read' instruction to the GPIB or LAN interface of the controller.

The response message to the above query might be: TIME_DIV 10 NS

The portion of the query preceding the question mark is repeated as part of the response message. If desired, this text can be suppressed with the command: COMM_HEADER.

Depending on the state of the oscilloscope and the computation to be done, several seconds may pass before a response is received. Command interpretation does not have priority over other oscilloscope activities.

The general form of a command or a query consists of a command header, <header>, optionally followed by one or several parameters, <data>, separated by commas:

<header>[?] <data>**,...,**<data>

The notation [?] shows that the question mark is optional (turning the command into a query).

There is a space between the header and the first parameter.

Use commas between parameters.

The terminator is not shown because usually it is automatically added by the interface driver routine writing to GPIB.

TIP: Set the controller I/O timeout conditions to three or more seconds to give the scope time to respond. An incorrect query will not get a response; and, if Remote Control Assistant is enabled, a beep will sound.

Following are examples of how program messages are made up of commands and queries.

GRID DUAL This program message consists of a single command that instructs the oscilloscope to display a dual grid.

BUZZ BEEP; DISPLAY OFF; DATE? This program message consists of two commands, followed by a query. They instruct the oscilloscope to beep once, turn off the display, and then ask for the current date. Again, the terminator is not shown.

DATE 15,JAN,1993,13,21,16 This command instructs the oscilloscope to set its date and time to 15 JAN 1993, 13:21:16. The command header DATE indicates the action, the 6 data values specify it in detail.

HEADERS

The header is the mnemonic form of the operation to be performed by the oscilloscope. 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 you can use them interchangeably. For 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 that different oscilloscopes will present the same programming interface for similar functions. All these mnemonics begin with an asterisk *. For example, the command *RST is the IEEE 488.2 imposed mnemonic for resetting the oscilloscope, whereas *TST? instructs the oscilloscope to perform an internal self-test and report the outcome.

HEADER PATHS

Certain commands or queries apply to a subsection of the oscilloscope; for example, a single input channel or a trace on the display. In such cases, you must prefix the header by a path name that indicates the channel or trace to which the command applies. The header path normally consists of a two-letter path name followed by a colon **:** immediately preceding the command header. One of the waveform traces can usually be specified in the header path:

Header Path Name	Waveform Trace
C1, C2	Channels 1 and 2
C3, C4	Channels 3 and 4 (on four-channel models)
M1, M2, M3, M4	Memories 1, 2, and 3 and 4
F1, 2, F3, F4, F5, F6, F7, F8 TA, TB, TC, TD	Traces F1 through F8 Equivalent to F1 through F4, for backward compatibility with other LeCroy DSOs.
EX, EX10, EX5	External trigger
LINE	LINE source for trigger

Example: C1:OFST -300 MV Command to set the offset of Channel 1 to -300 mV.

You need only specify a header path once. Subsequent commands with header destinations not indicated are assumed to refer to the last defined path. For example, the queries C2:VDIV?; C2:OFST? ask: What is the vertical sensitivity and the offset of channel 2? While the queries C2:VDIV?; OFST? ask exactly the same questions without repeating the path.

NOTE: If you use one of the older trace labels, for example "TC", any response from the scope uses the new label; for example, it substitutes F3 for TC.

DATA

Whenever a command or query uses additional data values, the values are expressed as ASCII characters. There is a single exception: the transfer of waveforms with the command/query WAVEFORM, where the waveform can be expressed as a sequence of binary data values. See Chapter 4, "Waveform Structure." ASCII data can have the form of character, numeric, string, or block data.

CHARACTER DATA

These are simple words or abbreviations to indicate a specific action.

Example: F3:TRA ON

In this example, the data value ON commands the trace F3 to be turned on (the data value OFF will have the opposite effect).

However, this 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 those parameter pairs that are to be changed need to be indicated.

Example: HARDCOPY_SETUP DEV,EPSON,PORT,GPIB

In this example, two pairs of parameters have been used. The first specifies the device as an EPSON (or compatible) printer, while the second indicates the GPIB port. While the command HARDCOPY_SETUP allows many more parameters, 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 or fractions, or in exponential representation:

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.

Example: There are many ways of setting the timebase of the oscilloscope to 5 µsec/div:

TDIV 5E-6	Exponential notation, without any suffix.
TDIV 5 US	Suffix multiplier U for 1E–6, with the (optional) suffix S for seconds, or TDIV 5000 NS or TDIV 5000E-3 US

You can follow numeric values with multipliers and units to modify the value of the numerical expression. The following mnemonics are recognized:

Multiplier	Exp. Note.	Suffix	Multiplier	Exp. Note.	Suffix
EX	1E18	Exa-	PE	1E15	Peta-
T	1E12	Tera-	G	1E9	Giga-
MA	1E6	Mega-	K	1E3	kilo-
M	1E–3	milli-	U	1E–6	micro-
N	1E–9	nano-	PI	1E–12	pico-
F	1E–15	femto-	A	1E–18	atto-

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'

The oscilloscope displays this message in the Message field above the grid.

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. These messages can be sent back to the oscilloscope in the form in which they were received, to be accepted as valid commands. In GPIB response messages, the <NL> <EOI> terminator is always used.

Example: The controller sends the program message:
TIME_DIV?;TRIG_MODE NORM;C1:COUPLING? (terminator not shown).

The oscilloscope might respond to this with:
TIME_DIV 50 NS;C1:COUPLING D50 (terminator not shown).

The response message refers only to the queries: TRIG_MODE 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.

Whenever you expect a response from the oscilloscope, you must have the control program instruct the GPIB or LAN interface 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 will be discarded. The oscilloscope keeps to stricter rules for response messages than for acceptance of program messages. While you can send program messages from the controller in uppercase or lowercase characters, response messages are always returned in uppercase. Program messages may contain extraneous spaces or tabs (white space), but response messages will not. And while program messages may contain a mixture of short and long command or query headers, response messages always use short headers by default.

However, you can use the command COMM_HEADER to force the oscilloscope to use long headers, or none at all. If the response header is omitted, the response transfer time will be minimized. But the response will not be able to be sent back to the oscilloscope. Suffix units are also suppressed in the response. An advantage of headerless operation is the ease with which programs can use the data, because they do not have to find and remove the headers. But C1:PAVA? ALL will return a string like this - AMPL,292.3E-3,OK,DLY,-2.333E-6,OK,FALL,95.121E-9,OK,MEAN,66E-6,OK,PER,332.8E-9,OK,PKPK,308E-3,OK,RISE,92.346E-9,OK,RMS,106.1E-3,OK,SDEV,106.1E-3,OK,WID,166.3E-9,OK, even with CHDR OFF, because only the header is removed. All other alphabetic information is always transmitted.

If you were to set the trigger slope of Channel 1 to negative, the query C1:TRSL? might yield the following responses:

C1:TRIG_SLOPE NEG	header format: long
C1:TRSL NEG	header format: short
NEG	header format: off

TIP: 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.

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CHAPTER TWO: *Control by GPIB*

In this chapter, see how to

- ***Address your X-Stream scope for GPIB***
- ***Configure GPIB software***
- ***Enable remote and local control***
- ***Make transfers of data***
- ***Make service requests***
- ***Poll your X-Stream scope***
- ***Set timing and synchronization***

Talk, Listen, or Control

You can control your X-Stream DSO remotely, using the General Purpose Interface Bus (GPIB). GPIB is similar to a standard computer bus. But 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. GPIB also carries both program and interface messages.

Program messages, often called device dependent messages, contain programming instructions, measurement results, oscilloscope status and waveform data.

Interface messages manage the bus itself. They perform functions such as initialization, addressing and "unaddressing" of devices, and the setting of remote and local modes.

On the one hand, devices connected by GPIB to your X-Stream DSO 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. The host computer must be able to play all three roles. For details of how the controller configures the GPIB for specific functions, refer to the GPIB interface manufacturer's manual.

On the other hand, the X-Stream DSO can be a talker or listener, but NOT a controller.

Much of the material in this chapter is general to all GPIB systems, but where detailed instructions and program fragments are provided in this manual, they are based on National Instruments hardware and software, and on some form of BASIC language. Where INCLUDES are mentioned, this points to the need to couple the programming language to the GPIB by including some drivers. The National Instruments manuals explain this. Variables ending with % are integers, and variables ending with $ are strings, in accordance with the practice in some BASIC languages. The entire system is of course compatible with any hardware and software based on IEEE-488.2, and any programming language can be used if it can be linked to GPIB.

INTERFACE

X-Stream DSO interface capabilities include the following IEEE 488.1 definitions:

AH1	Complete Acceptor Handshake	**DC1**	Complete Device Clear Function
SH1	Complete Source Handshake	**DT1**	Complete Device Trigger
L4	Partial Listener Function	**PP1**	Parallel Polling: remote configurable
T5	Complete Talker Function	**C0**	No Controller Functions
SR1	Complete Service Request Function	**E2**	Tri-state Drivers
RL1	Complete Remote/Local Function		

ADDRESS

Every device on the GPIB has an address. To address the X-Stream DSO, set the remote control port to **GPIB** by means of the scope's front panel UTILITIES button and on-screen menus.

If you address the X-Stream DSO to talk, it will remain in that state until it receives a universal untalk command (UNT), its own listen address (MLA), or another oscilloscope's talk address.

If you address the X-Stream DSO to listen, it will remain configured to listen until a universal unlisten command (UNL), or its own talker address (MTA), is received.

To avoid conflicts, use the general Unlisten and Untalk commands before setting up the talker and listener states.

The following characters are used in GPIB to control talking and listening:

ASCII 63 = ?	General Unlisten
ASCII 95 = _	General Untalk
ASCII 32 = Space	Base Listen Address
ASCII 64 = @	Base Talk Address

To make an actual talk address and listen address, we have to add the GPIB address to the ASCII values of the base characters, to give the ASCII value of the new character. So a string of these commands looks like a random set of characters. Using named variables makes programs easier to understand. For example, if we have a DSO at GPIB address 4, and a PC at address 4, we construct the command strings as follows, for use later in the program.

```
UnListen$ = Chr$ (63) : UnTalk$ = Chr$(95)
BaseListen% = 32 : BaseTalk% = 64 : DSOAddress% = 4
DSOListen$ = Chr$ (BaseListen% + DSOAddress%)
DSOTalk$ = Chr$ (BaseTalk% + DSOAddress%)
```

If the PC is at address 0, we can also write

```
PCTalk$ = Chr$ (BaseTalk%) : PCListen$ = Chr$(BaseListen%)
```

Finally:

```
DSOListenPCTalk$ = UnListen$ + UnTalk$ + PCTalk$ + DSOListen$
DSOTalkPCListen$ = UnListen$ + UnTalk$ + PCListen$ + DSOTalk$
```

These last two strings, once defined, can be used in programs for sending to the DSO.

GPIB SIGNALS

The GPIB system consists of 16 signal lines and eight ground or shield lines. The signal lines are divided into three groups:

Data Lines: These eight lines, usually called DIO1 through DIO8, carry both program and interface messages. Most of the messages use the 7-bit ASCII code, in which case DIO8 is unused.

Handshake Lines: These three lines control the transfer of message bytes between devices. The process is called a three-wire interlocked handshake, and it guarantees that the message bytes on the data lines are sent and received without transmission error.

Interface Management Lines: These five lines manage the flow of information across the interface:

- **ATN (ATteNtion):** The controller drives the ATN line true when it uses the data lines to send interface messages such as talk and listen addresses or a device clear (DCL) message. When ATN is false, the bus is in data mode for the transfer of program messages from talkers to listeners.
- **IFC (InterFace Clear):** The controller sets the IFC line true to initialize the bus.
- **REN (Remote ENable):** The controller uses this line to place devices in remote or local program mode.
- **SRQ (Service ReQuest):** Any device can drive the SRQ line true to asynchronously request service from the controller. This is the equivalent of a single interrupt line on a computer bus.

- **EOI (End Or Identify):** This line has two purposes: The talker uses it to mark the end of a message string. The controller uses it to tell devices to identify their response in a parallel poll (discussed later in this section).

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. 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.

USE IEEE 488.1 STANDARD MESSAGES

The IEEE 488.1 standard 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 with the interface management lines of the GPIB, usually with ATN true.

All these messages except GET are executed immediately upon receipt.

The command list in Part Two of this manual does not contain a command for clearing the input or output buffers or for setting the oscilloscope to the remote state.

NOTE: In addition to the IEEE 488.1 interface message standards, the IEEE 488.2 standard specifies certain standardized program messages, i.e., command headers. They are identified with a leading asterisk * and are listed in the System Commands section.

This is because such commands are already specified as IEEE 488.1 standard messages. Refer to the GPIB interface manual of the host controller as well as to its support programs, which should contain special calls for the execution of these messages.

The following description covers those IEEE 488.1 standard messages that go beyond mere reconfiguration of the bus and that have an effect on X-Stream DSO operation.

DEVICE CLEAR

In response to a universal Device CLear (DCL) or a Selected Device Clear message (SDC), the X-Stream DSO 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 X-Stream DSO to arm the trigger system, and is functionally identical to the *TRG command.

REMOTE ENABLE

X-Stream DSOs do not lock out any local controls when placed in the remote state, or in RWLS. It always accepts remote as well as local control inputs (unless you turn off remote control capability in Utilities→ Remote.)

INTERFACE CLEAR

The InterFace Clear message (IFC) initializes the GPIB but has no effect on the operation of the X-Stream DSO.

NOTE: To illustrate the GPIB programming concepts, a number of examples are included here, written in a similar way to BASIC. It is assumed that the controller is IBM-PC compatible, and that it is equipped with a National Instruments GPIB interface card. Nevertheless, GPIB programming with other languages such as C or Pascal is quite similar. If you're using another type of computer or GPIB interface, refer to the interface manual for installation procedures and subroutine calls.

This procedure refers to the installation and configuration of a GPIB card under the DOS operating system. More recent operating systems (Windows 95, 98, ME, NT, 2000, XP, etc) generally use 'Plug 'n' Play' GPIB drivers, which are configured using an icon in the control panel.

CONFIGURE THE GPIB DRIVER SOFTWARE

Verify that the GPIB interface is properly installed in the computer. If it is not, follow the interface manufacturer's installation instructions. In the case of the National Instruments interface, it is possible to modify the base I/O address of the board, the DMA channel number, and the interrupt line setting using switches and jumpers. In the program examples below, default positions are assumed.

Connect the X-Stream DSO to the computer with a GPIB interface cable.

Set the GPIB address to the required value. The program examples assume a setting of **4**.

The host computer requires an interface driver that handles the transactions between the operator's programs and the interface board.

In the case of the National Instruments interface, the installation procedure will:

- Copy the GPIB handler GPIB.COM into the boot directory.
- Modify the DOS system configuration file CONFIG.SYS to declare the presence of the GPIB handler.
- Create a sub-directory called GPIB-PC, and install in GPIB-PC a number of files and programs useful for testing and reconfiguring the system and for writing user programs.

The following files in the sub-directory GPIB-PC are particularly useful:

IBIC.EXE allows interactive control of the GPIB by means of functions entered at the keyboard. Use of this program is highly recommended to anyone unfamiliar with GPIB programming or with the X-Stream DSO's remote commands.

IBCONF.EXE is an interactive program that allows inspection or modification of the current settings of the GPIB handler. To run IBCONF.EXE or a later program version, refer to the National Instruments manual.

NOTE: In the program examples in this section, it is assumed that the National Instruments (NI) GPIB driver GPIB.COM is in its default state, i.e., that you have not modified it with IBCONF.EXE. This means that the interface board can be referred to by the symbolic name 'GPIB0' and that devices on the GPIB bus with addresses between 1 and 16 can be called by the symbolic names 'DEV1' to 'DEV16'. If you have a National Instruments PC2 interface card rather than PC2A, you must run IBCONF to declare the presence of this card rather than the default PC2A. Later boards from National Instruments, and boards from other vendors, will require their own software, though NI has achieved good compatibility with its earlier systems, and older software will often work with newer boards.

MAKE SIMPLE TRANSFERS

For a large number of remote control operations, it is sufficient to use just three different subroutines (IBFIND, IBRD and IBWRT) provided by National Instruments. The following complete program reads the timebase setting of the X-Stream DSO and displays it on the terminal:

```
GPIB:    This line holds the INCLUDE for the GPIB routines

Find:    DEV$ = "DEV4"                ‘  Because the DSO has been set at
         address 4.

         CALL IBFIND (DEV$, SCOPE%)   ‘  Find the DSO: label it "SCOPE%".

Send:    CMD$ = "TDIV?"               ‘  Make a query string about the
                                        time base speed.

         CALL IBWRT (SCOPE%, CMD$)    ‘  Send the string to the DSO.

Read:    CALL IBRD (SCOPE%, RD$)      ‘  Read the response from the DSO.

         PRINT RD$                    ‘  Print the response string.

         END
```

Explanation

GPIB: This line or lines must hold the link between the programming language and the National Instruments GPIB functions and drivers.

Find: Open the device DEV4 and associate with it the descriptor SCOPE%. All I/O calls after that will refer to SCOPE%. The default configuration of the GPIB handler recognizes DEV4 and associates with it a device with the GPIB address 4.

Send: Prepare the command string TDIV? and transfer it to the oscilloscope. The command instructs the oscilloscope to respond with the current setting of the timebase.

Read: Read the response of the oscilloscope and place it into the character string RD$.

When running this sample program, the X-Stream DSO will automatically be set to the remote state when IBWRT is executed, and will remain in that state. Here is a slightly modified version of the sample program that checks if any error occurred during GPIB operation:

```
GPIB:     ‘ This line should hold the INCLUDE for the GPIB routines
Address:  DEV$ = “DEV4”
Find:     CALL IBFIND (DEV$, SCOPE%)    ‘ Find the DSO.
Send:     CMD$ = “TDIV?”  ‘  Time base query
          CALL IBWRT (SCOPE%, CMD$)     ‘ Send the string to the DSO.
ErrorS:        IF IBSTA% < 0 THEN PRINT “WRITE ERROR =” ; IBERR% : END
Read:     CALL IBRD (SCOPE%, RD$)       ‘ Try to read a string from the
          DSO.
ErrorR:           IF IBSTA% < 0 THEN PRINT “READ ERROR =” ; IBERR% : END
          PRINT RD$


190       END
```

The GPIB status word IBSTA%, the GPIB error variable IBERR% and the count variable IBCNT% are defined by the GPIB handler and are updated with every GPIB function call. IBSTA% is negative if there is an error, while IBERR% shows what type of error has occurred. IBCNT% is the number of bytes transferred. Refer to the National Instruments manual for details. The sample program above would report an error if the GPIB address of the oscilloscope was set to a value other then 4. When you are sending remote commands to the DSO, the IBSTA% and IBERR% don’t necessarily indicate that the scope accepted the string, but merely that the string was correctly transmitted to the DSO to interpret. To ensure that commands were valid, and weren’t rejected by the DSO, use the Remote Control Assistant.

USE ADDITIONAL DRIVER CALLS

IBLOC is used to execute the IEEE 488.1 standard message Go To Local (GTL); i.e., it returns the oscilloscope to the local state. The programming example above illustrates its use.

IBCLR executes the IEEE 488.1 standard message Selected Device Clear (SDC).

IBRDF and **IBWRTF**, respectively, allow data to be read from GPIB to a file, and written from a file to GPIB. Transferring data directly to or from a storage device does not limit the size of the data block, but may be slower than transferring to the computer memory.

IBRDI and IBWRTI allow data to be read from GPIB to an integer array, and written from integer array to GPIB. Since the integer array allows storage of up to 64 kilobytes (in BASIC), IBRDI and IBWRTI should be used for the transfer of large data blocks to the computer memory, rather than IBRD or IBWRT, which are limited to 256 bytes by the BASIC string length. Note that IBRDI and IBWRTI only exist for BASIC, since for more modern programming languages, such as C, the functions called IBRD and IBWRT are far less limited in data block size.

IBTMO can be used to change the timeout value during program execution. The default value of the GPIB driver is 10 seconds — for example, if the oscilloscope does not respond to an IBRD call, IBRD will return with an error after the specified time.

IBTRG executes the IEEE 488.1 standard message Group Execute Trigger (GET), which causes the X-Stream DSO to arm the trigger system.

National Instruments supplies a number of additional function calls. In particular, it is possible to use the so-called board level calls, which allow a very detailed control of the GPIB.

NOTE: 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.

MAKE SERVICE REQUESTS

When an X-Stream DSO is used in a remote application, events often occur asynchronously, i.e., at times that are unpredictable for the host computer. The most common example of this is a trigger wait after the oscilloscope is armed: 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. Continuous status bit polling is described in more detail below. For a complete explanation of status bits, refer to Chapter 5.

Perhaps a more efficient way of detecting events occurring in the oscilloscope is the use of the 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. 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. In the absence of real interrupt service routines, the use of SRQ may not be very advantageous.

In the default state, after power-on, the Service ReQuest is disabled. You enable SRQ by setting the Service Request Enable register with the command "*SRE" and by specifying which event should generate an SRQ. The X-Stream DSO will interrupt the controller as soon as 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.

Example: To assert SRQ in response to "new signal acquired." 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. Thus the command INE 5 is needed:

```
CMD$ = "INE 5 ; *SRE 1"
CALL IBWRT (SCOPE%, CMD$)
```

Take Instrument Polls

You can regularly monitor state transitions within the oscilloscope by polling selected internal status registers. There are four basic polling methods you can use to detect the occurrence of a given event: continuous, serial, parallel, and *IST. By far the simplest of these is continuous polling. The others are appropriate only when interrupt-service routines (servicing the SRQ line) are supported, or multiple devices on GPIB require constant monitoring. To emphasize the differences between the methods, described below, the same example (determining whether a new acquisition has taken place) is used in each case.

DO 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, i.e., value 1) is non-zero, indicating that a new waveform has been acquired. Reading INR clears this at the same time, so that there is no need for an additional clearing action after a non-zero value has been detected. The command CHDR OFF instructs the oscilloscope to omit any command headers when responding to a query, simplifying the decoding of the response. The oscilloscope will then send “1” instead of “INR 1”:

```
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%
```

TAKE A SERIAL POLL

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.

In the following example, the command INE 1 enables the event "new signal acquired" to be reported in 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, and &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 will only exit if there was a timeout or if the oscilloscope (SCOPE%) generated SRQ. The additional function call IBRSP fetches the value of the status byte, which may be further interpreted. For this to work properly, the value of "Disable Auto Serial Polling" must be set to "off" in the GPIB handler (use IBCONF.EXE to check).

```
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%
```

Board-level function calls can deal simultaneously with several oscilloscopes attached to the same interface board. Refer to the National Instruments manual.

NOTE: 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.

DO A PARALLEL POLL

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.

In the following example, the command INE 1 enables the event "new signal acquired" in the INR to be reported to the INB bit of the status byte STB. The PaRallel poll Enable register (PRE) determines which events will be summarized in the IST status bit. The command *PRE 1 enables the INB bit to set the IST bit whenever it is itself set. Once parallel polling has been established, the parallel-poll status is examined until a change on data bus line DIO2 takes place.

Stage 1

1. Enable the INE and PRE registers
2. Configure the controller for parallel poll
3. Instruct the X-Stream DSO to respond on data line 2 (DIO2) with 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$)
```

Stage 2

4. Parallel poll the oscilloscope until DIO2 is set with these commands:

```
Do
CALL IBRPP (BRD0%, PPR%)
Loop Until (PPR% AND &H2) = 2
```

Stage 3

5. Disable parallel polling (hex 15) and clear the parallel poll register with 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$):
```

In the above example, board-level GPIB function calls are used. It is assumed that the controller (board) and the X-Stream DSO (device) are located at addresses 0 and 4, respectively.

The listener and talker addresses for the controller and the X-Stream DSO are:

LOGIC DEVICE	LISTENER ADDRESS	TALKER ADDRESS
External Controller	32 (ASCII<space>)	64 (ASCII @)
X-Stream DSO	32 + 4 = 36 (ASCII $)	64 + 4 = 68 (ASCII D)

PERFORM AN *IST POLL

You can also read the state of the Individual STatus bit (IST) returned in parallel polling by sending the *IST? query. To enable this poll mode, you must initialize the X-Stream DSO as 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 to be reported to the INB bit of the status byte STB. The command *PRE 1 enables the INB bit to set the IST bit whenever it is set. 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:

```
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 DSO series, even between Waverunner DSOs and WavePro DSOs. In X-Stream DSOs, these effects may be even more pronounced than in previous scopes, for several reasons. Firstly, X-Stream DSOs are faster than our earlier scopes. Secondly, X-Stream DSOs support faster interfaces. That is, the standard network interface is 100Base-T instead of 10Base-T. Secondly, and more significantly, for the most part our earlier scope series processed remote commands sequentially. That is, they would not start executing any command until execution of the previous one had finished. This meant that many operations were automatically synchronous by default, and remote control programs which did not use status bytes or *OPC?, may have worked "by luck." That is not the case in X-Stream DSOs. Since they use multitasking , you must be much more diligent in programming.

Most timing and synchronization problems are related to changing acquisitions, or the completion of analysis after an acquisition occurs. For example, if you change the offset of channel 1 while the scope is in Auto trigger mode, and then you use the PAVA? query to read a parameter computed on channel 1, in the older scopes, you would almost always get the results after the data has been acquired with the new offset. However, in X-Stream DSOs, 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 of ensuring that your program gives the correct results when controlling the scope remotely. To simplify the synchronization issue, in most cases you can put the scope into single trigger mode. Then you can use either the status registers available in the scope, or the *OPC? query and the WAIT command to detect completion when the acquisition and any processing are done.

Note that when you arm the scope by sending the TRMD SINGLE command, the scope will automatically perform any necessary calibrations before actually starting to acquire data. These calibrations may take several seconds, so if you query the status immediately after sending TRMD SINGLE, you need to have the GPIB (or remote) timeout set to be at least 10 seconds to prevent a timeout before getting the correct results. Calibrations are performed if your program changes some control settings (e.g., volts/div, number of active channels, etc.) or if the temperature of the scope has changed significantly. You can disable the calibrations by sending the AUTO_CALIBRATE OFF command. However, the scope performance may be degraded if the temperature changes and it does not get a chance to self calibrate. A calibration of the X-Stream DSO can be "forced" by issuing a *CAL? command. This technique allows you to control the timing of calibrations so that they will not interfere with the acquisition of important data.

One case when you may need to use "normal" or "auto" trigger mode is the accumulation of many acquisitions for functions such as averaging or histogramming. In this case, it is best to stop the acquisitions, set up the scope, and then set the trigger mode to NORMAL to acquire the data. (A possible alternative is to use sequence mode. It is faster, but does require that you know how many acquisitions to accumulate. That number can be specified and captured in sequence mode).

STATUS REGISTERS

Status registers store a record of events and conditions that occur inside the DSO. Some of the events recorded are: New data has been acquired; Processing has completed; Hardcopy has completed; An error has occurred; etc. The programmer can use the registers to sense the condition of the instrument by polling them until the desired status bit has been set. A status register can be polled by querying its associated remote command (e.g., *STB, INR?, *ESR, etc.). Alternatively, with GPIB, the scope can request service from the controller by using the mask registers to select the events of interest.

The following diagram (Figure 1) shows the steps necessary to acquire data using the status registers for synchronization.

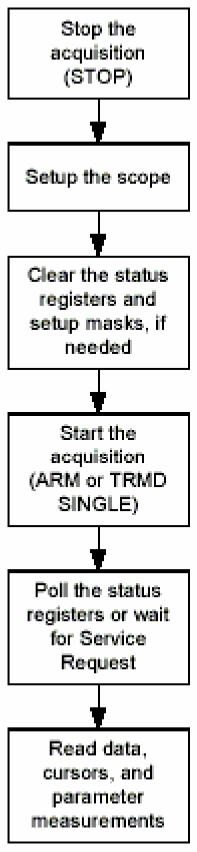
Stop the acquisition (STOP)
Setup the scope
Clear the status registers and setup masks, if needed
Start the acquisition (ARM or TRMD SINGLE)
Poll the status registers or wait for Service Request
Read data, cursors, and parameter measurements

Figure 1

If the data have already been acquired and you want to do further analysis (math, parameters, cursors) on it, you can proceed as shown in Figure 2:

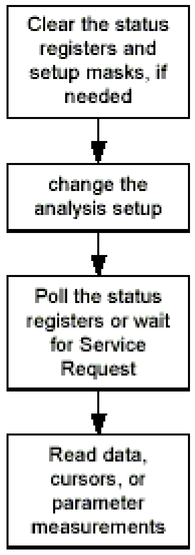
Clear the status registers and setup masks, if needed
change the analysis setup
Poll the status registers or wait for Service Request
Read data, cursors, or parameter measurements

Figure 2

For more details on Status registers, see Chapter 5.

SYNCHRONZING WITH *OPC? AND WAIT

The *OPC? query returns a 1 when the previous commands have finished. Therefore, you can use this query with the WAIT command to synchronize the scope with your controller, using the steps shown in Figure 3 below. The WAIT command waits for the acquisition to complete, but it does not wait for the processing. The WAIT command allows you to specify an optional timeout so that if the scope does not trigger, your program will not hang. However, if you use the timeout, it is strongly advised to subsequently check the status registers to ensure that the scope actually triggered and that any processing has completed.

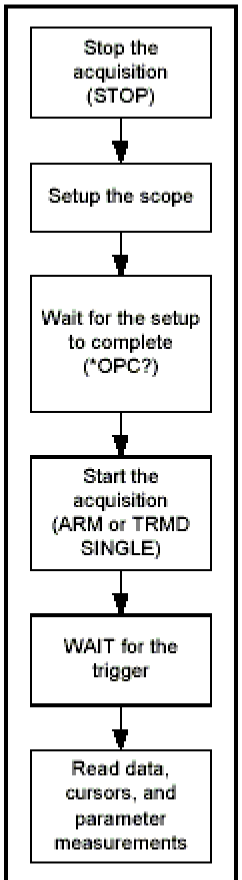
Stop the acquisition (STOP)
Setup the scope
Wait for the setup to complete (*OPC?)
Start the acquisition (ARM or TRMD SINGLE)
WAIT for the trigger
Read data, cursors, and parameter measurements

Figure 3

§ § §

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CHAPTER THREE: *Control by LAN*

In this chapter, see how to

- ***Control X-Stream by LAN***
- ***Simulate GPIB messages using LAN***

Introduction

- ➢ The Ethernet connection (10Base-T and 100Base-T) allows you to control the instrument over a network, or through a direct connection between the oscilloscope and a computer. The connection is made through the Ethernet port located at the rear of the oscilloscope.
- ➢ This chapter introduces the basic capabilities for control of the instrument over the Ethernet interface.

This manual gives a complete description of the remote control commands. The commands apply to control of the oscilloscope via Ethernet and GPIB.

Implementation Standard

To the greatest extent possible, these remote commands conform to the IEEE 488.2[1] standard, which may be considered an extension of the IEEE 488.1 standard, dealing mainly with electrical and mechanical issues. When using LAN, the strings of data that are to be sent to the instrument must be preceded by the requisite header.

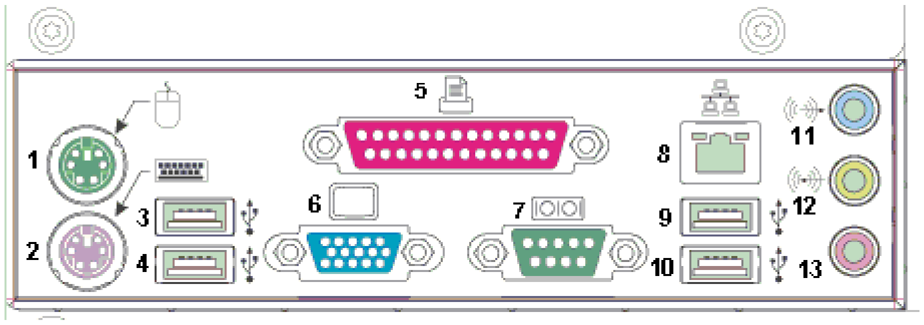
Connections

The oscilloscope can be connected to the computer via Ethernet, using a TCP/IP network protocol.

This connection can be made through a **network** (using a hub, switch, etc,) with a **straight through** network cable, or between the oscilloscope's Ethernet interface and a **computer** using a **crossover** network cable.

Connecting the Instrument to its Host

This section describes connecting the instrument to the host PC or network over the standard 10Base-T/100Base-T Ethernet. Windows NT and Windows 95 operating systems are supported.



1 ANSI/IEEE Std. 488.2–1987, *IEEE Standard Codes, Formats, Protocols, and Common Commands*. The Institute of Electrical and Electronics Engineers Inc., 345 East 47th Street, New York, NY 10017, USA.

Scope Rear Panel

The LAN connector is shown in the illustration above (item 8).

- Supports IEEE 802.3 Ethernet standards
- Supports 10Base-T and 100Base-T

Ethernet Connection

The instrument operates over a standard 10Base-T/100Base-T Ethernet connection. The instrument can be plugged into a network or operated from a direct connection to a host computer. A different type of cable is required for each of these connections. For a direct connection to the PC, a crossover cable is required, whereas the network connection is made using a straight cable.

Headers for LAN Data Transfers

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

Byte #	Purpose
0	Operation
1	Header Version
2	Spare (reserved for future expansion)
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 ‘Operation’ bits and meanings are:

D7	D6	D5	D4	D3	D2	D1	D0
DATA	REMOTE	LOCKOUT	CLEAR	SRQ	Reserved	Reserved	EOI

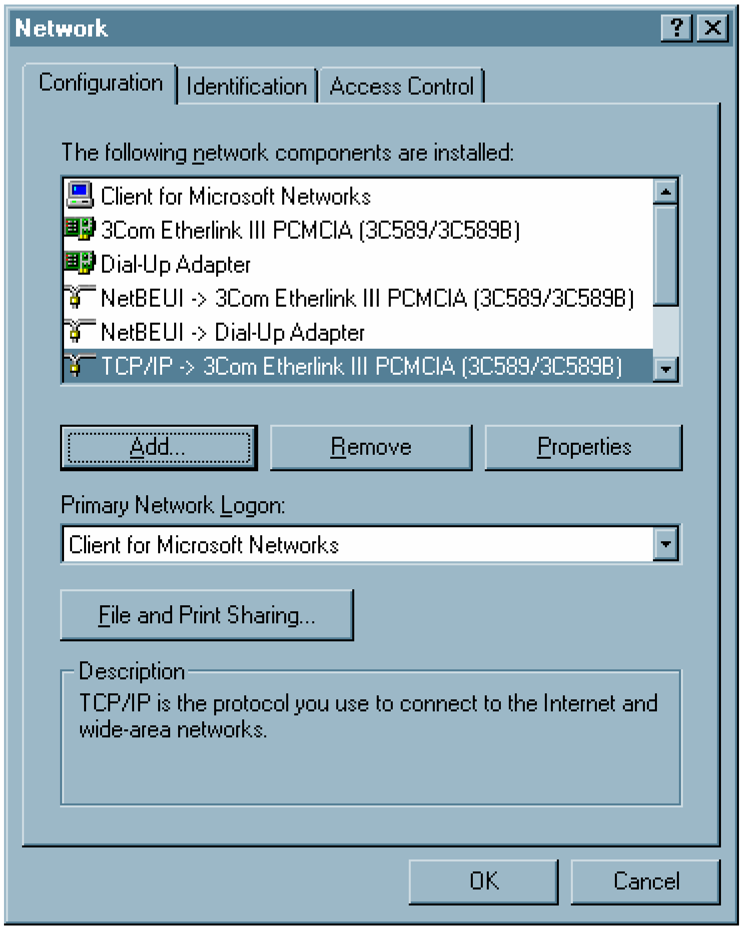
DATA BIT	MNEMONIC	PURPOSE
D7	DATA	Data block (D0 indicates termination with/without EOI)
D6	REMOTE	Remote Mode
D5	LOCKOUT	Local Lockout (Lockout front-panel)
D4	CLEAR	Device Clear (if sent with data, clear occurs before data block is passed to parser)
D3	SRQ	SRQ (Device to PC only)
D2..D1	Reserved	Reserved for future expansion
D0	EOI	Block terminated in EOI Logic "1" = use → EOI terminator Logic "0" = no EOI terminator

Note: ***The following examples assume that the host PC operates from Windows™ 95. The connection procedure for Windows NT is similar.***

Manual Setting of LAN Address

If you do need to set an address for the instrument, go into Windows and perform the usual operations for setting an address. **Before establishing a direct connection between the oscilloscope and the host computer, the PC must first be properly configured. A specific TCP/IP address must be assigned — known as "static addressing." But this means that the PC *cannot* be set up to obtain its IP address from a DHCP server. To set the host PC's static address with Windows 95:**

1. Select Start → Settings → Control Panel.
2. Double-click the Network icon in the Control Panel. A network dialog box similar to this one appears:


Network

Configuration | Identification | Access Control

The following network components are installed:

- Client for Microsoft Networks
- 3Com Etherlink III PCMCIA (3C589/3C589B)
- Dial-Up Adapter
- NetBEUI -> 3Com Etherlink III PCMCIA (3C589/3C589B)
- NetBEUI -> Dial-Up Adapter
- TCP/IP -> 3Com Etherlink III PCMCIA (3C589/3C589B)

Add... | Remove | Properties

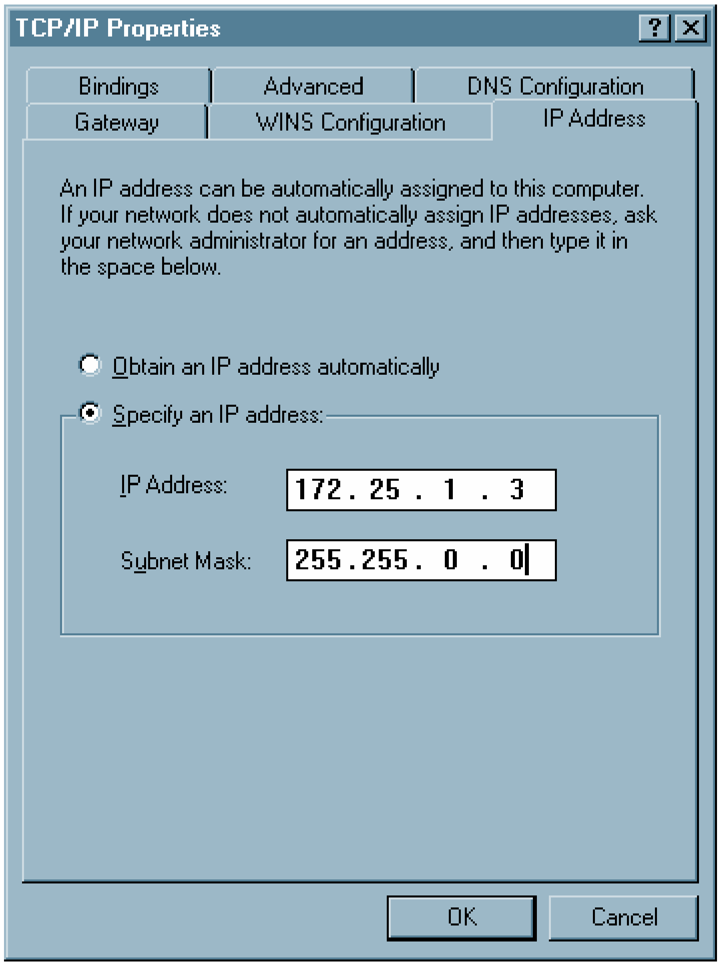
Primary Network Logon: Client for Microsoft Networks

File and Print Sharing...

Description
TCP/IP is the protocol you use to connect to the Internet and wide-area networks.

OK | Cancel

3. If the TCP/IP protocol is not listed, you will have to add it. Follow your operating system user guide to add the TCP/IP protocol and bind it to the Ethernet adapter.
4. Double-click the TCP/IP -> line. A dialog box similar to the one below appears. Select [✓ Specify an IP address:]



TCP/IP Properties

An IP address can be automatically assigned to this computer. If your network does not automatically assign IP addresses, ask your network administrator for an address, and then type it in the space below.

Obtain an IP address automatically [✓ Specify an IP address:]

IP Address: 172 . 25 . 1 . 3

Subnet Mask: 255 . 255 . 0 . 0

5. If this has already been selected, the computer's static address is set and nothing more needs to be done. Cancel out of the TCP/IP and network dialog boxes, and close the control panel.
6. If the address has not already been selected, fill in the IP address and subnet mask as shown above. The subnet mask for 172.25.x.x is 255.255.0.0. If the computer will not be plugged into a network, the above

address (or almost any address within the chosen subnet) will suffice. The only address that will not work is the same one as that of the oscilloscope to be controlled.

7. Now click OK in the TCP/IP Properties dialog box. Depending on the operating system and version, you may need to reboot the computer. If so, a dialog box should alert you to this.

Making Physical Connection

To make the physical connection between the oscilloscope and the host computer:

1. Connect the oscilloscope to the PC using a crossover cable (for direct connection).
2. Power the oscilloscope unit on.

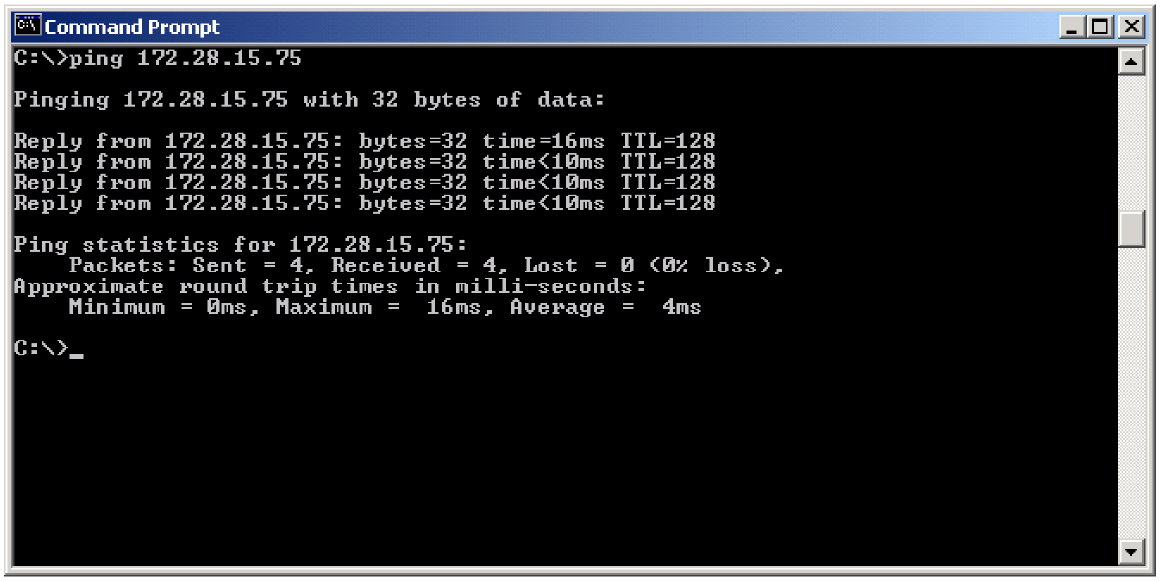
Note: ***If your PC does not have TCIP/IP, see your computer's User's Manual for installation instructions.***

Note: ***If you are making connection using the VCIP protocol, use this syntax:***
VICP::<scope's IP address>
For example, VICP::172.28.15.16

Verifying Connection

The physical connection and the PC's TCP/IP configuration can be verified using the "ping" command, available on both Windows™ 95 and Windows™ NT with TCP/IP network protocol installed. In order to check the network connection between the PC and the oscilloscope:

1. Start MS-DOS Prompt
2. Type ping <ip_address>, where <ip_address> is the static address assigned to the oscilloscope. The Command Prompt window on the next page illustrates the result of a successful "ping," with the Ethernet connection shown established. **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 PC'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:\>_
```

Network Connection

Check with your network administrator before connecting the oscilloscope to a network. Incorrect addresses on a network can cause both the network and the oscilloscope to behave strangely. However, a network connection ought to be as simple as plugging the oscilloscope into the network. *Proper connection can be verified by following the verification instructions in the previous section.*

If you are concerned mainly with system throughput, network connection is *not* recommended because the network traffic will slow down the oscilloscope's data transfer rate.

Note: The default Gateway is assigned as "172.25.0.1". Unless your network has this Gateway available, you must ensure that the computer and the oscilloscope are on the same subnet.

Changing IP Address Once the IP address is changed, the unit will no longer respond to the original address.

If the network settings are unknown or accidentally set to invalid values, they can be recovered by following the procedure above.

Introduction to Software Tools

The instrument software tools allow you to develop your own application specific programs quickly and easily. These tools are based on *ActiveDSO™.* The files for all the software described here are to be found on the CD-ROM and on LeCroy's Web site at http://www.lecroy.com/tm/library/software/.

ActiveDSO Based on Microsoft's ActiveX control technology, *ActiveDSO* gives leverage to widely available Microsoft software tools, and makes programming within the Microsoft environment easier. *ActiveDSO* simplifies the computer's interface with the instrument, and simplifies programming within Visual C++, Visual Basic, or any other ActiveX compatible applications. For example, Microsoft Excel can even be used to control and retrieve data directly from the instrument. This tool becomes part of the target application and provides seamless access to the full power of the instrument.

Using ActiveDSO

ActiveDSO is highly suitable for fast program development in the Microsoft environment. This program is a control of ActiveX, the software technology developed by Microsoft as a subset of its COM model.

ActiveDSO facilitates programming with the instrument by providing a ready interface between the instrument and the host computer. Programs such as Visual C++, Visual Basic, or Visual Basic for Applications (VBA) can be used under remote control without concern for interfacing complications. ActiveDSO acts as the key design structure allowing effective integration of software from the different manufacturers supporting ActiveX containment.

CONTROL INSTANTIATION

This ActiveX component can be instantiated more than once by using the Visual Basic function CreateObject. Once the object is created, invoking the connection method will initialize it. ActiveDSO enables control of the instrument from a variety of PC desktop applications. The complexities of programming with Ethernet are fully encapsulated in this control. For example, with less than 10 lines of VBA code in an Excel macro the spreadsheet can recover pre-scaled waveform data from the X-Stream DSO (see the on-line Excel example in ActiveDSO).

ActiveDSO control can be used in two fundamental ways:

1. As a visible object embedded in an OLE automation compatible client (PowerPoint, for example) showing a captured instrument display image. See the Embedded Control example below for more details.
2. As an invisible object accessed through a scripting language (VBA, for example) to remotely control the instrument. See VBA example below for more details.

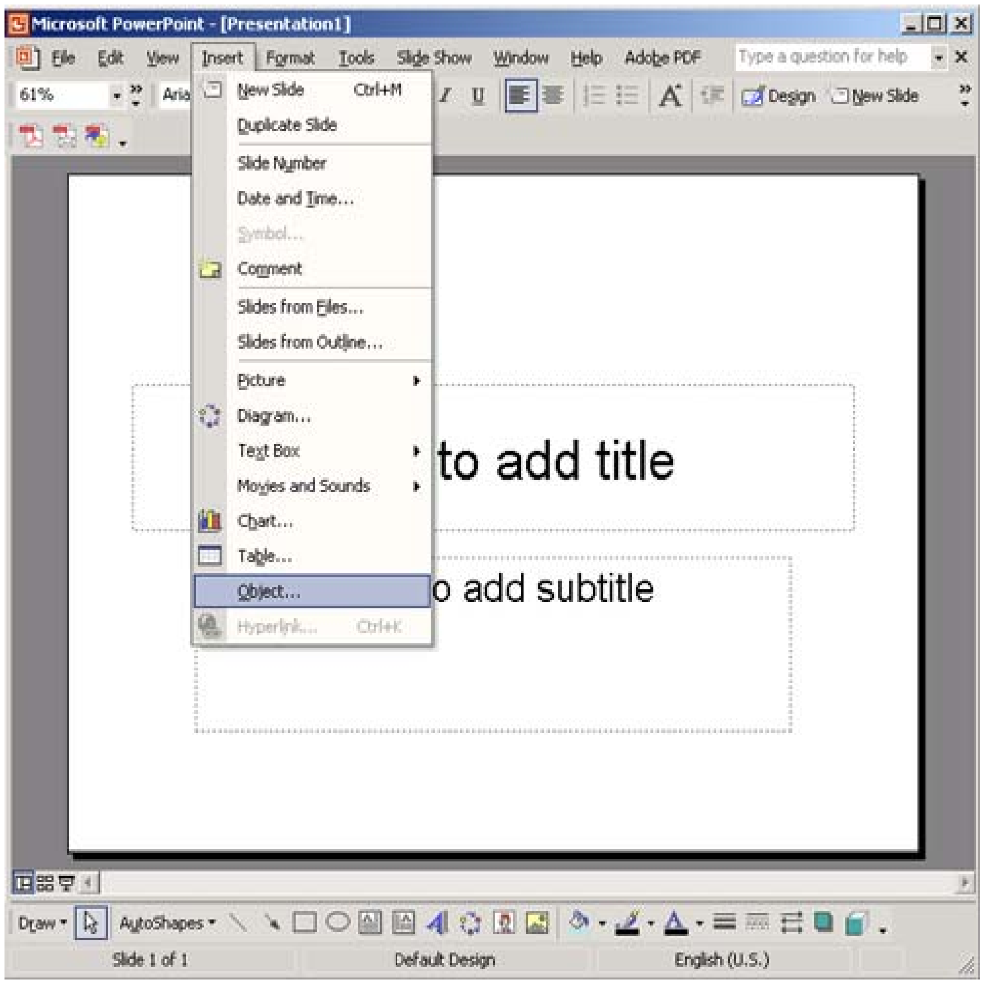
The ActiveDSO control may be embedded in any ActiveX containment-capable client, and may be used manually without need of any programming or scripting.

***Example:* PowerPoint**This example shows the control being embedded in a Microsoft PowerPoint slide. The waveform captured by the instrument can be easily imported into PowerPoint with just a few mouse clicks:

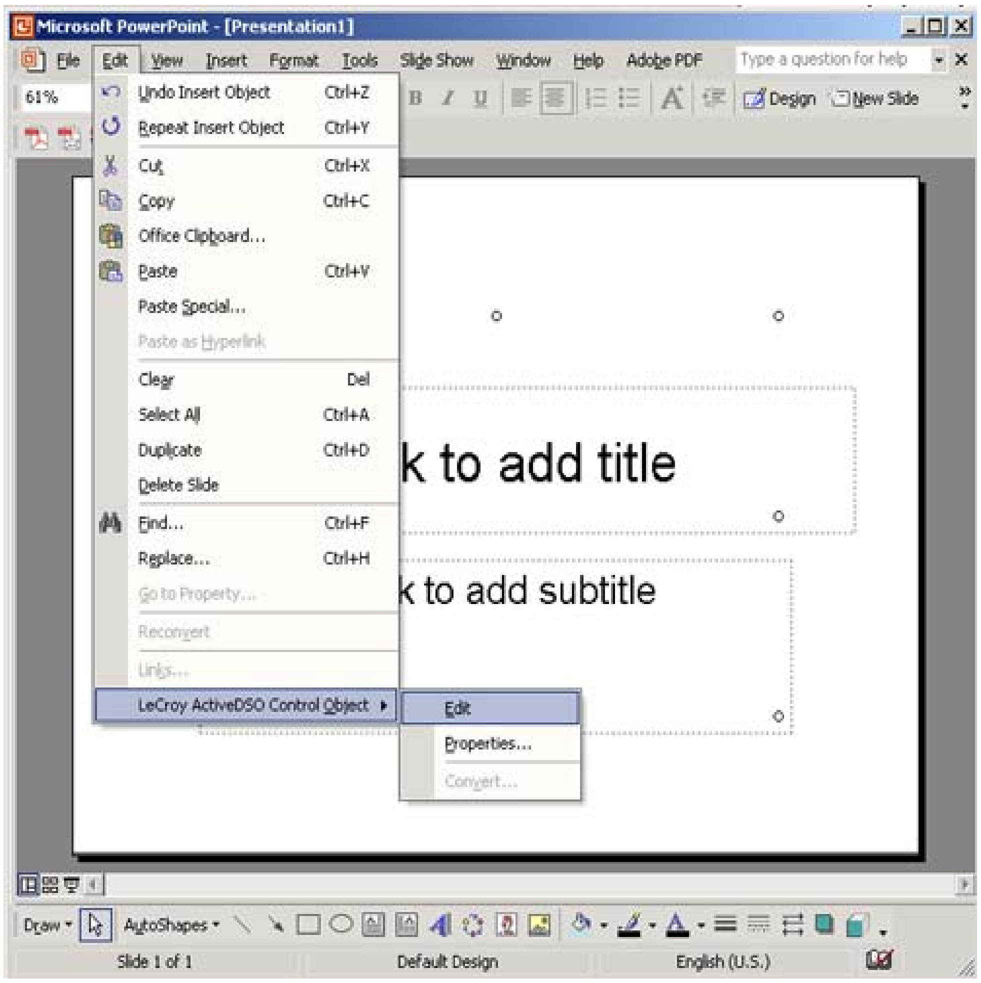
1. Ensure that the ActiveDSO files from the CD-ROM are installed on the PC.
2. Verify that the PC and instrument are properly connected to the Ethernet.
3. Open a new blank presentation in PowerPoint.

Note: This example assumes that PowerPoint 2002 is being used. Earlier (or Later) versions may not behave in the same manner.

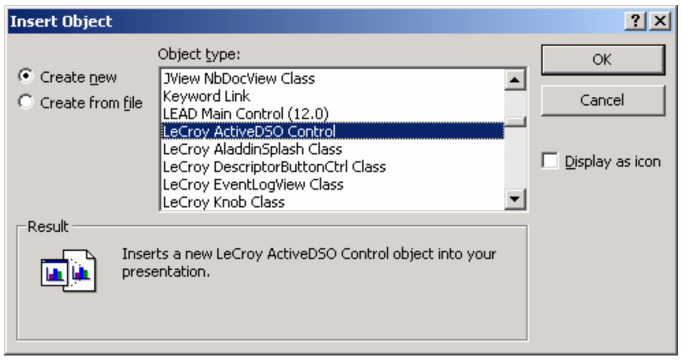
4. Select **Insert**, then **Object**, as shown here:



5. From the pop-up window, select **LeCroy ActiveDSO Control**, as shown here:



6. From the Edit menu, select **LeCroy ActiveDSO Control Object**, then **Edit**::


Insert Object

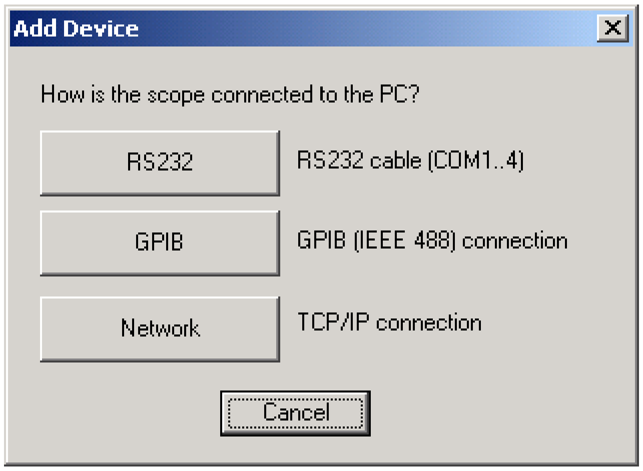
Create new
Create from file

Object type:
JView NbDocView Class
Keyword Link
LEAD Main Control (12.0)
LeCroy ActiveDSO Control
LeCroy AladdinSplash Class
LeCroy DescriptorButtonCtrl Class
LeCroy EventLogView Class
LeCroy Knob Class

Result
Inserts a new LeCroy ActiveDSO Control object into your presentation.

7. Right-click the object and select **Make Connection**.

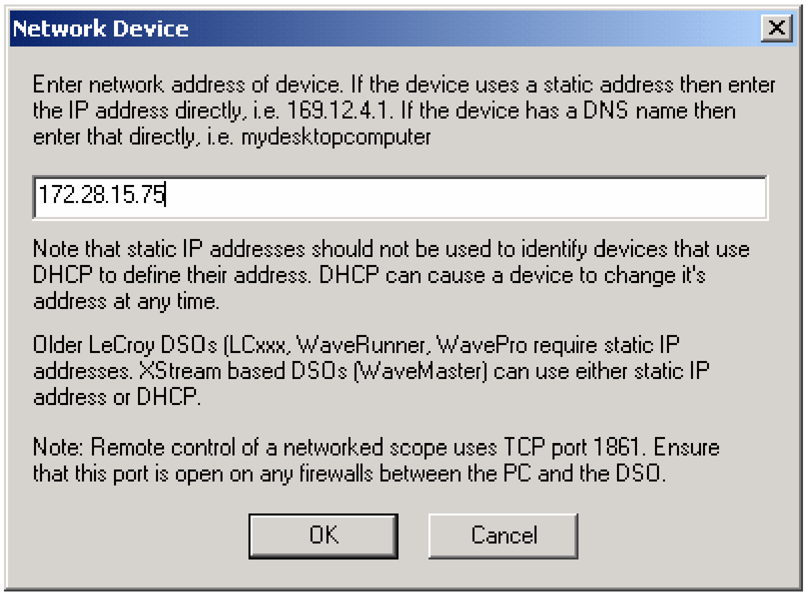
8. Select **Network TCP/IP connection**, as shown here ("scope" = WaveMaster):


Add Device

How is the scope connected to the PC?

RS232	RS232 cable (COM1..4)
GPIB	GPIB (IEEE 488) connection
Network	TCP/IP connection

9. Enter the instrument's IP address and click **OK**.



Enter network address of device. If the device uses a static address then enter the IP address directly, i.e. 169.12.4.1. If the device has a DNS name then enter that directly, i.e. mydesktopcomputer

172.28.15.75

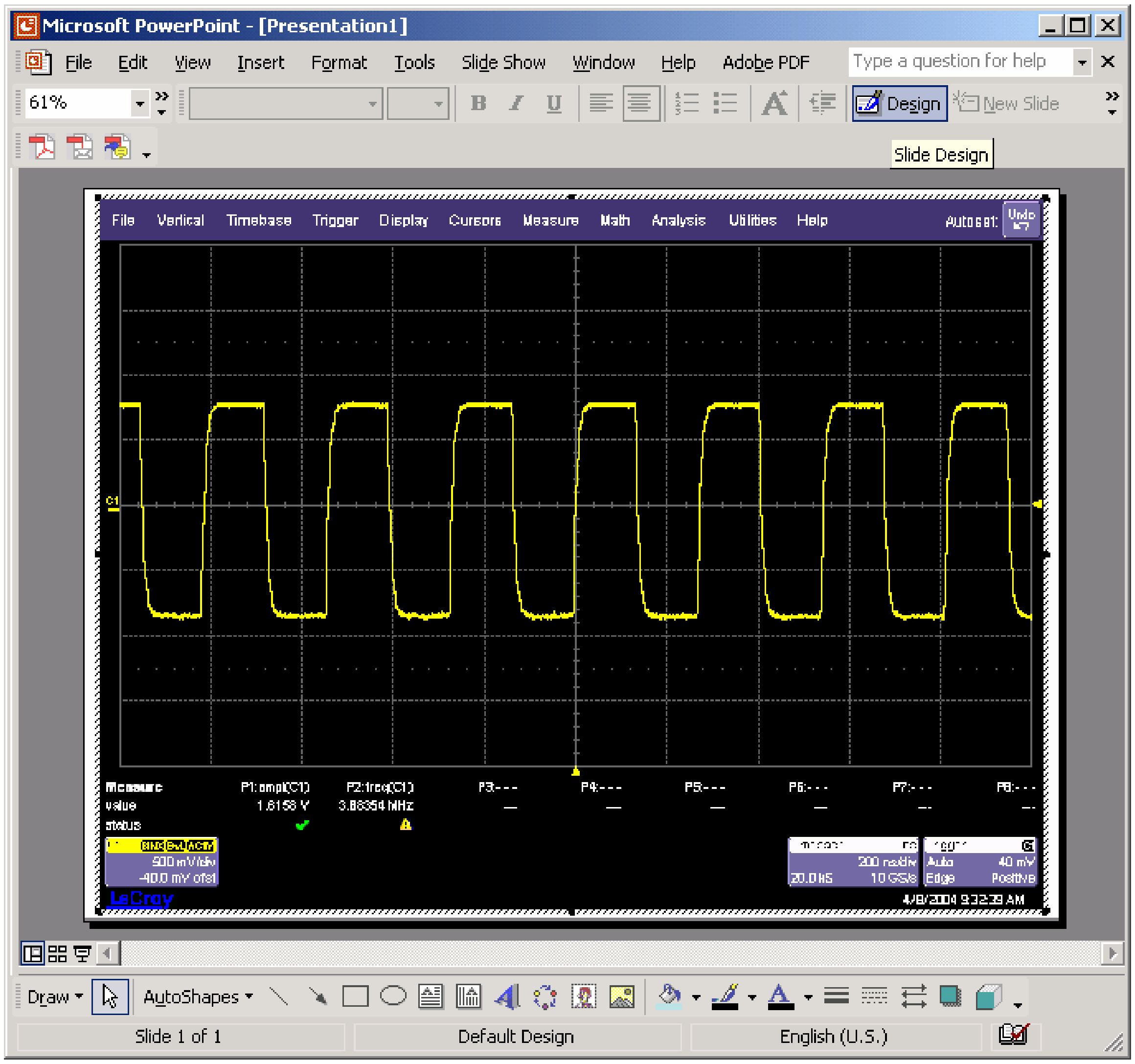
Note that static IP addresses should not be used to identify devices that use DHCP to define their address. DHCP can cause a device to change it's address at any time.

Older LeCroy DSOs (LCxxx, WaveRunner, WavePro require static IP addresses. XStream based DSOs (WaveMaster) can use either static IP address or DHCP.

Note: Remote control of a networked scope uses TCP port 1861. Ensure that this port is open on any firewalls between the PC and the DSO.

The address can also be specified in URL form, or 127.0.0.1 if you are running the controlling application on the instrument.

10. Right-click the object again and select the **Refresh Image** menu item. A captured waveform will be displayed similar to the one shown here:


Microsoft PowerPoint - [Presentation1]
File Edit View Insert Format Tools Slide Show Window Help Adobe PDF
Type a question for help
61%
Design New Slide
Slide Design
File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
Measure P1:ampl(C1) P2:freq(C1) P3:--- P4:--- P5:--- P6:--- P7:--- P8:---
value 1.6158 V 3.88354 MHz
status
500 mV/div
-40.0 mV ofst
200 ns/div
20.0 kS 10 GS/s
Auto 40 mV
Edge Positive
4/8/2004 9:32:39 AM
Draw AutoShapes
Slide 1 of 1
Default Design
English (U.S.)

Instrument's captured waveform imported into PowerPoint

Once the ActiveDSO object has been properly set within the application, a macro script can be created, utilizing an object method such as WriteString() to send DISP ON, C1:TRA ON, TRMD. Then RefreshImage() method can be used to update the screen.

Example:

VBA

VBA is the programming language built in to many of the more recent Windows applications. It is a subset of Visual Basic that makes using OLE Automation Servers and ActiveX Controls very simple. The following VBA subroutine demonstrates how easy it is to connect to an instrument and send remote commands to it.

```
Sub LeCroyDSOTest()

Dim dso As Object

     Set dso = CreateObject("LeCroy.ActiveDSO.1")
     Call dso.AboutBox                          ' Present the control's About box
     Call dso.MakeConnection("IP:172.25.1.2")  ' Connect to the unit
     Call dso.WriteString("C1:VDIV 2", 1)      ' Setup C1 for 2 Volts/Div
     Call dso.WriteString("TRMD AUTO", 1)      ' Set the trigger mode to AUTO
End Sub
```

To enter the VBA editor in members of the Microsoft Office suite:

1. Select Tools → Macro → Visual Basic Editor menu item.
2. When the VBA window appears, select the Insert → Module menu item.
3. Copy the above example into the editor window that appears.

To execute:

4. Position the text cursor within the subroutine.
5. Either select the Run → Run Sub/UserForm or press function key F5.

Note: For more information, see the ActiveDSO on-line Help. On-line Help contains VisualC++ examples, and explanations of ActiveDSO Methods and Properties.

ActiveDSO This **ActiveX™** control enables LeCroy oscilloscopes to be **controlled by**, and to **exchange data with**, a variety of Windows applications that support the ActiveX standard. MS Office programs, Internet Explorer, Visual Basic, Visual C++, Visual Java, and MATLAB (V5.3 and later) are a few of the many applications that support ActiveX controls. ActiveDSO is available on CD-ROM or on the internet at www.lecroy.com

- With **ActiveDSO** you can develop your test program using standard GPIB commands. For easy integration of your scope data with your Windows Application (through GPIB or Ethernet 10Base-T or 100Base-T), ActiveDSO helps you with the following tasks:
- Generate a report by importing scope data right into Excel or Word.

- Archive measurement results on the fly in a Microsoft Access Database.
- Automate tests using Visual Basic, Java, C++, Excel (VBA).
- The ActiveDSO control hides the intricacies of programming and provides a simple and consistent interface to the controlling application. With less than 10 lines of VBA (Visual Basic for Applications) code in an Excel macro the spreadsheet can recover pre-scaled waveform data from a remote instrument.
- The ActiveDSO control can also be embedded visually in any OLE automation compatible client, and can be used manually without any need for programming. It will run on any PC running Windows 95, Windows 98, or Windows NT.
- There are two fundamental ways to use the control:
  - o As a visible object embedded in an OLE Automation compatible Client (PowerPoint for example) showing a captured display image. See Embedded Control Example for more details.
  - o As an invisible object accessed via a scripting language (Visual Basic for Applications, for example) to remotely control an instrument. See Accessing from VBA for more details.
- VBA (Visual Basic for Applications) is the programming language built into many of the more recent Windows applications. It is a subset of Visual Basic that makes it very simple to utilize the services of OLE Automation Servers and ActiveX Controls.
- The following VBA subroutine demonstrates how easy it is to connect to an instrument and send remote commands to it.

```
Sub LeCroyDSOTest()
    Dim o As Object
        Set o = CreateObject("LeCroy.ActiveDSOCtrl.1")
    Call o.AboutBox                ' Present the control's About box
    Call o.MakeConnection("IP: 172.28.11.26)  'Connect to device on LAN
    Call o.WriteString("BUZZ BEEP", True)  ' Make the DSO beep
End Sub
```

Example Syntax:

- Boolean controlName.WriteString
- The WriteString method has the following arguments.

ArgumentDescription

- controlnameThe name of the ActiveDSO control object.
- textStringString, Text string to send to the device.
- EOI Boolean, TRUE = terminate with EOI

- **Returns:** True on success, False on failure.
- **Remarks:** This method sends a string command to the instrument.
- If EOI is set to TRUE, the device will start to interpret the command immediately. This is normally the desired behavior.
- If EOI is set to 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.

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CHAPTER FOUR: *Understanding and Managing Waveforms*

In this chapter, see how to

- ***Structure Waveforms***
- ***Inspect waveform contents***
- ***Transfer waveforms rapidly***

Know Your Waveform

A waveform can be said to have two main parts. One is its basic data array: raw data values from the oscilloscope's ADCs (Analog-to-Digital Converters) obtained in the waveform's capture. The other is the description that accompanies this raw data: the 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 this descriptive information by remote control using the INSPECT? query, which interprets it in an easily understood ASCII text form. And you can rapidly transfer the waveform data using the WAVEFORM? query. You can write it back into the oscilloscope with the WAVEFORM command.

Your instrument contains a data structure (template, see Appendix II) that provides a detailed description of how waveform information is organized. Although a sample template is provided with this manual, we suggest you use the TEMPLATE? query to access the instrument template in the oscilloscope itself (the template may change as your oscilloscope's firmware is enhanced).

Using the STORE and STORE_SETUP commands, you can also store waveforms in preformatted ASCII output for popular spreadsheet and math processing packages.

LOGICAL DATA BLOCKS

Each of your waveforms will normally contain at least a waveform descriptor and data array block. However, other 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, as well as 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 Extrema or FFT math functions:

	EXTREMA	FFT
DATA_ARRAY_1	Roof trace	Real part
DATA_ARRAY_2	Floor trace	Imaginary part

NOTE: The instrument template also describes an array named DUAL. But this is simply a way to allow the INSPECT? command to examine the two data arrays together.

INSPECT WAVEFORM CONTENTS

Use the INSPECT? query to examine the contents of your waveform. You can use it on both of the main waveform parts. Its most basic form is: INSPECT? "name", the template giving you the name of a descriptor item or data block. You may use single quotation marks or double ones in the command (or none at all) but the reply will always use double quotes. The answer is returned as a single string, but may cover many lines. Some typical dialogue follows:

```
Question    C1:INSPECT? "VERTICAL_OFFSET"
Response    "VERTICAL_OFFSET: -4.0000e-002"

Question    C1:INSPECT? "TRIGGER_TIME"
Response    "TRIGGER_TIME: Date = APR  8, 2004, Time = 10:29: 0.311462573"
```

You can also use INSPECT? to provide a readable translation of the full waveform descriptor block using INSPECT? "WAVEDESC". Again, the template will give you the details for interpretation of each of the parameters. Also use INSPECT? "SIMPLE" to examine the measured data values of a waveform. For example, for an acquisition with 52 points:

```
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 table above are the fully converted measurements in volts. When the data block contains thousands of items the string will contain a great many lines.

Depending on the application, you may prefer the data in its raw form, with either a BYTE (8 bits) or a WORD (16 bits) for each data value. In that case, use the relations INSPECT? "SIMPLE",BYTE with

WAVEFORM?. 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 also wordy. INSPECT? cannot be used to send a waveform back to the oscilloscope. If you want to do this, or you want the information quickly, you should instead use WAVEFORM. With WAVEFORM_SETUP it is possible to examine just a part of the waveform or a sparsed form of it. See the following pages.

If you're 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. Using a stored waveform, this can be done in a format suitable for retransfer to the instrument with MC:INSPECT? "WAVEDESC";WAVEFORM?, and then placing the response directly into a disk file.

USE THE WAVEFORM QUERY

Use the WAVEFORM? query to transfer waveform data in block formats defined by the IEEE 488.2 standard. You can then download the response back to your instrument by using the WAVEFORM command. All your waveform's logical blocks can be read with the query C1:WAVEFORM? Completeness, as well as good use of time and space are the advantages of this approach when you have to read many waveforms with the same acquisition conditions, or when you are interested only in large amounts of raw integer data. Moreover, you can choose any single block for reading with a query such as C1:WAVEFORM? DAT1. See Part Two for the various block names.

You can place the binary response to a query of the form C1:WAVEFORM? or C1:WAVEFORM? ALL in a disk file, then dump it using the GPIB bus. Do this with default settings to show the hexadecimal and ASCII form, as on the following page.

NOTE: A waveform query response can easily be a block containing over 16 million bytes if it is in binary format, and twice as much if the HEX option is used.

Byte Offset Number			Binary Contents in Hexadecimal	ASCII Translation (.... = uninteresting)
0			43 31 3A 57 46 20 41 4C 4C 2C 23 39 30 30 30 30	C1:WFALL,#900000
16			30 30 34 35 30	0450
	0		57 41 56 45 44 45 53 43 00 00 00	WAVEDESC...
32	*11*		00 00 00 00 00 4C 45 43 52 4F 59 5F 32 5F 32 00	.....LECROY_2_2.
48	*27*		00 00 00 00 00 00 01 00 00 00 00 01 5A 00 00 00	....
64	*43*		00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	....
80	*59*		00 00 00 00 68 00 00 00 00 00 00 00 00 00 00 00	....
96	*75*		00 4C 45 43 52 4F 59 39 33 37 34 4C 00 00 00 00	.LECROYLT344....
112	*91*		00 37 84 09 40 00 00 00 00 00 00 00 00 00 00 00	
128	*107*		00 00 00 00 00 00 00 00 34 00 00 00 34 00 00 00	
144	*123*		32 00 00 00 00 00 00 00 33 00 00 00 00 00 00 00	
160	*139*		01 00 00 00 00 00 00 00 01 00 00 00 01 00 00 00	
176	*155*		00 34 83 12 6F 3A 0D 8E C9 46 FE 00 00 C7 00 00	
192	*171*		00 00 08 00 01 32 2B CC 77 BE 6B A4 BB 51 A0 69	
208	*187*		BB BE 6A D7 F2 A0 00 00 00 56 00 00 00 00 00 00	
224	*203*		00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	
240	*219*		00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	
256	*235*		00 00 00 00 00 00 00 00 00 53 00 00 00 00 00 00	
272	*251*		00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	
288	*267*		00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	
304	*283*		00 00 00 00 00 00 00 00 00 00 00 00 00 40 3B 00	
320	*299*		00 00 00 00 00 17 0A 05 02 07 C8 00 00 00 00 00	
336	*315*		00 00 00 00 00 00 00 00 01 00 0E 00 04 3F 80 00	
352	*331*		00 00 0A 00 00 3F 80 00 00 3A 0D 8E C9 00 00	
367		*0*	11	
368		*1*	00 13 00 04 00 FA 00 09 00 16 00 0B 00 F3 00 E8	
384		*17*	00 08 00 1B 00 1B 00 FA 00 EC 00 05 00 1B 00 1A	
400		*33*	00 FC 00 EC 00 05 00 14 00 18 00 03 00 F8 00 0D	
416		*49*	00 15 00 14 00 03 00 F4 00 05 00 11 00 10 00 F8	
432		*65*	00 F0 00 11 00 1D 00 1E 00 F9 00 EA 00 06 00 1D	
448		*81*	00 18 00 FE 00 EE 00 07 00 19 00 18 00 03 00 FA	
464		*97*	00 0A 00 16 00 11 00	
471	*(Terminator)*		0A	

Above: To illustrate the contents of the logical blocks, the relevant parts have been separated. To make counting easier, the corresponding Byte Offset numbering has been restarted each time a new block begins. The ASCII translation, only part of which is shown, has been similarly split and highlighted, showing how its parts correspond to the binary contents.

On the previous page...
The first 10 bytes translate into ASCII and resemble the simple beginning of a query response. These are followed by the string #9000000450, the beginning of a binary block in which nine ASCII integers are used to give the length of the block (450 bytes). The waveform itself starts immediately after this, at Byte 21. The very first byte is at zero byte count, as it is for the first byte in each block.

The first object is a DESCRIPTOR_NAME, a string of 16 characters with the value WAVEDESC.

Then, 16 bytes after the beginning of the descriptor, at Byte 37, we find the beginning of the next string: the TEMPLATE_NAME with the value LECROY_2_2.

Several other parameters follow. The INSTRUMENT_NAME, LECROYLT344, 76 bytes from the descriptor start (Byte 97), is easily recognizable.

A very important byte is found at position 34 after the descriptor start. This is the value COMM_ORDER, which gives the order of subsequent bytes in the file. This byte is of enum type, taking the possible values 0 for high byte first, and 1 for low byte first. All subsequent readings of the file must use the information given by this byte.

On the preceding line, 36 bytes after the descriptor start (Byte 57), a four-byte integer gives the length of the descriptor: WAVE_DESCRIPTOR = 00 00 01 5A (hex) = 346.

At 60 bytes from the descriptor start (Byte 81) we find another four-byte integer giving the length of the data array: WAVE_ARRAY_1 = 00 00 00 68 (hex) = 104.

And at 116 bytes after the descriptor (Byte 137), yet another four-byte integer gives the number of data points: WAVE_ARRAY_COUNT = 00 0000 34 (hex) = 52.

Now we know that the data will start at 346 bytes from the descriptor's beginning (Byte 367), and that each of the 52 data points will be represented by two bytes. The waveform has a total length of 346 + 104, which is the same as the ASCII string indicated at the beginning of the block. The final 0A at Byte 471 is the NL character associated with the GPIB message terminator <NL><EOI>.

Because the example was taken using an oscilloscope with an eight-bit ADC, we see the eight bits followed by a 0 byte for each data point. However, for many other kinds of waveform this second byte will not be zero and will contain significant information. The data is coded in signed form (two's complement) with values ranging from -32768 = 8000 (hex) to 32767 = 7FFF (hex). If we had chosen to use the BYTE option for the data format, the values would have been signed integers in the range -128 = 80 (hex) to 127 = 7F (hex). The ADC values are mapped to the display grid in the following way:

- 0 is located on the grid's center axis
- 127 (BYTE format) or 32767 (WORD format) is located at the top of the grid
- -128 (BYTE format) or -32768 (WORD format) is located at the bottom of the grid.

From bottom to top of the screen we have 80 , 81, 82 . . . . FD, FE, FF, 0, 1, 2 . . . . 7D, 7E, 7F.

To convert from these byte values to actual numerical values, or vice versa, we can use the following formula, for eight bit values: - New value = [Old value + 80 (hex)] AND 255.

INTERPRET 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 that they are stored as floating point numbers in the IEEE 32-bit format. An ASCII string giving the vertical unit is to be found in VERTUNIT, Byte 196. The vertical value is given by the relationship: value = VERTICAL_GAIN x data - VERTICAL_OFFSET, where:

VERTICAL_GAIN	2.44141e-07 from the floating point number 3483 126f at Byte 156
VERTICAL_OFFSET	0.00054 from the floating point number 3A0D 8EC9 at Byte 160
VERTICAL_UNIT	V = volts from the string 5600 ... at Byte 196

Therefore:

since data[4] =	FA00 = 64000 from the hexadecimal word FA00 at byte 373. Overflows the maximum. 16 bit value of 32767, so must be a negative value. Using the two's complement conversion 64000-2^{16} = -1536
value[4] =	-0.000915 V as stated in the inspect command

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 all 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 will be two arrays (one after the other) for the two of the result.

CALCULATE A DATA POINT'S HORIZONTAL POSITION

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 x i + HORIZ_OFFSET. For acquisition waveforms this time is from the trigger to the data point in question. It will be different from acquisition to acquisition since the HORIZ_OFFSET is measured for each trigger. In the case of the data shown above this means:

HORIZ_INTERVAL =	1e-08 from the floating point number 322b cc77 at Byte 194
HORIZ_OFFSET =	-5.149e-08 from the double precision floating point number be6b a4bb 51a0 69bb at Byte 198
HORUNIT = S =	seconds from the string 5300 ... at Byte 262

This gives:	x[0] =	-5.149e-08 S
	x[1] =	-4.149e-08 S.

Sequence waveforms: are really many independent acquisitions, so each segment will have its own horizontal offset. These can be found in the TRIGTIME array.

For the nth segment:

x[i,n] = HORIZ_INTERVAL x 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 (Random Interleaved Sampling) waveforms: are composed of many acquisitions interleaved together. The descriptor parameter, RIS_SWEEPS gives the number of acquisitions. The ith point will belong to the mth segment where:

m = i modulo (RIS_SWEEPS) will have a value between 0 and RIS_SWEEPS -1.

Then with: j = i - m

x[i] = x[j,m] = HORIZ_INTERVAL x j + RIS_OFFSET[m],

where the RIS_OFFSETs 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 get segments with times such that: RIS_OFFSET[i] ≅ PIXEL_OFFSET + (i - 0.5) x HORIZ_INTERVAL.

Thus, taking as an example a RIS with RIS_SWEEPS = 10, HORIZ_INTERVAL = 1 ns, and PIXEL_OFFSET = 0.0, we might find for a particular event that:

RIS_OFFSET[0] = -0.5 ns	RIS_OFFSET[1] = 0.4 ns
RIS_OFFSET[2] = 1.6 ns	RIS_OFFSET[3] = 2.6 ns
RIS_OFFSET[4] = 3.4 ns	RIS_OFFSET[5] = 4.5 ns
RIS_OFFSET[6] = 5.6 ns	RIS_OFFSET[7] = 6.4 ns
RIS_OFFSET[8] = 7.6 ns	RIS_OFFSET[9] = 8.5 ns

and therefore:

x[0] =	RIS_OFFSET[0] = -0.5 ns
x[1] =	RIS_OFFSET[1] = 0.4 ns
...	
x[9] =	RIS_OFFSET[9] = 8.5 ns
x[10] =	1 ns x 10 + (-0.5) = 9.5 ns
x[11] =	1 ns x 10 + 0.4 = 10.4 ns
...	
x[19] =	1 ns ´ 10 + 8.5 = 18.5 ns
x[20] =	1 ns ´ 20 + (-0.5) = 19.5 ns.
...	

USE THE WAVEFORM COMMAND

Waveforms you read with the WAVEFORM? query can be sent back into your instrument using WAVEFORM and related commands. Since the descriptor contains all of the necessary information, you need not be concerned with any of the communication format parameters. The oscilloscope will learn all it needs to know from the waveform.

TIP: Because waveforms can only be sent back to the instrument memory traces (M1, M2, M3, M4), consider removing or changing the prefix (C1 or CHANNEL_1) in the response to the WF? query. See Part Two for examples.

To ensure that the descriptor is coherent, however, when you synthesize waveforms for display or comparison read out a waveform of the appropriate size and then replace the data with the desired values.

Here are among the many ways to use WAVEFORM and its related commands to simplify or speed up work:

Partial Waveform Readout: Use WAVEFORM_SETUP to specify a short part of a waveform for readout, as well as to select a sparsing factor for reading every nth data point only.

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 will allow 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 or floppy will always remain in the format LSB first, the default DOS format. Thus you cannot use the CORD command in these cases, as it is only for data sent via the GPIB and LAN 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 will enable you to save by a factor of two the amount of data transferred or stored. If the computer you are using cannot read binary data, the HEX option allows a response form in which 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 will disappear). If you have also specified COMM_FORMAT OFF,BYTE,BIN, the response will be data bytes only (the #90000nnnnn will disappear; see page 55).

Transfer Waveforms at High Speed

You must take several important factors into account if you wish 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 in the computer. This means that you should avoid writing data to disk wherever possible, minimize operations such as per-data-point computations, and reduce the number of calls to the I/O system. To do this, you can 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 that the instrument takes to acquire events will be considerably increased if it is obliged 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? (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.

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CHAPTER FIVE: *Checking Waveform Status*

In this chapter, see how to

➢ ***Use status registers***

Use Status Registers

A wide range of status registers allows you to quickly determine the instrument's internal processing status at any time. These registers and the oscilloscope's status reporting system, which group related functions together, are designed to comply with IEEE 488.2 recommendations. Some, such as the Status Byte Register (STB) or the Standard Event Status Register (ESR), are required by the IEEE 488.2 Standard. Others are device specific, including the Command Error Register (CMR) and Execution Error Register (EXR). Those commands associated with IEEE 488.2 mandatory status registers are preceded by an asterisk (*).

OVERVIEW

The Standard Event Status Bit (ESB) and the Internal Status Change Bit (INB) in the STB are summary bits of the ESR and the Internal State Change Register (INR). The Message Available Bit (MAV) is set whenever there are data bytes in the output queue. The Value Adapted Bit (VAB) indicates that a parameter value was adapted during a previous command interpretation. For example, if the command TDIV 2.5 US was received, the timebase would be set to 2 ms/div along with the VAB bit.

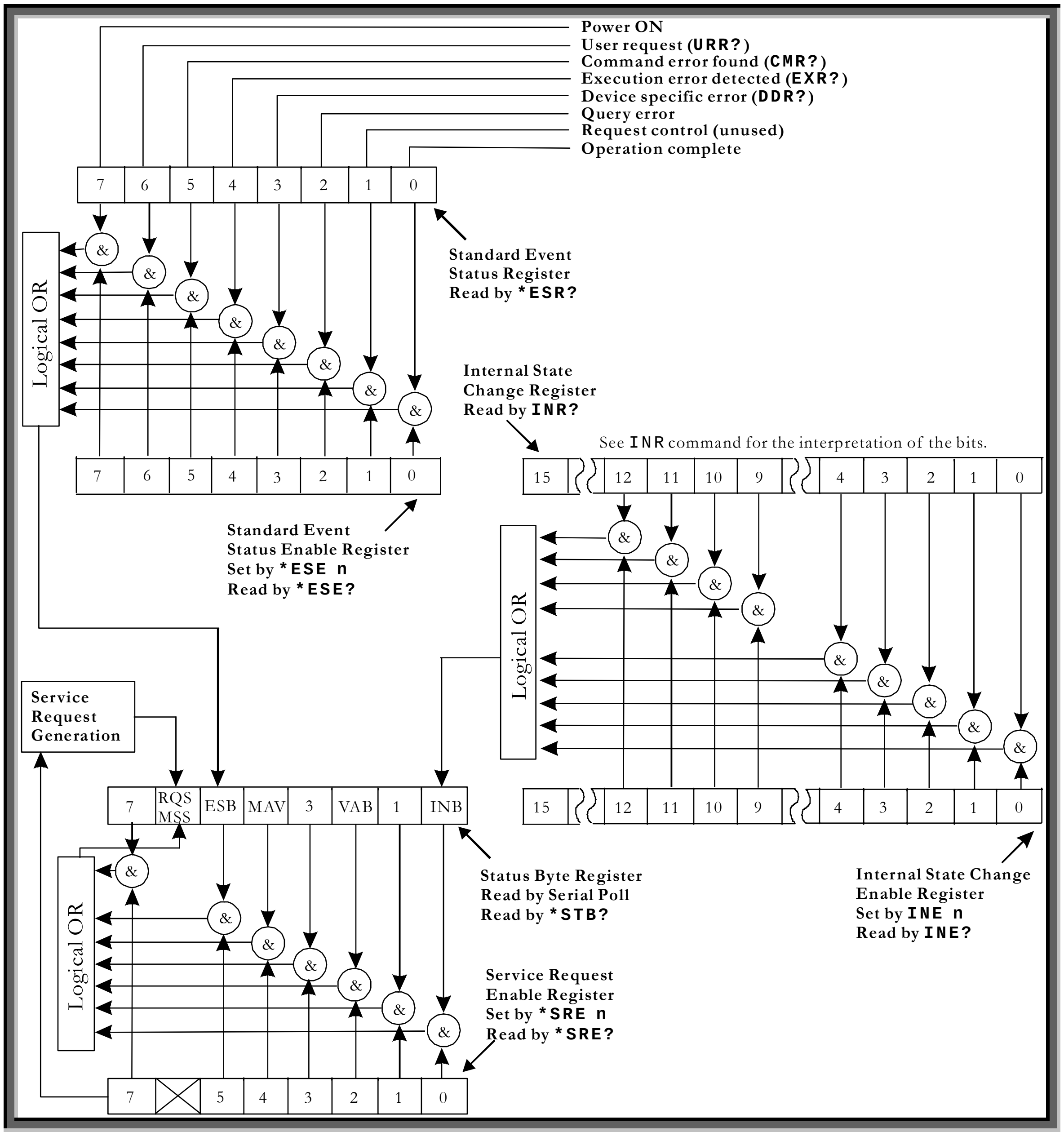
The Master Summary Status bit (MSS) indicates a request for service from the oscilloscope. You can only set the MSS bit if you have enabled one or more of the other STB bits with the Service Request Enable Register (SRE).

All Enable registers (SRE, ESE, and INE) are used to generate a bit-wise AND with their associated status registers. The logical OR of this operation is reported to the STB register. At power-on, all Enable registers are zero, inhibiting any reporting to the STB.

The ESR primarily summarizes errors, whereas the INR reports internal changes to the instrument. Additional details of errors reported by ESR can be obtained with the queries CMR?, DDR?, EXR?, and URR?.

The register structure contains one additional register, not shown on the next page (Fig.1). This is the Parallel Poll Enable Register (PRE), which behaves exactly like the SRE but sets the "ist" bit used in the Parallel Poll. Read the "ist" bit with the *IST? query.

Example: If you were to send the erroneous command TRIG_MAKE SINGLE to your instrument, the oscilloscope would reject it and set the Command Error Register (CMR) to the value 1 (unrecognized command/query header). The non-zero value of CMR would be reported to Bit 5 of the Standard Event Status Register (ESR), which is then set. Nothing further would occur unless the corresponding Bit 5 of the Standard Event Status Enable Register (ESE) was set with the command *ESE 32, enabling Bit 5 of ESR to be set for reporting to the summary bit ESB of the STB.



Power ON
User request (URR?)
Command error found (CMR?)
Execution error detected (EXR?)
Device specific error (DDR?)
Query error
Request control (unused)
Operation complete
7 6 5 4 3 2 1 0
Standard Event Status Register Read by *ESR?
Logical OR
&
Internal State Change Register Read by INR?
See INR command for the interpretation of the bits.
15 12 11 10 9 4 3 2 1 0
Standard Event Status Enable Register Set by *ESE n Read by *ESE?
Service Request Generation
7 RQS MSS ESB MAV 3 VAB 1 INB
Status Byte Register Read by Serial Poll Read by *STB?
Internal State Change Enable Register Set by INE n Read by INE?
Service Request Enable Register Set by *SRE n Read by *SRE?
7 5 4 3 2 1 0

Status Register Structure

If you enabled the setting of the ESB summary bit in STB, again nothing would occur unless you enabled further reporting by setting the corresponding bit in the SRE register with the command *SRE 32. The generation of a non-zero value of CMR would ripple through to MSS, generating a Service Request (SRQ).

You can read the value of CMR and simultaneously reset to zero at any time with the command CMR?. The occurrence of a command error can also be detected by analyzing the response to *ESR?. However, if you must survey several types of potential errors, it is usually far more efficient to enable propagation of the errors of interest into the STB with the enable registers ESE and INE.

To summarize: a command error (CMR) sets Bit 5 of ESR if

a. Bit 5 of ESE is set, ESB of STB is also set, or

b. Bit 5 of SRE is set, MSS/RQS (Request for Service) of STB is also set and a Service Request is generated.

STATUS BYTE REGISTER (STB)

STB is the instrument's central reporting structure. It is made up of eight single-bit summary messages, three of which are unused, that reflect the current status of the oscilloscope's associated data structures:

- Bit 0 is the INB summary bit of the Internal State Change Register. It is set if any INR bits are set, provided they are enabled by the corresponding bit of the INE register.
- Bit 2 is the VAB bit, indicating that a parameter value was adapted during a previous command interpretation.
- Bit 4 is the MAV bit, indicating that the interface output queue is not empty.
- Bit 5 is the summary bit ESB of the ESR. It is set if any of the bits of the ESR are set, provided they are enabled by the corresponding bit of the ESE register.
- Bit 6 is either the MSS or RQS bit.

You can read the STB using the *STB? query. It reads and clears the STB, in which case Bit 6 is the MSS bit, and it indicates whether the oscilloscope has any reason to request service. The response to the query represents the binary weighted sum of the register bits. The register is cleared by *STB?, ALST?, *CLS, or when power is applied to the instrument.

Another way to read the STB is using the serial poll (see Chapter 2). In this case, Bit 6 is the RQS bit, indicating that the instrument has activated the SRQ line on the GPIB. The serial poll clears only the RQS bit. And the STB's MSS bit, and any other bits which caused MSS to be set, will remain set after the poll. These bits must be reset.

STANDARD EVENT STATUS REGISTER (ESR)

ESR is a 16-bit register reflecting the occurrence of events. ESR bit assignments have been standardized by IEEE 488.2. Only the lower eight bits are currently in use.

Read ESR using *ESR?. The response is the binary weighted sum of the register bits. The register is cleared with *ESR? or ALST?, with *CLS, or when power is applied to the scope.

Example:

The response message *ESR 160 tells you that a command error occurred and that the ESR is being read for the first time after power-on. The value 160 can be broken down into 128 (Bit 7) plus 32 (bit 5). See the table with the ESR command description in Part Two for the conditions corresponding to the bits set.

The Power ON bit appears only on the first *ESR? query after power-on, as the query clears the register. You can determine this type of command error by reading the CMR with CMR?. It is not necessary that you read, or simultaneously clear, this register in order to set the CMR bit in the ESR on the next command error.

STANDARD EVENT STATUS ENABLE REGISTER (ESE)

This register allows you to report one or more events in the ESR to the ESB summary bit in the STB.

Modify ESE with *ESE and clear it with *ESE 0, or with power-on. Read it with *ESE?.

Example: Use *ESE 4 to set bit 2 (binary 4) of the ESE Register, and to enable query errors to be reported.

SERVICE REQUEST ENABLE REGISTER (SRE)

SRE specifies which Status Byte Register summary bit or bits will bring about a service request. This register consists of eight bits. Setting a bit allows the summary bit located at the same bit position in the SBR to generate a service request, provided that the associated event becomes true. Bit 6 (MSS) cannot be set and is always reported as zero in response to *SRE?.

Modify SRE with *SRE and clear it with *SRE 0, or with power-on. Read it using *SRE?.

PARALLEL POLL ENABLE REGISTER (PRE)

This specifies which Status Byte Register summary bit or bits will set the “ist” individual local message. PRE is similar to SRE, but is used to set the parallel poll “ist” bit rather than MSS.

The value of the “ist” may also be read without a Parallel Poll via the query *IST?. The response indicates whether or not the “ist” message has been set (values are 1 or 0).

Modify PRE with *PRE and clear it with *PRE 0, or with power-on. Read this register with *PRE?.

Example: Use *PRE 5 to set the register’s bits 2 and 0 (decimal 4 and 1).

INTERNAL STATE CHANGE STATUS REGISTER (INR)

INR reports the completion of a number of internal operations (the events tracked by this 16-bit-wide register are listed with the INR? description in Part Two).

Read the register using INR?. The response is the binary weighted sum of the register bits. Clear the register with INR? or ALST?, a *CLS command, or with power-on.

INTERNAL STATE CHANGE ENABLE REGISTER (INE)

INE allows one or more events in the Internal State Change Status Register to be reported to the INB summary bit in the STB.

Modify INE with INE and clear it with INE 0, or after power-on. Read it with INE?.

COMMAND ERROR STATUS REGISTER (CMR)

This register contains the code of the last command error detected by the oscilloscope. List these error codes using CMR?.

Read CMR with CMR?. The response is the error code. Clear the register with a CMR? or ALST? query, a *CLS command, or with power-on.

DEVICE DEPENDENT ERROR STATUS REGISTER (DDR)

DDR indicates the type of hardware errors affecting your instrument. Individual bits in this register report specific hardware failures. List them using DDR?.

Also read this register using the DDR? query. The response is the binary weighted sum of the error bits. Clear it with another DDR? or with ALST?, a *CLS command, or with power-on.

EXECUTION ERROR STATUS REGISTER (EXR)

EXR contains the code of the last execution error detected by the oscilloscope. List these error codes with EXR?.

Read the register, again using the EXR? query. The response is the error code. Clear with another EXR? or with ALST?, a *CLS command, or with power-on.

USER REQUEST STATUS REGISTER (URR)

Finally, URR contains the identification code of the last menu button pressed. List these codes with URR?. Read URR using the same query. The response is the decimal code associated with the selected menu button. And clear the register with another URR?, or with ALST?, a *CLS command, or with power-on.

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CHAPTER SIX: *Linking with Automation*

In this chapter, discover

- ***What Automation is***
- ***How to use the VBS command***

What is Automation ?

OVERVIEW

Automation enables you to control programs from your own applications as if you were using a keyboard and a mouse. For example, if you want to use Excel, Mathcad, MATLAB, or other proprietary programs, you can do so within the chain of operations of the oscilloscope, without having to go outside the X-Stream software to instantiate the proprietary software. Here we offer a simple introduction.

SOME DETAILS

Here is the start of a typical instrument setup file. You don't necessarily have to know about this to use the instrument, but any setup file is a convenient source of examples to illustrate the workings of Automation in the instrument.

```
' WaveMaster ConfigurationVBScript ...

On Error Resume Next
set WaveMaster = CreateObject("LeCroy.WaveMasterApplication")

' AladdinPersona ...
WaveMaster.HideClock = False
WaveMaster.TouchScreenEnable = True

Set Display = WaveMaster.Display
                                 ' Display ...
Display.GridMode = "Dual"        ' The scope variables are
Display.TraceStyle = "Line"      ' in groups, such as Display,
Display.GridIntensity = 70       ' Acquisition, Horizontal,
Display.GridOnTop = False        ' and Trigger.
Display.AxisLabels = False
Display.NumSegmentsDisplayed = 1 ' The dot notation is well
Display.StartSegment = 1         ' known in object-oriented
Display.SegmentMode = "Adjacent" ' programming.  It makes
Display.ScreenSaveEnable = True  ' hierarchies easy to create.
Display.ScreenSaveTimeout = 60   ' Properties can be handed down
Display.LockPersistence = "AllLocked"  ' through a hierarchy.
Display.PersistenceStyle = "ColorGraded"
Display.Persisted = False
Display.PersistenceMonoChrome = True ' To save a lot of typing, you
Display.Persistence3d = False        ' can write statements like
Display.Persist3DQuality = "Solid"   ' Set Display = WaveMaster.Display
Display.AxisXRotation = 45           ' as a kind of shorthand.
Display.AxisYRotation = 20
Display.PersistenceSaturation = 50     ' Automation remote control
Display.PersistenceTime = "Infinite"   ' commands are merely copies of
Display.PersistenceLastTrace = False   ' statements like these.

Set Acquisition = WaveMaster.Acquisition
' Acquisition ...                      ' Automation queries are merely
Acquisition.TriggerMode = "Stopped"    ' the same things reversed.
                                       ' To find out the state of the
Set C1 = Acquisition.C1                ' grid you can write
' C1 ...                               ' GM = Display.GridMode
C1.View = True                         ' Where you have already defined
C1.UseGrid = "YT1"                     ' GM as a string variable.
C1.UseDotJoin = True
C1.Persisted = False
C1.PersistenceSaturation = 50
C1.PersistenceMonoChrome = True
```

The complete setup file shows that the variables are grouped as follows.

- Acquisition
- Cursors
- Display
- Math
- Measure
- Memory
- PassFail
- SaveRecall
- Utility

The X-Stream DSO differs from earlier scopes in that this same language and structure can be employed by the scope user to send commands from external computers; to send commands from programs inside the instrument, using ActiveDSO; to write scripts; and to run many other applications.

The setup file is a means of setting the scope very quickly into a given state. Individual commands can be sent as required, to make changes during the running of an application. Because the setup files are in ASCII text format, they can be edited very simply, using a program such as Notepad. This makes your system very much less vulnerable to changes in the scope system. It also enables people to share information very easily.

HOW TO USE THE VBS COMMAND

The key to using automation commands in an existing GPIB program is the VBS command. This is described in detail in Part Two of this manual. Please note that "app" refers to the instrument application program. It can be defined by a statement like this:

```
Set WaveMaster = CreateObject("LeCroy.WaveMasterApplication")
```

Here are some examples of VBS, with the older GPIB equivalents. The command syntax is
`VBS <automation command>.`

```
CMD$="VBS 'app.Acquisition.C1.VerScale=0.05'
      CMD$ "C1:VDIV 50 MV"  (Earlier equivalent)

CMD$="VBS 'app.Horizontal.HorScale = 500e-9'
      CMD$ "TDIV 0.5e-6"  (Earlier equivalent)

CMD$="VBS 'app.Display.GridMode="Dual"'
      CMD$ "GRID DUAL"  (Earlier equivalent)
```

Note that where the command includes double quotation marks, you may have to split up the string and use a code to replace the quotation marks. In QuickBasic you would use Chr$(34). In Visual Basic you would use Chr(34).

Here is an example of setting up the Amplitude parameter:

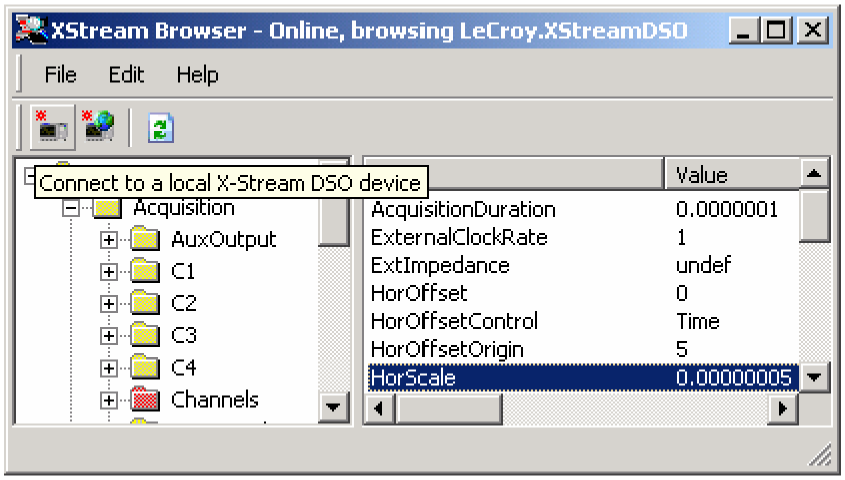
```
VBS "Measure.P1.View = True"
VBS "Measure.P1.ParamEngine = "AMPL""
VBS "Measure.P1.Source1 = "C1""
VBS "Measure.P1.GateStart = 1.667"
VBS "Measure.P1.GateStop = 3.333"
```

HOW TO USE X-STREAM BROWSER

The number of different variables and methods in a complete setup is obviously large. To facilitate the job of creating control statements, LeCroy has produced the program XStreamBrowser. Using this program, you can quickly find the information that corresponds to any part of the instrument.

On opening XStreamBrowser, you will see three icons at the top left of the screen.

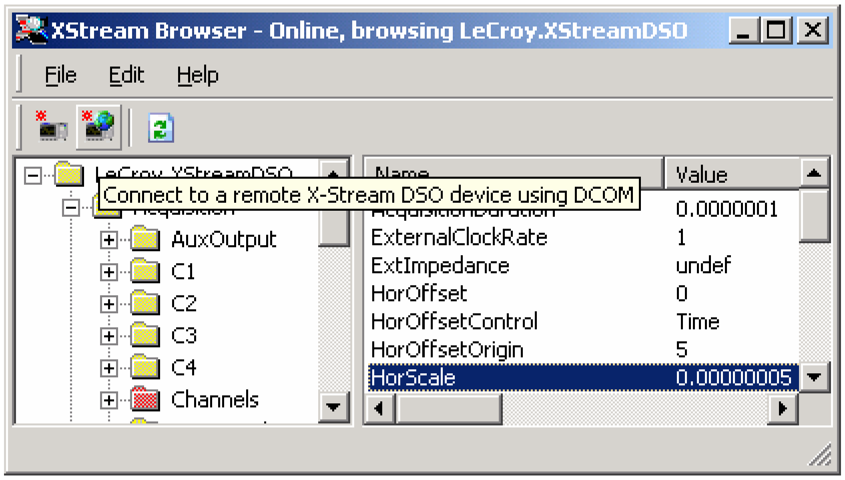
The first one makes the connection between XstreamBrowser and the instrument:



Connect to a local X-Stream DSO device

	Value
AcquisitionDuration	0.0000001
ExternalClockRate	1
ExtImpedance	undef
HorOffset	0
HorOffsetControl	Time
HorOffsetOrigin	5
HorScale	0.00000005

The second icon makes the connection by means of Microsoft's distributed component object model (DCOM):

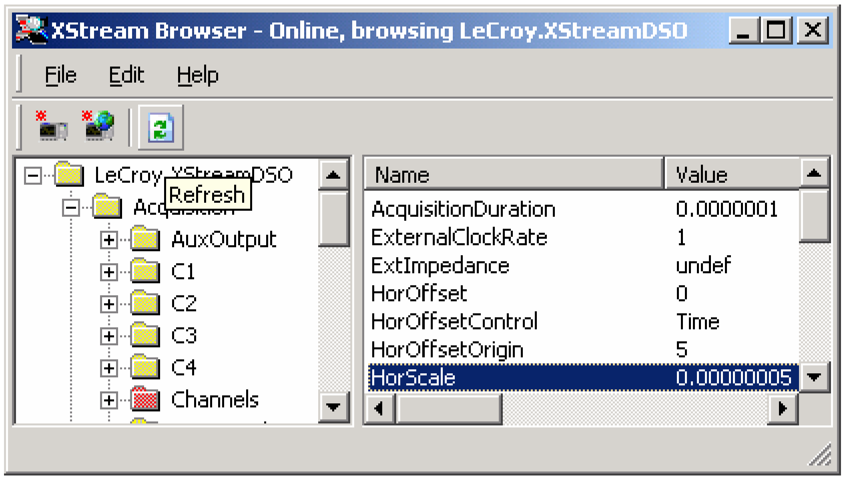


Connect to a remote X-Stream DSO device using DCOM

Name	Value
AcquisitionDuration	0.0000001
ExternalClockRate	1
ExtImpedance	undef
HorOffset	0
HorOffsetControl	Time
HorOffsetOrigin	5
HorScale	0.00000005

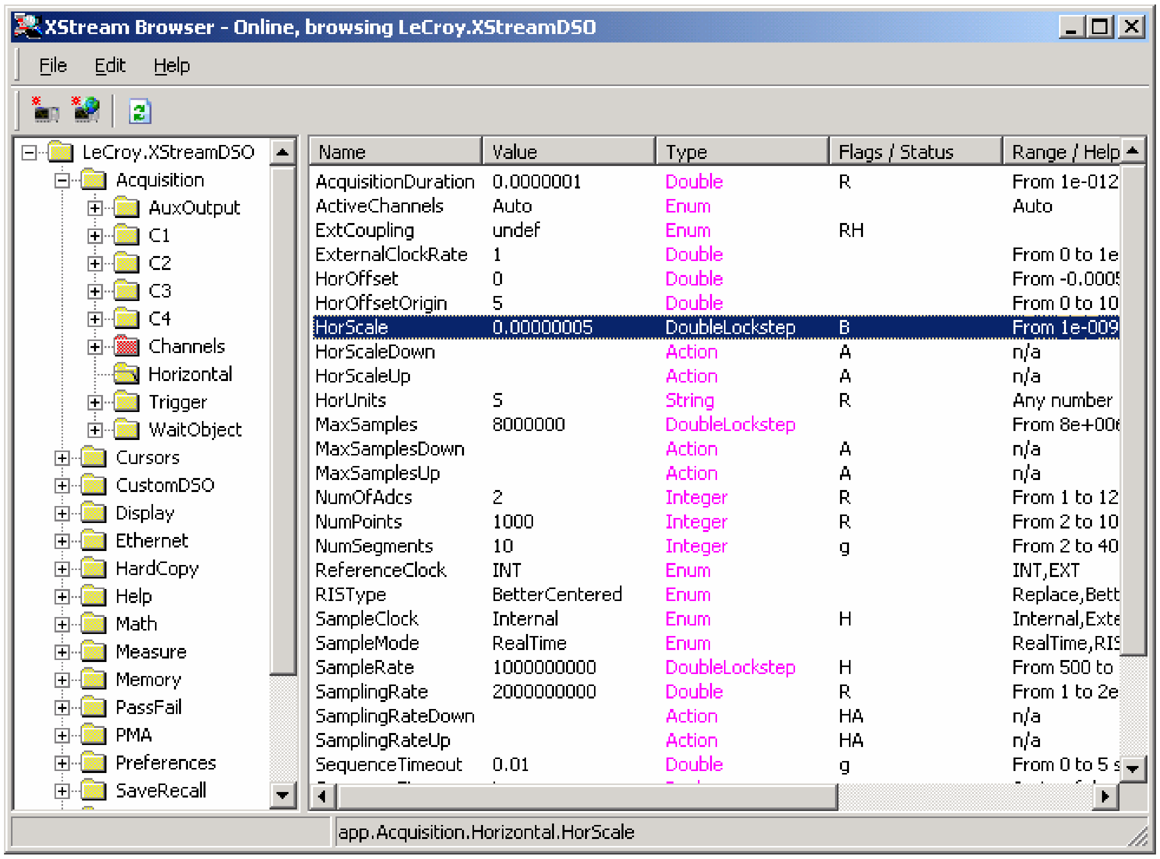
DCOM permits the distribution of different components for a single application across two or more networked computers, running an application distributed across a network and remotely displaying an application.

The third icon refreshes the connection. If you make changes to the instrument setup, you must click on this icon if you want XStreamBrowser to capture the changes:



Name	Value
AcquisitionDuration	0.0000001
ExternalClockRate	1
ExtImpedance	undef
HorOffset	0
HorOffsetControl	Time
HorOffsetOrigin	5
HorScale	0.00000005

Here is an example of the selection of a line to go into the clipboard:



Name	Value	Type	Flags / Status	Range / Help
AcquisitionDuration	0.0000001	Double	R	From 1e-012
ActiveChannels	Auto	Enum		Auto
ExtCoupling	undef	Enum	RH	
ExternalClockRate	1	Double		From 0 to 1e
HorOffset	0	Double		From -0.0005
HorOffsetOrigin	5	Double		From 0 to 10
HorScale	0.00000005	DoubleLockstep	B	From 1e-009
HorScaleDown		Action	A	n/a
HorScaleUp		Action	A	n/a
HorUnits	S	String	R	Any number
MaxSamples	8000000	DoubleLockstep		From 8e+006
MaxSamplesDown		Action	A	n/a
MaxSamplesUp		Action	A	n/a
NumOfAdcs	2	Integer	R	From 1 to 12
NumPoints	1000	Integer	R	From 2 to 10
NumSegments	10	Integer	g	From 2 to 40
ReferenceClock	INT	Enum		INT,EXT
RISType	BetterCentered	Enum		Replace,Bett
SampleClock	Internal	Enum	H	Internal,Exte
SampleMode	RealTime	Enum		RealTime,RIS
SampleRate	1000000000	DoubleLockstep	H	From 500 to
SamplingRate	2000000000	Double	R	From 1 to 2e
SamplingRateDown		Action	HA	n/a
SamplingRateUp		Action	HA	n/a
SequenceTimeout	0.01	Double	g	From 0 to 5 s

app.Acquisition.Horizontal.HorScale

The statement at the bottom of the screen is the one that will be placed in the clipboard when the icon is clicked. The column labeled **F** contains Flags and Status values. For example, **R** means read and **W** means write. **HorScale** is equivalent to the older-style command **TDIV**. The Range/Help column provides short form information about the possible values that the variable can take.

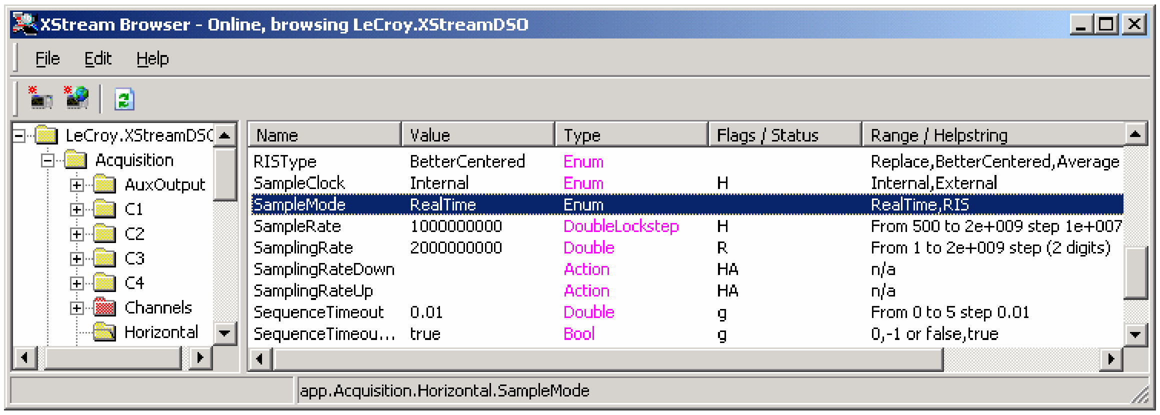
You can, for example, write `app.Acquisition.Horizontal.HorScale = 0.001` to set the timebase.

You can also, for example, write `HS = app.Acquisition.Horizontal.HorScale` to read the timebase setting.

Typical variable types are as follows:

Single	Single precision floating point number
Double	Double precision floating point number
Integer	Integer
Long	Long integer
Enum	Member of list
String	String

In the case of enum variables, you may specify the value using the actual values (for example, "INT" or "EXT") for Reference source in the example already given. You may also give the position in the list for the value you want to use (for example, 0 or 1 in the given example). All lists begin with the zeroth element. In the next figure we see that the variable for SampleMode is an enum type, and that the scope is currently running in real time mode.



Name	Value	Type	Flags / Status	Range / Helpstring
RISType	BetterCentered	Enum		Replace,BetterCentered,Average
SampleClock	Internal	Enum	H	Internal,External
SampleMode	RealTime	Enum		RealTime,RIS
SampleRate	1000000000	DoubleLockstep	H	From 500 to 2e+009 step 1e+007
SamplingRate	2000000000	Double	R	From 1 to 2e+009 step (2 digits)
SamplingRateDown		Action	HA	n/a
SamplingRateUp		Action	HA	n/a
SequenceTimeout	0.01	Double	g	From 0 to 5 step 0.01
SequenceTimeou...	true	Bool	g	0,-1 or false,true

app.Acquisition.Horizontal.SampleMode

The following inputs are allowed.

```
Real Time Mode     app.Acquisition.Horizontal.SampleMode = 0
Real Time Mode     app.Acquisition.Horizontal.SampleMode = "RealTime"

Sequence Mode      app.Acquisition.Horizontal.SampleMode = 1
Sequence Mode      app.Acquisition.Horizontal.SampleMode = "Sequence"
```

Were you to select **Edit, Copy** at this point the line `app.Acquisition.Horizontal.SampleMode` would be copied into the clipboard for use in your own application program.

You will see that some lines in XStreamBrowser are classified as "Action" rather than as a variable type. These actions are performed simply by sending the Action name with no argument, for example:
`app.InternalCollection("Display").ClearSweeps`
This would clear all the data from a persistence trace, for example. You can often reduce the amount of typing by the following kind of statements:

```
Set Acquisition = WaveMaster.Acquisition
Set Horizontal = Acquisition.Horizontal

Horizontal.SampleClock = "Internal"
Horizontal.ExternalClockRate = 1
Horizontal.HorScale = 0.0000005
Horizontal.HorOffset = 0
Horizontal.HorOffsetOrigin = 5
Horizontal.SampleMode = "Sequence"
```

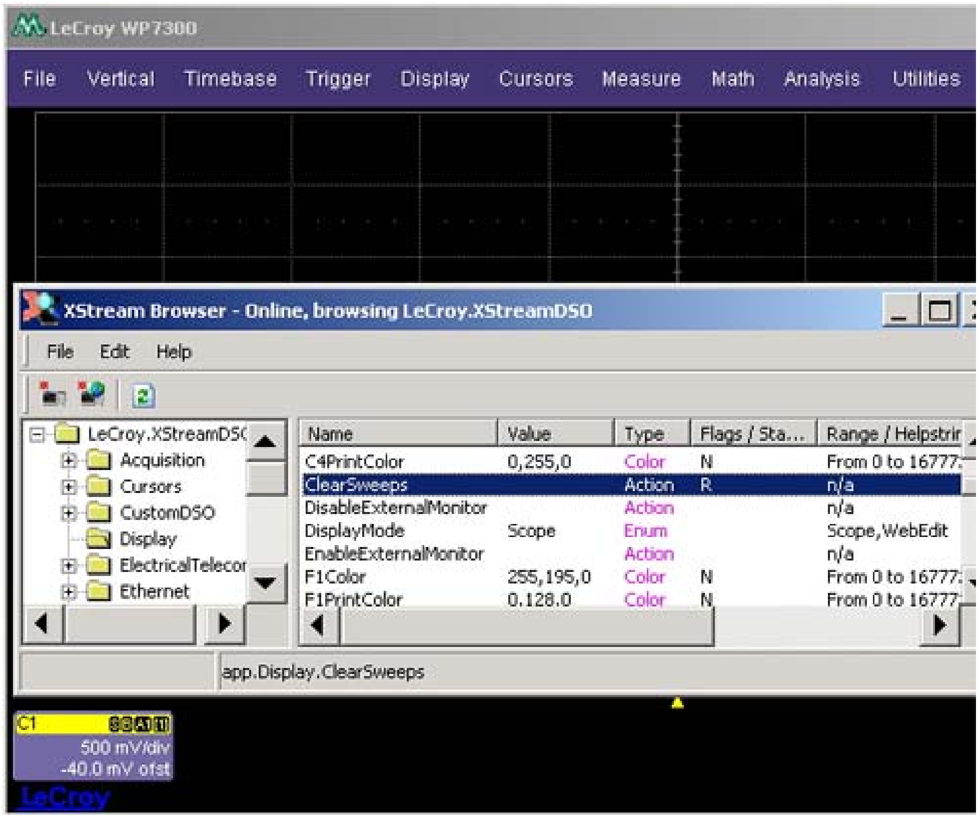
etc.

You could of course choose a much shorter word than `Horizontal`. For example, you could write:

```
Set Horiz = WaveMaster.Acquisition.Horizontal
Horiz.HorScale = 0.000001
```

ACTIONS

Besides the Control Variables, automation also provides for Actions. For example, we might want to Clear Sweeps on a particular trace. The XStreamBrowser example below shows the command for clearing a persistence trace.



Name	Value	Type	Flags / Sta...	Range / Helpstrir
C4PrintColor	0,255,0	Color	N	From 0 to 16777
ClearSweeps		Action	R	n/a
DisableExternalMonitor		Action		n/a
DisplayMode	Scope	Enum		Scope,WebEdit
EnableExternalMonitor		Action		n/a
F1Color	255,195,0	Color	N	From 0 to 16777
F1PrintColor	0,128,0	Color	N	From 0 to 16777

app.Display.ClearSweeps

The statement in your script or program would be as follows –

VBS 'app.InternalCollection("Display").ClearSweeps'

Other examples of actions are as follows:

```
app.Display.FactoryDefault
app.Acquisition.Horizontal.ZeroDelay
app.Acquisition.Trigger.ZeroLevel
app.Measure.SetGateToDefault
app.Memory.ClearAllMem
```

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PART TWO

COMMANDS

Part Two describes the commands and queries you will need to operate your instrument remotely.

Important Note for users of other LeCroy instruments with existing remote control software.

Trace labels TA, TB, TC and TD have been replaced by traces F1, F2, F3 and F4, respectively. Existing software that includes the old trace labels will work with X-Stream scopes, but new software should use the new labels unless it will also be used on an earlier instrument. In addition to these four traces, the instrument includes F5, F6, F7, and F8. Responses to queries will always use the new labels, even if the old labels are used in the query, however. Traces F1 through F8 are completely equivalent in ability to perform zooms or processing.

Parameter labels have also changed. These are now P1 through P8, but the older labels Cust1 through Cust5, etc. will still work. Responses to queries will always use the new labels, even if the old labels are used.

PART TWO: COMMANDS

In this part of the manual, you will find the commands and queries to run the instrument remotely.

Use Commands and Queries

This part of the manual describes the remote control commands and queries recognized by the instrument. All of them can be executed in either local or remote state.

The commands and queries are listed in alphabetical order according to the long form of their name. For example, the description of `ATTENUATION`, whose short form is `ATTN`, is listed before that of `AUTO SETUP`, whose short form is `ASET`. Each command or query description starts on a new page. The name (header) is given in both long and short form at the top of the first page of each description.

Queries perform actions such as obtaining information. They are recognized by **?** following their headers. Many commands can be used as queries simply by adding the question mark. In order to find out the correct form of a command, it is very useful to set up the scope manually to the exact condition that you require, and then to send a query which corresponds to the required command. The reply from the scope can be copied into your program as a command.

A brief explanation of the operation performed by the command or query is followed by the formal syntax, with the full-name header given in lowercase characters and the short form derived from it in uppercase characters (e.g., `DoT_JoiN` gives `DTJN)`. Where applicable, the syntax of the query is given with the format of its response. For each command, a short GPIB example illustrating a typical use is also provided. The GPIB examples assume that the controller is equipped with a National Instruments interface board, which calls to the related interface subroutines in BASIC, though the principles will be similar in other languages. The device name of the oscilloscope is defined as **SCOPE%** in the examples, but you can substitute any valid device name.

Use the two tables that precede the descriptions to quickly find a command or query. The first of these lists the commands and queries in alphabetical order according to their long form. The second table groups them according to the subsystem or category they belong to.

COMMAND NOTATION

The following notation is used in the commands:

< >	Angular brackets enclose words that are used as placeholders, of which there are two types: the header path and the data parameter of a command.
: =	A colon followed by an equals sign separates a placeholder from the description of the type and range of values that can be used in a command instead of the placeholder.
{ }	Braces enclose a list of choices, one of which must be made.
[ ]	Square brackets enclose optional items.
…	An ellipsis indicates that the items left and right of it can be repeated any number of times.

Example: consider the syntax notation for the command to set the vertical input sensitivity:

1. <channel> : `VOLT_DIV` <v_gain>
2. <channel> : = {`C1`, `C2`}
3. <v_gain> : = 5.0 mV to 2.5 V

The first line shows the formal appearance of the command: <channel> denotes the placeholder for the header path; <v_gain> is the placeholder for the vertical gain value.

The second line indicates that either `C1` or `C2` must be chosen for the header path.

The third line means that the actual vertical gain can be set to any value from 5 mV to 2.5 V.

Table of Commands and Queries — By Short Form

SHORT FORM	LONG FORM	SUBSYSTEM (CATEGORY)	WHAT THE COMMAND OR QUERY DOES
ALST?	**ALL_STATUS?**	STATUS	Reads and clears the contents of all status registers.
ARM	**ARM_ACQUISITION**	ACQUISITION	Changes acquisition state 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.
ACAL	**AUTO_CALIBRATE**	MISCELLANEOUS	Enables and disables automatic calibration
BUZZ	**BUZZER**	MISCELLANEOUS	Controls the buzzer in the instrument.
BWL	**BANDWIDTH_LIMIT**	ACQUISITION	Enables/disables bandwidth-limiting low-pass filter.
***CAL?**	***CAL?**	MISCELLANEOUS	Performs a complete internal calibration of the DSO.
CFMT	**COMM_FORMAT**	COMMUNICATION	Selects the format for sending waveform data.
CHDR	**COMM_HEADER**	COMMUNICATION	Controls formatting of query responses.
CHLP	**COMM_HELP**	COMMUNICATION	Controls operational level of the RC Assistant.
CHL	**COMM_HELP_LOG**	COMMUNICATION	Returns the contents of the RC Assistant log.
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**	COMMUNICATION	Controls the byte order of waveform data transfers.
COUT	**CAL_OUTPUT**	MISCELLANEOUS	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.
CRST	**CURSOR_SET**	CURSOR	Allows positioning of any cursor.
CRVA?	**CURSOR_VALUE?**	CURSOR	Returns trace values measured by specified cursors.
CRS	**CURSORS**	CURSOR	Sets the cursor type.
DATE	**DATE**	MISCELLANEOUS	Changes the date/time of the internal real-time clock.
DDR?	**DDR?**	STATUS	Reads, clears the Device Dependent Register (DDR).
DEF	**DEFINE**	FUNCTION	Specifies math expression for function evaluation.
DELF	**DELETE_FILE**	MISCELLANEOUS	Deletes a file from the currently selected directory.
DIR	**DIRCTORY**	MISCELLANEOUS	Creates or deletes directories, or changes current one.
DISP	**DISPLAY**	DISPLAY	Controls the display screen.
DTJN	**DOT_JOIN**	DISPLAY	Controls the interpolation lines between data points.
MAIL	**EMAIL**	MISCELLANEOUS	Sets up email protocol and addresses.
***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).
FCR	**FIND_CENTER_RANGE**	FUNCTION	Automatically sets the center and width of a histogram.
FRTR	**FORCE_TRIGGER**	ACQUISITION	Forces the instrument to make one acquisition.

SHORT FORM	LONG FORM	SUBSYSTEM (CATEGORY)	WHAT THE COMMAND OR QUERY DOES
FRST	FUNCTION_RESET	FUNCTION	Resets a waveform-processing function.
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?	MISCELLANEOUS	For identification purposes.
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.
OFST	OFFSET	ACQUISITION	Allows output channel vertical offset adjustment.
OFCT	OFFSET_CONSTANT	CURSOR	Sets offset to be fixed in either divisions or volts.
*OPC	*OPC	STATUS	Sets the OPC bit in the Event Status Register (ESR).
*OPT?	*OPT?	MISCELLANEOUS	Identifies oscilloscope options.
PNSU	PANEL_SETUP	SAVE/RECALL	Complements the *SAV/*RST commands.
PARM	PARAMETER	CURSOR	Controls the parameter mode.
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.
PAST?	PARAMETER_STATISTICS?	CURSOR	Returns parameter statistics results.
PAVA?	PARAMETER_VALUE?	CURSOR	Returns current parameter, mask test values.
PF	PASS_FAIL	CURSOR	Sets up pass fail system.
PFDO	PASS_FAIL_DO	CURSOR	Defines outcome and actions for Pass/Fail
PERS	PERSIST	DISPLAY	Enables or disables the persistence display mode.
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.
PESA	PERSIST_SAT	DISPLAY	Sets the color saturation level in persistence.
PESU	PERSIST_SETUP	DISPLAY	Selects display persistence duration.
*PRE	*PRE	STATUS	Sets the PaRallel poll Enable register (PRE).
*RCL	*RCL	SAVE/RECALL	Recalls one of five non-volatile panel setups.
RCPN	RECALL_PANEL	SAVE/RECALL	Recalls a front panel setup from mass storage.
RCLK	REFERENCE_CLOCK	SAVE/RECALL	Toggles between internal clock and external clock.
*RST	*RST	SAVE/RECALL	Initiates a device reset.
*SAV	*SAV	SAVE/RECALL	Stores current state in non-volatile internal memory.

SHORT FORM	LONG FORM	SUBSYSTEM (CATEGORY)	WHAT THE COMMAND OR QUERY DOES
SCLK	**SAMPLE_CLOCK**	ACQUISITION	Toggles between internal clock and external clock.
SCDP	**SCREEN_DUMP**	HARD COPY	Initiates a screen dump.
SEQ	**SEQUENCE**	AQUISITION	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.
STOP	**STOP**	ACQUISITION	Immediately stops signal acquisition.
STO	**STORE**	WAVEFORM TRANSFER	Stores a trace in internal memory or mass storage.
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.
TRFL	**TRANSFER_FILE**	WAVEFORM TRANSFER	Transfers ASCII files to and from storage media, or between scope and computer.
***TRG**	***TRG**	ACQUISITION	Executes an ARM command.
TRCP	**TRIG_COUPLING**	ACQUISITION	Sets the coupling mode of the specified trigger source.
TRDL	**TRIG_DELAY**	ACQUISITION	Sets the time at which the trigger is to occur.
TRLV	**TRIG_LEVEL**	ACQUISITION	Adjusts the trigger level of the specified trigger source.
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.
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.

Table of Commands and Queries — By Subsystem

SHORT FORM	LONG FORM	WHAT THE COMMAND OR QUERY DOES
	ACQUISITION — TO CONTROL WAVEFORM CAPTURE	
ARM	ARM_ACQUISITION	Changes acquisition state from “stopped” to “single.”
ASET	AUTO_SETUP	Adjusts vertical, timebase and trigger parameters for signal display.
ATTN	ATTENUATION	Selects the vertical attenuation factor of the probe.
BWL	BANDWIDTH_LIMIT	Enables or disables the 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 or disables Random Interleaved Sampling (RIS).
MSIZ	MEMORY_SIZE	Allows selection of maximum memory length.
OFST	OFFSET	Allows vertical offset adjustment of the specified input channel.
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.
*TRG	*TRG	Executes an ARM command.
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.
TRLV	TRIG_LEVEL	Adjusts the level of the specified trigger source.
TRMD	TRIG_MODE	Specifies Trigger mode.
TRPA	TRIG_PATTERN	Defines a trigger pattern.
TRSE	TRIG_SELECT	Selects the condition that will trigger acquisition.
TRSL	TRIG_SLOPE	Sets the slope of the specified trigger source.
VDIV	VOLT_DIV	Sets the vertical sensitivity in volts/div.
WAIT	WAIT	Prevents new command analysis until current acquisition completion.
	AUTOMATION — TO SEND AUTOMATION COMMANDS	
VBS	VBS	Send Automation commands.
	COMMUNICATION — TO SET COMMUNICATION CHARACTERISTICS	
CFMT	COMM_FORMAT	Selects the format to be used for sending waveform data.
CHDR	COMM_HEADER	Controls formatting of query responses.
CHLP	COMM_HELP	Controls operational level of the RC Assistant.
CHL	COMM_HELP_LOG	Returns the contents of the RC Assistant log.
CORD	COMM_ORDER	Controls the byte order of waveform data transfers.

SHORT FORM	LONG FORM	WHAT THE COMMAND OR QUERY DOES
		CURSOR — TO PERFORM MEASUREMENTS
CRMS	CURSOR_MEASURE	Specifies the type of cursor or parameter measurement for display.
CRST	CURSOR_SET	Allows positioning of any cursor.
CRVA?	CURSOR_VALUE?	Returns the values measured by the specified cursors for a given trace.
CRS	CURSORS	Sets the cursor type.
OFCT	OFFSET_CONSTANT	Sets offset to be constant in divisions or volts.
PARM	PARAMETER	Controls the parameter mode.
PACL	PARAMETER_CLR	Clears all current parameters in Custom and Pass/Fail modes.
PACU	PARAMETER_CUSTOM	Controls parameters with customizable qualifiers.
PADL	PARAMETER_DELETE	Deletes a specified parameter in Custom and Pass/Fail modes.
PAST?	PARAMETER_STATISTICS	Returns parameter statistics results.
PAVA?	PARAMETER_VALUE?	Returns current value(s) of parameter(s) and mask tests.
PF	PASS_FAIL	Sets up the Pass / Fail system.
PFDO	PASS_FAIL_DO	Defines outcome and actions for the Pass/Fail system.
PECS	PER_CURSOR_SET	Positions one of the six independent cursors.
		DISPLAY — TO DISPLAY WAVEFORMS
DISP	DISPLAY	Controls the oscilloscope display screen.
DTJN	DOT_JOIN	Controls the interpolation lines between data points.
GRID	GRID	Specifies grid display in single, dual or quad mode.
HMAG	HOR_MAGNIFY	Horizontally expands the selected expansion trace.
HPOS	HOR_POSITION	Horizontally positions the intensified zone's center on the source trace.
INTS	INTENSITY	Controls the brightness of the grid on the instrument screen.
MSG	MESSAGE	Displays a string of characters on the instrument screen for a short time.
PERS	PERSIST	Enables or disables the Persistence Display mode.
PECL	PERSIST_COLOR	Controls color rendering method of persistence traces.
PELT	PERSIST_LAST	Shows the last trace drawn in a persistence data map.
PESA	PERSIST_SAT	Sets the color saturation level in persistence.
PESU	PERSIST_SETUP	Selects display persistence duration in Persistence mode.
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 — TO PERFORM WAVEFORM MATHEMATICAL OPERATIONS
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.

SHORT FORM	LONG FORM	WHAT THE COMMAND OR QUERY DOES
		HARD COPY — TO PRINT THE CONTENTS OF THE DISPLAY
HCSU	**HARDCOPY_SETUP**	Configures the hard-copy driver.
SCDP	**HARDCOPY_SETUPSCREEN_ DUMP**	Initiates a screen dump.
		MISCELLANEOUS
ACAL	**AUTO_CALIBRATE**	Enables or disables automatic calibration
BUZZ	**BUZZER**	Controls the buzzer in the instrument.
***CAL?**	***CAL?**	Performs a complete internal calibration
COUT	**CAL_OUTPUT**	Sets the type of signal put out at the CAL connector.
DATE	**DATA**	Changes the date/time of the internal real-time clock.
DELF	**DELETE_FILE**	Deletes a file from the currently selected directory.
DIR	**DIRECTORY**	Creates or deletes directories, or changes the current directory.
MAIL	**EMAIL**	Sets up email protocol and addresses.
***IDN?**	***IDN?**	Used for identification purposes.
***OPT?**	***OPT?**	Identifies the installed oscilloscope options.
		SAVE/RECALL SETUP — TO PRESERVE AND RESTORE FRONT PANEL SETTINGS
PNSU	**PANEL_SETUP**	Complements the *SAV/*RST commands.
***RCL**	***RCL**	Recalls one of five non-volatile panel setups.
RCPN	**RECALL_PANEL**	Recalls a front panel setup from mass storage.
***RST**	***RST**	Initiates a device reset.
***SAV**	***SAV**	Stores the current state in non-volatile internal memory.
STPN	**STORE_PANEL**	Stores the complete front panel setup on a mass-storage file.
		STATUS — TO OBTAIN STATUS INFORMATION AND SET UP SERVICE REQUESTS
ALST?	**ALL_STATUS?**	Reads and clears the contents of all (but one) of the status registers.
***CLS**	***CLS**	Clears all the status data registers.
CMR?	**CMR?**	Reads and clears the contents of the CoMmand error Register (CMR).
DDR?	**DDR?**	Reads and clears the Device-Dependent error Register (DDR).
***ESE**	***ESE**	Sets the standard Event Status Enable (ESE) register.
***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 the INternal state change Register (INR).
IST?	**IST?**	Individual STatus reads the current state of IEEE 488.
***OPC**	***OPC**	Sets to true the OPC bit (0) 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 IEEE 488.
***WAI**	***WAI**	WAIt to continue (required by IEEE 488)

SHORT FORM	LONG FORM	WHAT THE COMMAND OR QUERY DOES
		WAVEFORM TRANSFER — TO PRESERVE AND RESTORE WAVEFORMS
`INSP?`	`INSPECT?`	Allows acquired waveform parts to be read.
`STO`	`STORE`	Stores a trace in one of the internal memories M1–4 or mass storage.
`STST`	`STORE_SETUP`	Sets up waveform storage
`TMPL?`	`TEMPLATE?`	Produces a copy of the template describing a complete waveform.
`TRFL`	`TRANSFER_FILE`	Transfers ASCII files to and from storage media, or between scope and computer.
`WF`	`WAVEFORM`	Transfers a waveform from the controller to the oscilloscope.
`WFSU`	`WAVEFORM_SETUP`	Specifies amount of waveform data for transmission to controller.

STATUS **ALL_STATUS?, ALST?**

Query

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,`<value>`,ESR,`<value>`,INR,`<value>`,` `DDR,`<value>`,CMR,`<value>`,EXR,`<value>`,URR,`<value>

<value> : = 0 to 65535

EXAMPLE (GPIB)

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?`

ACQUISITION — ARM_ACQUISITION, ARM

Command

DESCRIPTION

The `ARM_ACQUISITION` command arms the scope and forces a single acquisition if it is already armed.

COMMAND SYNTAX

```
ARM_acquisition
```

EXAMPLE

The following instruction enables signal acquisition:

```
CMD$=“ARM”: CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`STOP, *TRG, TRIG_MODE, WAIT, FRTR`

ACQUISITION — ATTENUATION, ATTN

Command/Query

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`, `C2`, `C3`, `C4`, `EX`, `EX10`}
<attenuation> : = {`1`, `2`, `5`, `10`, `20`, `25`, `50`, `100`, `200`, `500`, `1000`, `10000`}

QUERY SYNTAX

<channel> : `ATTeNuation?`

RESPONSE FORMAT

<channel> : `ATTeNuation` <attenuation>

AVAILABILITY

<channel> : {C3, C4} available only on four-channel oscilloscopes.

EXAMPLE (GPIB)

The following instruction sets to 100 the attenuation factor of Channel 1:

```
CMD$="C1:ATTN 100": CALL IBWRT(SCOPE%,CMD$)
```

MISCELLANEOUS

AUTO_CALIBRATE, ACAL

Command/Query

DESCRIPTION

The AUTO_CALIBRATE command is used to enable or disable the automatic calibration of your X-Stream 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 will perform 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?

ACQUISITION AUTO_SETUP, ASET

Command

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 <channel> : AUTO_SETUP FIND command adjusts gain and offset only for the specified channel.

COMMAND SYNTAX

<channel> : Auto_SETup [FIND]

<channel> : = {C1, C2, C3, C4}

If the FIND keyword is present, gain and offset adjustments will be performed only on the specified channel. If no <channel> prefix is added, an auto-setup will be performed on the channel used on the last ASET FIND remote command. In the absence of the FIND keyword, the normal auto-setup will be performed, regardless of the <channel> prefix.

AVAILABILITY

<channel> : = {C3, C4} only on four-channel oscilloscopes.

EXAMPLE

The following instructs the oscilloscope to perform an auto-setup:

```
CMD$=“ASET”: CALL IBWRT(SCOPE%,CMD$)
```

ACQUISITION — BANDWIDTH_LIMIT, BWL

Command/Query

DESCRIPTION

`BANDWIDTH_LIMIT` enables or disables the bandwidth-limiting low-pass filter. The command is used to set the bandwidth individually for each channel. The response to the `BANDWIDTH_LIMIT?` query indicates whether the bandwidth filters are on or off.

COMMAND SYNTAX

`BandWidth_Limit` <mode>

`BandWidth_Limit` <channel>`,`<mode>[`,`<channel>`,`<mode>
[`,`<channel>`,`<mode>[`,`<channel>`,`<mode>]]]

<mode> : = {OFF, ON, 200MHZ,1GHZ,3GHZ*,4GHZ*}
Note: OFF = Full, ON = 20MHz
<channel> : = {`C1`, `C2`, `C3`, `C4`}

QUERY SYNTAX

`BandWidth_Limit?`

RESPONSE FORMAT

`BandWidth_Limit` <mode>

If at least two channels have their bandwidth limit filters set differently from one another, the response is:

`BandWidth_Limit` <channel>`,`<mode>[`,`<channel>`,`<mode>
[`,`<channel>`,`<mode>[`,`<channel>`,`<mode>]]]

AVAILABILITY

* Available only on 5 GHz and 6 GHz instruments, DDA-5005, and SDA

GPIB EXAMPLE

The following instruction asserts bandwidth limit on channel 1:

```
CMD$="BWL C1,ON": CALL IBWRT(SCOPE%,CMD$)
```

MISCELLANEOUS — BUZZER, BUZZ

Command

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$="BUZZ BEEP;BUZZ BEEP":
CALL IBWRT(SCOPE%<CMD$)
```

MISCELLANEOUS **`*CAL?`**

Query

DESCRIPTION

The `*CAL?` query causes the oscilloscope to perform an internal self-calibration and generates a response that indicates whether or not your oscilloscope completed the calibration 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 has indicated how the calibration terminated, 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?. That is, *CAL? may be used whether AUTO_CALIBRATE has been set on or off.

QUERY SYNTAX

`*CAL?`

RESPONSE FORMAT

`*CAL` <diagnostics>

<diagnostics> : = `0` or other

`0` = Calibration successful

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`

MISCELLANEOUS — CAL_OUTPUT, COUT

Command/Query

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> : = 5 mV to 1.00 V into 1 MΩ
<rate> : = 5 Hz to 5 MHz.

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

ADDITIONAL INFORMATION

NOTATION	
`CALSQ`	Provides a square signal
`LEVEL`	Provides a DC signal at the requested level
`OFF`	Provides no signal (ground level)
`PF`	Pass/Fail mode
`PULSE`	Provides a single pulse
`TRIG`	Trigger Out mode

FUNCTION **CLEAR_MEMORY, CLM**

Command

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`, `M2`, `M3`, `M4`}

EXAMPLE (GPIB)

The following instruction clears the memory M2.

```
CMD$="CLM M2": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`STORE`

FUNCTION — CLEAR_SWEEPS, CLSW

Command

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 will restart the cumulative processing:

```
CMD$="CLSW": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`INR`

STATUS ***CLS**

Command

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`

STATUS **CMR?**

Query

DESCRIPTION

The CMR? query reads and clears the contents of the CoMmand error Register (see table next page) which specifies the last syntax error type detected by your oscilloscope.

QUERY SYNTAX

`CMR?`

RESPONSE FORMAT

`CMR` <value>

<value> : = 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`

ADDITIONAL INFORMATION

COMMAND ERROR STATUS REGISTER STRUCTURE (CMR)	
Value	**Description**
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

ACQUISITION **COMBINE_CHANNELS, COMB**

Command/Query

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}

Selecting **1** means no combining of channels will take place; i.e., in the Timebase (Horizontal) dialog, 4 channels will be shown as the selection.

QUERY SYNTAX

COMBine_channels?

RESPONSE FORMAT

COMB <state>

EXAMPLE (GPIB)

The following instruction engages channel interleaving between Channels 1 and 2, and Channels 3 and 4:

CMD$="COMB 2": CALL IBWRT(SCOPE%,CMD$)

The following instruction sets Auto-Combine mode:

CMD$="COMB AUTO": CALL IBWRT(SCOPE%,CMD$)

RELATED COMMANDS

TDIV

COMMUNICATION **COMM_FORMAT, CFMT**

Command/Query

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.

The `COMM_FORMAT?` query returns the currently selected waveform data format.

COMMAND SYNTAX

`Comm_ForMaT` <block_format>`,`<data_type>`,`<encoding>

<block_format> : = {`DEF9`}
<data_type> : = {`BYTE`, `WORD`}
<encoding> : = {`BIN`}

Initial settings (i.e. after power-on) are:
For GPIB and LAN: `DEF9`, `WORD`, `BIN`

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. The data will be transmitted as a block of definite length. Data will be coded in binary and represented as 8-bit integers.

```
CMD$="CFMT DEF9,BYTE,BIN": CALL
IBWRT(SCOPE%,CMD$)
```

ADDITIONAL INFORMATION

Block Format

DEF9:

Uses the IEEE 488.2 definite length arbitrary block response data format. 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>

where <DAB> represents an eight-bit binary data byte.

A <NL^END> (new line with EOI) signifies that block transmission has ended.

The same data bytes as above would be sent as:

`WF DAT1,#0`<DAB><DAB><DAB><NL^END>

NOTE:* *The 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:	Binary encoding

RELATED COMMANDS `WAVEFORM`

COMMUNICATION

COMM_HEADER, CHDR

Command/Query

DESCRIPTION

The `COMM_HEADER` command controls the way the oscilloscope formats responses to queries. There are three response formats: LONG, in which responses start with the long form of the header word; SHORT, where responses start with the short form of the header word; and OFF, for which headers are omitted from the response and units in numbers are suppressed.

Unless you request otherwise, the SHORT response format is used.

- This command does not affect the interpretation of messages sent to the oscilloscope. Headers can be sent in their long or short form regardless of the `COMM_HEADER` setting.
- Querying the vertical sensitivity of Channel 1 may result in one of the following responses:

COMM_HEADER	**RESPONSE**
LONG	C1:VOLT_DIV 200E-3 V
SHORT	C1:VDIV 200E-3 V
OFF	200E-3

COMMAND SYNTAX

`Comm_HeaDeR` <mode>

<mode> : = {`SHORT`, `LONG`, `OFF`}

QUERY SYNTAX

`Comm_HeaDeR?`

RESPONSE FORMAT

`Comm_HeaDeR` <mode>

EXAMPLE (GPIB)

The following code sets the response header format to SHORT:

```
CMD$=“CHDR SHORT”: CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`COMM_HELP_LOG`

COMMUNICATION — `COMM_HELP, CHLP`

Command/Query

DESCRIPTION

The `COMM_HELP` command controls the level of operation of the diagnostics utility Remote Control Assistant, which assists in debugging remote control programs. Selected using your instrument's Utilities menu, 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 and can choose from three levels:

`OFF`	Don't assist at all.
`EO`	Log detected Errors Only (default after power-on).
`FD`	Log the Full Dialog between the controller and the oscilloscope.

COMMAND SYNTAX

`Comm_HeLP` <level>,<reset at power on>

<level> : = {`OFF`, `EO`, `FD`}

<reset at power on> : = { `NO,YES`}

The default <level> is EO.

If <reset at power on> is set to YES (default), 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.

Note: Setting CHLP EO, NO is useful in logging command sequences that include rebooting the oscilloscope.

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 will be logged:

```
CMD$=“CHLP FD”: CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`COMM_HELP_LOG`

COMMUNICATION — COMM_HELP_LOG?, CHL?

Query

DESCRIPTION

The `COMM_HELP_LOG` query returns the current contents of the log generated by the Remote Control Assistant (see `CHLP` description). If the optional parameter `CLR` is specified, the log will be cleared after the transmission. Otherwise, it will be kept.

QUERY SYNTAX

`Comm_HeLP_Log?` [`CLR`]

RESPONSE FORMAT

`Comm_Help_Log` <string containing the logged text>

EXAMPLE (GPIB)

The following instruction reads the remote control log and prints it:

```
CMD$=“CHL?”: CALL IBWRT(SCOPE%,CMD$)PRINT
```

RELATED COMMANDS

`COMM_HELP`

COMMUNICATION COMM_ORDER, CORD

Command/Query

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, i.e. 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

The order of transmission of waveform data depends on the data type. The following table illustrates the different possibilities:

TYPE	CORD HI	CORD 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`

ACQUISITION

COUPLING, CPL

Command/Query

DESCRIPTION

The `COUPLING` command selects the coupling mode of the specified input channel.

The `COUPLING?` query returns the coupling mode of the specified channel.

COMMAND SYNTAX

<channel> : `CouPLing` <coupling>

<channel> : = {`C1`, `C2`, `C3`, `C4`, `EX`, `EX10`, `ETM10`}

<coupling> : = {`A1M*`, `D1M*`, `D50`, `GND`}

QUERY SYNTAX

<channel> : `CouPLing?`

RESPONSE FORMAT

<channel> : `CouPLing` <coupling>

<coupling> : = {`A1M`, `D1M`, `D50`, `GND`, `OVL`}

<coupling> : `OVL` is returned in the event of signal overload while in DC 50 Ω coupling. In this condition, the oscilloscope will disconnect the input.

AVAILABILITY

<channel> : = {C3, C4} only on four-channel instruments.

* attenuation pertains only to instruments with a probe connected

EXAMPLE (GPIB)

The following instruction sets the coupling of Channel 2 to 50 Ω DC:

```
CMD$=“C2:CPL D50”: CALL IBWRT(SCOPE%,CMD$)
```

CURSOR

CURSOR_MEASURE, CRMS

Command/Query

DESCRIPTION

The CURSOR_MEASURE command specifies the type of cursor or parameter measurement to be displayed, and is the main command for displaying parameters and Pass/Fail.

The modes PARAM, SHOW DASH, and LIST used in some earlier LeCroy instruments are not available in X-Stream instruments.

The CURSOR_MEASURE? query indicates which cursors or parameter measurements are currently displayed.

NOTATION	
CUST [,STAT]	custom parameters
FAIL	Pass/Fail: fail
HABS	horizontal absolute cursors
HPAR [,STAT]	standard time parameters
HREL [,ABS,DELTA,SLOPE]	horizontal relative cursors
OFF	cursors and parameters off
PASS	Pass/Fail: pass
VABS	vertical absolute cursors
VPAR [,STAT]	standard voltage parameters
VREL [,ABS,DELTA]	vertical relative cursors

COMMAND SYNTAX

CuRsor_MeaSure <mode>[,<submode>]

<mode> : = {CUST, FAIL, HABS, HPAR, HREL, OFF, PASS, VABS, VPAR, VREL}

<submode> : = {STAT, ABS,DELTA,SLOPE}

NOTE: The keyword STAT is optional with modes CUST, HPAR, and VPAR. If present, STAT turns parameter statistics on. Absence of STAT turns parameter statistics off.

The submodes ABS, DELTA, SLOPE are optional with mode HREL. If it is present, ABS chooses absolute amplitude reading of relative cursors. Absence of keyword selects relative, DELTA, amplitude reading of relative cursors. Submodes ABS and DELTA are used with VREL; presence of ABS selects absolute amplitude, absence selects DELTA.

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 of response message:

```
CRMS OFF
```

RELATED COMMANDS

`CURSOR_SET, PARAMETER_STATISTICS, PARAMETER_VALUE, CURSORS, PARAMETER, PASS_FAIL`

ADDITIONAL INFORMATION

To turn off the cursors, parameter measurements or Pass/Fail tests, use:

```
CURSOR_MEASURE OFF
```

To turn on a cursor display, use one of these five forms:

```
CURSOR_MEASURE HABS
CURSOR_MEASURE HREL
CURSOR_MEASURE VABS
CURSOR_MEASURE VREL
CURSOR_MEASURE FAIL
```

CURSOR

CURSOR_SET, CRST

Command/Query

DESCRIPTION

The `CURSOR_SET` command allows you to position any one of the independent cursors at a given grid location.

When you are setting a cursor position, you must specify a trace, relative to which the cursor will be positioned. This means that the trace must be turned on, a requirement that does not apply to all earlier LeCroy instruments. Also new to X-Stream instruments is that PREF and PDIF are not supported, because each parameter has its own independent gate.

NOTE: To change only the trace without repositioning the cursors, the CURSOR_SET command can be given with no argument (for example, F2:CRST).

The `CURSOR_SET?` query indicates the current position of the cursor(s). The values returned depend on the grid type selected.

NOTATION			
HABS	horizontal absolute	VABS	vertical absolute
HDIF	horizontal difference	VDIF	vertical difference
HREF	horizontal reference	VREF	vertical reference

COMMAND SYNTAX

<trace> : `CuRsor_SeT` <cursor>,<position>[,<cursor>,<position>, <cursor> ,<position>]

<trace> : = {F1, F2, F3, F4, F5, F6, F7, F8, TA, TB, TC, TD, C1, C2, C3, C4,M1,M2,M3,M4} TA through TD are for compatibility with existing software with earlier instruments. These four mnemonics are not returned by queries.

<cursor> : = {HABS, VABS, HREF, HDIF, VREF, VDIF}

<position> : = 0 to 10 DIV (horizontal)

<position> : = -3.99 to 3.99 DIV (vertical)

NOTE: Parameters are grouped in pairs. The first parameter specifies the cursor to be modified and the second one indicates its new value. Parameters can be grouped in any order and restricted to those items to be changed.

The unit DIV is optional.

QUERY SYNTAX

<trace> : `CuRsor_SeT?` <cursor> – only if the cursors are visible. No <cursor> implies ALL, even though all are not visible.

<cursor> : = {`HABS`, `VABS`, `HREF`, `HDIF`, `VREF`, `VDIF`, `ALL`}

RESPONSE FORMAT

<trace> : `CuRsor_SeT`
<cursor>`,`<position>[`,`<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.

AVAILABILITY

<trace> : {C3, C4} available only on four-channel oscilloscopes.

EXAMPLE (GPIB)

The following instruction positions the VREF and VDIF cursors at +3 DIV and -2 DIV respectively, using Trace F1 as a reference:

```
CMD$="F1:CRST VREF,3DIV,VDIF,-2DIV":
CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`CURSOR_MEASURE, CURSOR VALUE, PARAMETER_VALUE`

CURSOR

CURSOR_VALUE?, CRVA?

Query

DESCRIPTION

The CURSOR_VALUE? query returns the values measured by the specified cursors for a given trace. (The PARAMETER_VALUE? query is used to obtain measured waveform parameter values.)

There are important differences in the function of this command between X-Stream instruments and earlier LeCroy instruments.

The keyword ALL should NOT be used, neither should multiple keywords. If they are used, the word UNDEF will be returned.

For the CRVA? query to work, the specified trace MUST be visible, and the current cursor mode must be the same as in the query. If it is not the same, UNDEF will be returned.

NOTATION	
HABS	horizontal absolute
HREL	horizontal relative

QUERY SYNTAX

<trace> : CuRsor_VAlue? [<mode>]

<trace> : = {F1, F2, F3, F4, F5, F6, F7, F8, TA, TB, TC, TD, C1, C2, C3, C4} TA through TD are for compatibility with existing software with earlier instruments. These four mnemonics are not returned by queries.

<mode> : = {HABS, HREL, VABS, VREL }

RESPONSE FORMAT

<trace> : CuRsor_VAlue HABS,<abs_hori>,<abs_vert>

<trace> : CuRsor_VAlue HREL,<delta_hori>,<delta_vert>, <abs vert_ref>,<abs vert_dif>,<slope>. The dV/dt value <slope> is displayed in the appropriate trace label box.

<trace> : CuRsor_VAlue VABS,<abs_vert>

<trace> : CuRsor_VAlue VREL,<delta_vert>

For horizontal cursors, both horizontal as well as vertical values are given. For vertical cursors only vertical values are given.

AVAILABILITY

<trace> : = {C3, C4} available only on four-channel oscilloscopes.

EXAMPLE (GPIB)

The following query reads the measured absolute horizontal value of the cross-hair cursor (HABS) on Channel 2:

```
CMD$="C2:CRVA? HABS": CALL
IBWRT(SCOPE%,CMD$):
```

```
CALL IBRD(SCOPE%,RSP$): PRINT RSP$
```

Response message:

```
C2:CRVA HABS,34.2E-6 S, 244 E-3 V
```

CURSORS

CURSORS, CRS

Command/Query

DESCRIPTION

Sets the type of cursor to be used and the readout. Unlike CRMS, this will not change the state of parameters or pass/fail.

COMMAND SYNTAX

```
CURSORS <type>[,<readout>]
```

<type>:=[OFF,HREL,HABS,VREL,VABS]

<readout>:=[ABS,SLOPE,DELTA] for HREL

<readout>:=[ABS,DELTA] for VREL

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

DATE

DATE

Command/Query

DESCRIPTION

Sets the date and time of the real-time clock in the instrument. Note that you do not need to specify any parameters after the one you want to change, but you MUST include all those before it.

COMMAND SYNTAX A

```
DATE
<day>[,<month>][,<year>][,<hour>][,<minute>][
,<second>]
```

COMMAND SYNTAX B

`DATE SNTP` (to set the date and the time from the internet.

QUERY SYNTAX

```
DATE?
```

EXAMPLE (GPIB)

The following instruction sets the date to January 1, 1997, and the time to 1:21:16.

```
CMD$="DATE 1,JAN,1997,13,21,16"
CALL IBWRT(SCOPE%,CMD$)
```

STATUS

DDR?
Query

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. The following table gives details.

BIT	BIT VALUE	DESCRIPTION	
15...14		0	Reserved
13	8192	1	Timebase hardware failure detected
12	4096	1	Trigger hardware failure detected
11	2048	1	Channel 4 hardware failure detected
10	1024	1	Channel 3 hardware failure detected
9	512	1	Channel 2 hardware failure detected
8	256	1	Channel 1 hardware failure detected
7	128	1	External input overload condition detected
6...4		0	Reserved
3	8	1	Channel 4 overload condition detected
2	4	1	Channel 3 overload condition detected
1	2	1	Channel 2 overload condition detected
0	1	1	Channel 1 overload condition detected

QUERY SYNTAX

`DDR?`

RESPONSE FORMAT

`DDR` <value>

<value> : = 0 to 65535

FUNCTION — DEFINE, DEF

Command/Query

DESCRIPTION

The `DEFINE` command specifies the mathematical expression to be evaluated by a function. This command is used to control all math tools and zoom in the standard oscilloscope as well as those in the optional math software packages. See the *Operator's Manual* for details.

COMMAND SYNTAX

<function> `: DEFine EQN,'`<equation>`'`
`[,`<param_name>`,`<value>`,`...]

NOTE: Function parameters are grouped in pairs. The first in the pair names the variable to be modified, <param_name>, while the second one gives the new value to be assigned. Pairs can be given in any order and restricted to the variables to be changed.

Space (blank) characters inside equations are optional.

QUERY SYNTAX

<function> `: DEFine?`

RESPONSE FORMAT

<function> `: DEFine EQN,'`<equation>`'[,MAXPTS,`<max_points>]
`[,SWEEPS,`<max_sweeps>`][,WEIGHT,`<weight>`][,BITS,`<bits>]

FUNCTION PARAMETERS		
<param_name>	**<value>**	**Description**
`BITS`	<bits>	Number of ERES bits
`CENTER`	<center>	Horizontal center position for histogram display.
`EQN`	'<equation>'	Function equation as defined below
`LENGTH`	<length>	Number of points to use from first waveform
`MAX_EVENTS`	<max_values>	Maximum number of values in histogram
`MAXBINS`	<bins>	Number of bins in histogram
`START`	<start>	Starting point in second waveform

SWEEPS	<max_sweeps>	Maximum number of sweeps
UNITS	<units>	Physical units
VERT	<vert_scale>	Vertical scaling type
WEIGHT	<weight>	Continuous Average weight
WIDTH	<width>	Width of histogram display
WINDOW	<window_type>	FFT window function

FUNCTION EQUATIONS AND NAMES		
NOTES: These functions are available according to the options installed in your X-Stream oscilloscope. It can be very useful to run a function in query mode to determine whether it is available in your oscilloscope, and to determine the current form of the command in your model. The response to any query can be copied straight into a program and used as a command. Functions can also be defined using the VBS command (see Chapter 6). ***Underlined names in the left column of this table represent Boolean expressions, which take the values ON and OFF.***		
<source1>-<source2>	DIFFERENCE	Difference of two waveforms
-<source>	INVERSION	Inversion (negation) of waveform
<source1>*<source2>	PRODUCT	Product of two waveforms
<source1>/<source2>	RATIO	Ratio of two waveforms
1/<source>	RECIPROCAL	Reciprocal of a waveform
<source1>+<source2>	SUM	Sum of two waveforms
ABS(<source>)		Absolute Value
AVG(<source>),<averagetype>,<sweeps>,<sumhelptext>,<continuoushelptext>		AVERAGETYPE is SUMMED or CONTINUOUS.
BOXCAR(<source>),<length>		Boxcar average with specified filter length
CORR(<source1>,<source2>),<corrlength>,<corrstart>		Correlation of two waveforms with specified correlation length and start point
DERI(<source>),<verscale>,<veroffset>,<enableautoscale>		Derivative of waveform using subtraction of adjacent samples
<source1>-<source2>	DIFFERENCE	Difference between two waveforms
DESKEW,(<source>),<wavedeskew>		Shift a waveform in time by a specified amount

ERES(<source>),<bits>	Smoothing function defined by 0.5, 1.0, 1.5, 2.0, 2.5 or 3.0 extra bits of resolution
EXCELMATH(<source1>,<source2>),<source1cell>,<source2cell>,<outputcell>,<source1headercell>,<source2headercell>,<outputheadercell>,<withheader>,<outputenable>,<source1enable>,<source2enable>,<newsheet>,<advanced>,<scaling>,<spreadsheetfilename>	Perform math in Excel. <scaling>:=AUTOMATIC, MANUAL, FROMSHEET
EXP(<source>)	Exponential (power of e)
EXP10(<source>)	Exponential (power of 10)
EXTR(<source>),<sweeps>	Extrema (Roof and Floor) of waveform
FFT(<source>),<type>,<window>,<algorithm>,<filltype>,<suppressdc>	Fast Fourier transform of waveform. Available values are as follows – <type>:=REAL, IMAGINARY, MAGNITUDE, PHASE, POWERSPECTRUM, POWERDENSITY <window>:=BLACKMANHARRIS, FLATTOP, HAMMING, RECTANGULAR, VONHANN <algorithm>:=LEASTPRIME, POWER2 <filltype>:=TRUNCATE, ZEROFILL
FILTER(<source>),<firoriir>,<filterkind>,<filtertype>,<window>,<kaiserbeta>,<gaussianbt>,<cosinebeta>,<transitionwidh>,<f3dbwidth>,<stopbandattenuation>,<passbandripple>,<lowfreqstop>,<lowfreqpass>,<f3dbfreq>,<cornerfreq>,<centerfreq>,<highfreqstop>,<highfreqpass>,<rolloff>,<numberoftaps>,<numberofstages>,<advanced>,<autolength>	Digital filter
FIR(<source>),<type>,<window>,<cutoff>,<coefficients>	Finite impulse response filter
FLOOR(<source>),<sweeps>	Lowest vertical value at each X value in N sweeps
GFILL(<source>),<samplesperperiod>,<sourcefrequency>,<time1>,<time2>,<setwindow>,<areatofill>,<windowstart>,<windowstop>	
HIST(<source>),<values>,<bins>,<horscale>,<center>,<verscaletype>,<autofindscale>	Histogram of parameter values. VERSCALETYPE can be LINEAR or LINCONSTMAX.
HISTD(<source>),<verscaletype>	Histogram of data
HSUM(<source>),<verscaletype>	Sum of a sequence of histograms

IFFT(<source>)	Inverse FFT, real output from complex input -<source> INVERT Inversion (negation) of waveform.
INTG(<source>),<multiplier>,<adder>,<verscale>,<veroffset>	
INTRP(<source>),<interpolatetype>,<expand>	Interpolate extra points in waveform. INTERPOLATETYPE IS LINEAR, QUADRATIC, OR SINXX.
(-<source>) INVERT	Inversion (negation) of waveform
JITTERSIM	
LN(<source>)	Natural logarithm of waveform values
LOG10(<source>)	Base 10 logarithm of waveform values
LPFIR	
MCAD(<source1>,<source2>),<source1var>,<source2var>,<outputvar>,<source1headervar>,< source2headervar>,<outputheadervar>,<withheader>	Produces a waveform using Mathcad
MATLAB(<source1>,<source2>),<matlabcode>,<matlabplot>,<matlabzerooffset>,<matlabscaleperdiv>	Produces a waveform using MATLAB
PERHIST(<source>),<vercutcenter>,<vercutwidth>,<horcutcenter>,<horcutwidth>,<cutdirection>,<cuttype>, <cutwidth>	Histogram of a slice through a persistence map
PMEAN(<source>)	Waveform derived from the mean of a persistence map
PRANGE(<source>),<pctpopulation>	Waveform derived from the range of a persistence map
PSIGMA(<source>),<sigma>	Waveform derived from the st dev of a persistence map
PHSHIFT(<source>),<phase>	Change the phase of a set of complex data.
DESKEW(<source>),<wavedeskew> RESAMPLE	Shift a waveform in time.
RESC(<source>),<multiplier>,<adder>,<customunit>, <unit>	Rescale waveform as Out = A*Wave(In) + B
ROOF(<source>),<sweeps>	Highest Y value at each X in a set of waveforms
SEG(<source>),<selectedsegment>	Select one segment from a sequence
SINX(<source>)	Ten times interpolation using sin (x) / x
SLICE(<source1>,<source2>),<frequency>,<priorperiods>,<postperiods>,<parameter>	Slices waveform 2 to make many waveforms, using wf 1

SPACK(<source>)	Magnitude of complex result
SPARSE(<source>),<sparsingfactor>,<sparsingphase>	Produces as waveform with fewer points than the input.
SQR(<source>)	Square of a waveform
SQRT(<source>)	Square root of waveform values
TRACK(<source>),<autofindscale>,<verscale>,<center>	Track of the values of a parameter
TREND(<source>),<verscale>,<center>,<autofindscale>	Trend of the values of a parameter
WAVESCRIPT(<source1>,<source2),<language>,<code>,<status>,<timeout>	Visual Basic script producing a waveform
ZOOMONLY(<source>)	Zoom of waveform

***NOTE:** The numbers in CUST1 through CUST8 refer to the column numbers of the selected custom parameters. TA, TB, TC and TD are included for compatibility with existing scopes such as WavePro scopes and Waverunner scopes. These four mnemonics are not returned in responses to queries.*

SOURCE VALUES

<sourceN> : = {F1, F2, F3, F4, F5, F6, F7, F8, TA, TB, TC, TD, M1, M2, M3, M4, C1, C2, C3, C4}. TA through TD are for compatibility with existing software with earlier instruments. These four mnemonics are not returned by queries. This is true for the following entries also.

<function> : = {F1,F2,F3,F4,F5,F6,F7,F8,TA,TB,TC,TD}

<custom_column> : = {CUST1,CUST2,CUST3,CUST4,CUST5, P1,P2,P3,P4,P5,P6,P7,P8} CUSTn are for backward compatibility, and are not returned by queries.

<extended_source> : = {C1,C2,C3,C4,F1,F2,F3,F4,F5,F6,F7,F8, TA,TB,TC,TD,M1,M2,M3,M4}

VALUES TO DEFINE NUMBER OF POINTS/SWEEPS:

<max_points> : = 50 to 10 000 000

<max sweeps> : = 1 to 1000

<max_sweeps> : = 1 to 1 000 000

<max_sweeps> : = 1 to 50 000

VALUES FOR RESCALE FUNCTION:

<addend> : = 0.0 to 1e15

<multiplier> : = 0.0 to 1e15

<units> : = {UNCHANGED, A, CEL, C, HZ, K, N, OHM, PAL, V, W, DB, DEG, PCT, RAD, S}

RESCALE PHYSICAL UNITS VALUE NOTATION			
UNCHANGED	The unit remains unchanged.	PAL	Pascal
A	Amperes	V	Volt
CEL	Celsius	W	Watt
C	Coulomb	DB	decibel
HZ	Hertz	DEG	degree
K	Kelvin	PCT	percent
N	Newton	RAD	radian
OHM	Ohm	S	second

AVAILABILITY

<sourceN> : = {C3, C4} only on four-channel oscilloscopes.

<extended_source> : = {C3, C4} only on four-channel oscilloscopes

EXAMPLES (GPIB)

The following instruction defines Trace F1 to compute the summed average of Channel 1 over 200 sweeps:

```
CMD$="F1:DEF
EQN,‘AVG(C1)’,AVGTYPE,SUMMED,SWEEPS,200":
CALL IBWRT(SCOPE%,CMD$)
CALL IBWRT(SCOPE%,CMD$)
```

The following instruction defines Trace F1 to compute the product of Channel 1 and Channel 2:

```
CMD$=“F1:DEF EQN,‘C1*C2’”:
CALL IBWRT(SCOPE%,CMD$)
```

The following instruction defines Trace f1 to compute the Power Spectrum of the FFT of Channel 1. The window function is Rectangular.

```
CMD$=“F1:DEF EQN,‘PS(FFT(C1))’,WINDOW, RECT”:
CALL IBWRT(SCOPE%,CMD$)
```

The following instruction defines Trace F2 to compute the Power Average of the Power Spectrum of Channel 1, over a maximum of 244 sweeps.

```
CMD$=“F2:DEF EQN,
'AVG(FFT(C1))',TYPE,POWERSPECTRUM,WINDOW,RECTA
NGULAR,ALGORITHM,POWER2,
```

```
FILLTYPE,TRUNCATE,SUPPRESSDC,ON,AVERAGETYPE,SU
MMED,SWEEPS,244":
```

The following instruction defines Trace F3 to construct the histogram of the rise time measurements made on source Channel 1. The rise time measurement is defined on custom line 2. 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.

```
CMD$=“PACU 2,RISE,C1”:CALL IBWRT(SCOPE%,CMD$)
```

```
CMD$="F3:DEF
EQN,‘HIST(P2)',VALUES,1000,BINS,100,HORSCALE,1
S,CENTER,0E-12
S,VERSCALETYPE,LINEAR,AUTOFINDSCALE,ON":
```

```
CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

```
FIND_CTR_RANGE, FUNCTION_RESET, INR?,
PARAMETER_CUSTOM, PARAMETER_VALUE?,
PASS_FAIL_CONDITION
```

MORE EXAMPLES OBTAINED USING F1:DEF?

NOTE New lines in these examples have been inserted for clarity. The actual strings are continuous.

F1:DEF EQN,"CORR(C1,C2)",CORRLENGTH,5 DIV,CORRSTART,0E-3 DIV

F1:DEF EQN,"DERI(C1)",VERSCALE,1E+6 V/S,VEROFFSET,48E+3 V/S,ENABLEAUTOSCALE,ON

```
F1:DEF EQN,"ERES(C1)",BITS,0.5

F1:DEF EQN,"EXCEL(C1,C2)",SOURCE1CELL,A2,SOURCE2CELL,B2,OUTPUTCELL,C2,
SOURCE1HEADERCELL,F2,SOURCE2HEADERCELL,G2,OUTPUTHEADERCELL,H2,
WITHHEADER,ON,OUTPUTENABLE,ON,SOURCE1ENABLE,ON,SOURCE2ENABLE,OFF,
NEWSHEET,ON,ADVANCED,OFF,SCALING,AUTOMATIC,
SPREADSHEETFILENAME,D:\TEST34.XLS

F1:DEF EQN,"FFT(C1)",TYPE,POWERSPECTRUM,WINDOW,RECTANGULAR,
ALGORITHM,LEASTPRIME,FILLTYPE,TRUNCATE,SUPPRESSDC,ON

F1:DEF EQN,"FILTER(C1)",FIRORIIR,FIR,FILTERKIND,LOWPASS,FILTERTYPE,BUTTERWORTH,
WINDOW,RECTANGULAR,KAISERBETA,0,GAUSSIANBT,30 PCT,COSINEBETA,30 PCT,
TRANSITIONWIDTH,100E+3 HZ,F3DBWIDTH,100E+3 HZ,STOPBANDATTENUATION,40 DB,
PASSBANDRIPPLE,1 DB,PASSBANDATTENUATION,1 DB,LOWFREQSTOP,1.1E+6 HZ,
LOWFREQPASS,1E+6 HZ,F3DBFREQ,1E+6 HZ,CORNERFREQ,1E+6 HZ,CENTERFREQ,1E+6 HZ,
HIGHFREQSTOP,10E+6 HZ,HIGHFREQPASS,10E+6 HZ,ROLLOFF,5 DB,
NUMBEROFTAPS,11,NUMBEROFSTAGES,4,ADVANCED,OFF,AUTOLENGTH,OFF

F1:DEF EQN,"FIR(C1)",TYPE,LOWPASS,WINDOW,RECTANGULAR,LFCUTOFF,1E+6 HZ,
COEFFICIENTS,32

F1:DEF EQN,"HIST(C1)",VALUES,1000,BINS,100,HORSCALE,50E-3 V,CENTER,-2E-3 V,
VERSCALETYPE,LINEAR,AUTOFINDSCALE,ON

F1:DEF EQN,"INTG(C1)",MULTIPLIER,1,ADDER,0E-12,VERSCALE,5E-9,VEROFFSET,7.703E-9

F1:DEF EQN,"INTRP(C1)",INTERPOLATETYPE,SINXX,EXPAND,10
```

```
F1:DEF EQN,"MCAD(C1, C2)",SOURCE1VAR,S1,SOURCE2VAR,S2,OUTPUTVAR,S1,
SOURCE1HEADERVAR,S1HDR,SOURCE2HEADERVAR,S2HDR,OUTPUTHEADERVAR,O1HDR,
WITHHEADER,ON,OUTPUTENABLE,ON,SOURCE1ENABLE,ON,SOURCE2ENABLE,OFF,
NEWSHEET,ON,ADVANCED,OFF,SCALING,AUTOMATIC,
WORKSHEETFILENAME,C:\MATHCAD89.MCD

F1:DEF EQN,"MATLAB(C1,C2)",MATLABCODE,WFORMOUT = -0.5 * WFORMIN1;,
MATLABPLOT,OFF,MATLABZEROOFFSET,0E-9,MATLABSCALEPERDIV,50E-3

F1:DEF EQN,"SPARSE(C1)",SPARSINGFACTOR,1,SPARSINGPHASE,0

F1:DEF EQN,"TRACK(C1)",AUTOFINDSCALE,ON,VERSCALE,50E-3,CENTER,-1.56249851E-3

F1:DEF EQN,"SCRIPT(C1,C2)",LANGUAGE,VBSCRIPT,
CODE,FUNCTION UPDATE()" + vbcrlf + "OUTRESULT.SAMPLES = INRESULT.SAMPLES" + vbcrlf
+ "STARTDATA = 0" + vbcrlf + "ENDDATA = OUTRESULT.SAMPLES" + vbcrlf +
"REDIM NEWDATAARRAY(OUTRESULT.SAMPLES)" + vbcrlf +
"UNSCALEDDATA = INRESULT.DATAARRAY(FALSE)" + vbcrlf +
"LASTPOINT = ENDDATA - 1" + vbcrlf + "FOR I = 0 TO LASTPOINT" +
vbcrlf + "NEWDATAARRAY(I) = -UNSCALEDDATA(I)" + vbcrlf + "NEXT" +
vbcrlf + "OUTRESULT.DATAARRAY(FALSE) = NEWDATAARRAY" + vbcrlf + "END FUNCTION" +
vbcrlf + ",STATUS,OK,TIMEOUT,360 S
```

MISCELLANEOUS

DELETE_FILE, DELF

Command

DESCRIPTION

The DELETE_FILE command deletes a file from the currently selected directory.

COMMAND SYNTAX

```
DELF,DISK,<medium>,FILE,'<filename>'
```

<medium>:= {FLOPPY, HDD}

EXAMPLE (GPIB)

The following instruction deletes a front panel setup from the floppy disk:

```
CMD$="DELF,DISK,FLOPPY,FILE,'TESTRUN.TRC'
CALL IBWRT(SCOPE%,CMD$)
```

MASS STORAGE — DIRECTORY, DIR

Command/Query

DESCRIPTION

The DIRECTORY command is used to create or delete file directories on mass storage devices. It also allows selection of the current working directory and listing of files in the directory.

The query response consists of a double-quoted string containing a DOS-like listing of the directory. If no mass storage device is present, or if it is not formatted, the string will be empty.

COMMAND SYNTAX

DIRectory
DISK,<device>, ACTION,<action>,'<directory>'

QUERY SYNTAX

DIRectory? DISK,<device> [,'<directory>']

<device> : = {FLPY, HDD}

<action> : = {CREATE, DELETE, SWITCH}

<directory> : = A legal DOS path or filename. (This can include the '\' character to define the root directory.)

RESPONSE FORMAT

DIRectory DISK,<device> '<directory>'

<directory> : = A variable length string detailing the file content of the hard disk.

DISPLAY

DISPLAY, DISP
Command/Query

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.

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 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`, `OFF`}

QUERY SYNTAX

`DISPlay?`

RESPONSE FORMAT

`DISPlay` <state>

EXAMPLE (GPIB)

The following instruction turns off the display:

```
CMD$=“DISP OFF”: CALL IBWRT(SCOPE%,CMD$)
```

DISPLAY — DOT_JOIN, DTJN

Command/Query

DESCRIPTION

The `DOT_JOIN` command controls the interpolation lines between data points. Setting `DOT_JOIN ON` selects **Points** in the "Display" dialog; `OFF` selects **Line**.

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$="DTJN OFF": CALL IBWRT(SCOPE%,CMD$)
```

DISPLAY

EMAIL, MAIL

Command/Query

DESCRIPTION

The EMAIL command sets up the e-mail configuration in the "Preferences" dialog.

COMMAND SYNTAX

`EMAIL MODE,`<SMTP or MAPI>`,TO,'`<to address>`',`
`FROM,'`<from address>`',SERVER,'`<SMTP Server>`'`

<SMTP or MAPI>:={SMTP, MAPI}

<to address >:= valid recipient address, e.g., "myName@myProvider.com"

<from address>:=valid originator address, e.g., "myXStreamDSO@LeCroy.com"

<SMTP Server>:=valid SMTP server address, e.g., "domino.lecroy.com"

QUERY SYNTAX

```
MAIL?
```

RESPONSE FORMAT

```
MAIL
MODE,SMTP,TO,"MYNAME@MYPROVIDER.COM",FROM,"MY
XSTREAMDSO@LECROY.COM",SERVER,"DOMINO.LECROY.
COM"
```

EXAMPLE (GPIB)

```
CMD$=" MAIL
MODE,SMTP,TO,'MYNAME@MYPROVIDER.COM',FROM,'MY
XSTREAMDSO@LECROY.COM',SERVER,'DOMINO.LECROY.
COM'": CALL IBWRT(SCOPE%,CMD$)
```

STATUS ***ESE**

Command/Query

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 on page 139.

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, i.e. decimal 64) and/or a device dependent error (DDE bit 3, i.e. decimal 8) occurs. Summing these values yields the ESE register mask 64+8=72.

```
CMD$="*ESE 72": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`*ESR`

STATUS

*ESR?

Query

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 table below gives 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`

ADDITIONAL INFORMATION

STANDARD EVENT STATUS REGISTER (ESR)

Bit	Bit Value	Bit Name	Description		See Note ...
15...8			0	Reserved by IEEE 488.2	
7	128	PON	1	Power off-to-ON transition has occurred	1.
6	64	URQ	1	not used	2.
5	32	CME	1	CoMmand parser Error has been detected	3.
4	16	EXE	1	EXecution Error detected	4.
3	8	DDE	1	Device Dependent (specific) Error occurred	5.
2	4	QYE	1	QuerY Error occurred	6.
1	2	RQC	0	Oscilloscope never ReQuests bus Control	7.
0	1	OPC	0	OPeration Complete bit not used	8.

NOTES: (refer to table above)

1. ***The Power On (PON) bit is always turned on (1) when the unit is powered up.***
2. ***On older LeCroy scopes, this bit reports softkey inputs. It does not apply to X-Stream scopes.***
3. ***The CoMmand parser Error bit (CME) 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 the query CMR? for further details.***
4. ***The EXecution Error bit (EXE) is set true (1) when a command cannot be executed due to some device condition (e.g., 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 query EXR? for further details.***
5. ***The Device specific Error (DDE) 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.***

6. *The QuerY Error bit (QYE) 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).*

7. *The ReQuest Control bit (RQC) is always false (0), as the oscilloscope has no GPIB controlling capability.*

8. *The OPeration Complete bit (OPC) 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.*

STATUS **EXR?**

Query

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 table next page.

QUERY SYNTAX

```
EXR?
```

RESPONSE FORMAT

`EXR` <value>

<value> : = 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`

ADDITIONAL INFORMATION

EXECUTION ERROR STATUS REGISTER STRUCTURE (EXR)	
Value	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.
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 filename not DOS compatible, or illegal filename. [*]
62	Cannot write on mass storage because filename already exists. [*]

[*] Only with memory card or removable hard disk option.

FUNCTION — FIND_CTR_RANGE, FCR

Command

DESCRIPTION

The FIND_CTR_RANGE command automatically sets the center and width of a histogram to best display the accumulated events.

COMMAND SYNTAX

<function>`:Find_Ctr_Range`

<function>`:={TA,TB,TC,TD,F1,F2,F3,F4}`

AVAILABILITY

Only available with an option installed that includes Histograms.

EXAMPLE (GPIB)

Assuming that Trace A (TA) has been defined as a histogram of one of the custom parameters, the following example will determine the best center and width and then rescale the histogram:

```
CMD$="TA:FCR": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`DEFINE, PARAMETER_CUSTOM`

ACQUISITION **FORCE_TRIGGER, FRTR**

Command

DESCRIPTION

Causes the instrument to make one acquisition.

COMMAND_SYNTAX

FoRce_TRigger

EXAMPLE (GPIB)

Either of the following pairs of instructions will force the scope to make one acquisition:

```
CMD$=”TRMD SINGLE;ARM;FRTR”
CALL IBWRT(Scope%, CMD$)

CMD$ = “TRMD STOP;ARM;FRTR”
CALL IBWRT(Scope%, CMD$)
```

MASS STORAGE — FORMAT_FLOPPY, FFLP

Command/Query

DESCRIPTION

The `FORMAT_FLOPPY` command formats a floppy disk in the Double Density or High Density format.

COMMAND SYNTAX

`Format_FLoPpy` [<type>]

<type> : = {`DD,HD,QUICK`}

If no argument is supplied, HD is used by default.

EXAMPLE (GPIB)

The following code will format a floppy disk:

```
CMD$="FFLP DD":IBWRT(SCOPE%,CMD$)CMD$="FFLP?":
CALL IBWRT(SCOPE%,CMD$):
```

RELATED COMMANDS

`DIRECTORY`

FUNCTION

FUNCTION_RESET, FRST

Command

DESCRIPTION

The FUNCTION_RESET command resets a waveform processing function. The number of sweeps will be reset to zero and the process restarted.

COMMAND SYNTAX

<function> : Function_ReSeT

EXAMPLE (GPIB)

<function> : = {F1, F2, F3, F4, F5, F6, F7, F8, TA, TB, TC, TD}
TA through TD are included for backward compatibility with software designed for earlier LeCroy instruments. They are not used in responses to queries.

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`

DISPLAY

GRID
Command/Query

DESCRIPTION

The `GRID` command defines the style of the grid used in the display.

The `GRID?` query returns the grid style currently in use.

COMMAND SYNTAX

`GRID` <grid>

<grid> : = {`SINGLE`, `DUAL`, `QUAD`, `OCTAL,AUTO,XY,XYSINGLE,XYDUAL`}

QUERY SYNTAX

`GRID?`

RESPONSE FORMAT

`GRID` <grid>

EXAMPLE (GPIB)

The following instruction sets the screen display to dual grid mode:

```
CMD$="GRID DUAL": CALL IBWRT(SCOPE%,CMD$)
```

HARD COPY

HARDCOPY_SETUP, HCSU

Command/Query

DESCRIPTION

The HARDCOPY_SETUP command configures the instrument's hard copy driver. It enables you to specify the device type and transmission mode of the hard copy unit connected to the instrument. This can be clipboard or disk drive as well as a printer. One or more individual settings can be changed by specifying the appropriate keywords, together with the new values. As with all multiple entry commands, you can send any combination or permutation of keywords. If you send contradictory values within a command, the result is governed by the last one sent. See the following pages for command notation. Note that some values are in quotation marks, because they are to be the names of directories, files, or printers, which may contain spaces and other non-alphanumeric characters. The other values must be chosen from the lists provided below.

COMMAND SYNTAX

HardCopy_SetUp DEV, <device>,FORMAT,<format>, BCKG,<bckg>,DEST,"<destination>",DIR,"<directory>", FILE,"<filename>",AREA,<hardcopyarea>,PRINTER,"<printe rname>"

<device> : = {PSD, BMP, BMPCOMP, JPEG, PNG, TIFF}

<format> : = {PORTRAIT, LANDSCAPE}

<bckg> : = {BLACK, WHITE}

<destination> : = {PRINTER, CLIPBOARD, EMAIL, FILE, REMOTE}

<directory> : = valid destination directory name, for FILE mode only.

<filename> : = valid destination filename, auto incremented, for FILE mode only.

<area>:={GRIDAREAONLY, DSOWINDOW, FULLSCREEN}

<portname> : = {GPIB, RS232, NET} only accepted with a command (for backward compatibility) and sets DEST, REMOTE.

<printername> : = valid printer name, for PRINTER mode only.

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,”GE
NEVSVRHP4050RD”
```

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

ADDITIONAL INFORMATION

Hard-copy 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 will be unaffected.

DISPLAY

HOR_MAGNIFY, HMAG

Command/Query

DESCRIPTION

The `HOR_MAGNIFY` command horizontally expands the selected expansion trace by a 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 (see table on page 212) 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

<exp_trace> : `Hor_MAGnify` <factor>

<exp_trace> : = {`F1,F2,F3,F4,F5,F6,F7,F8, TA,TB,TC,TD`} TA through TD are included for backward compatibility with software designed for earlier LeCroy instruments. These four mnemonics will not be returned in response to queries.

<factor> : = 1 to 20000

QUERY SYNTAX

<exp_source> : `Hor_MAGnify?`

RESPONSE FORMAT

<exp_source> : `Hor_MAGnify` <factor>

EXAMPLE (GPIB)

The following instruction horizontally magnifies Trace A (TA) by a factor of 5:

```
CMD$="F1:HMAG 5": CALL IBWRT(SCOPE%,CMD$)
```

DISPLAY

HOR_POSITION, HPOS

Command/Query

DESCRIPTION

The `HOR_POSITION` command horizontally positions the geometric center of the intensified zone on the source 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 the multiple zoom is enabled, the difference between the specified and the current horizontal position of the specified trace is applied to all expanded traces. If this would cause the horizontal position of any expanded trace to go outside the left or right screen boundaries, the difference of positions is adapted and then applied to the traces.

If the sources of expanded traces are sequence waveforms, and the multiple zoom is enabled, the difference between the specified and the current segment of the specified trace is applied to all expanded traces. If this would cause the segment of any expanded trace to go outside the range of the number of source segments, the difference is adapted and then applied to the traces.

The VAB bit (bit 2) in the STB register (see table on page 212) 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 on the source trace.

NOTE: Segment number 0 has the special meaning "Show All Segments Unexpanded".

COMMAND SYNTAX

<exp_trace> : `Hor_POSition` <hor_position>`,`<segment>
<exp_trace> : = {`F1,F2,F3,F4,F5,F6,F7,F8,TA,TB,TC,TD,M1,M2,M3,M4`} TA through TD are included for backward compatibility with software designed for earlier LeCroy instruments. These four mnemonics will not be returned in response to queries.
<hor_position> : = 0 to 10 DIV
<segment> : = 0 to max segments

***NOTE:** The segment number is only relevant for waveforms acquired in sequence mode; it is ignored in single waveform acquisitions. When the segment number is set to 0, all segments will be shown.*

The unit DIV is optional.

QUERY SYNTAX

<exp_trace> : `Hor_POSition?`

RESPONSE FORMAT

<exp_trace> : `Hor_POSition` <hor_position>[`,`<segment>]

***NOTE:** The segment number is only given for sequence waveforms.*

EXAMPLE (GPIB)

The following instruction positions the center of the intensified zone on the trace currently viewed by Trace A (TA) at division 3:

```
CMD$="F1:HPOS 3": CALL IBWRT(SCOPE%,CMD$)
```

MISCELLANEOUS ***IDN?**

Query

DESCRIPTION

The `*IDN?` query causes the instrument to identify itself. The response comprises manufacturer, scope 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> : = two digits giving the major release level followed by a period, then one digit giving the minor release level followed by a period and a single-digit update level (xx.y.z)

EXAMPLE (GPIB)

This issues an identification request to the scope:

```
CMD$="*IDN?": CALL IBWRT(SCOPE%,CMD$):
CALL IBRD(SCOPE%,RSP$): PRINT RSP$
```

Response message:

```
*IDN LECROY,WAVEMASTER,WM01000,3.3.0
```

STATUS

INE
Command/Query

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 table on the next page.

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, i.e. decimal 2), or a waveform has been acquired (bit 0, i.e. 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?`

STATUS **INR?**

Query

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.

INTERNAL STATE REGISTER STRUCTURE (INR)

Bit	Bit Value	Description	
15		0	Reserved for future use.
14	16384	1	Probe was changed.
13	8192	1	Trigger is ready.
12	4096	1	Pass/Fail test detected desired outcome.
11	2048	1	Reserved
10	1024	1	Reserved
9	512	1	Reserved
8	256	1	Reserved
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.

QUERY SYNTAX	`INR?`
RESPONSE FORMAT	`INR` <state> <state> : = 0 to 65535

EXAMPLE (GPIB)	The following instruction reads the contents of the INR register:
	`CMD$="INR?": CALL IBWRT(SCOPE%,CMD$)`
	Response message:
	`INR 1026`
	i.e., waveform processing in Function C and a screen dump have both terminated.

RELATED COMMANDS	`ALL_STATUS, *CLS, INE`

WAVEFORM TRANSFER

INSPECT?, INSP?
Query

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 template (use the TEMPLATE? query to obtain an up-to-date copy).

Any logical block of a waveform can be inspected using this query by giving its name enclosed in quotes as the first (string) parameter (see the template itself).

The special logical block named WAVEDESC can also be inspected in more detail. By giving the name of a variable in the block WAVEDESC, enclosed in quotes as the first (string) parameter, it is possible to inspect only the actual value of that variable. See Chapter 4 for more on INSPECT?.

NOTATION	
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)

QUERY SYNTAX

<trace> : INSPect? '<string>'[,<data_type>]

<trace> : = {F1,F2,F3,F4,F5,F6,F7,F8,TA,TB,TC, TD,M1,M2,M3,M4,C1,C2,C3,C4} Note that TA through TD are included for compatibility with software designed for earlier LeCroy instruments. These four labels will not be returned in responses to queries.

<data_type> : = {BYTE, WORD, FLOAT}. TA through TD are for backward compatibility, and are not returned by queries.

NOTE: 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.

RESPONSE FORMAT

<trace> : `INSPect` "<string>"

<string> : = A string giving name(s) and value(s) of a logical block or a variable.

AVAILABILITY

<trace> : = {C3, C4} only on four-channel oscilloscopes.

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

`TEMPLATE, WAVEFORM_SETUP`

DISPLAY

INTENSITY, INTS

Command/Query

DESCRIPTION

The INTenSity command sets the intensity level of the grid. The command TRACE,n is accepted for backward compatibility, but the actual trace intensity is always 100%.

COMMAND SYNTAX

```
INTenSity GRID,<value>,TRACE,<value>[PCT]
```

<value>:= 0 to 100 (in percent). GRID and TRACE may be interchanged; the order is immaterial.

QUERY SYNTAX

```
INTenSity?
```

RESPONSE FORMAT

```
INTenSity TRACE,<value>,GRID,<value>
```

EXAMPLE (GPIB)

The following example sets the grid intensity to 70%.

```
CMD$=”INTS GRID,70” : CALL
IBWRT(SCOPE%,CMD$)
```

ACQUISITION INTERLEAVED, ILVD

Command/Query

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

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`

STATUS

`*IST?`
Query

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`

ACQUISITION

MEMORY_SIZE, MSIZ

Command/Query

DESCRIPTION

On most models where this command/query is available, MEMORY_SIZE allows selection of the maximum memory length used for acquisition. See the specifications in the *Operator's Manual*.

TIP: Reduce the number of data points for faster throughput.

The MEMORY_SIZE? query returns the current maximum memory length used to capture waveforms.

COMMAND SYNTAX

Memory_SIZe <size>

NOTE: The oscilloscope will adapt to the closest valid <size> or numerical <value> according to available channel memory.

<size> : = {500, 1e+3, …, 2.5e+6, 5e+6, 1e+7}, for example, in standard numeric format.

Or, alternatively:

= {500, 1000, 2500, 5000, 10K, 25K, 50K, 100K, 250K, 500K, 1MA, 2.5MA, 5MA, 10MA, 25MA}

However, values not absolutely identical to those listed immediately above will be recognized by the scope as *numeric data* (see the table under this heading in Chapter 1). For example, the scope will recognize 1.0M as 1 millisample. But it will recognize 1.0MA as 1 megasample.

QUERY SYNTAX

Memory_SIZe?

RESPONSE FORMAT

Memory_SIZe <size>

EXAMPLE

The following instruction will set the oscilloscope to acquire at most 10,000 data samples per single-shot or RIS acquisition:

```
CMD$="MSIZ 10K": CALL IBWRT(SCOPE%,CMD$)
```

or `CMD$="MSIZ 10e+3": CALL IBWRT(SCOPE%,CMD$)`

RELATED COMMANDS

TDIV

MESSAGE, MSG

DISPLAY

Command/Query

DESCRIPTION

The MESSAGE command displays a string of characters in the message field at the bottom of the instrument screen.

COMMAND SYNTAX

```
MeSsaGe '<string>' or MSG "<string>"
```

<string>:= a string of up to 49 characters. Longer strings will be truncated to 49 characters, but the original string will be retained and returned by the MSG? Query.

QUERY SYNTAX

```
MeSsaGe?
```

RESPONSE FORMAT

```
MeSsaGe "<string>"
```

EXAMPLE (GPIB)

The following causes the message `Touch Probe 2 to Test Point 7` to appear in the message field.

```
CMD$="MSG 'Touch Probe 2 to Test Point 7'":
CALL IBWRT(SCOPE%, CMD$)
```

ACQUISITION — OFFSET, OFST

Command/Query

DESCRIPTION

The OFFSET command allows adjustment of the vertical offset of the specified input channel.

The maximum ranges depend on the fixed sensitivity setting. See the *Operator's Manual* for 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.

NOTE: The probe attenuation factor is not taken into account in offset adjustments.

The unit V is optional.

The OFFSET? query returns the DC offset value of the specified channel.

COMMAND SYNTAX

<channel> : OFfSeT <offset>

<channel> : = {C1, C2, C3, C4}

<offset> : = See the *Operator's Manual* for specifications.

QUERY SYNTAX

<channel> : OFfSeT?

RESPONSE FORMAT

<channel> : OFfSeT <offset>

AVAILABILITY

<channel> : {C3, C4} only on four-channel oscilloscopes.

EXAMPLE (GPIB)

The following instruction sets the offset of Channel 2 to -3 V:

```
CMD$="C2:OFST -3V": CALL IBWRT(SCOPE%,CMD$)
```

CURSOR OFFSET_CONSTANT, OFCT

Command/Query

DESCRIPTION

As you change the gain, this command allows you to either keep 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 will remain on the grid as you increase the gain; whereas, if Volts is selected, the waveform could move off the grid.

Regardless of whether you select Volts or Div, however, the "Offset" shown in the scope's channel setup dialog always indicates volts. However, when Div is selected for the Offset Control, the offset in volts is scaled proportional to the change in gain, thereby keeping the division on the grid 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$)
```

STATUS

*OPC

Command/Query

DESCRIPTION

The `*OPC` (OPeration Complete) command sets to true the OPC bit (bit 0) in the standard Event Status Register (ESR). This command has no other effect on the operation of the oscilloscope because the oscilloscope starts parsing a command or query only after it has completely processed the previous command or query.

The `*OPC?` query always responds with the ASCII character **1** because the oscilloscope only responds to the query when the previous command has been entirely executed.

COMMAND SYNTAX `*OPC`

QUERY SYNTAX `*OPC?`

RESPONSE FORMAT `*OPC 1`

RELATED COMMANDS `*WAI`

MISCELLANEOUS

***OPT?**
Query

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 will be 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 will be returned as:

```
* DFP2,SDM,JTA2,GPIB
```

Response message if no options are installed:

```
*OPT 0
```

SAVE/RECALL SETUP — PANEL_SETUP, PNSU

Command/Query

DESCRIPTION

The PANEL_SETUP command complements the *SAV or *RST commands. PANEL_SETUP allows you to archive panel setups in encoded form on external storage media.

Only setup data read by the PNSU? query can be recalled into the oscilloscope. A panel setup error (see table on page 142) will be generated if the setup data block contains invalid data.

NOTE: The communication parameters (those 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 <setup>

<setup> : = A setup previously read by PNSU?

QUERY SYNTAX

PaNel_SetUp?

RESPONSE SYNTAX

PaNel_SetUp <setup>

EXAMPLE (GPIB)

The following instruction saves the oscilloscope's current panel setup in the file PANEL.SET:

```
FILE$ = "PANEL.SET": CMD$="PNSU?":
CALL IBWRT(SCOPE%,CMD$): CALL IBRDF(SCOPE%,FILE$)
```

Whereas the following recalls the front panel setup, stored previously in the file PANEL.SET, into the oscilloscope:

```
CALL IBWRTF(SCOPE%,FILE$)
```

RELATED COMMANDS

*RCL, *SAV

CURSORS — PARAMETER, PARM

Command/Query

DESCRIPTON

This command turns statistics and histicons on or off.

COMMAND SYNTAX

`PARM <type>,[readout]`

Type:= CUST, HPAR, VPAR, OFF

Readout:= STAT, HISTICON, BOTH, OFF

Without argument, state of histograms and statistics is unchanged.

Unlike CRMS, PARM does not change the state of cursors or pass/fail.

QUERY SYNTAX

`PARAMETER? or PARM?`

RESPONSE SYNTAX

`PARM <type>,<readout>`

EXAMPLE (GPIB)

The following instruction turns the histicons on:

```
CMD$="PARM CUST,HISTICON";CALL
IBWRT(SCOPE%,CMD$)
```

CURSOR

PARAMETER_CLR, PACL
Command

DESCRIPTION

The PARAMETER_CLR command clears all the current parameters from the 8-line list used in the Custom and Pass/Fail modes.

COMMAND SYNTAX

```
PArameter_CLr
```

RELATED COMMANDS

PARAMETER_DELETE, PARAMETER_VALUE,

CURSOR — PARAMETER_CUSTOM, PACU

Command/Query

DESCRIPTION

The `PARAMETER_CUSTOM` command controls the parameters that have customizable qualifiers and can also be used to assign any parameter for histogramming.

NOTE: When PAVA? is used to query a Custom parameter, the prefix is returned for consistency. However, the source for the measurement is the one configured using the PACU command.

TIP: Use `PAVA?` to read the measured value of a parameter that was set up with `PACU`. To determine the correct form of a PACU command in your scope model it is useful to set up the scope manually to the configuration that you want, and then send a PACU query. The response from the scope can be copied straight into your program for use as a query.

COMMAND SYNTAX

`Parameter_Custom`
<column>,<parameter>,<qualifier>[,<qualifier>,...]

<column> : = 1 to 8

<parameter> : = {a parameter from the table below or any parameter listed in the `PAVA?` command}

<qualifier> : = Measurement qualifier(s) specific to each <param>. See below.

CUSTOMIZABLE PARAMETERS ON ALL MODELS		
<param>	**Definition**	**<qualifier> list**
AMPL	Amplitude	
AREA	Area	<source>
BASE	Base	
CYCL	Cycles on screen	
DLY	Delay	
DDLY	Delta delay	<source2>

DTLEV	Delta time at level	<slope1>,<pctabs>,<leveltype>,<percentlevel1>,<abslevel1>,<source2>,<slope2>,<pctabs>,<leveltype>,<percentlevel2>,<abslevel2>,<hysteresis>
DUR	duration of acquisition	
DUTY	duty cycle	
DULEV	Duty cycle at level	<slope>,<pcctabs>,<leveltype>,<percentlevel>,abslevel>,<hysteresis>
EDLEV	Edges at level	<slope>,<pcctabs>,<leveltype>,<percentlevel>,abslevel>,<hysteresis>
FALL82	Fall time 80 % to 20 %	
FALL	Fall time 90 % to 10 %	
FLEV	Fall at levels	<pctabs>,<levelsare>,<highpct>,<highabs>,<pctabs>,<levelsare>,<lowpct>,<lowabs>
FRST	First cursor position	
FREQ	Frequency	
HOLDLEV	Clock to data time	<Clockslope>,<pctabs>,<clocklevelis>,<clockpctlevel>,<clockabslevel>,<source2>,<dataslope>,<pctabs>,<datalevelis>,<datapctlevel>,<dataabslevel>,<clockhysteresis>,<datahysteresis>
LAST	Last cursor position	
MAX	Maximum value	
MEAN	Mean value	<cyclic>
MEDI	Median	<cyclic>
MIN	Minimum value	
PNTS	Period	
NULL	phase difference	
OVSN	Overshoot negative	
OVSP	Overshoot positive	
PKPK	Peak to peak	
PER	Period	
PHASE	Phase difference	
POPATX	Population of bin at x	<horvalue>,<cursorshape>

RISE	Rise time 10% to 90 %	
RISE28	Rise 20 % to 80 %	
RLEV	Rise time at levels	<pctabs>,<levelsare>,<lowpct>,<lowabs>,<pctabs>,<levelsare>,<highpct>,<highabs>
RMS	root mean square	<cyclic>
SETUP	Data edge to clock edge	<Clockslope>,<pctabs>,<clocklevelis>,<clockpctlevel>,<clockabslevel>,<source2>,<dataslope>,<pctabs>,<datalevelis>,<datapctlevel>,<dataabslevel>,<clockhysteresis>,<datahysteresis>
SDEV	Standard deviation	<cyclic>
TLEV	Time at level	<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>
TOP	Top	
WID	Width	
WIDLV	Width at level	<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>
XMAX	Pos of max data value	
XMIN	Pos if min data value	
XAPK	Nth highest hist peak	<peaknumber>
CUSTn	Custom parameter	

CUSTOMIZABLE PARAMETERS WITH EXTENDED MATH OPTION

<param>	Definition	<qualifier> list
DTLEV	Delta time at level	<source1>,<slope1>,<level1>,<source2>,<slope2>,<level2>, <hysteresis>
FLEV	fall at level	<source>,<high>,<low>
RLEV	rise at level	<source>,<low>,<high>
TLEV	Time at level	<source>,<slope>,<level>,<hysteresis>

CUSTOMIZABLE PARAMETERS WITH SDA & SDM OPTION		
<param>	**Definition**	**<qualifier> list**
AVG	Histogram mean	
CROSSPERCENT	Differential crossing %	
DCD		
DPLEV	Delta period at level	<signaltype>,<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>,<usebasefrequency>,<basefrequency>,<stdbasefrequency>
DTLEV	Delta time at levels	<slope1>,<pctabs>,<leveltype>,<percentlevel1>,<abslevel1>,<source2>,<slope2>,<pctabs>,<leveltype>,<percentlevel2>,<abslevel2>,<hysteresis>
DWIDLEV	Delta width at level	<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>
EDLEV	Edges at level	<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>
EXTRATIO	Eye level ratios	
EYEAMPL	Eye amplitude	
EYEBER	Eye bit error rate estim	
EYEHEIGHT	TBD	
EYEWIDTH	Eye width	
EYECRW		
EYECROSSINGCALC		
FREQLEV	Frequency at level	<signaltype>,<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>,<usebasefrequency>,<basefrequency>,<stdbasefrequency>
FWHM	Histogram FWHM	
FWXX	Hist peak FW at level	<hfractionht>
HPER	Half period	<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>
HAMPL	Histogram amplitude	
HBASE	Histogram base level	
HIGH	Histogram right bin	

HMEDI	Histogram median	
HRMS	Histogram rms	
HTOP	Histogram top level	
HOLDLEV	Clock to data edge time	<clockslope>,<pctabs>,<clocklevelis>,<clockpctlevel>,<clockabslevel>,<source2>,<dataslope>,<pctabs>,<datalevelis>,<datapctlevel>,<dataabslevel>,<clockhysteresis>,<datahysteresis>
LOW	Histogram left bin	
MAXP	Histogram highest peak	
MODE	Histogram mode	
ONELEVEL?		
PKS	Histogram no of peaks	
PCTL	Histogram percentile	
PLEV	Period at level	<signaltype>,<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>,<usebasefrequency>,<basefrequency>,<stadbasefrequency>
	PERIODIC JITTER	
POPATX	Histogram bin population	<horvalue>,<cursorshape>
EyeQ?		<patternlength>
RANGE	Histogram range	
SETUP	Data to clock edge time	<Clockslope>,<pctabs>,<clocklevelis>,<clockpctlevel>,<clockabslevel>,<source2>,<dataslope>,<pctabs>,<datalevelis>,<datapctlevel>,<dataabslevel>,<clockhysteresis>,<datahysteresis>
SIGMA	Histogram standard dev	
SKEW	Time clock to clock edge	<clock1slope>,<pctabs>,<clock1levelis>,<clock1pctlevel>,<clock1abslevel>,<source2>,<clock2slope>,<pctabs>,<clock2levelis>,<clock2pctlevel>,<clock2abslevel>,<clock1hysteresis>,<clock2hysteresis>
TIELEV	Time interval error at level	<signaltype>,<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<resultscaling>,<hysteresis>,<usebasefrequency>,<basfrequency>,<stdbasefrequency>
TJ	Total jitter at set BER	
TOTP	Histogram total populate	

WIDLV	Width at level	<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>
XAPK	Histogram Nth peak	Peaknumber
ZEROLVL?	Eye diagram zero level	

CUSTOMIZABLE PARAMETERS WITH XMAP OPTION		
<param>	**Definition**	**<qualifier> list**
AVG	Histogram mean	
DPLEV	Delta period at level	<signaltype>,<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>,<usebasefrequency>,<basefrequency>,<stdbasefrequency>
DTLEV	Delta time at level	<slope1>,<pctabs>,<leveltype>,<percentlevel1>,<abslevel1>,<source2>,<slope2>,<pctabs>,<leveltype>,<percentlevel2>,<abslevel2>,<hysteresis>
DWIDLEV	Delta width at level	<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>
EDLEV	Edges at level	<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>
EXCELPARAM	Parameter using Excel	<source1var>,<source2var>,<outputvar>,<source1headervar>,<source2headervar>,<outputheadervar>,<withheader>,<outputenable>,<source1enable>,<source2enable>,<newsheet>,<advanced>,<worksheetfilename>
EXCELPARAMARITH	Param arithmetic Excel	
FLEV	Frequency at level	<pctabs>,<levelsare>,<highpct>,<hightabs>,<pctabs>,<levelsare>,<lowpct>,<lowabs>
FWHM	Histogram FWHM	
FWXX	Histogram FW at level	<hfractionht>
HPER	Half period	<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>
HAMPL	Histogram amplitude	
HBASE	Histogram base	
HIGH	Histogram right bin	
HMEDI	Histogram median	
HRMS	Histogram RMS	

HTOP	Histogram top	<hfractionht>
HOLDLEV	Time clock to data edge	<clockslope>,<pctabs>,<clocklevelis>,<clockpctlevel>,<clockabslevel>,<source2>,<dataslope>,<pctabs>,<data levelis>,<datapctlevel>,<dataabslevel>,<clockhysteresis>,<datahysteresis>
LOW	Histogram left bin	
MATHCADPARAM	Param using Mathcad	<source1var>,<source2var>,<outputvar>,<source1headervar>,<source2headervar>,<outputheadervar>,<withheader>,<outputenable>,<source1enable>,<source2enable>,<newsheet>,<advanced>,<worksheetfilename>
MATHCADPARAMARITH	Param arith Mathcad	
MATLABPARAM	Parameter using MATLAB	
MAXP	Histogram highest peak	
MODE	Histogram mode	
NBPH	Narrow band phase	<frequency>
NBPW	Narrow band power	<frequency>
NUMMODES	Histogram no of peaks	
PCONST	Parameter constant	
PSCRIPT	Param VBS Meas – param	<language>,<code>
PARAMSCRIPT	Param VBS WF – param	<language>,<code>
PKS	Histogram peaks	
PCTL	Histogram percentile	<hpctpop>
PLEV	Period at level	<signaltype>,<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>,<usebasefrequency>,<basefrequency>,<stadbasefrequency>
POPATX	Histogram bin population	<horvalue>,<cursorshape>
RANGE	Histogram range	
SETUP	Time data to clock edge	<clockslope>,<pctabs>,<clocklevelis>,<clockpctlevel>,<clockabslevel>,<source2>,<dataslope>,<pctabs>,<data levelis>,<datapctlevel>,<dataabslevel>,<clockhysteresis>,<datahysteresis>
SIGMA	Histogram standard dev	

SKEW	Time clock to clock edge	<clock1slope>,<pctabs>,<clock1levelis>,<clock1pctlevel>,<clock1abslevel>,<source2>,<clock2slope>,<pctabs>,<clock2levelis>,<clock2pctlevel>,<clock2abslevel>,<clockhysteresis>,<clock2hysteresis>
TIELEV	Time interval error	<signaltype>,<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<resultscaling>,<hysteresis>,<usebasefrequency>,<basfrequency>,<stdbasefrequency>
TOTP	Histogram total pop	
WIDLV	Width at level	<slope>,<pctabs>,<leveltype>,<percentlevel>,<abslevel>,<hysteresis>
XAPK	Histogram Nth peak	<peaknumber>

CUSTOMIZABLE PARAMETERS WITH XMATH OPTION		
<param>	**Definition**	**<qualifier> list**
AVG	Histogram mean	
FWHM	Histogram FWHM	
FWXX	Histogram FW at level	<hfractionht>
HAMPL	Histogram amplitude	
HBASE	Histogram base	
HIGH	Histogram right bin	
HMEDI	Histogram median	
HRMS	Histogram RMS	
HTOP	Histogram top	<hfractionht>
LOW	Histogram left bin	
MAXP	Histogram highest peak	

Where:

<sourceN> : = {`C1`,`C2`,`C3`,`C4`,`F1,F2,F3,F4,F5,F6,F7,F8,TA,TB,TC,TD`}. TA through TD are for compatibility with existing software with earlier instruments. These four mnemonics are not returned by queries.

<slopeN> : = {`POS`, `NEG`, `FIRST`}

<edgeN> : = {`POS`, `NEG`}

<clock edge> : = {POS, NEG, ALL}

<levelN>, <low>, <high> : = 1 to 99 if level is specified in percent (PCT), or

<levelN>, <low>, <high> : = Level in <sourceN> in the units of the waveform.

<delay> : = -100 PCT to 100 PCT

<freq> : = 10 to 1e9 Hz (Narrow Band center frequency)

<hysteresis> : = 0.01 to 8 divisions

<length> : = 1e-9 to 0.001 seconds

<operator> : = {ADD, SUB, MUL, DIV}*

<rank> : = 1 to 100

<threshold> : = 0 to 100 percent

<angular unit> = {PCT, DEG, RAD}

<cyclic> = {OFF, ON}

QUERY SYNTAX

`PArameter_CUstom?` <column>

RESPONSE FORMAT

`PArameter_Custom`
<column>,<parameter>,<qualifier>[,<qualifier>,...]

AVAILABILITY

<sourceN> : = {C3, C4} only on four-channel oscilloscopes.

EXAMPLE 1

DTLEV

Command Example:

```
PACU 2,DTLEV,C1,POS,345E-3,C2,NEG,-789E-3
```

Query/Response Examples:

`PACU? 2` returns:

```
PACU 2,DTLEV,C1,POS,345E-3,C2,NEG,-789E-3
```

`PAVA? CUST2` returns:

```
C2:PAVA CUST2,789 NS
```

* For Parameter Math option

EXAMPLE 2	**`DDLY`**
Command Example:	`PACU 2,DDLY,C1,C2`

Query/Response Examples:	`PACU? 2` returns:
	`PACU 2,DDLY,C1,C2`
	`PAVA? CUST2` returns:
	`C2:PAVA CUST2,123 NS`

EXAMPLE 3	**`RLEV`**
Command Example:	`PACU 3,RLEV,C1,2PCT,67PCT`

Query/Response Examples:	`PACU? 3` returns:
	`PACU 3,RLEV,C1,2PCT,67PCT`
	`PAVA? CUST3` returns:
	`C1:PAVA CUST3,23 MS`

EXAMPLE 4	**`FLEV`**
Command Example:	`PACU 3,FLEV,C1,345E-3,122E-3`

Query/Response Examples:	`PACU? 3` returns:
	`PACU 3,FLEV,C1,345E-3,122E-3`
	`PAVA? CUST3` returns:
	`C1:PAVA CUST3,23 MS`

EXAMPLE 5 (Parameter Math)	**`CALC`*`x`***
Command Example:	`PACU 5,CALC1,AMPL,C3,DIV,AMPL,C2`

Query/Response Examples:	`PACU? 5` returns:
	`PACU 5,CALC1,AMPL,C3,DIV,AMPL,C2`
	`PAVA? CUST5` returns:
	`C2:PAVA CUST1,4.884,OK`

RELATED COMMANDS PARAMETER_DELETE, PARAMETER_VALUE

EXAMPLE RESPONSE to PACU? 1 where Parameter 1 is a script –

```
PACU 1,PARAMSCRIPT,C1,VBSCRIPT,FUNCTION UPDATE()
TRACELENGTH = INRESULT.SAMPLES
INDATA = INRESULT.DATAARRAY
YTOTAL = 0
XYTOTAL = 0
FOR K = 0 TO TRACELENGTH - 1
Y = INDATA(K) : YY = Y * Y
YTOTAL = YTOTAL + YY
XYTOTAL = XYTOTAL + K * YY
NEXT
OUTRESULT.VALUE = XYTOTAL / YTOTAL
END FUNCTION
```

CURSOR

PARAMETER_DELETE, PADL

Command

DESCRIPTION

The `PARAMETER_DELETE` command deletes a parameter at a specified column from the list of parameters used in the Custom mode.

NOTATION		
1	Column 1	of Custom or Pass/Fail display
2	Column 2	of Custom or Pass/Fail display
3	Column 3	of Custom or Pass/Fail display
4	Column 4	of Custom or Pass/Fail display
5	Column 5	of Custom or Pass/Fail display
6	Column 6	of Custom or Pass/Fail display
7	Column 7	of Custom or Pass/Fail display
8	Column 8	of Custom or Pass/Fail display

COMMAND SYNTAX

`PArameter_DeLete` <column>

<column> : = {`1,2,3,4,5,6,7,8`}

EXAMPLE (GPIB)

The following instruction deletes the third test condition in the list:

```
CMD$="PADL 3": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`PARAMETER_CLR, PARAMETER_VALUE,`

CURSOR

PARAMETER_STATISTICS?, PAST?

Query

DESCRIPTION

The PARAMETER_STATISTICS? query returns the current values of statistics for the specified pulse parameter mode and specified statistic for all columns of the parameter display, or all statistics for the specified parameter.

QUERY SYNTAX A

`PArameter_STatistics? <mode>, <statistic>`

<mode>:={CUST, HPAR, VPAR}

<statistic>:={AVG, LOW, HIGH, SIGMA, SWEEPS, LAST, PARAM}

No	
AVG	average
CUST	custom parameters
HIGH	highest value
HPAR	horizontal standard
VPAR	vertical standard pa
LOW	lowest value
PARAM	parameter definitior
SIGMA	sigma (standard dev
SWEEPS	number of sweeps a
VPAR	vertical standard pa

NOTE: In CUST mode, if keyword* `PARAM` *is specified, the query returns the list of the five pairs <parameter_name>,<source>.

QUERY SYNTAX B

`PArameter_STatistics? <mode>, <param>`

<mode>:={CUST, HPAR, VPAR}

<param>:={P1, P2, P3, P4, P5, P6, P7, P8}

EXAMPLE (GPIB) A

The following instruction reads the average values for all the columns individually:

```
CMD$ = “PAST? CUST, AVG”
CALL IBWRT (SCOPE%,CMD$)
CALL IBRD(SCOPE%,RD$)
```

EXAMPLE (GPIB) B

The following instruction reads all the statistical values for parameter P2:

```
CMD$ = “PAST? CUST, P2”
CALL IBWRT (SCOPE%,CMD$)
CALL IBRD(SCOPE%,RD$)
```

RESPONSE FORMAT A

```
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
```

RESPONSE FORMAT B

```
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
```

CURSOR **PARAMETER_VALUE?, PAVA?**

Query

DESCRIPTION

The PARAMETER_VALUE query returns the current values of the pulse waveform parameters and mask tests for the specified trace. Traces do not need to be displayed or selected to obtain the values measured by the pulse parameters or mask tests.

AVAILABLE ON ALL MODELS					
ALL	all parameters	FRST	First cursor position	POPATX	Population of bin at x
AMPL	Amplitude	FREQ	Frequency	RISE	Rise time 10% to 90 %
AREA	Area	HOLDLEV	Clock to data time	RISE28	Rise 20 % to 80 %
BASE	Base	LAST	Last cursor position	RLEV	Rise time at levels
CYCL	Cycles on screen	MAX	Maximum value	RMS	root mean square
DLY	Delay	MEAN	Mean value	SETUP	Data edge to clock edge
DDLY	Delta delay	MEDI	Median	SDEV	Standard deviation
DTLEV	Delta time at level	MIN	Minimum value	TLEV	Time at level
DUR	duration of acquisition	PNTS	Period	TOP	Top
DUTY	duty cycle	NULL	phase difference	WID	Width
DULEV	Duty cycle at level	OVSN	Overshoot negative	WIDLV	Width at level
EDLEV	Edges at level	OVSP	Overshoot positive	XMAX	Pos of max data value
FALL82	Fall time 80 % to 20 %	PKPK	Peak to peak	XMIN	Pos if min data value
FALL	Fall time 90 % to 10 %	PER	Period	XAPK	Nth highest hist peak
FLEV	Fall at levels	PHASE	Phase difference	CUSTn	Custom parameter

CUSTOM PARAMETERS DEFINED USING PARAMETER_CUSTOM COMMAND[*]							
CUST1	CUST2	CUST3	CUST4	CUST5	CUST6	CUST7	CUST8

[*] The numbers in the terms CUST1 through CUST8 refer to the line numbers of the selected custom parameters.

AVAILABLE WITH SDA OPTION			
AVG	Histogram mean	HTOP	Histogram top level
CROSSPERCENT	Differential crossing %	HOLDLEV	Clock to data edge time
DCD		LOW	Histogram left bin
DPLEV	Delta period at level	MAXP	Histogram highest peak
DTLEV	Delta time at levels	MODE	Histogram mode
DWIDLEV	Delta width at level	ONELEVEL?	
EDLEV	Edges at level	PKS	Histogram no of peaks
EXTRATIO	Eye level ratios	PCTL	Histogram percentile
EYEAMPL	Eye amplitude	PLEV	Period at level
EYEBER	Eye bit error rate estim		PERIODIC JITTER
EYEHEIGHT	TBD	POPATX	Histogram bin population
EYEWIDTH	Eye width	EyeQ?	
EYECRW		RANGE	Histogram range
EYECROSSINGCALC		SETUP	Data to clock edge time
FREQLEV	Frequency at level	SIGMA	Histogram standard dev
FWHM	Histogram FWHM	SKEW	Time clock to clock edge
FWXX	Hist peak FW at level	TIELEV	Time interval error at level
HPER	Half period	TJ	Total jitter at set BER
HAMPL	Histogram amplitude	TOTP	Histogram total populate
HBASE	Histogram base level	WIDLV	Width at level
HIGH	Histogram right bin	XAPK	Histogram Nth peak
HMEDI	Histogram median	ZEROLVL?	Eye diagram zero level
HRMS	Histogram rms		

AVAILABLE WITH XMAP OPTION			
AVG	Histogram mean	MATLABPARAM	Parameter using MATLAB
DPLEV	Delta period at level	MAXP	Histogram highest peak
DTLEV	Delta time at level	MODE	Histogram mode
DWIDLEV	Delta width at level	NBPH	Narrow band phase
EDLEV	Edges at level	NBPW	Narrow band power
EXCELPARAM	Parameter using Excel	NUMMODES	Histogram no of peaks
EXCELPARAMARITH	Param arithmetic Excel	PCONST	Parameter constant
FLEV	Frequency at level	PSCRIPT	Param VBS Meas – param
FWHM	Histogram FWHM	PARAMSCRIPT	Param VBS WF – param
FWXX	Histogram FW at level	PKS	Histogram peaks
HPER	Half period	PCTL	Histogram percentile
HAMPL	Histogram amplitude	PLEV	Period at level
HBASE	Histogram base	POPATX	Histogram bin population
HIGH	Histogram right bin	RANGE	Histogram range
HMEDI	Histogram median	SETUP	Time data to clock edge
HRMS	Histogram RMS	SIGMA	Histogram standard dev
HTOP	Histogram top	SKEW	Time clock to clock edge
HOLDLEV	Time clock to data edge	TIELEV	Time interval error
LOW	Histogram left bin	TOTP	Histogram total pop
MATHCADPARAM	Param using Mathcad	WIDLV	Width at level
MATHCADPARAMARITH	Param arith Mathcad	XAPK	Histogram Nth peak

AVAILABLE WITH XMATH OPTION			
`AVG`	Histogram mean	`MODE`	Histogram mode
`FWHM`	Histogram FWHM	`NBPH`	Narrow band phase
`FWXX`	Histogram FW peak	`NBPW`	Narrow band power
`HAMPL`	Histogram amplitude	`PKS`	Histogram no of peaks
`HBASE`	Histogram base	`PCTL`	Histogram percentile
`HIGH`	Histogram right bin	`POPATX`	Histogram bin population
`HMEDI`	Histogram median	`RANGE`	Histogram range
`HRMS`	Histogram RMS	`SIGMA`	Histogram standard dev
`HTOP`	Histogram top	`TOTP`	Histogram total pop
`LOW`	Histogram left bin	`XAPK`	Histogram Nth peak
`MAXP`	Histogram max pop		

PARAMETER COMPUTATION STATES			
`AV`	averaged over several (up to 100) periods	`OF`	Signal partially in overflow
`GT`	greater than given value	`OK`	Deemed to be determined without problem
`IV`	invalid value (insufficient data provided)	`OU`	Signal partially in overflow and underflow
`LT`	less than given value	`PT`	Window has been period truncated
`NP`	no pulse waveform	`UF`	signal partially in underflow

MASK TEST NAMES			
`ALL_IN`	all points of waveform inside mask (TRUE = 1, FALSE = 0)	`SOME_IN`	some points of waveform inside mask (TRUE = 1, FALSE = 0)
`ALL_OUT`	all points of waveform outside mask (TRUE = 1, FALSE = 0)	`SOME_OUT`	some points of waveform outside mask (TRUE = 1, FALSE = 0)

QUERY SYNTAX

<trace> : `PArameter_VAlue?` [<parameter>,...,<parameter>]

<trace> : = {`F1,F2,F3,F4,F5,F6,F7,F8,TA,TB,TC,TD,C1,C2,C3,C4`}. TA through TD are for backward compatibility, and are not returned by queries.

NOTE: When PAVA? Is used to query a Custom parameter, the prefix is returned for consistency. However, the source for the measurement is the one configured using the PACU command.

<parameter> : = See table of parameters.

Alternative forms of query for mask tests:

<trace> : `PArameter_VAlue?` <mask_test>, <mask>

<mask_test> : = {`ALL_IN`, `SOME_IN`, `ALL_OUT`, `SOME_OUT`}

<mask> : = {`F1,F2,F3,F4,F5,F6,F7,F8,TA,TB,TC,TD`} TA through TD are included for backward compatibility with software designed for earlier LeCroy instruments. These four mnemonics will not be returned in response to queries.

RESPONSE FORMAT

<trace> : `PArameter_VAlue` <parameter>`,`<value>`,`

<state> [`,`...`,`<parameter>`,`<value>`,`<state>]

<value> : = A decimal numeric value

<state> : = {`OK, AV, PT, IV, NP, GT, LT, OF, UF, OU`}

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.

AVAILABILITY

<trace> : {C3, C4} only available on four-channel oscilloscopes.

EXAMPLE (GPIB)

The following instruction query reads the rise time of Trace B (TB):

```
CMD$="F2:PAVA? RISE": CALL
IBWRT(SCOPE%,CMD$):
CALL IBRD (SCOPE%,RD$): PRINT RD$
```

Response message:

```
TB:PAVA RISE,3.6E-9S,OK
```

RELATED COMMANDS CURSOR_MEASURE, CURSOR_SET, PARAMETER_CUSTOM, PARAMETER_STATISTICS

MISCELLANEOUS **PASS_FAIL, PF**

Command/Query

DESCRIPTION

The PASS_FAIL command sets up the pass/fail system.

COMMAND SYNTAX

`PASS_FAIL` <state>[,<logic>[,<stop after>]]

<state>:=`{ON,OFF}`

<logic>:=`{AllTrue,AllFalse,AnyTrue,AnyFalse,AllQ1ToQ4OrQ5ToQ8,AnyQ1ToQ4AndAnyQ5ToQ8}`

<stop after>:={1 to 1,000,000,000 sweeps}

QUERY SYNTAX

`PASS_FAIL? or PF?`

EXAMPLE (GPIB)

The following instruction sets the pass/fail system to all false, and to stop after 20 acquisitions:

```
CMD$="PF ON,ALLFALSE,20": CALL
IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`CRMS`

CURSOR

PASS_FAIL_DO, PFDO

Command/Query

DESCRIPTION

The PASS_FAIL_DO command defines the desired outcome and the actions that have to be performed after a Pass/Fail test. The PASS_FAIL_D? query indicates which actions are currently selected. Note that BEEP, PULS, SCDP and STO are provided for backward compatibility with existing software for earlier instruments.

NOTATION

ALARM or BEEP	Emit a beep.
PRINT or SCDP	Make a hard copy.
PULSE or PULS	Emit a pulse on the Aux out connector.
SAVE or STO	Store in memory or media.
STOP	Stop acquisition.

COMMAND SYNTAX

```
Pass_Fail_DO [<outcome>[,<act>[,<act> …]]]
```

<outcome>:= {PASS, FAIL}

<act>:= {ALARM, BEEP, PRINT, SCDP, PULSE, PULS, SAVE, STO, STOP}

QUERY SYNTAX

```
Pass_Fail_DO?
```

RESPONSE SYNTAX

```
Pass_Fail_DO [<pass_fail>[,<act>[,<act>
…]]]
```

<pass_fail>:= {PASS, FAIL}

<act>:= {ALARM, PRINT, PULSE, SAVE, STOP}

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 — PERSIST, PERS

Command/Query

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`

DISPLAY

PERSIST_COLOR, PECL

Command/Query

DESCRIPTION

The `PERSIST_COLOR` command controls the color rendering method of persistence traces.

The response to the `PERSIST_COLOR?` query indicates the color rendering method, Analog Persistence or Color Graded Persistence.

See the Operator's Manual.

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`

CURSOR

PER_CURSOR_SET, PECS

Command/Query

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? query to work.

NOTATION

HABS	Horizontal absolute	VABS	Vertical absolute
HDIF	Horizontal difference	VDIF	Vertical difference
HREF	Horizontal reference	VREF	Vertical reference

COMMAND SYNTAX

<trace>:PEr_Cursor_Set <cursor>,<position>[,<cursor>,<position>,…,<cursor>,<position>]

<trace>:={C1, C2, C3, C4, F1 through F8, M1, M2, M3, M4, TA, TB, TC, TD}. TA through TD are included for compatibility with existing software for earlier instruments. These four mnemonics will not be used in responses to queries.

QUERY SYNTAX

<trace>:PEr_Cursor_Set?

EXAMPLE(GPIB)

The following instruction positions the HREF and HDIF cursors at +2.6 DIV and +7.4 DIV respectively, using Channel 2 as a reference:

```
CMD$="C2:PECS HREF,2.6 DIV,HDIF,7.4 DIV"
CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

CURSOR_MEASURE, CURSOR_SET, PER_CURSOR_VALUE

DISPLAY — PERSIST_LAST, PELT

Command/Query

DESCRIPTION

The PERSIST_LAST command controls whether or not the last trace drawn in a persistence data map is shown. This command checks or unchecks the **Show Last Trace** checkbox in the "Persistence" dialog.

The response to the PERSIST_LAST? query indicates whether the last trace is shown within its persistence data map.

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`

DISPLAY

PERSIST_SAT, PESA

Command/Query

DESCRIPTION

The `PERSIST_SAT` command sets the level at which the color spectrum of the persistence display is saturated. 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 will saturate (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 data maps.

COMMAND SYNTAX

`PErsist_SAt` <trace>`,`<value> [<trace>`,`<value>]

<trace> : = `{C1,C2,C3,C4,F1,F2,F3,F4,F5,F6,F7,F8,TA,TB,TC,TD}`. TA through TD are for compatibility with existing software with earlier instruments. These four mnemonics are not returned by queries.

<value> : = 0 to 100 PCT
Note: The unit PCT is optional.

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 be 60 %; that is, 60 % of the data points will be displayed with the color spectrum, with 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`

DISPLAY — PERSIST_SETUP, PESU

Command/Query

DESCRIPTION

The `PERSIST_SETUP` command selects the persistence duration of the display, in seconds, in persistence mode. In addition, the persistence can be set either to all traces or only the top two 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 does not support the argument "Top2" of earlier instruments.

QUERY SYNTAX

`PErsist_SetUp?`

RESPONSE FORMAT

`PErsist_SetUp` <time>, <mode>

EXAMPLE (GPIB)

The following instruction sets the variable persistence at 10 seconds on all traces:

```
CMD$="PESU 20,ALL": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`PERSIST, PERSIST_COLOR, PERSIST_PERS, PERSIST_SAT`

STATUS

*PRE

Command/Query

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 will affect the 'ist' individual status bit.

The *PRE? query reads the contents of the PRE register. The response is a decimal number that corresponds to the binary sum of the register bits.

COMMAND SYNTAX

`PRE` <value>

<value> : = 0 to 65 535

QUERY SYNTAX

`*PRE?`

RESPONSE FORMAT

`*PRE` <value>

EXAMPLE (GPIB)

The following instruction will cause the 'ist' status bit to become 1 as soon as the MAV bit (bit 4 of STB, i.e. decimal 16) is set, and yields the PRE value 16:

```
CMD$="*PRE 16": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`*IST`

***RCL**
Command

SAVE/RECALL SETUP

DESCRIPTION

The `*RCL` command sets the state of your instrument, using one of the six non-volatile panel setups (Panel 1 to Panel 6), by recalling the complete front panel setup of the oscilloscope. Entering panel setup "0" corresponds to the default panel setup.

The `*RCL` command produces an effect the opposite of the *SAV command.

If the desired panel 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 6

EXAMPLE (GPIB)

The following instruction recalls your instrument setup previously stored in panel setup 3:

```
CMD$="*RCL 3": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`PANEL_SETUP, *SAV, EXR`

RECALL_PANEL, RCPN

Command

SAVE/RECALL SETUP

DESCRIPTION

The RECALL_PANEL command recalls a front panel setup from the current directory on mass storage.

COMMAND SYNTAX

`ReCall_PaNel DISK,<device>,FILE,'<filename>'`

<device> : = {FLPY, HDD}

<filename> : = A string of up to eight characters with the extension .LSS. Include the path to the file; for example, D:\Applications\USB2\Setups\CHIRP_MEAS.LSS

EXAMPLE (GPIB)

The following instruction recalls the front panel setup from file P012.LSS on the floppy disk:

```
CMD$="RCPN DISK, FLPY, FILE,'P012.LSS'":

CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

PANEL_SETUP, *SAV, STORE_PANEL, *RCL

ACQUISITION

REFERENCE_CLOCK, RCLK

Command/Query

DESCRIPTION

The REFERENCE_CLOCK command allows you to choose between the internal reference clock and an external reference clock.

COMMAND SYNTAX

`Reference_CLocK` <state>
<state>:= `{INTERNAL, EXTERNAL}`

QUERY SYNTAX

`Reference_CLocK?`

RESPONSE FORMAT

<state>

EXAMPLE (GPIB)

The following instruction sets the instrument to use an external reference clock:

```
CMD$=”RCLK EXTERNAL”:CALL IBWRT(SCOPE%,CMD$)
```

SAVE/RECALL SETUP

`*RST`
Command

DESCRIPTION

The `*RST` command initiates a device reset. `*RST` sets all eight traces to the GND line and recalls the default setup.

COMMAND SYNTAX

```
*RST
```

EXAMPLE (GPIB)

The following instruction resets the oscilloscope:

```
CMD$="*RST": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`*CAL, *RCL`

ACQUISITION

SAMPLE_CLOCK, SCLK

Command/Query

DESCRIPTION

The SAMPLE_CLOCK command allows you to choose between the internal sample clock and an 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$="SCLK EXTERNAL":CALL IBWRT(SCOPE%,CMD$)
```

SAVE/RECALL SETUP

***SAV**
Command

DESCRIPTION

The *SAV command stores the current state of your instrument in non-volatile internal memory. The *SAV command stores the complete front panel setup of the oscilloscope at the time the command is issued.

NOTE: Neither communication parameters (those modified by the commands COMM_FORMAT, COMM_HEADER, COMM_HELP, COMM_ORDER, and WAVEFORM_SETUP) nor enable registers of the status reporting system (*SRE, *PRE, *ESE, INE) are saved when *SAV is used.

COMMAND SYNTAX

*SAV <panel_setup>
<panel_setup> : = 1 to 6

EXAMPLE (GPIB)

The following instruction saves the current instrument setup in panel setup 3:

```
CMD$="*SAV 3": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

PANEL_SETUP, *RCL

HARD COPY

SCREEN_DUMP, SCDP

Command

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>

<status>:=`{OFF}`

EXAMPLE (GPIB)

The following instruction initiates a screen dump:

```
CMD$=“SCDP”: CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`INR, HARDCOPY_SETUP`

ACQUISITION

SEQUENCE, SEQ

Command/Query

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. The argument <max_size> can be expressed either as numeric fixed point, exponential, or using standard suffixes.

When Sequence mode is turned on by means of this command, SMART memory is automatically enabled and the memory length is set to the user-supplied <max_size> value.

Sequence mode cannot be used at the same time as random interleaved sampling (RIS). If RIS is on, SEQ ON will turn RIS off.

COMMAND SYNTAX

`SEQuence` <mode>[`,`<segments>[`,`<max_size>]]

<mode> : = `{OFF, ON}`

<segments> : = the right-hand column in the table below:

Max. memory length per channel	Max. number of segments
10 k	50
25 k	50
50 k	200
100 k	500
200 k	500
250 k	500
500 k	2000
1 M	2000
2 M	2000

<max_size> : = `{…10e+3, 10.0e+3,…11e+3,…}`, for example, in standard numeric format.

Or, alternatively:

```
= {50, 100, 250, 500, 1000, 2500, 5K, 10K,
25K, 50K, 100K, 250K, 500K, 1M}
```

However, values not absolutely identical to those listed immediately above will be recognized by the scope as *numerical data* (see the table under this heading in Chapter 1). For example, the scope will recognize `1.0M` as 1 millisample. But it will recognize `1.0MA` as 1 megasample.

NOTE: The oscilloscope will adapt the requested <max_size> to the closest valid value.

QUERY SYNTAX

`SEQuence?`

RESPONSE FORMAT

`SEQuence` <mode>`,`<segments>`,`<max_size>

<mode> : = `{ON, OFF}`

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`

STATUS ***SRE**

Command/Query

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 will generate a service request. Refer to the table on page 212 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, i.e. decimal 16) or the INB summary bit (bit 0, i.e. decimal 1) in the STB register, or both, are set. Summing these two values yields the SRE mask 16+1 = 17.

```
CMD$="*SRE 17": CALL IBWRT(SCOPE%,CMD$)
```

STATUS — *STB?

Query

DESCRIPTION

The *STB? query reads the contents of the 488.1 defined STatus Byte register (STB), and the 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. Refer to the table on page 212 for further details of the status register structure.

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`

ADDITIONAL INFORMATION

STATUS BYTE REGISTER (STB)					
Bit	**Bit Value**	**Bit Name**	**Description**		**Note**
7	128	DIO7	0	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		1. 2.
5	32	ESB	1	an ESR enabled event has occurred	3.
4	16	MAV	1	output queue is not empty	4.
3	8	DIO3	0	reserved	
2	4	VAB	1	a command data value has been adapted	5.
1	2	DIO1	0	reserved	
0	1	INB	1	an enabled internal state change has occurred	6.

NOTE: *For the above table...*

1. ***The Master Summary Status (MSS) indicates that the oscilloscope requests service, while the Service Request status (when set) specifies that the oscilloscope issued a service request. Bit position 6 depends on the polling method:***

   Bit 6 = MSS if an `*STB?` query is received,

   = RQS if serial polling is conducted.

2. ***Example: If SRE = 10 and STB = 10, then MSS = 1. If SRE = 010 and STB = 100 then MSS = 0.***
3. ***The Event Status Bit (ESB) indicates whether or not one or more of the enabled IEEE 488.2 events have 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. ***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.***
5. ***The Value Adapted Bit (VAB) is set true (1) whenever a data value in a command has been 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.***
6. ***The INternal state Bit (INB) is set true (1) whenever certain enabled internal states are entered. For further information, refer to the `INR` query.***

ACQUISITION **STOP**

Command

DESCRIPTION

The `STOP` command immediately stops the acquisition of a signal. If the trigger mode is AUTO or NORM, `STOP` will place the oscilloscope in STOPPED trigger mode to prevent further acquisition.

COMMAND SYNTAX

```
STOP
```

EXAMPLE

The following instruction stops the acquisition process:

```
CMD$ =“STOP”: CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`ARM_ACQUISITION, TRIG_MODE, WAIT, FORCE_TRIGGER`

WAVEFORM TRANSFER

STORE, STO
Command

DESCRIPTION

The STORE command stores the contents of the specified trace in one of the internal memories M1 to M4 or in the current directory in mass storage.

COMMAND SYNTAX

STOre [<trace>,<dest>]

<trace> : = {F1,F2,F3,F4,F5,F6,F7,F8,TA,TB,TC,TD,C1,C2,C3, C4,ALL_DISPLAYED}. TA through TD are for compatibility with existing software with earlier instruments. These four mnemonics are not returned by queries.

<dest> : = {M1, M2, M3, M4, FILE}

TIP: If you send the STORE command without an argument, all traces currently enabled in the Store Setup will be stored. Modify this setup using STORE_SETUP.

AVAILABILITY

<trace> : = {C3, C4} only available on four-channel oscilloscopes.

EXAMPLE (GPIB)

The following instruction stores the contents of Trace A (TA) into Memory 1 (M1):

```
CMD$="STO F1,M1": CALL IBWRT(SCOPE%,CMD$)
```

The following instruction stores all currently displayed waveforms onto the memory card:

```
CMD$="STO ALL_DISPLAYED, FILE":
CALL IBWRT(SCOPE%,CMD$)
```

The following instruction executes the storage operation currently defined in the Storage Setup (see command STORE_SETUP):

```
CMD$="STO": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

STORE_SETUP

SAVE/RECALL SETUP — STORE_PANEL, STPN

Command

DESCRIPTION

The `STORE_PANEL` command stores the complete front panel setup of your oscilloscope, at the time the command is issued, in a file in the current directory in mass storage.

***NOTE:** The communication conditions (those modified by commands **`COMM_FORMAT`**, **`COMM_HEADER`**, **`COMM_HELP`**, **`COMM_ORDER`** and **`WAVEFORM_SETUP`**) and the enable registers associated with the status reporting system (commands **`*SRE`**, **`*PRE`**, **`*ESE`**, **`INE`**) are not saved by this command.*

If no filename (or an empty string) is supplied, the oscilloscope generates a filename according to its internal rules.

COMMAND SYNTAX

`STore_PaNel DISK,` <device>, `FILE,‘`<filename>`’`

<device> : = {`FLPY`, `HDD`}

<filename> : = A string of up to eight characters with the extension `.LSS`.

EXAMPLE (GPIB)

The following instruction saves the current oscilloscope setup to floppy disk in a file called “DIODE.LSS”:

```
CMD$=“STPN DISK, FLPY, FILE,‘DIODE.LSS’”:
CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`PNSU, *SAV, RECALL_PANEL, *RCL`

WAVEFORM TRANSFER — STORE_SETUP, STST

Command/Query

DESCRIPTION

The STORE_SETUP command controls the way in which traces will be stored. Any one trace, or all displayed traces, can be set up for storage, either by auto-storing or by the STORE command. Using auto-store, two modes are available, FILL, which stops when the storage medium is full, and WRAP, which replaces the oldest trace by the latest one. Wrap mode will overwrite any trace file, whether or not it was made during the current session, and whether or not it records the same trace.

COMMAND SYNTAX

```
STore_SeTup
[<trace>,<dest>][,AUTO,<mode>][,FORMAT,<type
>]
```

`<trace>:={C1,C2,C3,C4,F1,F2,F3,F4,F5,F6,F7,F8,M1,M2,M3,M4,TA,TB,TC,TD,ALL_DISPLAYED}.`
TA through TD are for compatibility with existing software with earlier instruments. These four mnemonics are not returned by queries.

<dest>:=`{M1, M2, M3, M4, HDD}`

<mode>:= `{OFF, FILL, WRAP}`

<type>:= `{ASCII, BINARY, EXCEL,MATHCAD, MATLAB}`

QUERY SYNTAX

```
STore_SeTup?
```

RESPONSE FORMAT

```
STore_SeTup <trace>,<dest>,AUTO,<mode>
```

EXAMPLE (GPIB)

The following instruction enables autostore 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`

WAVEFORM TRANSFER — TEMPLATE?, TMPL?

Query

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.

See Chapter 4 for more on the waveform template, and Appendix II for a copy of the template itself.

QUERY SYNTAX

`TeMPLate?`

RESPONSE FORMAT

`TeMPLate "`<template>`"`

<template> : = A variable length string detailing the structure of a waveform.

RELATED COMMANDS

`INSPECT?`

ACQUISITION — **TIME_DIV, TDIV**

Command/Query

DESCRIPTION

The `TIME_DIV` command modifies the timebase setting. The new 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 (see table on page 212) to be set.

The `TIME_DIV?` query returns the current timebase setting.

COMMAND SYNTAX

`Time_DIV` <value>

<value> : = See the *Operator's Manual* for specifications.

The unit S (seconds) is optional.

QUERY SYNTAX

`Time_DIV?`

RESPONSE FORMAT

`Time_DIV` <value>

EXAMPLE (GPIB)

The following instruction sets the time base to 500 µs/div:

```
CMD$="TDIV 500US": CALL IBWRT(SCOPE%,CMD$)
```

The following instruction sets the time base to 2 msec/div:

```
CMD$="TDIV 0.002": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`TRIG_DELAY, TRIG_MODE`

DISPLAY

TRACE, TRA

Command/Query

DESCRIPTION

The TRACE command enables or disables the display of a trace. An environment error (see table on page 142) is set if an attempt is made to display more than four waveforms.

The TRACE? query indicates whether the specified trace is displayed or not.

COMMAND SYNTAX

<trace> : TRAce <mode>

<trace> : = {C1,C2,C3,C4,F1,F2,F3,F4,F5,F6,F7, F8,TA,TB,TC,TD}. TA through TD are for compatibility with existing software with earlier instruments. These four mnemonics are not returned by queries.
<mode> : = {ON, OFF}

QUERY SYNTAX

<trace> : TRAce?

RESPONSE FORMAT

<trace> : TRAce <mode>

AVAILABILITY

<trace> : = {C3, C4} only on four-channel instruments.

EXAMPLE (GPIB)

The following instruction displays Trace F1:

```
CMD$=“F1:TRA ON”: CALL IBWRT(SCOPE%,CMD$)
```

WAVEFORM STORAGE — TRANSFER_FILE, TRFL

Command/Query

DESCRIPTION

This command allows you to transfer files to and from storage media, or between scope 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

`TRanser_FiLe`
`DISK`,<device>,`FILE`,'<filepath>',#9nnnnnnnnn
<data><crc>

<device> : =`{FLPY, HDD}`

<filepath> := file name or complete path to a file in another directory

<n . . . n> : = file size in bytes (<data> size + <crc> size)

<data> : = file data (arbitrary data block)
<crc> : = reserved for future 32-bit CRC (cyclic redundancy check) of <data>, 8 bytes long

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 floppy disk:

```
CMD$=TRFL DISK,FLPY,FILE,'FAVORITE.DSO'
CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

DIRECTORY

ACQUISITION

***TRG**
Command

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`

ACQUISITION — TRIG_COUPLING, TRCP

Command/Query

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.

COMMAND SYNTAX

<trig_source> : `TRig_CouPling` <trig_coupling>

<trig_source> : = `{C1, C2, C3, C4, EX, EX10, ETM10}`

<trig_coupling> : = `{DC}` for channel source
`{DC50, GND, DC1M, AC1M}` for external source

QUERY SYNTAX

<trig_source> : `TRig_CouPling?`

RESPONSE FORMAT

<trig_source> : `TRig_CouPling` <trig_coupling>

AVAILABILITY

<trig_source> : = `{C3, C4}` only on four-channel instruments.

EXAMPLE (GPIB)

The following instruction sets the coupling mode of the trigger source Channel 2 to AC:

```
CMD$="C2:TRCP AC": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`TRIG_COUPLING, TRIG_DELAY, TRIG_LEVEL, TRIG_MODE, TRIG_SELECT, TRIG_SLOPE`

ACQUISITION

TRIG_DELAY, TRDL

Command/Query

DESCRIPTION

The TRIG_DELAY command sets the time at which the trigger is to occur with respect to the first acquired data point (displayed at the left-hand edge of the screen).

Positive trigger delays are to be expressed as a percentage of the full grid. This mode is called pre-trigger acquisition because data are acquired before the trigger occurs. Negative trigger delays must be given in seconds. This mode is called post-trigger acquisition because the data are acquired after the trigger has occurred.

If a value outside the range -10,000 div x time/div and 100% is specified, the trigger time will be set to the nearest limit and the VAB bit (bit 2) will be set in the STB register.

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 in X-Stream scopes places the trigger indicator at the center of the grid; unlike non-X-Stream scopes, which place it at the left edge of the grid.

COMMAND SYNTAX

`TRig_DeLay` <value>

<value> : = 0.00 PCT to 100.00 PCT (pretrigger)

-20 PS to -10 MAS (post-trigger)

NOTE: The unit is optional. For positive numbers, the unit PCT is assumed. For negative numbers, the unit S is assumed. MAS is the unit for Ms (megaseconds), useful only for extremely large delays at very slow timebases.

QUERY SYNTAX

`TRig_DeLay?`

RESPONSE FORMAT

`TRig_DeLay` <value>

EXAMPLE (GPIB)

The following instruction sets the trigger delay to -20 s (post-trigger):

```
CMD$="TRDL -20S": CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

```
TIME_DIV, TRIG_COUPLING, TRIG_LEVEL,
TRIG_MODE, TRIG_SELECT, TRIG_SLOPE
```

ACQUISITION — TRIG_LEVEL, TRLV

Command/Query

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>

<trig_source> : = {C1, C2, C3, C4, EX, EX10, ETM10}

NOTE: The unit V is optional.

QUERY SYNTAX

<trig_source> : TRig_LeVel?

RESPONSE FORMAT

<trig_source> : TRig_LeVel <trig_level>

AVAILABILITY

<trig_source> : = {C3, C4} only on four-channel instruments.

EXAMPLE (GPIB)

The following instruction adjusts the trigger level of Channel 2 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

ACQUISITION **TRIG_MODE, TRMD**

Command/Query

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}`

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
```

ACQUISITION

TRIG_PATTERN, TRPA

Command/Query

DESCRIPTION

The TRIG_PATTERN command defines a trigger pattern. The command specifies the logic level of the pattern sources (Channel 1, Channel 2, Channel 3, Channel 4, External), as well as the states under which a trigger can occur. This command can be used even if the complex trigger mode has not been activated.

The TRIG_PATTERN? query returns the current trigger pattern.

COMMAND SYNTAX

TRig_PAttern [<source>,<level>,...<source>,<level>],STATE,<state>

<source> : = {C1, C2, C3, C4, EX}
<level> : = {L,H,X}
<state> : = {AND,NAND,OR,NOR }

Note: If a source state is not specified in the command, the source will be set to the X (= don't care) state.

QUERY SYNTAX

`TRPA?`

RESPONSE FORMAT

TRig_PAttern [<source>,<level>,...<source>,<level>],STATE,<state>

EXAMPLE (GPIB)

The following instruction configures the logic state of the pattern as HLXH (CH 1 = H, CH 2 = L, CH 3 = X, CH 4 = H) and defines the state 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

ACQUISITION

TRIG_SELECT, TRSE
Command/Query

DESCRIPTION

The TRIG_SELECT command selects the condition that will 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 to be modified, while the second gives the new value to be assigned. Pairs may be given in any order and restricted to only those variables to be changed.

The TRIG_SELECT? query returns the current trigger condition.

TRIGGER NOTATION

DROP	Dropout Dropout	OFF	No hold-off on wait
EDGE	Edge Edge	PL	Greater Than Pulse larger than
EV	Events Events	PS	Less Than Pulse smaller than
GLIT	Glitch Glitch	P2	In Range Out Of Range Pulse width
HT	Hold type	QL	Qualifier
HV	Hold value	SNG	Single source
HV2	Second hold value	SQ	Qualify State Qualified
IL	Greater Than Interval larger than	SR	Source

INTV	Interval Interval	TEQ	Edge Edge Qualified
IS	Less Than Interval smaller than	TI	Time greater than
I2	In Range Interval width Out Of Range	TL	Time within

COMMAND SYNTAX

`TRig_SElect` <trig_type>`,SR,`<source>`,QL,`<source>`,`
`HT,`<hold_type>`,HV,`<hold_value>`,HV2,`<hold value>

<trig_type> : = `{DROP, EDGE, GLIT, INTV, STD, SNG, SQ, TEQ}`

<source> : = `{C1, C2, C3, C4, LINE, EX, EX10, PA, ETM10}`

<hold_type> : = `{TI, TL, EV, PS, PL, IS, IL, P2, I2, OFF}`

<hold_value> : = See specifications in the *Operator's Manual* for valid values

NOTE: The unit S (seconds) is optional.

QUERY SYNTAX

`TRig_SElect?`

RESPONSE FORMAT

`TRig_SElect`
<trig_type>`,SR,`<source>`,HT,`<hold_type>`,HV,`
<hold_value>`,`<hold_value>

- HV2 only returned if <hold_type> is P2 or I2

AVAILABILITY

<source> : {C3, C4} only available on four-channel instruments.

EXAMPLE (GPIB)

The following instruction selects the single-source trigger with Channel 1 as   trigger source. Hold type and hold value are chosen as "pulse smaller" than 20 ns:

```
CMD$="TRSE SNG,SR,C1,HT,PS,HV,20 NS":
CALL IBWRT(SCOPE%,CMD$)
```

ACQUISITION

TRIG_SLOPE, TRSL

Command/Query

DESCRIPTION

The TRIG_SLOPE command sets the trigger slope of the specified trigger source.

The TRIG_SLOPE? query returns the trigger slope 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>

AVAILABILITY

<trig_source> : = {C3, C4} only available on four-channel oscilloscopes.

EXAMPLE (GPIB)

The following instruction sets the trigger slope of Channel 2 to negative:

```
CMD$=“C2:TRSL NEG”: CALL IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`TRIG_COUPLING, TRIG_DELAY, TRIG_LEVEL, TRIG_MODE, TRIG_SELECT, TRIG_SLOPE`

AUTOMATION **VBS, VBS**

Command/Query

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 = sign may be flanked by optional spaces for clarity.

COMMAND SYNTAX

VBS <automation command>

QUERY SYNTAX

VBS? <Return=automation command>

EXAMPLES with "GPIB" Equivalents

The following instruction sets Channel 1 vertical scale to 50 mV/Div, the time per division to 500 ns, and the grid mode to Dual:

```
CMD$="VBS 'app.Acquisition.C1.VerScale=0.05'"
CMD$ "C1:VDIV 50 MV"  (GPIB equivalent)
CMD$="VBS 'app.Horizontal.HorScale = 500e-9'"
CMD$ "TDIV 0.5e-6"  (GPIB equivalent)
CMD$="VBS 'app.Display.GridMode="Dual"'
CMD$ "GRID DUAL"  (GPIB equivalent)
```

QUERY SYNTAX

```
CMD$ = "VBS?
'Return=app.Acquisition.C1.VerScale'"
```

DISPLAY

VERT_MAGNIFY, VMAG

Command/Query

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,F2,F3,F4,F5,F6,F7,F8,TA, TB,TC,TD`} TA through TD are included for backward compatibility with software designed for earlier LeCroy instruments. These four mnemonics will not be returned in response to queries.

<factor> : = 100E-3 to 181

QUERY SYNTAX

<trace> : `Vert_MAGnify?`

RESPONSE FORMAT

<trace> : `Vert_MAGnify` <factor>

EXAMPLE

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`

DISPLAY

VERT_POSITION, VPOS

Command/Query

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,F2,F3,F4,F5,F6,F7,F8,TA,TB,TC,TD,M1,M2,M3,M4`} TA through TD are included for backward compatibility with software designed for earlier LeCroy instruments. These four mnemonics will not be returned in response to queries.

<display_offset> : = -5900 to +5900 DIV

NOTE: 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

The following instruction shifts Trace A (TA) 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`

ACQUISITION **VOLT_DIV, VDIV**

Command/Query

DESCRIPTION

The `VOLT_DIV` command sets the vertical sensitivity in Volts/div. The VAB bit (bit 2) in the STB register (see table on page 212) is set if an out-of-range value is entered.

The probe attenuation factor is not taken into account for adjusting vertical sensitivity.

The `VOLT_DIV?` query returns the vertical sensitivity of the specified channel.

COMMAND SYNTAX

<channel> : `Volt_DIV` <v_gain>

<channel> : = {`C1`, `C2`, `C3`, `C4`}

<v_gain> : = See *Operator's Manual* for specifications.

NOTE: The unit V is optional.

QUERY SYNTAX

<channel> : `Volt_DIV?`

RESPONSE FORMAT

<channel> : `Volt_DIV` <v_gain>

AVAILABILITY

<channel> : = {C3, C4} only available on four-channel oscilloscopes.

EXAMPLE

The following instruction sets the vertical sensitivity of channel 1 to 50 mV/div:

```
CMD$="C1:VDIV 50MV": CALL IBWRT(SCOPE%,CMD$)
```

STATUS **`*WAI`**

Command

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`

RELATED COMMANDS

`*OPC`

ACQUISITION

WAIT

Command

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 will stop waiting for new acquisitions. If <t> is not given, or if <t> = 0.0, the scope will wait indefinitely.

COMMAND SYNTAX

```
WAIT [<t>]
```

<t>:=timeout in seconds (default is indefinite)

EXAMPLE (GPIB)

```
send: "TRMD SINGLE"
loop {send:"ARM;WAIT;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.

`C1:PAVA?MAX` instructs the oscilloscope to evaluate the maximum data value in the Channel 1 waveform.

RELATED COMMANDS

`*TRG, TRIG_MODE, ARM`

WAVEFORM TRANSFER WAVEFORM, WF

Command/Query

DESCRIPTION

A `WAVEFORM` command transfers a waveform from the controller to the oscilloscope, whereas a `WAVEFORM?` query transfers a waveform from the oscilloscope to the controller.

`WAVEFORM` stores an external waveform back into the oscilloscope's internal memory. A waveform consists of several distinct entities:

1. the descriptor (`DESC`)
2. the user text (`TEXT`)
3. the time (`TIME`) descriptor
4. the data (`DAT1`) block, and, optionally
5. a second block of data (`DAT2`).

See Chapter 4 for further information on waveform structure.

NOTE: You can restore to the oscilloscope only complete waveforms queried with `WAVEFORM? ALL`.

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 enumerated above.

NOTE: 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, M2, M3, M4}`

<waveform_data_block> : = Arbitrary data block (see Chapter 5).

QUERY SYNTAX

<trace> : `WaveForm?` <block>

<trace> : = `{F1,F2,F3,F4,F5,F6,F7,F8,TA,TB, TC,TD,M1,M2,M3,M4,C1,C2,C3,C4}`. TA through TD are for compatibility with existing software with earlier instruments. These four mnemonics are not returned by queries.

<block> : = `{DESC, TEXT, TIME, DAT1, DAT2, ALL}`

If you do not give a parameter, ALL will be 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. See the `COMM_HEADER` command for further details.

AVAILABILITY

<trace> : = `{C3, C4}` only available on four-channel oscilloscopes.

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 that 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 TRANSFER **WAVEFORM_SETUP, WFSU**

Command/Query

DESCRIPTION

The `WAVEFORM_SETUP` command specifies the amount of data in a waveform to be transmitted to the controller. The command controls the settings of the parameters listed below.

NOTATION			
FP	first point	NP	number of points
SN	segment number	SP	Sparsing

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

The `WAVEFORM_SETUP?` query returns the transfer parameters currently in use.

COMMAND SYNTAX

`WaveForm_SetUp`
`SP,`<sparsing>`,NP,`<number>`,FP,`<point>`,SN,`<segment>

NOTE: After power-on, all values are set to 0 (i.e., entire waveforms will be transmitted without sparsing).

Parameters are grouped in pairs. The first of 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 restricted to those variables to be changed.

QUERY SYNTAX

`WaveForm_SetUp?`

RESPONSE FORMAT

`WaveForm_SetUp`
`SP,`<sparsing>,`NP`,<number>,FP,<point>,SN, <segment>

EXAMPLE (GPIB)

The following instructs every 3rd data point (SP=3) starting at address 200 to be transferred:

```
CMD$="WFSU SP,3,FP,200": CALL
IBWRT(SCOPE%,CMD$)
```

RELATED COMMANDS

`INSPECT, WAVEFORM, TEMPLATE`

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Programming Examples

INTRODUCTION TO DSO SOFTWARE TOOLS

Although the X-Stream DSOs are unrivalled in their ability to process data internally, they are sometimes required to send information to the outside world. For this purpose, LeCroy provides tools that facilitate remote interaction with the instruments. This appendix describes two types of software.

The first type is provided in executable form, to enable users to make a quick start with remote control. This group includes examples in ActiveDSO®.

The second type is provided in source code, to provide programmers with simple examples for development. Some of these use ActiveDSO as well.

EXECUTABLE PROGRAMS

These are available on the CD-ROM which is shipped with the instruments, and on LeCroy's Web site, at http://www.lecroy.com/tm/library/software/.

ActiveDSO Based on Microsoft's ActiveX control technology, ActiveDSO gives leverage to widely available Microsoft software tools, and makes programming within the Microsoft environment easier. ActiveDSO simplifies the computer's interface with the instrument, and simplifies programming within Visual C++, Visual Basic, or any other ActiveX compatible application. For example, Microsoft Excel can be used to control and retrieve data directly from the X-Stream DSO. This tool, therefore, becomes part of the target application and provides seamless access to the full power of the instrument.

Other Software For users of LabVIEW, VI's are available for most LeCroy DSOs.

Executable programs can be found on LeCroy's Web site at http://www.lecroy.com/tm/library/software/.

SOURCE CODE PROGRAMS

These programs can be divided into two types, those using National Instruments GPIB software and hardware, and those using ActiveDSO, which for GPIB also connects to National Instruments software and hardware. A great benefit of ActiveDSO is that the code written by the user is completely independent of the hardware connection. The selection of GPIB, LAN, or RS232 (for earlier DSOs) is made by a single command near the start of a program.

Programming examples can be found on LeCroy's Web site at http://www.lecroy.com/tm/library/software/.

SOURCE CODE EXAMPLE GPIB - 1

Use the Interactive GPIB Program "IBIC"

This example assumes the use of an IBM PC (or compatible) computer equipped with a National Instruments GPIB interface card. The GPIB driver is left in default state so that the device name "dev4" corresponds to the GPIB address 4, the oscilloscope address. All text is entered by the user. Bold type represents prompts from the program.

```
IBIC<cr>
program announces itself
: ibfind<CR>
enter board/device name: dev4<CR>
dev4: ibwrt<CR>
enter string: "tdiv?"<CR>
[0100] ( cmpl )
count: 5
dev4: ibrd<CR>
enter byte count: 10<CR>
[0100] ( cmpl )
count: 10
54 44 49 56 20 35 30 45     T D I V5 0 E
2D 39                       - 9
dev4: ibwrt<CR>
enter string: "c1:cpl?"<CR>
[0100] ( cmpl )
count: 7
```

```
dev4: ibrd<CR>
enter byte count: 20<CR>
[2100] ( end cmpl )
count: 11
43 31 3A 43 50 4C 20 44     C 1 : C P L D
35 30 0A                    5 0 z
dev4: q<CR> to quit the program.
```

SOURCE CODE EXAMPLE GPIB - 2

Use the GPIB Program for IBM PC (High-Level Function Calls)

The following BASICA program allows full interactive control of the oscilloscope using an IBM PC as GPIB controller. As in Example 1, it is assumed that the controller is equipped with a National Instruments GPIB interface card. All commands can be used following this example simply by entering the text string of the command. For example, "C1:VDIV 50 MV" without the quotation marks. The program automatically displays the information sent back by the oscilloscope in response to queries.

In addition, a few utilities have been provided for convenience. The commands ST and RC enable waveform data to be stored on, or retrieved from, a disk if the correct drive and file names are provided. The command LC returns the oscilloscope to local mode. Responses sent back by the oscilloscope are interpreted as character strings and are thus limited to a maximum of 255 characters.

```
‘   INCLUDE – This line is symbolic of the National Instruments routines which
allow your language
‘   to communicate with GPIB.  Please see your NI manual for information.

CLS
PRINT "Control of the 9300 via GPIB and IBM PC" : PRINT
PRINT "Options : EX to exit            LC local mode"
PRINT "               ST store data      RC recall data" : PRINT ""
LINE INPUT "GPIB-address of oscilloscope (1...16)? :",ADDR$
DEV$ = "DEV" + ADDR$     ‘     Construct DSO address.
CALL IBFIND (DEV$,SCOPE%)
   IF SCOPE% < 0 THEN PRINT “IBFIND ERROR” : END     ‘     Cannot find DSO.
TMO% = 10     '     Timeout = 300 msec (rather than default 10 sec)
CALL IBTMO(SCOPE%,TMO%)
LOOP% = 1


   WHILE LOOP%
   LINE INPUT "Enter command (EX --> Exit) : ",CMD$
          Select Case CMD$
              Case “ex”, “EX” : LOOP% = 0 : GOSUB LocalMode : END
              Case "st", "ST" : GOSUB StoreData : GOTO LoopEnd
              Case "rc", "RC" : GOSUB RecallData : GOTO LoopEnd
              Case  "lc", "LC" : GOSUB LocalMode : GOTO LoopEnd
              Case "" : GOTO LoopEnd
       End Select
   CALL IBWRT(SCOPE%,CMD$)
      IF IBSTA% < 0 THEN GOSUB GPIBError : END
   GOSUB GetData
   LoopEnd : WEND

LocalMode:
`  Put DSO into Local Mode.
CALL IBLOC (SCOPE%) : PRINT
RETURN

GetData :
`  Get data from DSO.
   '  If there are no data to read, simply wait until timeout occurs
CALL IBRD (SCOPE%,RD$)
I = IBCNT% 'IBCNT% is the number of characters read
   FOR J = 1 TO I
   PRINT MID$ (RD$,J,1);
   NEXT J
PRINT : RETURN

StoreData :
`  Store waveform data in a file.
RD1$=SPACE$(3)
LINE INPUT "Specify trace (TA...TD,M1...M4,C1...C4): ",TRACE$
LINE INPUT "Enter filename : ",FILE$
CMD$="WFSU NP,0,SP,0,FP,0,SN,0; CHDR SHORT"
CALL IBWRT (SCOPE%,CMD$)
CMD$=TRACE$+":WF?"
CALL IBWRT (SCOPE%,CMD$)
CALL IBRD (SCOPE%,RD1$)       '     Discard first 3 chars of response
CALL IBRDF (SCOPE%,FILE$)
   IF IBSTA% < 0 THEN GODUB GPIBError : END
PRINT : RETURN


RecallData :
`  Recall waveform data from file and send them to DSO.
LINE INPUT "Specify target memory (M1...M4):",MEM$
LINE INPUT "Enter filename : ",FILE$
CMD$=MEM$+":"
CALL IBWRT (SCOPE%,CMD$)
CALL IBWRTF (SCOPE%,FILE$)
   IF IBSTA% < 0 THEN GOSUB GPIB Error : END
 RETURN

GPIBError:
PRINT "GPIB ERROR -- IBERR: ";IBERR%;"IBSTA: ";HEX$(IBSTA%) : RETURN
```

NOTE:

- ***It is assumed that the National Instruments GPIB driver GPIB.COM is in its default state. This means that the interface board can be referred to by its symbolic name 'GPIB0' and that devices on the GPIB with addresses 1 to 16 can be called by the symbolic name 'DEV1' to 'DEV16'.***
- ***Lines 1–99 are a copy of the file DECL.BAS supplied by National Instruments. The first six lines are required for the initialization of the GPIB handler. DECL.BAS requires access to the file BIB.M during the GPIB initialization. BIB.M is one of the files supplied by National Instruments, and must exist in the directory currently in use.***
- ***The first two lines of DECL.BAS each contains a string "XXXXX" that must be replaced by the number of bytes that determine the maximum workspace for BASICA (computed by subtracting the size of BIB.M from the currently available space in BASICA). For example, if the size of BIB.M is 1200 bytes and, when BASICA is loaded, it reports "60200 bytes free", "XXXXX" would be replaced by the value 59000 or less.***
- ***The default timeout of 10 seconds is modified to 300 ms during the execution of this program. However, the default value of the GPIB handler remains unchanged. Whenever a remote command is entered by the user, the program sends it to the instrument with the function call IBWRT. Afterwards, it always executes an IBRD call, regardless of whether or not a response is expected. If a response is received it is immediately displayed. If there is no response, the program waits until time-out and then asks for the next command.***

SOURCE CODE EXAMPLE GPIB - 3

USE GPIB Program for IBM PC (Low-Level Function Calls)

This example has the same function as Example 2, but is written with low-level function calls. The program assumes that the controller (board) and oscilloscope (device) are at addresses 0 and 4, respectively, and the decimal addresses are:

	Listener Address	Talker Address
CONTROLLER	32(ASCII <space>)	64 (ASCII @)
DEVICE	32+4=36 (ASCII $)	64+4=68 (ASCII D)

```
'   INCLUDE NATIONAL INSTRUMENTS GPIB ROUTINES
CLS
PRINT "Control of the 9300 (address 4) via GPIB and IBM PC" : PRINT
PRINT "Options :   EX to exit           LC local mode"
PRINT "                  ST store data     RC recall data" : PRINT

UnListen$ = Chr$ ( 63) : UnTalk$ = Chr$ (95)     '     General UnListen and
UnTalk
```

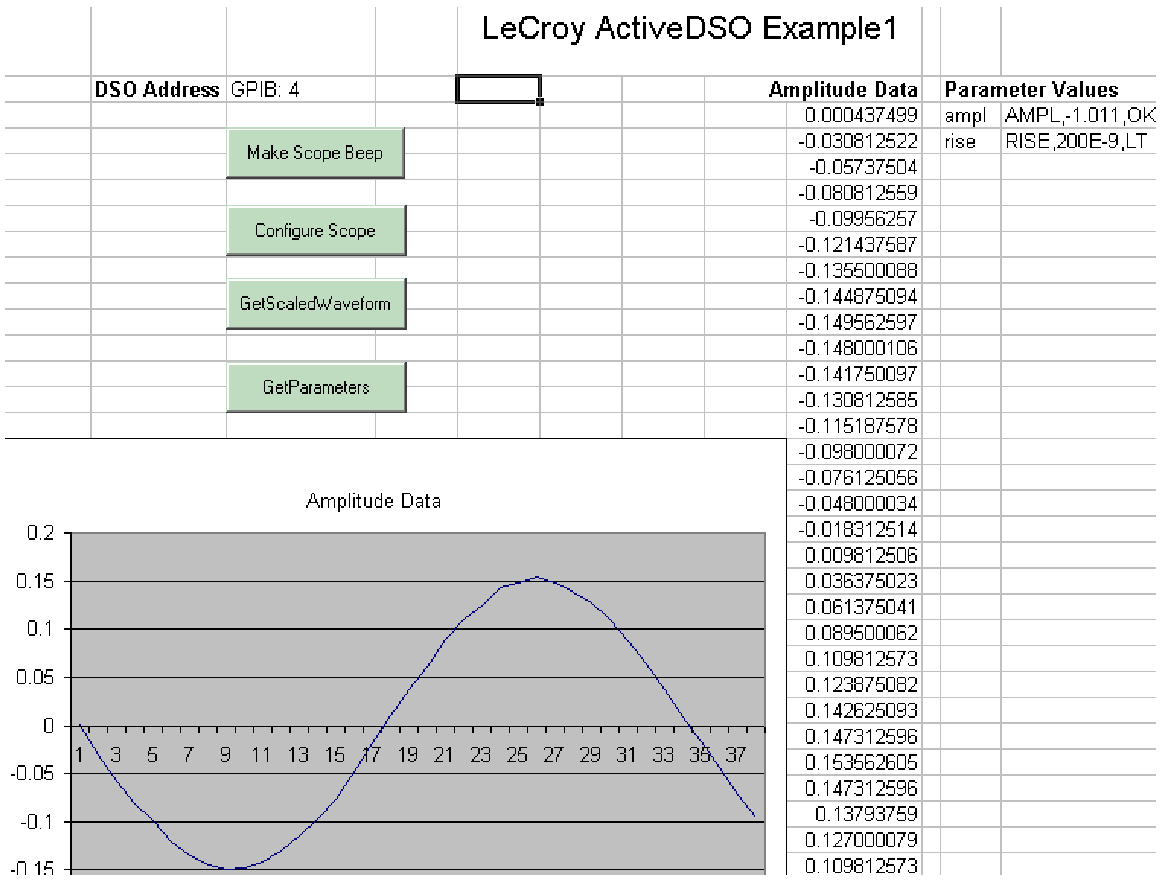
```
BaseListen% = 32 : BaseTalk% = 64
DSOAddress% = 4
DSOListen$ = UnListen$ + UnTalk$ + Chr$ (BaseTalk%) + Chr$ (BaseListen% +
DSOAddress%)
DSOTalk$ = UnListen$ + UnTalk$ + Chr$ (BaseListener%) + Chr$ (BaseTalk% +
DSOAddress%)

BDNAME$= "GPIB0" : CALL IBFIND (BDNAME$,BRD0%)
   IF BRD0% < 0 THEN PRINT "IBFIND ERROR" : STOP
CALL IBSIC (BRD0%) :
   IF IBSTA% < 0 THEN PRINT "IBFIND ERROR" : STOP
LOOP = 1

   WHILE LOOP
   LINE INPUT "Enter command (EX --> Exit) : ",CMD$
   V% = 1: CALL IBSRE(BRD0%,V%)
      IF CMD$ = "ex" OR CMD$ = "EX" THEN LOOP = FALSE : GOTO ExitGPIB
            IF CMD$ = "st" OR CMD$ = "ST" THEN GOSUB StoreData : GOTO LoopEnd
         IF CMD$ = "rc" OR CMD$ = "RC" THEN GOSUB RecallData : GOTO LoopEnd
         IF CMD$ = "lc" OR CMD$ = "LC" THEN  GOSUB DSOLocal : GOTO LoopEnd
      IF CMD$ = "" THEN GOTO LoopEnd
   CALL IBCMD (BRD0%,DSOListen$) : CALL IBWRT(BRD0%,CMD$): GOSUB GetData
   LoopEnd : WEND

ExitGPIB : CALL IBSIC (BRD0%): V%=0 : CALL IBSRE (BRD0%,V%)
CALL IBSIC (BRD0%) : END

DSOLocal :
V% = 0 : CALL IBSRE (BRD0%,V%) : PRINT : RETURN

GetData :
CALL IBCMD (BRD0%,DSOTalk$) : CALL IBRD ( BRD0%,RD$) : I=IBCNT%
   FOR J=1 TO I
   PRINT MID$ (RD$,J,1);
   NEXT J
PRINT :   RETURN

StoreData :
RD1$=SPACE$(3)
LINE INPUT "Specify trace (TA...TD,M1...M4,C1...C4) :  ",TRACE$
LINE INPUT "Enter filename : ",FILE$
CALL IBCMD (BRD0%, DSOListen$)
CMD$="WFSU NP,0,SP,0,FP,0,SN,0;CHDR SHORT"
CALL IBWRT (BRD0%,CMD$)
CMD$=TRACE$+":WF?": CALL IBWRT (BRD0%,CMD$)
CALL IBCMD (BRD0%,DSOTalk$) : CALL IBRD (BRD0%,RD1$)
CALL IBRDF (BRD0%,FILE$)
   IF IBSTA% < 0 THEN GOSUB GPIBError : STOP
PRINT : RETURN

RecallData :
```

```
LINE INPUT "Specify target memory (M1...M4) : ",MEM$
LINE INPUT "Enter filename : ",FILE$
CALL IBCMD (BRD0%,DSOListen$)
CMD$=MEM$+":" : CALL IBWRT (BRD0%,CMD$)
CALL IBWRTF (BRD0%,FILE$)
   IF IBSTA% < 0 THEN GOSUB GPIBError : STOP
PRINT : RETURN

GPIBError :
PRINT "GPIB ERROR -- IBERR : ";IBERR%;"IBSTA : ";HEX$ (IBSTA%) : RETURN

END
```

NOTE: The Template also describes an array named DUAL. This is simply a way to allow you to use the INSPECT? query to examine the two data arrays together.

SOURCE CODE EXAMPLE ACTIVEDSO -- 1 AND 2

The picture shows the screen of a program, ActiveDSOExcel1, that uses ActiveDSO embedded in Excel. ActiveDSOExcel2 is similar.



LeCroy ActiveDSO Example1

DSO Address GPIB: 4

Amplitude Data	**Parameter Values**	
0.000437499	ampl	AMPL,-1.011,OK
-0.030812522	rise	RISE,200E-9,LT
-0.05737504		
-0.080812559		
-0.09956257		
-0.121437587		
-0.135500088		
-0.144875094		
-0.149562597		
-0.148000106		
-0.141750097		
-0.130812585		
-0.115187578		
-0.098000072		
-0.076125056		
-0.048000034		
-0.018312514		
0.009812506		
0.036375023		
0.061375041		
0.089500062		
0.109812573		
0.123875082		
0.142625093		
0.147312596		
0.153562605		
0.147312596		
0.13793759		
0.127000079		
0.109812573		

This example shows how to create some simple applications, and can be a basis for further explorations in ActiveDSO. This example is included in the ActiveDSO system that can be downloaded from LeCroy's web-site at http://www.lecroy.com/tm/library/software/.

The fragment below is the subroutine that reads waveform data from the DSO and places the values in column I (9th column) of the spreadsheet.

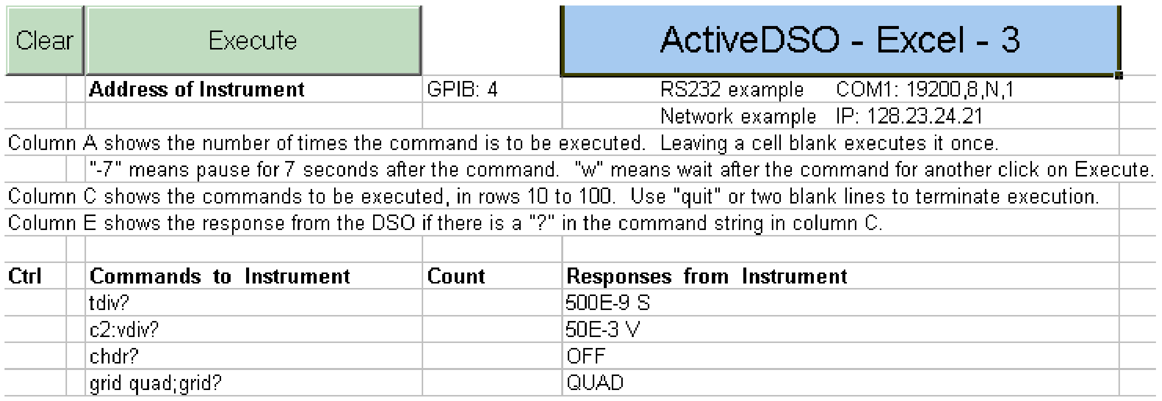
```
Private Sub GetScaledWaveformButton_Click()
Dim o As Object     '     Define variable o as an object.

'  Equate object o with the ActiveDSO object LeCroy.ActiveDSOCtrl1.
Set o = CreateObject("LeCroy.ActiveDSOCtrl.1")

'  Read the device address from cell 2C, and use it to connect the PC to
the DSO.
Dim deviceAddress As String
deviceAddress = Worksheets("Sheet1").Cells(2, 3).Value
Call o.MakeConnection(deviceAddress)
'  Set the DSO into remote control mode.
Call o.SetRemoteLocal(1)

'  Define an array of the size you need for your waveform data.
'  Read the waveform data from the DSO into the array.
Dim waveArray
waveArray = o.GetScaledWaveform("C1", 500000, 0)

'  Place the data into column I (9th column).
Dim i As Long
   For i = 0 To UBound(waveArray)
   Worksheets("Sheet1").Cells(i + 3, 9).Value = waveArray(i)
   Next i
End Sub
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
.

'  Release the control.
Call o.SetRemoteLocal(0)
Set o = Nothing
End Sub
```

SOURCE CODE EXAMPLE ACTIVEDSO -- 3 AND 4

The picture below shows the screen of programs ActiveDSOExcel3, which enables commands and queries to be sent to the X-Stream DSO, using LeCroy's ActiveDSO system. The VBA source code can be seen by clicking Tools / Macro / Visual Basic Editor. The Clear button clears all the commands and queries. The Execute button sends the commands and queries in order down the page.

In fact, this program can be used with earlier DSOs, which is why the RS232 option is still available. As with all ActiveDSO programs, a single string is all that is needed to change from one bus to another. Examples to go in cell 3D are shown here:

GPIB: 7	GPIB
IP: 127.0.0.1	LAN
COM1: 1920,8,N,1	RS232



ActiveDSO - Excel - 3

Address of Instrument GPIB: 4 RS232 example COM1: 19200,8,N,1

Network example IP: 128.23.24.21

Column A shows the number of times the command is to be executed. Leaving a cell blank executes it once.

"-7" means pause for 7 seconds after the command. "w" means wait after the command for another click on Execute.

Column C shows the commands to be executed, in rows 10 to 100. Use "quit" or two blank lines to terminate execution.

Column E shows the response from the DSO if there is a "?" in the command string in column C.

Ctrl	**Commands to Instrument**	**Count**	**Responses from Instrument**
	tdiv?		500E-9 S
	c2:vdiv?		50E-3 V
	chdr?		OFF
	grid quad;grid?		QUAD

The program fragments below are taken from the VBA code of this program.

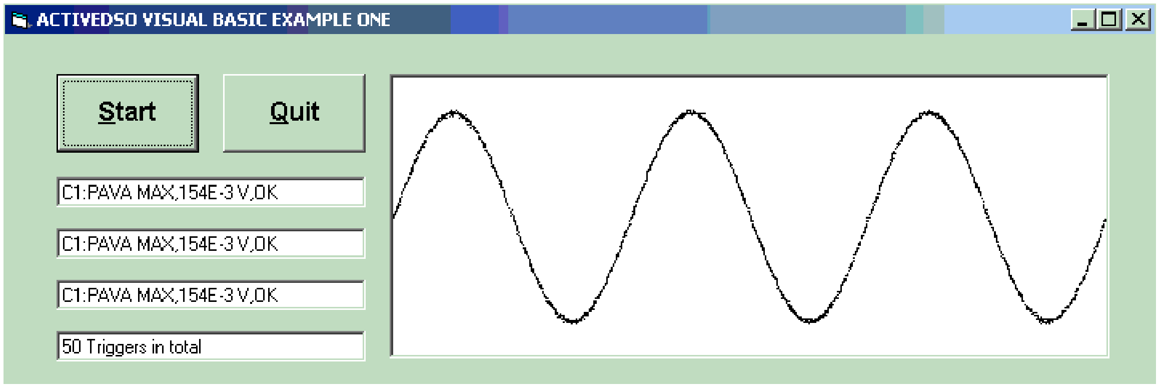
```
'   Procedure to send remote control commands to an instrument
'   and to receive responses from it.

Private Sub CommandButton1_Click()      '      Execute button
Dim o As Object      '      Define variable o as object.
'   Equate object o with the ActiveDSO object LeCroy.ActiveDSOCtrl1.
Set o = CreateObject("LeCroy.ActiveDSOCtrl.1")
'   Strings of the form o.ACBD represent methods or properties of object
o.
```

```
Dim DeviceAddress As String
‘  Read the device address from cell 2D, and use it to connect the PC to
the DSO.
DeviceAddress = Worksheets("Sheet1").Cells(2, 4).Value
Call o.MakeConnection(DeviceAddress)
‘  Set the DSO into remote control mode.
Call o.SetRemoteLocal(1)
'  Set TimeOut to 3 seconds instead of the default, which is 10 seconds.
Call o.SetTimeOut(3)

Dim ErrorFound, GetOut, Waiting As Boolean
Dim Row, Column, Counter, LoopTotal, TCounter, FCounter, TestLength As
Integer
Dim HoldOff, NewTime, XTime, StartRow As Single
Dim ControlDatum, NextData, NextNextData, Query, Quit, ReStart As String
'  Column containg the remote control commands.
Column = 3: StartRow = 10
'  Cell(2,6) is the cell containing the row for restart after a pause.
'  It is empty when starting from top of the list of commands, which is
'  Cell(StartRow,Column).
   If Worksheets("Sheet1").Cells(2, 6).Value < 1 Then
   Row = StartRow
   Else
   Row = Worksheets("Sheet1").Cells(2, 6).Value
   End If

Query = "?": Quit = "quit"
'  Set exit flag, error flag and waiting flag to false.
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
.

'  Execute the command line LoopTotal times.
   For Counter = 1 To LoopTotal
   '  Continue with loop only if no error was found in the loop.
      If ErrorFound = False Then
      '  Send data to instrument.
         If Len(NextData) > 1 Then Call o.WriteString(NextData, 1)
      '  Erase contents of cell ready for response from instrument.
      Worksheets("Sheet1").Cells(Row, Column + 2).Value = ""
         If LoopTotal > 1 Then
         '  Show progress in cell.
            Worksheets("Sheet1").Cells(Row, Column + 1).Value = Counter
            End If
      '  Look for"?" in command string.
            If InStr(NextData, Query) > 0 Then
         `   Collect response from instrument.
            Worksheets("Sheet1").Cells(Row, Column + 2).Value =
o.ReadString(1000)
            End If

      `  Check for Error
         If o.ErrorFlag = True Then
         '  Show error message.
         Worksheets("Sheet1").Cells(Row, Column + 2).Value =
o.ErrorString
         Waiting = True: HoldOff = 0: ErrorFound = Tru
         `  Store command line for restart.
         Worksheets("Sheet1").Cells(2, 6).Value = Row + 1
            End If
         End If
   Next Counter
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
.

`     Release the control.
Call o.SetRemoteLocal(0)
Set o = Nothing
End Sub
```

ActiveDSOExcel4 is a similar program using the Pass-Fail system.

EXAMPLE ACTIVEDSO – 5

The picture below shows the screen of program ActiveDSOVB1, a Visual Basic program using ActiveDSO.



C1:PAVA MAX,154E-3 V,OK

C1:PAVA MAX,154E-3 V,OK

C1:PAVA MAX,154E-3 V,OK

50 Triggers in total

This example shows how to arm the trigger, get a parameter from the X-Stream DSO, get waveforms, and draw them on the screen of the PC.

TRANSLATION EXAMPLES

Some source code examples are available for decoding binary waveform files. These are TranWM in Microsoft Visual Basic and TraceLook in VBA/Microsoft Excel.

INTRODUCTION TO ACTIVEDSO

This ActiveX™ control enables LeCroy oscilloscopes to be controlled by, and to exchange data with, a variety of Windows applications that support the ActiveX standard. MS Office programs, Internet Explorer, Visual Basic, Visual C++, Visual Java, and MATLAB (v5.3) are a few of the many applications that support ActiveX controls. ActiveDSO is available on the internet at http://www.lecroy.com/tm/library/software/

With **ActiveDSO** you can develop your test program using standard GPIB commands. For easy integration of your scope data with your Windows Application (through GPIB or Ethernet 10BaseT/100BaseT), ActiveDSO, helps you:

- Generate a report by importing scope data right into Excel or Word.
- Archive measurement results on the fly in a Microsoft Access Database.
- Automate tests using Visual Basic, Java, C++, Excel (VBA).
- The ActiveDSO control hides the intricacies of programming and provides a simple and consistent interface to the controlling application. With less than 10 lines of VBA (Visual Basic for Applications) code in an Excel macro the spreadsheet can recover pre-scaled waveform data from a remote instrument.
- The ActiveDSO control can also be embedded visually in any OLE automation compatible client, and can be used manually without any need for programming. It will run on any PC running Windows 95, Windows 98, or Windows NT.

There are two fundamental ways to use the control:

- As a visible object embedded in an OLE Automation compatible Client (PowerPoint for example) showing a captured display image. See Embedded Control Example for more details.
- As an invisible object accessed via a scripting language (Visual Basic for Applications, for example) to remotely control an instrument. See Accessing from VBA for more details.

VBA (Visual Basic for Applications) is the programming language built into many of the more recent Windows applications. It is a subset of Visual Basic that makes it very simple to utilize the services of OLE Automation Servers and ActiveX Controls.

The following VBA subroutine demonstrates how easy it is to connect to an X-Stream DSO and send remote commands to it.

```
Sub LeCroyDSOTest()
    Dim o As Object
        Set o = CreateObject("LeCroy.ActiveDSOCtrl.1")
    Call o.AboutBox                ' Present the control's About box
    Call o.MakeConnection("IP: 172.28.11.26)  'Connect to device on LAN
    Call o.WriteString("BUZZ BEEP", True)  ' Make the DSO beep
End Sub
```

Example Syntax:

Boolean	controlName.WriteString

The WriteString method has the following arguments:

controlname	The name of the ActiveDSO control object
textStringString	Text string to send to the device
EOIBoolean	TRUE = terminate with EOI

Returns:

True on success, False on failure

Remarks:

This method sends a string command to the instrument.

If EOI is set to TRUE, the device will start to interpret the command immediately. This is normally the desired behavior.

If EOI is set to 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 TRUE.

USING ACTIVEDSO

ActiveDSO is highly suitable for fast program development in the Microsoft environment. This program is a control of ActiveX, the software technology developed by Microsoft as a subset of its COM model.

ActiveDSO facilitates programming with the X-Stream DSO by providing a ready interface between the instrument and the host computer. Programs such as Visual C++, Visual Basic, or Visual Basic for Applications (VBA) can be used under remote control without concern for interfacing complications. ActiveDSO acts as the key design structure allowing effective integration of software from the different manufacturers supporting ActiveX containment.

INSTANTIATION

This ActiveX component can be instantiated more than once by using the Visual Basic function CreateObject. Once the object is created, invoking the connection method will initialize it. ActiveDSO enables control of the X-Stream DSO from a variety of PC desktop applications. The complexities of programming with Ethernet are fully encaspulated within this control. For example, with fewer than ten lines of VBA code in an Excel Macro, the spreadsheet can recover pre-scaled waveform data from the X-Stream DSO. An example is provided in this appendix.

ActiveDSO controls can be used in two fundamental ways:

- As a visible object embedded in an OLE automation compatible client (PowerPoint, for example) showing a captured X-Stream DSO display image. See the Embedded Control example below for more details.

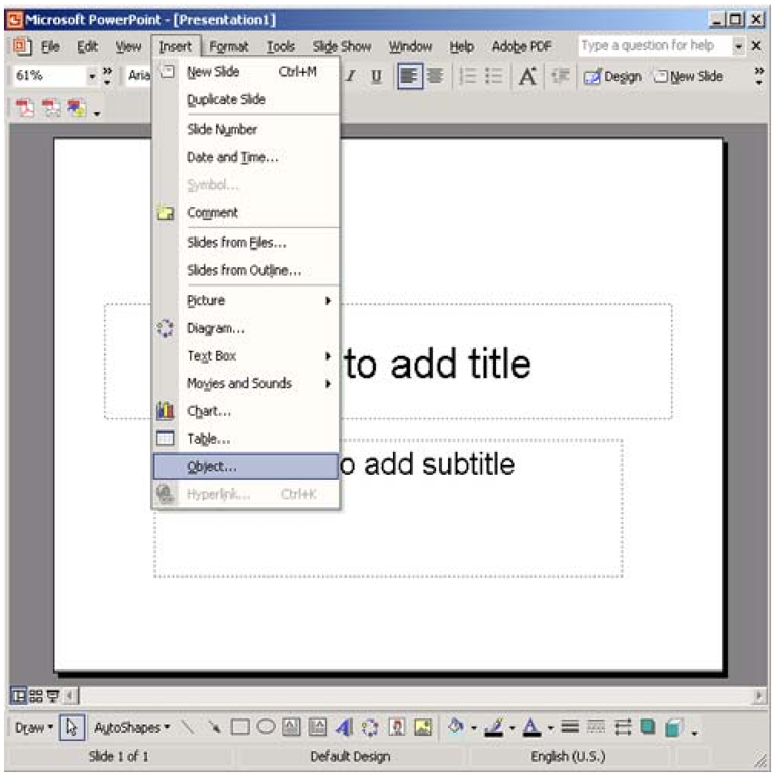
- As an invisible object accessed through a scripting language (VBA, for example) to remotely control the X-Stream DSO. See the VBA example below for more details.

The ActiveDSO control may be embedded in any ActiveX containment-capable client, and may be used manually without need of any programming or scripting.

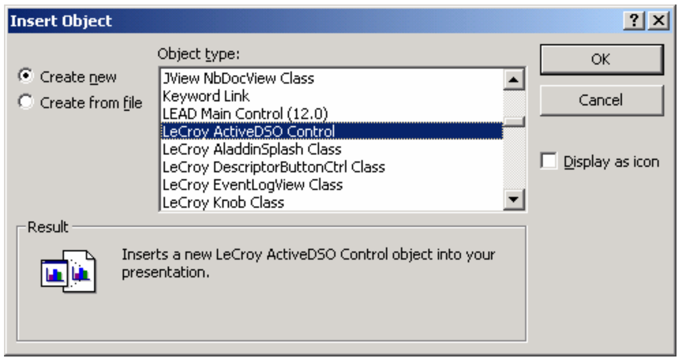
EXAMPLE USING POWERPOINT 97

This example shows the control being embedded in a Microsoft PowerPoint slide. The waveform captured by the X-Stream DSO can be easily imported into PowerPoint with just a few mouse clicks:

1. Ensure that the ActiveDSO files are installed on the PC.
2. Verify that the PC and X-Stream DSO are properly connected to the Ethernet.
3. Open a new blank presentation in PowerPoint.
4. Select **Insert**, then **Object**:



5. From the pop-up window, select **LeCroy ActiveDSO Control** object:

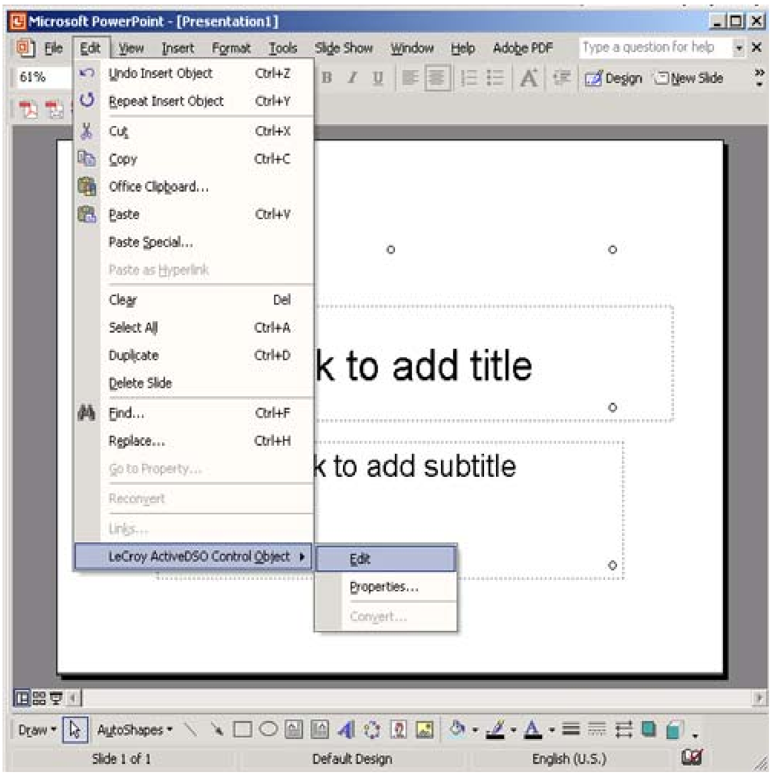


Create new
Object type: LeCroy ActiveDSO Control

JView NbDocView Class
Keyword Link
LEAD Main Control (12.0)
LeCroy ActiveDSO Control
LeCroy AladdinSplash Class
LeCroy DescriptorButtonCtrl Class
LeCroy EventLogView Class
LeCroy Knob Class

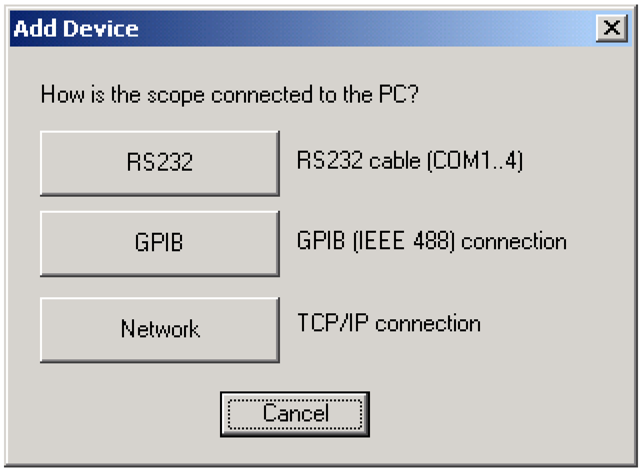
Inserts a new LeCroy ActiveDSO Control object into your presentation.

6. From the Edit menu, select **LeCroy ActiveDSO Control Object**, then **Edit**:

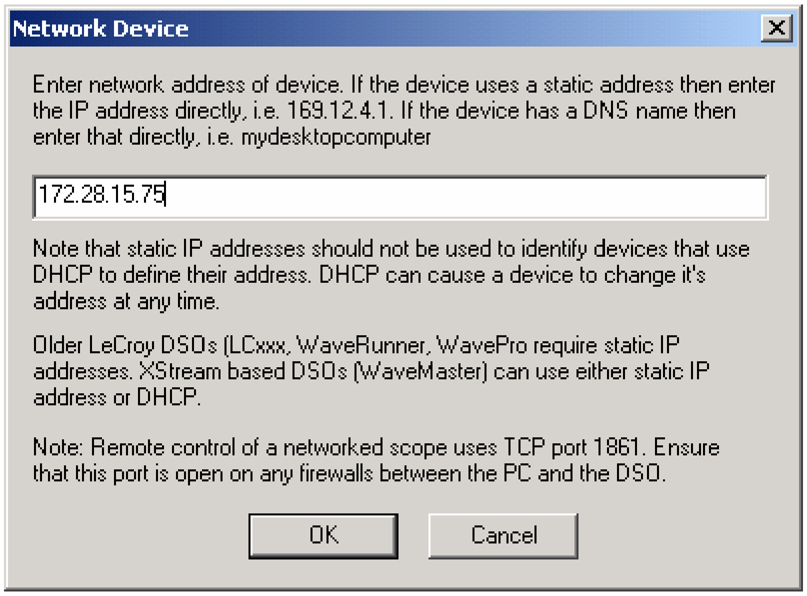


7. Right-click the object and select “Make Connection.”

8. Select "Network TCP/IP connection" ("scope" = WaveMaster):



9. Enter the X-Stream DSO's IP address and click "OK."



Enter network address of device. If the device uses a static address then enter the IP address directly, i.e. 169.12.4.1. If the device has a DNS name then enter that directly, i.e. mydesktopcomputer

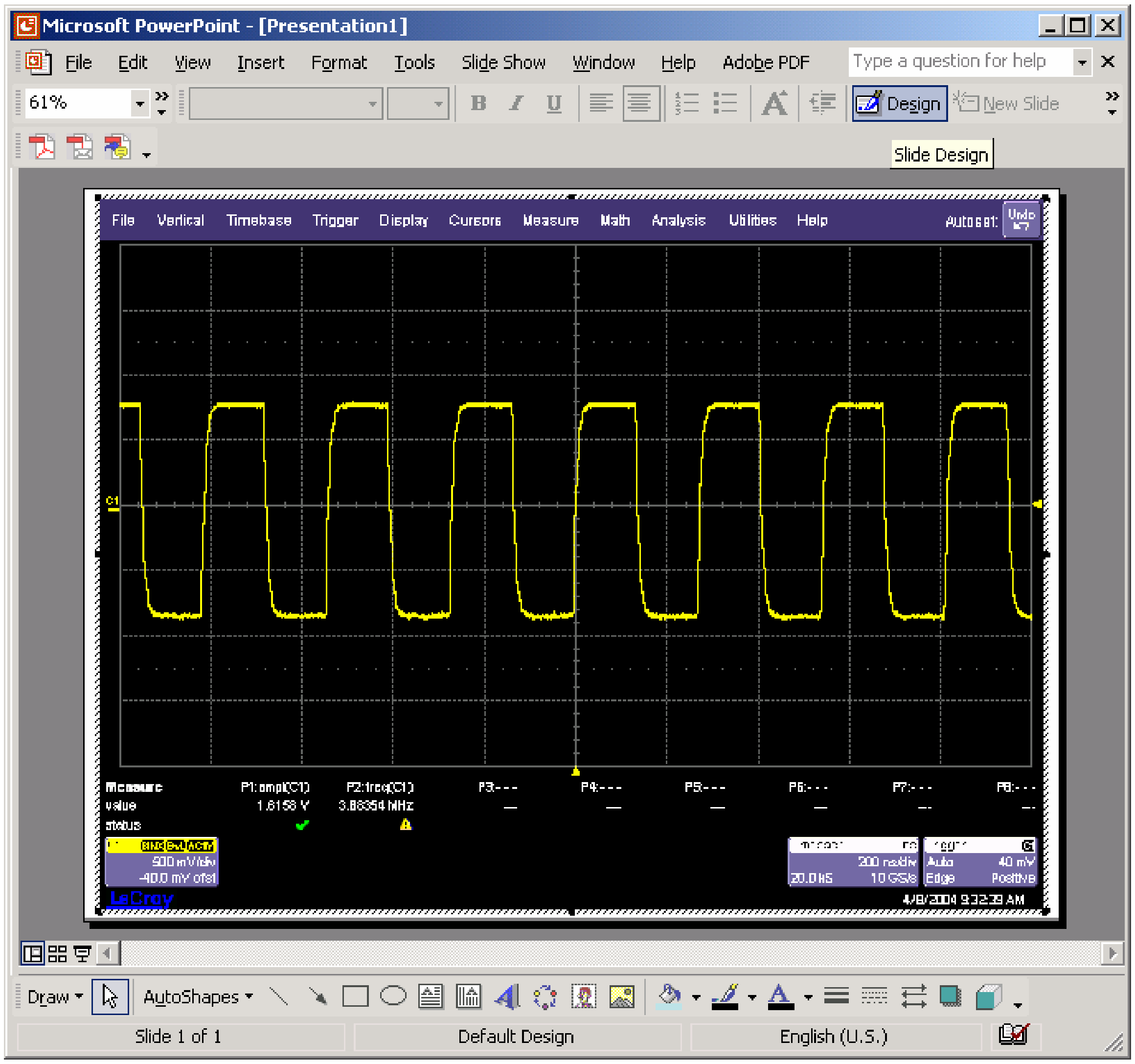
172.28.15.75

Note that static IP addresses should not be used to identify devices that use DHCP to define their address. DHCP can cause a device to change it's address at any time.

Older LeCroy DSOs (LCxxx, WaveRunner, WavePro require static IP addresses. XStream based DSOs (WaveMaster) can use either static IP address or DHCP.

Note: Remote control of a networked scope uses TCP port 1861. Ensure that this port is open on any firewalls between the PC and the DSO.

10. Right-click the object again and select the **Refresh Image** menu item. A captured waveform will be displayed similar to the one shown here:



```
Measure   P1:ampl(C1)  P2:freq(C1)   P3:---  P4:---  P5:---  P6:---  P7:---  P8:---
value     1.6158 V     3.88354 MHz   —       —       —       —       —       —
status    ✓            ⚠

500 mV/div                     200 ns/div   Auto    40 mV
-40.0 mV ofst           20.0 kS  10 GS/s    Edge    Positive
                                          4/8/2004 9:32:39 AM
```

X-Stream DSO's captured waveform imported into PowerPoint.

Once the ActiveDSO object has been properly set within the application, a macro script can be created utilizing an object method such as WriteString() to send DISP ON, C1:TRA ON, TRMD. Then RefreshImage() method can be used to update the screen.

EXAMPLE IN VBA

VBA is the programming language built in to many of the more recent Windows applications. It is a subset of Visual Basic that makes using OLE Automation Servers and ActiveX Controls very simple. The following VBA subroutine demonstrates how easy it is to connect to an X-Stream DSO and send remote commands to it.

```
Sub LeCroyDSOTest()
       Dim dso As Object

 Set dso = CreateObject("LeCroy.ActiveDSO.1")

       Call dso.AboutBoxPresent the control's About box
       Call dso.MakeConnection("IP:172.25.1.2")  Connect to the unit
       Call dso.WriteString("DISP ON", 1) Enable the internal display routine
 Call dso.WriteString("TRMD AUTO", 1) Set the trigger mode to AUTO
End Sub
```

To enter the VBA editor in members of the Microsoft Office suite:

1. Select Tools → Macro → Visual Basic Editor menu item.
2. When the VBA window appears, select the Insert → Module menu item.
3. Copy the above example into the editor window that appears.

To execute:

4. Position the text cursor within the subroutine.
5. Either select the Run → Run Sub/UserForm or press function key F5.

NOTE: For more information, see the ActiveDSO on-line Help. On-line Help contains VisualC++ example, explanations of ActiveDSO Methods and Properties.

§ § §

Waveform Template

This appendix contains the Waveform Template that describes the contents of the Waveform Descriptor that is produced by the commands WF? DESC and WF? ALL. After the template are explanations of the construction of floating point numbers from bytes in the descriptor, followed by program fragments that show a method of performing the calculations.

Waveform Template

This template is the oscilloscope's response to a TMPL? query:

```
/00
000000              LECROY_2_3:  TEMPLATE
                    8 66 111
;
; Explanation of the formats of waveforms and their descriptors on the
; LeCroy Digital Oscilloscopes,
;     Software Release 8.1.0, 98/09/29.
;
; A descriptor and/or a waveform consists of one or several logical data blocks
; whose formats are explained below.
; Usually, complete waveforms are read: at the minimum they consist of
;       the basic descriptor block WAVEDESC
;       a data array block.
; Some more complex waveforms, e.g. Extrema data or the results of a Fourier
; transform, may contain several data array blocks.
; When there are more blocks, they are in the following sequence:
;       the basic descriptor block WAVEDESC
;       the history text descriptor block USERTEXT (may or may not be present)
;       the time array block (for RIS and sequence acquisitions only)
;       data array block
;       auxiliary or second data array block
;
```

; In the following explanation, every element of a block is described by a
; single line in the form

```
;
; <byte position>   <variable name>: <variable type> ; <comment>
;
;  where
;
;   <byte position> = position in bytes (decimal offset) of the variable,
;                     relative to the beginning of the block.
;
;   <variable name> = name of the variable.
;
;   <variable type> = string        up to 16-character name
;                                   terminated with a null byte
;                       byte        08-bit signed data value
;                       word        16-bit signed data value
;                       long        32-bit signed data value
;                      float        32-bit IEEE floating point value
;  with the format shown below
;                                   31  30 .. 23   22 ... 0   bit position
;                                   s   exponent   fraction
;                                   where
;                                   s = sign of the fraction
;                                   exponent = 8 bit exponent e
;                                   fraction = 23 bit fraction f
;                                   and the final value is
;                                   (-1)**s * 2**(e-127) * 1.f
;                     double        64-bit IEEE floating point value
;                                   with the format shown below
;                                   63  62 .. 52   51 ... 0   bit position
;                                   s   exponent   fraction
;                                   where
;                                   s = sign of the fraction
;                                   exponent = 11 bit exponent e
;                                   fraction = 52 bit fraction f
;                                   and the final value is
;                                   (-1)**s * 2**(e-1023) * 1.f
;                       enum        enumerated value in the range 0 to N
;                                   represented as a 16-bit data value.
;                                   The list of values follows immediately.
;                                   The integer is preceded by an _.
;                 time_stamp        double precision floating point number,
;                                   for the number of seconds and some bytes
;                                   for minutes, hours, days, months and year.
;
;                                   double  seconds     (0 to 59)
;                                   byte    minutes     (0 to 59)
;                                   byte    hours       (0 to 23)
;                                   byte    days        (1 to 31)
;                                   byte    months      (1 to 12)
;                                   word    year        (0 to 16000)
;                                   word    unused
;                                   There are 16 bytes in a time field.
;                       data        byte, word or float, depending on the
;                                   read-out mode reflected by the WAVEDESC
;                                   variable COMM_TYPE, modifiable via the
;                                   remote command COMM_FORMAT.
;                       text        arbitrary length text string
;                                   (maximum 160)
;            unit_definition        a unit definition consists of a 48 character
;                                   ASCII string terminated with a null byte
;                                   for the unit name.
;
;===========================================================================
;
```

WAVEDESC: BLOCK

;

; Explanation of the wave descriptor block WAVEDESC;

```
;
;
<  0>          DESCRIPTOR_NAME: string  ; the first 8 chars are always WAVEDESC
;
< 16>          TEMPLATE_NAME: string
;
< 32>          COMM_TYPE: enum          ; chosen by remote command COMM_FORMAT
               _0      byte
               _1      word
               endenum
;
< 34>          COMM_ORDER: enum
               _0      HIFIRST
               _1      LOFIRST
               endenum
;
;
```

```
; The following variables of this basic wave descriptor block specify
; the block lengths of all blocks of which the entire waveform (as it is
; currently being read) is composed. If a block length is zero, this
; block is (currently) not present.
;
; Blocks and arrays that are present will be found in the same order
; as their descriptions below.
;
;BLOCKS :
;
< 36>          WAVE_DESCRIPTOR: long    ; length in bytes of block WAVEDESC
< 40>          USER_TEXT: long          ; length in bytes of block USERTEXT
< 44>          RES_DESC1: long          ;
;
;ARRAYS :
;
< 48>          TRIGTIME_ARRAY: long     ; length in bytes of TRIGTIME array
;
< 52>          RIS_TIME_ARRAY: long     ; length in bytes of RIS_TIME array
;
< 56>          RES_ARRAY1: long         ; an expansion entry is reserved
;
< 60>          WAVE_ARRAY_1: long       ; length in bytes of 1st simple
                                        ; data array. In transmitted waveform,
                                        ; represent the number of transmitted
                                        ; bytes in accordance with the NP
                                        ; parameter of the WFSU remote command
                                        ; and the used format (see COMM_TYPE).
;
< 64>          WAVE_ARRAY_2: long       ; length in bytes of 2nd simple
                                        ; data array
;
< 68>          RES_ARRAY2: long
< 72>          RES_ARRAY3: long         ; 2 expansion entries are reserved
;
; The following variables identify the instrument
;
< 76>          INSTRUMENT_NAME: string
;
< 92>          INSTRUMENT_NUMBER: long
;
< 96>          TRACE_LABEL: string      ; identifies the waveform.
;
<112>          RESERVED1: word
<114>          RESERVED2: word          ; 2 expansion entries
;
```

```
; The following variables describe the waveform and the time at
; which the waveform was generated.
;
<116>          WAVE_ARRAY_COUNT: long   ; number of data points in the data
                                        ; array. If there are two data
                                        ; arrays (FFT or Extrema), this number
                                        ; applies to each array separately.
;
<120>          PNTS_PER_SCREEN: long    ; nominal number of data points
                                        ; on the screen
;
<124>          FIRST_VALID_PNT: long    ; count of number of points to skip
                                        ; before first good point
                                        ; FIRST_VALID_POINT = 0
                                        ; for normal waveforms.
;
<128>          LAST_VALID_PNT: long     ; index of last good data point
                                        ; in record before padding (blanking)
                                        ; was started.
                                        ; LAST_VALID_POINT = WAVE_ARRAY_COUNT-1
                                        ; except for aborted sequence
                                        ; and rollmode acquisitions
;
<132>          FIRST_POINT: long        ; for input and output, indicates
                                        ; the offset relative to the
                                        ; beginning of the trace buffer.
                                        ; Value is the same as the FP parameter
                                        ; of the WFSU remote command.
;
<136>          SPARSING_FACTOR: long    ; for input and output, indicates
                                        ; the sparsing into the transmitted
                                        ; data block.
                                        ; Value is the same as the SP parameter
                                        ; of the WFSU remote command.
;
<140>          SEGMENT_INDEX: long      ; for input and output, indicates the
                                        ; index of the transmitted segment.
                                        ; Value is the same as the SN parameter
                                        ; of the WFSU remote command.
;
<144>          SUBARRAY_COUNT: long     ; for Sequence, acquired segment count,
                                        ; between 0 and NOM_SUBARRAY_COUNT
;
<148>          SWEEPS_PER_ACQ: long     ; for Average or Extrema,
                                        ; number of sweeps accumulated
                                        ; else 1
;
```

```
<152>          POINTS_PER_PAIR: word    ; for Peak Detect waveforms (which
always
                                        ; include data points in DATA_ARRAY_1
and
                                        ; min/max pairs in DATA_ARRAY_2).
                                        ; Value is the number of data points for
                                        ; each min/max pair.
;
<154>          PAIR_OFFSET: word        ; for Peak Detect waveforms only
                                        ; Value is the number of data points by
                                        ; which the first min/max pair in
                                        ; DATA_ARRAY_2 is offset relative to the
                                        ; first data value in DATA_ARRAY_1.
;
<156>          VERTICAL_GAIN: float
;
<160>          VERTICAL_OFFSET: float   ; to get floating values from raw data :
                                        ; VERTICAL_GAIN * data - VERTICAL_OFFSET
;
<164>          MAX_VALUE: float         ; maximum allowed value. It corresponds
                                        ; to the upper edge of the grid.
;
<168>          MIN_VALUE: float         ; minimum allowed value. It corresponds
                                        ; to the lower edge of the grid.
;
<172>          NOMINAL_BITS: word       ; a measure of the intrinsic precision
                                        ; of the observation: ADC data is 8 bit
                                        ;    averaged data is 10-12 bit, etc.
;
<174>          NOM_SUBARRAY_COUNT: word ; for Sequence, nominal segment count
                                        ; else 1
;
<176>          HORIZ_INTERVAL: float    ; sampling interval for time domain
                                        ;  waveforms
;
<180>          HORIZ_OFFSET: double     ; trigger offset for the first sweep of
                                        ; the trigger, seconds between the
                                        ; trigger and the first data point
;
<188>          PIXEL_OFFSET: double     ; needed to know how to display the
                                        ; waveform
;
<196>          VERTUNIT: unit_definition  ; units of the vertical axis
;
<244>          HORUNIT: unit_definition   ; units of the horizontal axis
;
<292>          HORIZ_UNCERTAINTY: float ; uncertainty from one acquisition to the
                                        ; next, of the horizontal offset in seconds
;
<296>          TRIGGER_TIME: time_stamp ; time of the trigger
;
<312>          ACQ_DURATION: float      ; duration of the acquisition (in sec)
                                        ; in multi-trigger waveforms.
                                        ; (e.g. sequence, RIS,  or averaging)
;
<316>          RECORD_TYPE: enum
```

```
               _0      single_sweep
               _1      interleaved
               _2      histogram
               _3      graph
               _4      filter_coefficient
               _5      complex
               _6      extrema
               _7      sequence_obsolete
               _8      centered_RIS
               _9      peak_detect
               endenum
;
<318>          PROCESSING_DONE: enum
               _0       no_processing
               _1       fir_filter
               _2       interpolated
               _3       sparsed
               _4       autoscaled
               _5       no_result
               _6       rolling
               _7       cumulative
               endenum
;
<320>          RESERVED5: word          ; expansion entry
;
<322>          RIS_SWEEPS: word         ; for RIS, the number of sweeps
                                        ; else 1
;
; The following variables describe the basic acquisition
; conditions used when the waveform was acquired
;
```

```
<324>          TIMEBASE: enum
               _0    1_ps/div
               _1    2_ps/div
               _2    5_ps/div
               _3    10_ps/div
               _4    20_ps/div
               _5    50_ps/div
               _6    100_ps/div
               _7    200_ps/div
               _8    500_ps/div
               _9    1_ns/div
               _10   2_ns/div
               _11   5_ns/div
               _12   10_ns/div
               _13   20_ns/div
               _14   50_ns/div
               _15   100_ns/div
               _16   200_ns/div
               _17   500_ns/div
               _18   1_us/div
               _19   2_us/div
               _20   5_us/div
               _21   10_us/div
               _22   20_us/div
               _23   50_us/div
               _24   100_us/div
               _25   200_us/div
               _26   500_us/div
               _27   1_ms/div
               _28   2_ms/div
               _29   5_ms/div
               _30   10_ms/div
               _31   20_ms/div
               _32   50_ms/div
               _33   100_ms/div
               _34   200_ms/div
               _35   500_ms/div
               _36   1_s/div
               _37   2_s/div
               _38   5_s/div
               _39   10_s/div
               _40   20_s/div
               _41   50_s/div
               _42   100_s/div
               _43   200_s/div
               _44   500_s/div
               _45   1_ks/div
               _46   2_ks/div
               _47   5_ks/div
               _100  EXTERNAL
               endenum
;
<326>          VERT_COUPLING: enum
               _0      DC_50_Ohms
               _1      ground
               _2      DC_1MOhm
```

```
                _3      ground
                _4      AC,_1MOhm
                endenum
;
<328>           PROBE_ATT: float
;
<332>           FIXED_VERT_GAIN: enum
                _0   1_uV/div
                _1   2_uV/div
                _2   5_uV/div
                _3   10_uV/div
                _4   20_uV/div
                _5   50_uV/div
                _6   100_uV/div
                _7   200_uV/div
                _8   500_uV/div
                _9   1_mV/div
                _10  2_mV/div
                _11  5_mV/div
                _12  10_mV/div
                _13  20_mV/div
                _14  50_mV/div
                _15  100_mV/div
                _16  200_mV/div
                _17  500_mV/div
                _18  1_V/div
                _19  2_V/div
                _20  5_V/div
                _21  10_V/div
                _22  20_V/div
                _23  50_V/div
                _24  100_V/div
                _25  200_V/div
                _26  500_V/div
                _27  1_kV/div
                endenum
;
```

```
<334>          BANDWIDTH_LIMIT: enum
               _0      off
               _1      on
               endenum
;
<336>          VERTICAL_VERNIER: float
;
<340>          ACQ_VERT_OFFSET: float
;
<344>          WAVE_SOURCE: enum
               _0      CHANNEL_1
               _1      CHANNEL_2
               _2      CHANNEL_3
               _3      CHANNEL_4
               _9      UNKNOWN
               endenum
;
/00              ENDBLOCK
;
;==========================================================================
;
USERTEXT: BLOCK
;
; Explanation of the descriptor block USERTEXT at most 160 bytes long.
;
;
<  0>          TEXT: text               ; a list of ASCII characters
;
/00              ENDBLOCK
;
;==========================================================================
;
TRIGTIME: ARRAY
;
; Explanation of the trigger time array TRIGTIME.
; This optional time array is only present with SEQNCE waveforms.
; The following data block is repeated for each segment which makes up
; the acquired sequence record.
;
<  0>          TRIGGER_TIME: double     ; for sequence acquisitions,
                                        ; time in seconds from first
                                        ; trigger to this one
;
<  8>          TRIGGER_OFFSET: double   ; the trigger offset is in seconds
                                        ; from trigger to zeroth data point
;
/00              ENDARRAY
;
;==========================================================================
;
RISTIME: ARRAY
;
; Explanation of the random-interleaved-sampling (RIS) time array RISTIME.
; This optional time array is only present with RIS waveforms.
; This data block is repeated for each sweep which makes up the RIS record
;
```

```
<  0>          RIS_OFFSET: double       ; seconds from trigger to zeroth
                                        ; point of segment
;
/00              ENDARRAY
;
;===========================================================================
;
DATA_ARRAY_1: ARRAY
;
; Explanation of the data array DATA_ARRAY_1.
; This main data array is always present. It is the only data array for
; most waveforms.
; The data item is repeated for each acquired or computed data point
; of the first data array of any waveform.
;
<  0>          MEASUREMENT: data        ; the actual format of a data is
                                        ; given in the WAVEDESC descriptor
                                        ; by the COMM_TYPE variable.
;
/00              ENDARRAY
;
;===========================================================================
;
DATA_ARRAY_2: ARRAY
;
; Explanation of the data array DATA_ARRAY_2.
; This is an optional secondary data array for special types of waveforms:
;       Complex FFT     imaginary part      (real part in DATA_ARRAY_1)
;       Extrema         floor trace         (roof trace in DATA_ARRAY_1)
;       Peak Detect     min/max pairs       (data values in DATA_ARRAY_1)
; In the first 2 cases, there is exactly one data item in DATA_ARRAY_2 for
; each data item in DATA_ARRAY_1.
; In Peak Detect waveforms, there may be fewer data values in DATA_ARRAY_2,
; as described by the variable POINTS_PER_PAIR.
;
<  0>          MEASUREMENT: data        ; the actual format of a data is
                                        ; given in the WAVEDESC descriptor
                                        ; by the COMM_TYPE variable.
;
/00              ENDARRAY
;
;===========================================================================
;
SIMPLE: ARRAY
;
; Explanation of the data array SIMPLE.
; This data array is identical to DATA_ARRAY_1. SIMPLE is an accepted
; alias name for DATA_ARRAY_1.
;
<  0>          MEASUREMENT: data        ; the actual format of a data is
                                        ; given in the WAVEDESC descriptor
                                        ; by the COMM_TYPE variable.
;
/00              ENDARRAY
;
;===========================================================================
;
DUAL: ARRAY
;
; Explanation of the DUAL array.
; This data array is identical to DATA_ARRAY_1, followed by DATA_ARRAY_2.
; DUAL is an accepted alias name for the combined arrays DATA_ARRAY_1 and
; DATA_ARRAY_2 (e.g. real and imaginary parts of an FFT).
;
<  0>          MEASUREMENT_1: data      ; data in DATA_ARRAY_1.
;
<  0>          MEASUREMENT_2: data      ; data in DATA_ARRAY_2.
;
/00              ENDARRAY
;
;
00                   ENDTEMPLATE
```

DECODING FLOATING POINT NUMBERS

Single precision values are held in four bytes. If these are arranged in decreasing order of value we get the following bits:

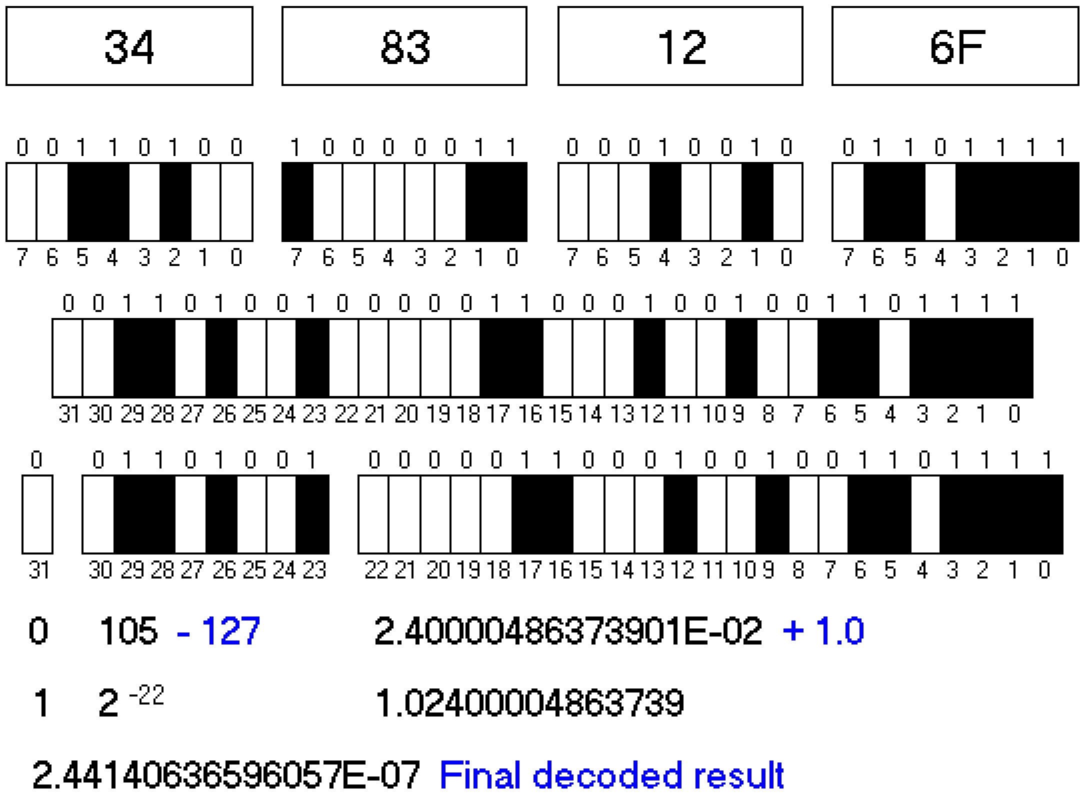
bit 31, bit 30, bit 29, bit 28 . . . . . bit 3, bit 2, bit 1, bit 0

We must remember that if the byte order command CORD has been set for low byte first, the bytes as received in a waveform descriptor will be received in the reverse order. But 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 together: S x E x F. These in turn are constructed as follows:

$S = (-1)^{s}$ $E = 2^{(e - 127)}$ $F = 1 + f$

and it is **s**, **e**, and **f** that are calculated directly from the 32 bits. The diagram below illustrates the calculation of the vertical gain example of Chapter 4.



In a way that does not follow the byte boundaries, the bits are to be 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 8 exponent bits have the following values:

bit 23 is worth 1, bit 24 is worth 2 . . . bit 29 $\rightarrow$ 64, bit 30 $\rightarrow$ 128, so the resulting number can range from 0 to 2^8 - 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

Example

In Chapter 4, one of the examples, Vertical Gain, states that the floating point number 34 83 12 6F leads to the decimal value 2.44141E-07. Let's see how this is done.

The bytes 34 83 12 and 6F can be written in binary as follows:

0011 0100   1000 0011   0001 0010   0110 1111.

This string of bits is to be split up as follows:

0   01101001   00000110001001001101111.

The first bit, 0, makes the sign of the number **S**, using the formula $S = (-1)^s = 1$.

The next eight bits make the exponent **e** as follows:

> 0 X 128 + 1 X 64 + 1 X 32 + 0 X 16 + 1 X 8 + 0 X 4 + 0 X 2 + 1 X 1 = 105, from which we subtract 127, giving -22.

So the factor **E** is $2^{(e-127)} = 2^{-22}$, which is 2.3842E-7.

Finally, we need to make the multiplier **F**. The remaining bits are given the values 0.5, 0.25, 0.125, 0.0625, 0.03125, etc. The first bits that are not zero are the 6th and 7th bits, whose values are 0.015625 and 0.078125, respectively. To get a rough value, we will take just these two bits, since the next three are zero, giving 0.0234375. We have to add 1 to this, giving 1.023 as a rough value for **F**.

The final result is therefore S x E x F = 1 X 2.3842E-7 X 1.023 = 2.439, which is a little smaller than the correct value because we did not use all the bits to calculate the value of **F**.

Double precision values are held in eight bytes. If these are arranged in decreasing order of value we get the following bits:

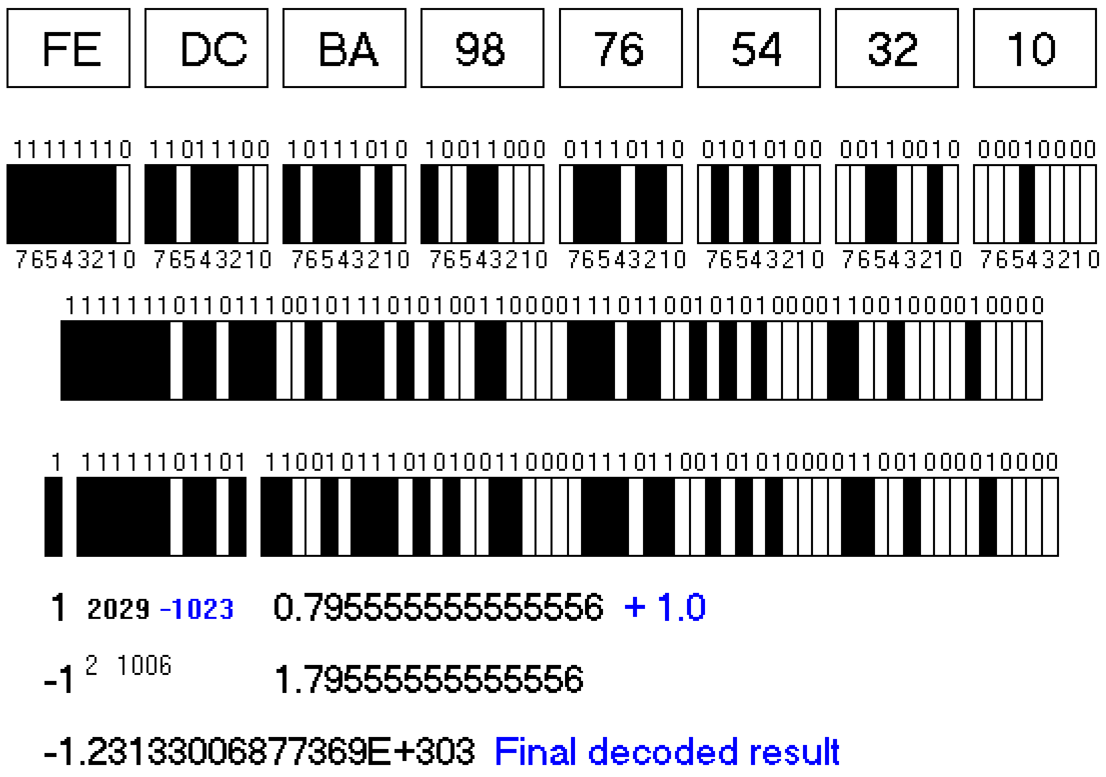
> 63, 62, 61, 62 . . . . . 3, 2, 1, 0.

We must remember that if the byte order command CORD has been set for low byte first, the bytes as received in a waveform descriptor will be received in the reverse order. But 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 together: S x E x F. These in turn are constructed as follows:

> $S = (-1)^s$ $E = 2^{(e - 1023)}$ $F = 1 + f$

and it is **s**, **e**, and **f** that are calculated directly from the 32 bits. The following diagram illustrates the calculation of an example.



In a way that does not follow the byte boundaries, the bits are to be segregated as follows:

63	62, 61 . . . . 53, 52	51, 50 . . . . 2, 1, 0
sign	11 exponent bits	52 fractional bits
bit		0.5, 0.25, 0.125 . . .

The sign bit 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 11 exponent bits have the following values:

52 → 1, 53 → 2 . . . 61 → 512, 62 → 1024

so the resulting number can range from 0 to 2^12 – 1, which is 2047. 1023 is then subtracted from this value, creating a range from -1023 to +1024. This is then used as a power of two to create a value **E**.

Then we have to create the multiplying number. The values of the 52 bits are as follows:

51 → 0.5, 50 → 0.25, 49 → 0.125, 48 → 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.

Alternatively, we can take the 52-bit number at face value, and divide it by 2^{53}

Finally we multiply together the sign, the value **E**, and the value **F**, to create the final result:

Result = S x E x F

HOW TO CONSTRUCT A FLOATING POINT NUMBER FROM FOUR BYTES

```
'   Routine to construct a floating point number from four bytes.

Function GetFloat(DescPoint as Integer)

'   DescPoint is the address of the byte in the waveform descriptor
'   where the data begin.
`   The data are assumed to be in an array called Desc (0 to 350).

'   For example, to calculate VERTICAL_GAIN, DescPoint = 156.

'   Constants needed by GetFloat
    Mult2 = 1 / 128
    Mult3 = Mult2 / 256
    Mult4 = Mult3 / 256

'   Comm_Order is the variable which provides information
'   about the order of the bytes in the descriptor and.
'   in the waveform data.  Comm_Order is the byte at position
'   34 in the descriptor.

'   Set ByteOrd = 1 when Comm_Order = 0 for high  byte first.
'   Set ByteOrd = -1 when Comm_Order = 1 for low byte  first.
'   Set ByteOrd3 = 3 * Comm_Order.
'   ______________________________________________________________

    ByteOrd = 1 - 2 * Comm_Order
    ByteOrd3 = 3 * Comm_Order
'   ______________________________________________________________

    FByte =  ByteOrd3                        ' Sign started

    FDigit =  Desc(DescPoint + FByte)
    FSign = (FDigit And 128) \  128
    FSign = 1 - 2 *  FSign                   ' Sign completed
'   ______________________________________________________________

    FExponent = FDigit  And  127              ' Exponent started
    FExponent = 2 * FExponent

    FByte = ByteOrd3 +  ByteOrd
    FDigit = Desc(DescPoint +  FByte)
    FExpBit = FDigit And  128

        If FExpBit = 128 Then FExpBit  = 1

    FExponent = FExponent + FExpBit - 127   '  Exponent completed
'   ______________________________________________________________
```

```
    FFraction =  CDbl(FDigit And 127)        ' Fraction  started
    FFraction = FFraction *  Mult2

    FByte = ByteOrd3 + 2 *  ByteOrd
    FDigit = Desc(DescPoint +  FByte)
    FFraction = FFraction + CDbl(FDigit) *  Mult3

    FByte = ByteOrd3 + 3 *  ByteOrd
    FDigit = Desc(DescPoint +  FByte)
    FFraction = FFraction + CDbl(FDigit) * Mult4   ' Fraction completed
'   _______________________________________________________________

    FVariable = 2  ^ FExponent
    GetFloat = FVariable * FSign * (1 +  FFraction)  ' Conversion
completed

    End

'   End of GetFloat ______________________________________________
```

HOW TO CONSTRUCT A FLOATING POINT NUMBER FROM FOUR BYTES

```
'   Routine to construct a double precision floating point number from
eight bytes.

Function GetDoubleFloat (DescPoint as Integer)

'   DescPoint is the address of the byte in the waveform descriptor
'   where the data begin.
`   The data are assumed to be in an array called Desc (0 to 350).

'   For example, to calculate HORIZontal_OFFSET, DescPoint = 180.

'   Constants needed by GetDoubleFloat
    DMult2 = 1 / 16
    DMult3 = DMult2 / 256

'   Comm_Order is the variable which provides information
'   about the order of the bytes in the descriptor and.
'   in the waveform data.  Comm_Order is the byte at position
'   34 in the descriptor.

'   Set ByteOrd = 1 when  Comm_Order = 0 for high byte first.
'   Set ByteOrd = -1 when Comm_Order  = 1 for low byte first.
'   Set ByteOrd7 = 7 * Comm_Order.
'   ______________________________________________________________

    ByteOrd = 1 - 2 * Comm_Order
    ByteOrd7 = 7 * Comm_Order

    DMult3 = DMult2 / 256
'   ______________________________________________________________

    FByte =  ByteOrd7                         ' Sign started
    FDigit = Desc(DescPoint +  FByte)
    FSign = (FDigit And 128) \  128
    FSign = 1 - 2 *  FSign                    ' Sign completed

    FExponent = FDigit  And  127               ' Exponent started
    FExponent = 16 * FExponent

    FByte = ByteOrd7 +  ByteOrd
    FDigit = Desc(DescPoint +  FByte)
    FExponent = (FExponent + CDbl((FDigit And 240) \  16)) -  1023
                                             ' Exponent  completed
'   ______________________________________________________________

    FFraction = CDbl((FDigit And 15)) *  DMult2    ' Fraction  started
```

```
        For I = 2 To
        FByte = ByteOrd7 + I *  ByteOrd
        FDigit = Desc(DescPoint +  FByte)
        FFraction = FFraction +  CDbl(FDigit) * DMult3
        DMult3 =  DMult3 / 256
        Next  I                               ' Fraction completed
'    ________________________________________________________________

    FVariable = 2 ^  FExponent

    GetDoubleFloat = FVariable *  FSign * (1 + FFraction)

End

'   End of GetDoubleFloat _________________________________________
```

§ § §