Controlling the LSA1000

The LeCroy LSA1000 is operated by remote control using a controlling device, normally a computer but perhaps a simple terminal. Connected via Ethernet, it has a TCP/IP port, but also possesses a USB (Universal Serial Bus) port, to be supported by software in the future.

The only actions of the LSA1000 that cannot be performed remotely are power on or off.

This chapter introduces the basic concepts affecting the instrument's operation, while the following chapter explains how it operates through the Ethernet. Chapter 4 offers a detailed description and run-through of the transfer and formatting of waveforms. And Chapter 5 explains the use of status bytes for error reporting.

The special *System Commands* section provides a complete directory and description of the remote control commands and queries that can be used to operate the LSA1000.

Implementation Standard

To the greatest extent possible, these remote commands conform to the IEEE 488.2* standard, which may be considered as an extension of the IEEE 488.1 standard, dealing mainly with electrical and mechanical issues.

Program Messages

Program messages sent to the LSA1000 from the external controller must conform to precise format structures. The instrument will execute such messages, but will ignore program messages in which errors are detected.

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.

* 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.

Commands and Queries

Program messages consist of either one or several commands or queries or both. A command directs the instrument to change its state — for example, to change its timebase or vertical sensitivity. A query asks the instrument about its state. Very often, the same mnemonic is used 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, the controller sends the following command to the instrument:

```
TIME_DIV 2 MS
```

To ask the instrument about its timebase, this query should be sent:

```
TIME_DIV?
```

A query causes the instrument to send a response message. The control program should read this message with a 'read' instruction to the ETHERNET interface of the controller. The response message to the query above 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 may be suppressed with the command "COMM_HEADER".

Depending on the state of the instrument and the computation to be done, the controller may have to wait up to several seconds for a response. Command interpretation does not have priority over other LSA1000 activities. It is therefore judicious to set the controller IO timeout conditions to three or more seconds. In addition, it must be remembered that an incorrect query message will not generate a response message.

Program Message Form

An instrument is remotely controlled with program messages that consist of one or several commands or queries, separated by semicolons <;> and ended by a terminator:

<command/query>;.....;<command/query> <terminator>

Upper or lower-case characters or both can be used in program messages.

The instrument does not decode an incoming program message before a terminator has been received, except if the program

message is longer than the 256 byte input buffer of the instrument, when the LSA1000 starts analyzing the message when the buffer is full. The commands or queries are executed in the order in which they are transmitted.

See Chapter 3 for a description of LeCroy's Versatile Instrument Control Protocol (VICP) for operation over ETHERNET.

Example

`ARM`

This program message consists of a single command that instructs the instrument to change its state from "stopped" to "single". The terminator is not shown, as it is assumed to be automatically added by the interface driver routine.

`COMB 2; ARM; DATE?`

This program message consists of two commands, followed by a query. They instruct the instrument to combine channels, arm the acquisition, and then ask for the current date. Again, the terminator is not shown.

Command/Query Form

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). The detailed listing of all commands in *System Commands* indicates which may also be queries. There is a space between the header and the first parameter. There are commas between parameters.

Example

`DATE 15,JAN,1998,13,21,16`

This command instructs the LSA1000 to set its date and time to 15 JAN 1998, 13:21:16. The command header "DATE" indicates the action, the 6 data values specify it in detail.

Header

The header is the mnemonic form of the operation to be performed by the LSA1000. All command mnemonics are listed in alphabetic order in the System Commands section.

The majority of the command or query headers have a long form for optimum legibility and a short form for better transfer and decoding speed. The two forms are fully equivalent and can be used

interchangeably. For example, the following two commands for switching to the normal trigger mode are fully equivalent:

TRIG_MODE NORM and **TRMD NORM**

Some command/query mnemonics are imposed by the IEEE 488.2 standard. They are standardized so that different instruments 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 instrument, whereas "*TST?" instructs the instrument to perform an internal self-test and to report the outcome.

Header path

Some commands or queries apply to a sub-section of the LSA1000 — a single input channel or a trace, for example. In such cases, the header must be preceded 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 (refer to the individual commands listed in *System Commands* for details of the values applying to given command headers):

C1, C2	Channels 1 and 2
M1, M2, M3, M4	Memories 1, 2, 3, 4
TA, TB, TC, TD	Traces A, B, C and D
EX	External trigger

Example

C1:OFST -300 MV

Set the offset of Channel 1 to –300 mV

Header paths need only be specified once. Subsequent commands whose header destination is not indicated are assumed to refer to the last defined path. For example, the following commands are identical:

C2:VDIV?; C2:OFST?	What is the vertical sensitivity and the offset of channel 2?
C2:VDIV?; OFST?	Same as above, without repeating the path.

Data

Whenever a command/query uses additional data values, the values are expressed in terms of ASCII characters. There is a single exception: the transfer of waveforms with the command/query "WAVEFORM", where the waveform may be expressed as a sequence of binary data values. Chapter 5 gives a detailed explanation of the format of waveforms.

ASCII data can have the form of character, numeric, string or block data.

Numeric Data

The numeric data type is used to enter quantitative information. Numbers can be entered as integers or fractions, or in exponential representation.

`C2:OFST 3.56`	Set the DC offset of Channel 2 to 3.56 V.
`TDIV 5.0E-6`	Adjust the timebase to 5 µs/div.

***Note:** Numeric values may be followed by multipliers and units, modifying the value of the numerical expression. The following mnemonics are recognized:*

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-

Examples

There are many ways of setting the timebase of the instrument to 5 µs/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
TDIV 5000E-3 US
```

Block Data

These are binary data values coded in hexadecimal ASCII, i.e. 4-bit nibbles are translated into the digits 0,...9, A,...F and transmitted as ASCII characters. They are used only for the transfer of waveforms (command “WAVEFORM”) and of the instrument configuration

Response Message Form

The instrument sends a response message to the controller, as an answer to a query. The format of such messages is the same as that of program messages, i.e. individual responses in the format of commands, separated by semicolons <;> and ended by a terminator. They can be sent back to the instrument in the form in which they are received, and will be accepted as valid commands.

For example, if the controller sends the program message:

`TIME_DIV?;TRIG_MODE NORM;C1:VDIV?`

(terminator not shown).

The instrument might respond as follows:

`TIME_DIV 50 NS;C1:VDIV 125mV` (terminator not shown).

The response message refers only to the queries: “TRIG_MODE” is left out. If this response is sent back to the instrument, 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 a response is expected from the instrument, the control program must instruct the ETHERNET interface to read from the instrument.

The instrument uses somewhat stricter rules for response messages than for the acceptance of program messages. Whereas the controller may send program messages in upper or lower case characters, response messages are always returned in upper case. Program messages may contain extraneous spaces or tabs (white space); response messages do not. And while program messages may contain a mixture of short and long command/query headers, response messages always use short headers as a default. However, the instrument can be forced with the command “COMM_HEADER” to use long headers or no headers at all. If the

response header is omitted, the response transfer time is minimized, but such a response could not be sent back to the instrument again. In this case suffix units are also suppressed in the response.

If the trigger slope of Channel 1 is set to negative, the query “C1:TRSL?” could yield the following responses:

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

Waveforms which are obtained from the instrument using the query “WAVEFORM?” constitute a special kind of response message. Their exact format can be controlled via the “COMM_FORMAT” and “COMM_ORDER” commands.

2 Overview of LSA1000 Control