

**Gould 500 DSO  
Remote Control using  
IEEE 488.2 & RS423  
Operator Manual**

Conforming to SCPI 1991.0

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Contents	
Introduction	
About GPIB & RS423	1
About Commands	2
Common Commands	3
ALL Subsystem	4
ASETup Subsystem	5
CALCulate Subsystem	6
Measurement Instructions	7
CALibration Subsystem	8
DISPlay Subsystem	9
FORMat Subsystem	10
HELP? Subsystem	11
INPut Subsystem	12
PLOT Subsystem	13
SENSe Subsystem	14
STATus Subsystem	15
SYSTem Subsystem	16
TRACe Subsystem	17
TRIGger Subsystem	18
Instrument Models	19
Command Index	20
Service Centers	21

<b>Introduction</b>	<b>1</b>
<b>1. About GPIB &amp; RS423 interfaces</b>	<b>2</b>
<b>1.1 GPIB</b>	<b>2</b>
<b>1.2 Protocols</b>	<b>3</b>
<b>1.3 Interface capabilities</b>	<b>4</b>
<b>1.4 RS423</b>	<b>4</b>
<b>2. About Commands</b>	<b>5</b>
<b>3. Common Commands</b>	<b>7</b>
*CAL?	7
*CLS (no query)	7
*ESE	7
*ESR?	7
*IDN?	7
*OPC	8
*OPT?	8
*RST (no query)	8
*SRE	9
*STB?	9
*TRG (no query)	10
*TST?	10
*WAI (no query)	10
<b>4. ALL Subsystem</b>	<b>11</b>
ALL?	11
<b>5. ASETup Subsystem</b>	<b>12</b>
ASETup (no query)	12
<b>6. CALCulate Subsystem</b>	<b>13</b>
CALCulate	13
:FILTer	13
[:GATE]	13
:FREQuency	13
:IMMediate (no query)	13
:STOP <numeric_value>	14
:INTEgrate	14
[:IMMediate] (no query)	14
:SCALing <numeric_value>	14
:INVert	15
[:IMMediate]	15
:LIMit	15
[:FAIL]?	15
:MODE CONTInuous SOFail	15
:STATe <Boolean>	15
:MATH	15
[:EXPRession] <numeric_expression>	15
:IMMediate (no query)	16
:TRACe TRACe1 TRACe2 REFerence	16
:X	16
[:POSition] <numeric_value>	16
:Y	16
:MAGNify <numeric_value>	16
[:POSition] <numeric_value>	16

<b>7.</b>	<b>Measurement Instructions</b>	<b>17</b>
<b>7.1</b>	<b>CONFigure Subsystem</b>	<b>19</b>
	CONFigure (no query)	19
	[:SCALar]	19
	[:VOLTag]	19
	:AC	19
	:AREA	19
	:DCYCLe	19
	:FALL	20
	[:OVERshoot] <expected_value>	20
	:PREShoot <expected_value>	20
	:FTIME <lower reference>,<upper reference>,<expected_value>	20
	[:FREQuency]	20
	:MAXimum	20
	:MINimum	20
	:NWIDTH <reference>,<expected_value>	20
	:PERiod	20
	:PTPeak	20
	:PWIDth <reference>,<expected_value>	21
	:RISE	21
	[:OVERshoot] <expected_value>	21
	:PREShoot <expected_value>	21
	:RTIME <lower reference>,<upper reference>,<expected_value>	21
	:RVOLtag	21
<b>7.2</b>	<b>FETCH Subsystem</b>	<b>22</b>
	FETCH (no query)	22
	[:SCALar]	22
	[:VOLTag]	22
	:AC	22
	:AREA	22
	:DCYCLe	23
	:FALL	23
	[:OVERshoot]	23
	:PREShoot	23
	:FTIME <lower reference>,<upper reference>	23
	[:FREQuency]	23
	:MAXimum	23
	:MINimum	23
	:NWIDTH <reference>	23
	:PERiod	23
	:PTPeak	23
	:PWIDth <reference>	24
	:RISE	24
	[:OVERshoot]	24
	:PREShoot	24
	:RTIME <lower reference>,<upper reference>	24
	:RVOLtag	24

<b>7.3</b>	<b>MEASure Subsystem</b>	<b>25</b>
	MEASure (query only)	25
	[:SCALar]	25
	[:VOLTage]	25
	:AC	25
	:AREA	25
	:DCYCLe	25
	:FALL	26
	[:OVERshoot] <expected_value>	26
	:PREShoot <expected_value>	26
	:FTIME <lower reference>,<upper reference>,<expected_value>	26
	[:FREQuency]	26
	:MAXimum	26
	:MINimum	26
	:NWIDTH <reference>,<expected_value>	26
	:PERiod	26
	:PTPeak	26
	:PWIDTH <reference>,<expected_value>	27
	:RISE	27
	[:OVERshoot] <expected_value>	27
	:PREShoot <expected_value>	27
	:RTIME <lower reference>,<upper reference>,<expected_value>	27
	:RVOLTage	27
<b>7.4</b>	<b>READ Subsystem</b>	<b>28</b>
	READ (query only)	28
	[:SCALar]	28
	[:VOLTage]	28
	:AC	28
	:AREA	28
	:DCYCLe	29
	:FALL	29
	[:OVERshoot]	29
	:PREShoot	29
	:FTIME <lower reference>,<upper reference>	29
	[:FREQuency]	29
	:MAXimum	29
	:MINimum	29
	:NWIDTH <reference>	29
	:PERiod	29
	:PTPeak	29
	:PWIDTH <reference>	30
	:RISE	30
	[:OVERshoot]	30
	:PREShoot	30
	:RTIME <lower reference>,<upper reference>	30
	:RVOLTage	30
<b>8.</b>	<b>CALibration Subsystem</b>	<b>31</b>
	CALibration	31
	:AUTO <Boolean>	31

<b>9.</b>	<b>DISPlay Subsystem</b>	<b>32</b>
	DISPlay	33
	:CURSor	33
	[:POSition] <numeric_value>	33
	:TRACe OFF TRACe1 TRACe2 REFerence	33
	:DATum	33
	:X	33
	[:POSition] <numeric_value>	33
	:Y	33
	[:POSition] <numeric_value>	33
	:DJOin <Boolean>	34
	:HOLD[12] <Boolean>	34
	:LIMit <Boolean>	34
	:MEASurement[123] <measurement_name>	34
	:MENU	35
	[:NAME] <menu_name>	35
	:MODE ROLL REFresh XY	35
	:PWIDth	35
	[:REFerence]	35
	:HIGH <numeric_value>	35
	:LOW <numeric_value>	36
	:REFerence	36
	[:STATe] <Boolean>	36
	:REStore (no query)	36
	:RTIME	36
	[:REFerence]	36
	:HIGH <numeric_value>	36
	:LOW <numeric_value>	36
	[:WINDow]	37
	:GRATicule	37
	:BRIGhtness <Boolean>	37
	:TEXT	37
	:CLEar (no query)	37
	[:DATA] <string>	37
	:LOCate <row>,<column>	37
	:TRACe	38
	:PERsistence	38
	:CYCLes <numeric_value>	38
	:MODE OFF CYCLes TIME	38
	[:TIME] <numeric_value>	38
	:X	38
	:MAGNify	38
	[:SCALE]	38
	:CENTer <numeric-value>	38
<b>10.</b>	<b>FORMat Subsystem</b>	<b>39</b>
	FORMat	39
	[:DATA] ASCii HEXadecimal OCTal BINary PACKed	39
<b>11.</b>	<b>HELP? Subsystem</b>	<b>40</b>
	HELP? <name>	40

<b>12.</b>	<b>INPut Subsystem</b>	<b>41</b>
	INPut[12]	41
	:COUPling ACIDCIGROund	41
	:GAIN <numeric_value>	41
	[:STATe] <Boolean>	41
<b>13.</b>	<b>PLOT Subsystem</b>	<b>42</b>
	PLOT	42
	:ABORt (no query)	42
	:APAPer (no query)	42
	:CURSor <Boolean>	42
	:DESTination INTernallGPIB SERial	42
	:GRATicule	43
	[:STATe] <Boolean>	43
	:TYPE SOLId BROKEn	43
	[:INITiate] (no query)	43
	:MODE SINGLe AUTO	43
<b>14.</b>	<b>SENSe Subsystem</b>	<b>44</b>
	SENSe	44
	:AVERage	44
	:COUNT <numeric_value>	44
	[:STATe] <Boolean>	44
	:CORRection[12]	45
	:GAIN	45
	[:INPut]	45
	[:MAGNitude] <numeric-value>	45
	:SWEep	45
	[:TIME] <numeric_value>	45
	[:VOLTage[12]]	45
	[:DC]	45
	:ADD <Boolean>	45
	:BLIMit <Boolean>	45
	:MMIN <Boolean>	45
	[:RANGe]	46
	:OFFset <numeric_value>	46
	:PTPeak <numeric_value>	46
	:UNCalibrated <Boolean>	46
	:VARIable <numeric_value>	46
<b>15.</b>	<b>STATus Subsystem</b>	<b>48</b>
	STATus	48
	:OPERation	48
	:ACQuisition	48
	:CONDition?	48
	:ENABle <NRf>	48
	[:EVENT]?	48
	:CONDition?	49
	:ENABle <NRf>	49
	[:EVENT]?	49
	:PRESet	49
	:QUEStionable	49
	:CONDition?	49
	:ENABle <NRf>	49
	[:EVENT]?	49



<b>16.</b>	<b>SYSTem Subsystem</b>	<b>51</b>
	SYSTem	51
	:COMMunicate	51
	:GPIB	51
	:ADDRes <numeric_value>	51
	:EOI <Boolean>	51
	:SERial	52
	:CONTRol	52
	:RTS?	52
	:EPRompt <Boolean>	52
	:PSCHeme NONE HARDware SOFTware	52
	[:RECeive]	52
	:BAUD <numeric_value>	52
	:BITS?	52
	:PACE?	52
	:PARity	52
	[:TYPe]?	52
	:SBITS?	52
	:TRANsmit	53
	:BAUD <numeric_value>	53
	:BITS?	53
	:PACE?	53
	:PARity	53
	[:TYPe]?	53
	:SBITS?	53
	:DATE <year>,<month>,<day>	53
	[:ERRor]?	54
	:KEY <numeric-value>	55
	:TIME <hour>,<minute>,<second>	55
	:VERSion?	55
<b>17.</b>	<b>TRACe Subsystem</b>	<b>56</b>
	TRACe	56
	:CATalog?	57
	:COPY <trace_name>,<trace_name> (no query)	57
	[:DATA] <trace_name>,<block> <numeric_value>{,<numeric_value>}	57
	:RANGe	57
	:X <trace_name>,<numeric-value>	57
	:Y <trace_name>,<numeric-value>	58
	:STARt <numeric_value>	58
	:STOP <numeric_value>	58

<b>18.</b>	<b>TRIGger Subsystem</b>	<b>59</b>
	ABORt (no query)	59
	INITiate	59
	:CONTInuous <Boolean>	59
	[:IMMediate] (no query)	59
	TRIGger	59
	:COUPLing AC DC	59
	:DELay <numeric_value>	59
	:FILTer	60
	[LPASs]	60
	[:STATe] <Boolean>	60
	[:IMMediate] (no query)	60
	:LEVel <numeric_value>	60
	:MODE NORMal AUTO	60
	:PTRigger <numeric_value>	60
	:SLOPe POSitive NEGative	60
	:SOURce EXTernal INTernal1 INTernal2 LINE	60
<b>19.</b>	<b>Instrument Models</b>	<b>61</b>
<b>20.</b>	<b>Command Index</b>	<b>64</b>
<b>21.</b>	<b>Service Centers</b>	<b>67</b>

## Figure List

Table 1.1	GPIO IEEE-488 Pin Connections
Table 3	*RST Settings
Table 6	Filter Frequencies
Table 7	Default Settings
Table 14	Sweep Ranges
Figure 15	Status Reporting Structure
Figure 16	SYSTem:KEY Numbers
Figure 19.1	SCPI Instrument Model
Figure 19.2	Basic ARM-Trigger Model
Figure 19.3	Expanded ARM-Trigger Model
Figure 20	SCPI Commands for Button Functions

## Introduction to Standard Commands for Programmable Instruments (SCPI)

Commercial computer-controlled test instruments introduced in the 1960s used a wide variety of non-standard proprietary interfaces and communication protocols. In 1975, the Institute of Electrical and Electronic Engineers approved *IEEE 488-1975*. *IEEE 488* defined a standard electrical and mechanical interface for connectors and cables. It also defined handshaking, addressing and, general protocol for transmitting individual bytes of data to and from instruments and computers. This standard has been updated and is now *IEEE 488.1-1987*.

Although it solved the problem of how to send bytes of data between instruments and computers, *IEEE 488* did not specify the data bytes' meanings. Instrument manufacturers freely invented new commands as they developed new instruments. The format of data returned from instruments varied as well. By the early 1980s, work began on additional standards to specify how to interpret data sent via *IEEE 488*.

In 1987, the IEEE released *IEEE 488.2-1987, Codes, Formats, Protocols and Common Commands for Use with IEEE-488.1-1987*. This standard defined the role of instruments and controllers in a measurement system and a structured scheme for communication. In particular, *IEEE 488.2* described how to send commands to instruments and how to send responses to controllers. It defined some frequently used "housekeeping" commands explicitly, but each instrument manufacturer was left with the task of naming any other types of command and defining their effect. *IEEE 488.2* specified how certain types of features should be implemented if they were included in an instrument. It generally did not specify which features or commands should be implemented for a particular instrument. Thus, it was possible that two similar instruments could each conform to *IEEE 488.2*, yet they could have an entirely different command set.

*Standard Commands for Programmable Instruments (SCPI)* is the new instrument command language for controlling instruments that goes beyond *IEEE 488.2* to address a wide variety of instrument functions in a standard manner. SCPI promotes consistency, from the remote programming stand-point, between instruments of the same class and between instruments with the same functional capability. For a given measurement function such as frequency or voltage, SCPI defines the specific command set that is available for that function. Thus, two oscilloscopes made by different manufacturers could be used to make frequency measurements in the same way. It is also possible for a SCPI counter to make a frequency measurement using the same commands as an oscilloscope.

SCPI commands are easy to learn, self-explanatory and account for both novice and expert programmer's usage. Once familiar with the organization and structure of SCPI, considerable efficiency gains can be achieved during control program development, independent of the control program language selected.

*(Foreword from SCPI 1991 Volume 1: Syntax and Style)*

## SCPI Conformance Information

This manual is for use with the Gould 500 Digital Storage oscilloscope (DSO). This instrument complies with SCPI version 1991.0, May 1991 and use the commands described in this manual.

Unless otherwise noted, the commands in this manual are SCPI confirmed commands. The source of other commands, which are either SCPI approved commands for version 1992.0 or non SCPI commands created following SCPI rules, is noted in the command descriptions. To find the SCPI command for common oscilloscope functions, the command index and figure in section 20 may be helpful.

The notation employed throughout this manual conforms to that used in the SCPI 1991 manual.

<Boolean> is used throughout this manual as a shorthand for the form ON|OFF|<NRf>. Boolean parameters have a value of 0 or 1 and are unitless.

On input, <NRf> is rounded to an integer. A non-zero result is interpreted as 1.

ON and OFF are accepted as inputs to the DSO. ON corresponds to 1 and OFF corresponds to 0.

Queries always return 1 or 0, never ON or OFF.

Each Instrument-control header or key word has both a long form and a short form. The DSO will only accept the exact short form or the exact long form. In this manual the long form is always used and the short form is indicated by the uppercase characters in the long form. When using commands, case is unimportant. Both upper and lower case are acceptable.

Commands are based on an hierarchical structure. This allows the same instrument-control header (keyword) to be used several times for different purposes.

All commands, unless otherwise noted, have a query form. A query is a command header followed by a question mark.

Some commands have only a query form, that is they do not modify the instrument status, merely examine a particular feature.

## 1. About GPIB & RS423 Interfaces

This manual introduces the concepts of GPIB and RS423 communication and explains in detail the command set.

There are four basic operations that can be performed with a controller and the DSO through an interface:

- Set up the instrument and make waveform measurements
- Retrieve measurement results
- Send captured waveform data to the controller
- Return previously transferred waveforms to the DSO

Other more complicated tasks can be accomplished by combining these four building blocks.

Both the GPIB and the RS423 interface options are very versatile allowing fast communication between a host computer and the DSO.

The two ports are electrically different, but the high level communication format is essentially the same in either case.

Except where indicated this manual applies to both GPIB and RS423 operation.

### 1.1 GPIB (IEEE-488)

This is a parallel bus interface allowing communication between a host computer and up to 30 peripherals. It is based on the controller/talker/listener structure whereby the controller – usually the host computer – commands various peripherals to ‘talk’ or ‘listen’ according to the desired data path. Each peripheral on the bus is assigned a unique address number and on the DSO this is set via the I/O interface menu – section 3.7 of the operators manual.

There are two main modes of operation of the GPIB:

**Local:** The operator has full control of the instrument via the front panel. The DSO may be interrogated but not manipulated in any way by the host computer.

**Remote with Local Lock Out:** All the DSO’s GPIB commands can be used in this mode. None of the instrument’s front panel controls operate except the power on/off switch and the Plot/Abort button.

The connections to the GPIB are listed below. For further details of the connector see Appendix 5 of the operators manual.

Pin	Signal	Description	
1	DIO1	Data input output line 1	
2	DIO2	Data input output line 2	
3	DIO3	Data input output line 3	
4	DIO4	Data input output line 4	
13	DIO5	Data input output line 5	
14	DIO6	Data input output line 6	
15	DIO7	Data input output line 7	
16	DIO8	Data input output line 8	
5	EOI	End Or Identify	Interface Management Lines
17	REN	Remote Enable	
9	IFC	Interface Clear	
10	SRQ	Service Request	
11	ATN	Attention	
6	DAV	Data Valid	Handshake Lines
7	NRFD	Not ready for data	
8	NDAC	Data not accepted	
18	(DAV)		Return lines Twisted With same name line
19	(NRFD)		
20	(NDAC)		
21	(IFC)		
22	(SRQ)		
23	(ATN)		
12	Shield		
24	Logic Ground		

Table 1.1 GPIB IEEE-488 pin connections

## 1.2 Protocols

The protocols of IEEE 488.2 define the overall structure of the communication process, when devices should talk or listen and what happens when protocols are not followed.

### Elements

**Input Buffer** The input buffer of the DSO is the memory area where commands and queries are stored prior to being parsed and actioned. This allows the controller to send a string of commands to the DSO which can then be parsed and actioned by the instrument while the controller is performing other tasks such as talking to another instrument. The DSO's input buffer will hold 48 bytes of data, although the DSO is capable of handling block data greater than this where appropriate.

**Output Queue** The output queue of the DSO is the memory area where all output data is stored until read by the controller. The DSO's output queue will hold 48 bytes of data, although the DSO is capable of handling block data greater than this where appropriate.

**Parser** The parser is the name given to the software which interprets commands sent to the DSO and determines the appropriate actions. Parsing means the action taken by the parser to action a command.

### Protocol operation

Each time the instrument is powered up or when it receives a device clear command, the input and output buffers are cleared, and the parser is reset to the root level of the command tree.

The DSO and the controller communicate using program messages and response messages. Program messages are sent by the controller to the DSO and response messages are sent to the controller from the DSO in response to a query message. A query message is a program message that contains one or more queries.

The DSO can only talk in response to a valid query message. i.e. when it has something to say. The controller should always read a response before sending another program message.

### Protocol errors

**Addressed to talk with nothing to say** If the DSO is addressed to talk before it has received a query, it will indicate a query error and will not send any bytes over the bus. If the DSO has nothing to say because of an error during a query execution the instrument will not indicate a query error but simply wait to receive the next transmission from the controller.

**Addressed to talk with no listeners on the bus** If the DSO is addressed to talk while there are no listening devices on the bus the DSO will wait for a device to listen or for the controller to take control.

**Command error** A command error will be reported if the instrument detects a syntax error or an unrecognized command.

**Execution Error** An execution error will be reported if a parameter is found to be out of range, or if the current instrument settings are not suitable for the requested command or query.

**Device Specific Error** A device specific error will be reported if the instrument is unable to execute a device dependent command.

**Query Error** A query error will be reported if the proper protocol for reading a query is not followed. A query error will also be generated by an unterminated and interrupted message as detailed below.

**Unterminated Condition** A query error will be generated if the controller attempts to read a response message before terminating the program message. If this occurs, the parser will be reset and the response will be cleared from the DSO's output queue. The response will not be sent over the bus.

**Interrupted condition** A query error will be generated if the controller attempts to send a program message before reading the entire response message to a previous query. The unread part of the response is lost but the new program message will not be affected.

**Buffer Deadlock** If the DSO's input and output queues both become full a buffer deadlock may occur. This is only likely to happen if a very long program message containing queries that result in a lot of response data is sent to the DSO. The input buffer will become full so that the entire programme message cannot be sent but the controller cannot read any of the response data until it has finished sending the program message; a deadlock.

If this situation occurs, the DSO will clear the output queue, thus breaking the deadlock, and it will continue to clear the responses until the end of the current program message. The query error bit will be set by this condition.

### 1.3 Interface Capabilities & Concepts

#### Capabilities

The interface capabilities of the DSO, as defined by IEEE 488.1 are SH1, AH1, T5, L4, SR1, RL1, DC1, C0, E2, PP1 and DT1.

#### Concepts

The GPIB bus has two modes of operation: Command mode and Data mode.

The bus is in Command mode when the ATN line is true and in Data mode when ATN is false.

The Data mode is used to send device dependant messages which include all the commands and queries detailed in sections 2-16.

The command mode is used to send talk and listen addresses and the following bus commands

**DCL** Device Clear; Clears input and output buffers, resets the parser and clears any outstanding commands

**SDC** Selected Device Clear; Clears input and output buffers, resets the parser and clears any outstanding commands

**GET** Group Execute Trigger command: causes the DSO to behave as if the S/Shot button has been pressed.

**IFC** Interface Clear; Halts all bus activity, un addresses all devices and returns control to the controller.

### 1.4 RS423

The RS423 interface is an updated form of the RS232 standard and is a serial connection requiring a dedicated input and output on the host computer to each peripheral.

RS423 uses lower voltages and lower impedances than RS232 but is electrically compatible

Occasionally problems can be encountered with RS423 cabling. These difficulties are almost always resolved by correct connection of the data and handshake lines to ensure the correct direction of signal travel.

The RS423 connections on the interface for the DSO are listed below. For further details of the connectors see Appendix 5 of the operator manual.

Pin	Signal	Description
1	0V	Protective Ground
2	RXD	Receive Data
3	TXD	Transmit Data
4	CTS	Clear to Send
5	RTS	Request to Send
7	0V	Signal Ground
9	0V	Signal Ground
18	0V/5V	Limits Test Fail

*Table 1.4 RS423 Pin Connections*

## 2. About GPIB and RS423 Commands

Command tables are used to define a set of SCPI commands. A table shows the commands, their hierarchical relationships, related parameters (if any) and associated notes. A separate command table is shown, at the beginning of the section, for each command subsystem.

The **KEYWORD** column of the command table provides the name of the command. The actual name of a command can consist of one or more keywords since SCPI commands are based on a hierarchical system known as a tree system.

In this system, associated commands are grouped together under a common node in the hierarchy. To obtain a command, the full path to it must be specified. The path is represented in the tables and command descriptions by placing the highest node in the hierarchy in the left-most position. Lower nodes are indented one position to the right, below the parent node.

Square brackets ( [ ] ) are used to indicate a keyword that is optional when programming the command; that is, the DSO processes the command to have the same effect whether or not the optional node is present. Such a node is called a default node.

Square brackets enclosing parameters following a command indicate that one and only one of the options is required as part of the keyword. e.g. the keyword **HOLD[12]** would be used as either **HOLD1** or as **HOLD2**.

For such commands, an asterisk ( \* ) is also a valid parameter which means all possible options as in **HOLD\*** which is the equivalent of **HOLD1** and **HOLD2**.

The query form of a command is created by adding a question mark after the last keyword. Some commands do not have a query form and some commands only exist in the query form. The **NOTES** column of the command tables is used to indicate this.

**Finding Commands** At first sight, the SCPI commands for some functions may seem poorly chosen and do not reflect oscilloscope functionality. The reader must remember that SCPI is an *instrument* standard, not an *oscilloscope* standard. Therefore, commands for functions which may exist on a range of different instruments must be chosen to be as relevant on one instrument as any other. SCPI has resolved this problem by the use of the SCPI instrument model for a general instrument. The general policy adopted by SCPI in this is to choose words which are meaningful in terms of the *signal*, not the measuring method. Most command words stem directly from this model which is shown in Fig 19.1 on page 61.

To assist those making the transition to SCPI, an index and figure in section 20, SCPI commands for Button functions, allows SCPI commands to be quickly found for most functions on the DSO.

**Using Commands** Commands and queries may be used in either the long form (complete spelling) or short form (abbreviated spelling). In the command tables and descriptions, letter case is used to differentiate between the short and long form of the command. The characters shown in upper case denote the short form and the long form is all the characters. Either the long or short form must be used, any other abbreviation will result in an error. When programming, case is unimportant so that commands can be sent to the instrument as a combination of upper or lower case characters but the instrument always responds in uppercase.

Programs written using the long form of commands are more easily read and understood. Programs written using short form commands use less memory and are faster as less data has to be transmitted.

As an example of commands, the following all set the vertical datum to the center of the display. The **POSition** command is a default node:

```
DISPLAY:DATUM:X:POSITION 5
DISPLAY:DATUM:X 5
DISP:DAT:X 5
```

Multiple commands and queries can be sent on the same line by separating each command with a semi-colon.

```
DISPLAY:Cursors:TRACE TRACE1;POSITION 8
```

Note that in the above example, the full path of the **CURSor:POSition** command is not required as it is at the same tree level as the **CURSor:TRACe** command.

In the following example, the second command is on a different node so the full path must be specified.

```
DISP:CURS:TRAC TRACE1;;DISP:DAT:X 2
```

The **PARAMETER** column of the command tables indicates the number and order of parameters associated with a command and their permitted values. In this column a number of special characters are used.

| separates permitted values or options and should be read as “or”. One and only one of these options must be included in the command but they are not required for the query form.

{ } are used to enclose one or more parameters that may be included zero or more times.

<numeric\_value> Indicates that a numeric value is required and will be taken as the argument of the command. The appropriate ranges of valid values are specified in the command description sections. Numbers that appear in commands must conform to certain conditions:

- The number must contain less than 20 characters,
- The mantissa may contain a sign (+/-), + will be assumed if none is specified,
- The exponent is optional, if included it must be preceded by an ‘E’
- The exponent may contain a sign (+ or -), if omitted + is assumed.
- Numbers which exceed  $\pm 9.9 \text{ E } 37$  generate an execution error; -222 Data out of range.
- Numbers are rounded to the closest permitted value for the command in use.

<expected\_value> specified in the command description sections.

<Boolean> means that where the command is a simple on/off function, numeric data or OFF or ON can be used. Zero stands for OFF and any other number stands for ON. In these cases the individual command descriptions detail the meaning of zero and non zero values.

In the response to a query, the DSO returns either 1 or 0. The individual command descriptions detail the meaning of 1 and 0.

<NRf> Decimal numeric programme data as defined in IEEE 488.2 section 7.7.2.1



### 3. Common Commands

The DSO's common commands are defined in the 488.2 standard and are common to all instruments complying with this standard. The common commands are used to control some of the DSO's basic functions such as instrument identification and reset and status reporting and clearing.

KEYWORD	PARAMETER FORM	NOTES
*CAL?		Query only
*CLS		
*ESE		
*ESR?		Query only
*IDN?		Query only
*OPC		
*OPT?		Query only
*RST		
*SRE		
*STB?		Query only
*TRG		
*TST?		
*WAI		
*CAL?	Calibration Query. If calibrations are enabled, this query performs calibration of the current setup. Returns 0 if successful, 1 for failure or 2 if calibrations are disabled.	
*CLS	Clear Status Command. This command is used to clear the DSO's status registers. See figure 15 and page 98 of IEEE 488.2 standard.	
*ESE	Standard Event Status Enable command and query. The command form is used to set the Standard Event Status Enable Register bits. See figure 13. The bits set by this command enable the matching bits in the Standard Event Status Register.  The *ESE? query returns the contents of the Standard Event Status Enable Register. See figure 13 and page 102 of IEEE 488.2 standard.  The numeric value for both the command and query is in the range 0–255.	
*ESR?	Standard Event Status Register query. This query returns the contents of the Standard Event Status Register. See figure 13 and page 102 of IEEE 488.2 standard.  The numeric value returned is in the range 0–255.  Reading the Standard Event Status Register clears it.	
*IDN?	Identification query. Returns 4 ASCII fields in accordance with page 103 of IEEE 488.2 standard. For example:  GOULD,500,0,<version>  where <version> is the software version number, e.g. 11.01.  <b>Notes</b> The 0 in the returned string is the serial number field and is not implemented. The version is the software version fitted to the instrument and will change each time the software is updated.	

### \*OPC

Operation Complete command and query. The command causes the DSO to set the operation complete bit in the Standard Event Status Register when all pending device operations are complete.

The \*OPC? query returns a "1" when when all pending selected device operations are complete.

Operations that can be pending are: Plotting incomplete and Waiting for INITiate[:IMMediate] to complete.

See page 105 of IEEE 488.2 standard.

### \*OPT?

Option Identification query. Reports the status of options in accordance with page 105 of the IEEE 488.2 standard. If no options are fitted, the response is a single ASCII '0'. If all the options are fitted, the response would be:

GPIB,PLOTTER,CLOCK,MEASUREMENTS

A single ASCII '0' is returned in the field corresponding to any option not fitted.

### \*RST

Reset command. This command performs a device reset. The GPIB or RS423 interface setup will not change nor will the instrument's calibration settings. The table below shows the DSO's reset conditions. See page 110 of IEEE 488.2 standard.

Function	SCPI Command	Setting
Integrate scaling	CALCulate:INTEgrate:SCALing	1
Filter frequency	CALCulate:FILTer[:GATE]:FREQuency:STOP	1
Limit testing mode	CALCulate:LIMit:MODE	CONTInuous
Limits testing	CALCulate:LIMit:STATe	OFF
Math destination	CALCulate:MATH:TRACe	REFerence
Post storage X shift	CALCulate:X[:POSition]	0
Post storage Y mag	CALCulate:Y:MAGNify	1
Post storage Y position	CALCulate:Y[:POSition]	0
Auto calibrations	CALibration:AUTO	ON
Cursor position	DISPlay:CURSor[:POSition]	9
Cursor trace	DISPlay:CURSor:TRACe	TRACe1
Vertical Datum Position	DISPlay:DATum:X[:POSition]	0
Horizontal datum pos.	DISPlay:DATum:Y[:POSition]	1
Holds	DISPlay:HOLD[12]	OFF
Limit trace display	DISPlay:LIMit	OFF
Measurement 1	DISPlay:MEASurement1	VTIME
Measurement 2	DISPlay:MEASurement2	OFF
Measurement 3	DISPlay:MEASurement3	OFF
Trace/Menu display	DISPlay:MENU[:NAME]	TRACes
Display mode	DISPlay:MODE	REFResh
Pulsewidth high reference	DISPlay:PWIDth[:REFerence]:HIGH	50
Pulsewidth low reference	DISPlay:PWIDth[:REFerence]:LOW	50
Reference trace	DISPlay:REFerence[:STATe]	OFF
Risetime high reference	DISPlay:RTIME[:REFerence]:HIGH	90
Risetime low reference	DISPlay:RTIME[:REFerence]:LOW	10
Graticule brightness	DISPlay[:WINDow]:GRATICule:BRIGhtness	ON
Persistence cycles	DISPlay[:WINDow]:TRACe:PERStence:CYCLes	10
Persistence time	DISPlay[:WINDow]:TRACe:PERStence[:TIME]	0.5
Persistence mode	DISPlay[:WINDow]:TRACe:PERStence:MODE	OFF

(continued)

(continued)		
Function	SCPI Command	Setting
X-Mag	DISPlay[:WINDow]:TRACe:X:MAGNify	1
X Shift	DISPlay[:WINDow]:TRACe:X[:SCALE]:CENTer	0
Data format	FORMat[:DATA]	ASCii
Initiate	INITiate:CONTInuous	OFF
Input coupling	INPut[12]:COUPling	AC
Input gain	INPut[12]:GAIN	1
Channel state	INPut[12][:STATe]	ON
Plot cursor	PLOT:CURSor	OFF
Plot graticule	PLOT:GRATicule[:STATe]	OFF
Plot graticule type	PLOT:GRATicule:TYPE	SOLid
Plot mode	PLOT:MODE	SINGLE
Averaging count	SENSe:AVERAge:COUNT	2
Averaging	SENSe:AVERAge[:STATe]	OFF
Probe Gain	SENSe:CORRection[12]:GAIN[:INPut][:MAGNitude]	1
Sweep rate	SENSe:SWEep[:TIME]	100E-6
Add	SENSe[:VOLTage[12]][:DC]:ADD	OFF
Bandwidth limit	SENSe[:VOLTage[12]][:DC]:BLIMit	OFF
Maxmin	SENSe[:VOLTage[12]][:DC]:MMIN	OFF
Vertical shift	SENSe[:VOLTage[12]][:DC][:RANGe]:OFFset	0
PT peak	SENSe[:VOLTage[12]][:DC][:RANGe]:PTPeak	4E1
Uncal	SENSe[:VOLTage[12]][:DC][:RANGe]:UNCalibrated	OFF
Variable Gain	SENSe[:VOLTage[12]][:DC][:RANGe]:VARIABLE	1
Data transfer start point	TRACe:STARt	0
Data transfer stop point	TRACe:STOP	500
Trigger coupling	TRIGger:COUPling	AC
Trigger delay	TRIGger:DELay	0
Hf rej	TRIGger:FILTer[:LPASs][:STATe]	OFF
Trigger level	TRIGger:LEVel	0
Trigger mode	TRIGger:MODE	AUTO
Pre trigger	TRIGger:PTRigger	0
Trigger slope	TRIGger:SLOPe	POSitive
Trigger source	TRIGger:SOURce	INTernal

Table 3 \*RST Settings

- \*SRE** Service Request Enable command. The command is used to set the Service Request Enable Register bits. See figure 13 and page 111 of IEEE 488.2 standard. The bits set by this command enable the matching bits in the Status Byte Register.
- This query returns the contents of the Service Request Enable Register. See figure 15 and page 111 of IEEE 488.2 standard.
- The numeric value for both the command and query is in the range 0–255.
- \*STB?** Read Status Byte query. This query returns the contents of the Status Byte Register. See figure 13 and page 111 of IEEE 488.2 standard.
- The numeric value returned is in the range 0–255.
- The MSS (Master Summary Status) bit, not the RQS message, is reported on bit 6 of this register.

- \*TRG** This command is an alias of the INITiate [:IMMediate] command.
- \*TST?** Self Test query. This query always returns 0. See page 112 of IEEE 488.2 standard.
- \*WAI** Wait-to-Continue command. This command does not set a bit or return a value, it instructs the DSO to wait until all pending operations are complete when it will respond to further commands. While it is waiting, the instrument will not execute any further commands.
- The DSO is pending when it is waiting for a plot to complete or for INITiate[:IMMediate] to complete.
- See page 112 of IEEE 488.2 standard.

**4. ALL Subsystem**

This subsystem has only one command, ALL and is used obtain a set of query responses from the DSO.

**KEYWORD****PARAMETER FORM****NOTES****ALL****ALL?**

Output all query responses for most commands that have both command and query forms.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## 5. ASETup Subsystem

This subsystem has only one command, ASETup and is used to implement the DSO's Autosetup routine.

KEYWORD	PARAMETER FORM	NOTES
ASETup		No query form
<b>ASETup</b>	<p>This causes the instrument to perform a full instrument auto-setup procedure. It produces the same result as pressing the front panel AUTO-SETUP button.</p> <p>This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.</p> <p>This command is an event and therefore has no associated *RST condition.</p>	

## 6 CALCulate Subsystem

This subsystem performs post-acquisition data processing on the cursor trace. The cursor trace is defined by the CURSor command in the DISPlay subsystem. Functions in the SENSE subsystem are related to data acquisition while the CALCulate subsystem operates on the data acquired by the SENSE subsystem.

The CALCulate subsystem is logically between the SENSE subsystem and the data output to the display or bus. When a measurement is triggered by a MEASure command, an INITiate command or meeting the prevailing TRIGger conditions, the SENSE subsystem collects data. This data is transformed by CALCulate as specified, and then passed on to the selected output. In effect, the collection of new data triggers the CALCulate subsystem. The CALCulate subsystem can also be directed by command to change the configuration of CALCulate and therefore derive a different display from the same SENSEd data without the need to re-acquire the SENSE data.

KEYWORD	PARAMETER FORM	NOTES
CALCulate		
:FILTer		
[:GATE]		
FREQuency		
:IMMediate		No query form
:STOP	<numeric_value>	
:INTEgrate		
[:IMMediate]		No query form
:SCALing	<numeric_value>	
:INVert		
[:IMMediate]		No query form
:LIMit		
[:FAIL]?		
:MODE	CONTinuous SOFail	
:STATE	<Boolean>	
:MATH		
[:EXPRession]	<numeric_expression>	
:IMMediate		No query form
:TRACe	TRACe1 TRACe2 REFerence	
:X		
[:POSition]	<numeric_value>	
:Y		
:MAGNify	<numeric_value>	
[:POSition]	<numeric_value>	

6

### CALCulate

#### :FILTer

This subsystem defines a filtering process to be performed on the SENSE data.

#### [:GATE]

#### :FREQuency

#### :IMMediate

This command causes the CALCulate subsystem to execute the filtering process and has no query form.

**CAUTION:** When performing any waveform processing that modifies a displayed trace, the new data could be overwritten almost immediately by a fresh acquisition unless the selected trace is held or further acquisitions are prevented e.g. the instrument is in single shot mode and the trace stored or no triggers are provided.

This command is an event and therefore has no associated \*RST condition.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:STOP <numeric\_value>**

Unitless, value in range 1 to 6 selecting preset cut-off frequency dependent upon the current timebase range as shown in table below.

At \*RST, STOP is set to 1.

Timebase	1	2	3	4	5	6
50s	111mHz	45.5mHz	21.3mHz	10.3mHz	5.05mHz	2.51mHz
20s	278mHz	114mHz	53.2mHz	25.8mHz	12.6mHz	6.27mHz
10s	556mHz	227mHz	106mHz	51.5mHz	25.3mHz	12.5mHz
5s	1.11Hz	455mHz	213mHz	103mHz	50.5mHz	25.1mHz
2s	2.78Hz	1.14Hz	532mHz	258mHz	126mHz	62.7mHz
1s	5.56Hz	2.27Hz	1.06Hz	515mHz	253mHz	125mHz
500ms	11.1Hz	4.55Hz	2.13Hz	1.03Hz	505mHz	251mHz
200ms	27.8Hz	11.4Hz	5.32Hz	2.58Hz	1.26Hz	627mHz
100ms	55.6Hz	22.7Hz	10.6Hz	5.15Hz	2.53Hz	1.25Hz
50ms	111Hz	45.5Hz	21.3Hz	10.3Hz	5.05Hz	2.51Hz
20ms	278Hz	114Hz	53.2Hz	25.8Hz	12.6Hz	6.27Hz
10ms	556Hz	227Hz	106Hz	51.5Hz	25.3Hz	12.5Hz
5ms	1.11kHz	455Hz	213Hz	103Hz	50.5Hz	25.1Hz
2ms	2.78kHz	1.14kHz	532Hz	258Hz	126Hz	62.7Hz
1ms	5.56kHz	2.27kHz	1.06kHz	515Hz	253Hz	125Hz
500μs	11.1kHz	4.55kHz	2.13kHz	1.03kHz	505Hz	251Hz
200μs	27.8kHz	11.4kHz	5.32kHz	2.58kHz	1.26kHz	627Hz
100μs	55.6kHz	22.7kHz	10.6kHz	5.15kHz	2.53kHz	1.25kHz
50μs	111kHz	45.5kHz	21.3kHz	10.3kHz	5.05kHz	2.51kHz
20μs	278kHz	114kHz	53.2kHz	25.8kHz	12.6kHz	6.27kHz
10μs	556kHz	227kHz	106kHz	51.5kHz	25.3kHz	12.5kHz
5μs	1.11MHz	455kHz	213kHz	103kHz	50.5kHz	25.1kHz
2μs	2.78MHz	1.14MHz	532kHz	258kHz	126kHz	62.7kHz
1μs	5.56MHz	2.27MHz	1.06MHz	515kHz	253kHz	125kHz
500ns	11.1MHz	4.55MHz	2.13MHz	1.03MHz	505kHz	251kHz
250ns	22.2MHz	9.09MHz	4.26MHz	2.06MHz	1.01MHz	501kHz
200ns	27.8MHz	11.4MHz	5.32MHz	2.58MHz	1.26MHz	627kHz
100ns	55.6MHz	22.7MHz	10.6MHz	5.15MHz	2.53MHz	1.25MHz
50ns	111MHz	45.5MHz	21.3MHz	10.3MHz	5.05MHz	2.51MHz
25ns	222MHz	90.9MHz	42.6MHz	20.6MHz	10.1MHz	5.01MHz

Table 6. Filter Frequencies

**CALCulate****:INTEgrate**

This subsystem allows the selected trace to be integrated.

**[:IMMediate]**

This command causes the CALCulate subsystem to execute the integration process and has no query form.

This command is an event and therefore has no associated \*RST condition.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:SCALing <numeric\_value>**

This command defines the scaling factor to be applied to any integrations. The allowed value is one of 1, 0.5, 0.2, 0.1.

At \*RST this value is set to 1.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.



**CALCulate****:INVert**

This subsystem allows the selected trace to be inverted.

**[ :IMMediate ]**

This command causes the CALCulate subsystem to invert the selected trace data and has no query form.

This command is an event and therefore has no associated \*RST condition.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**CALCulate****:LIMit**

This subsystem allows limit testing of the selected trace to be performed.

**[ :FAIL ]?**

This query returns a 0 or 1, to indicate if the LIMit test has failed or not; 0 represents pass and 1 represents fail.

**:MODE CONTInuous|SOFail**

This command selects the limit testing mode to be used by the LIMit command.

At \*RST, this function is set to CONTInuous.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:STATe <Boolean>**

This command turns limit testing on/off.

At \*RST, this function is set to OFF.

**CALCulate****:MATH**

This subsystem permits processing of sense data in numerical format. The operators are +, -, and \*.

**[ :EXPRession ] <numeric\_expression>**

This command defines the expression used for math operations. For example to add the two traces together, the expression:

CALCulate:MATH:EXPRession (TRACE1+TRACE2) would be used.

The valid forms of <numeric-expression> are:

(<trace\_name>+<trace\_name>)  
(<trace\_name>-<trace\_name>)  
(<trace\_name>\*<trace\_name>\*<scale>)

where <trace\_name> is one of TRACE1, TRACE2 or REFERENCE and <scale> is one of 1, 0.5, 0.2, 0.1.

At \*RST, this function is unaffected.

## CALCulate

### :MATH

#### :IMMediate

This command causes the CALCulate subsystem to execute the math expression and has no query form.

**CAUTION:** When performing any waveform processing that modifies a displayed trace, the new data could be overwritten almost immediately by a fresh acquisition unless the selected trace is held or further acquisitions are prevented e.g. the instrument is in single shot mode and the trace stored or no triggers are provided.

This command is an event and therefore has no associated \*RST condition.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

#### :TRACe TRACe1|TRACe2|REFerence

This command sets the destination trace for trace math.

At \*RST, this function is set to REFerence.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

6

## CALCulate

### :X

#### [:POSition] <numeric\_value>

This command is used to perform post storage horizontal shift of the selected trace. The <numeric\_value> is in units of divisions from -5 to 5. 0 corresponds to no shift.

At \*RST, this function is set to 0.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## CALCulate

### :Y

#### :MAGNify <numeric\_value>

This command sets the Y magnification factor of the selected trace. The <numeric\_value> is unitless and is in the range 0.0625 to 4.000.

At \*RST, this function is set to 1.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

#### [:POSition] <numeric\_value>

This command is used to perform post storage vertical shift of the selected trace. The <numeric\_value> is in units of divisions from -30 to 30. 0 corresponds to no shift.

At \*RST, this function is set to 0.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## 7. Measurement Instructions

The main commands/queries in this sub-system are MEASure, CONFigure, READ and FETch. MEASure is the highest level command supported by the DSO, and may be used to instruct the DSO to perform a complete measurement and return the result.

For example, to instruct the DSO to measure the frequency of the signal connected to CH1 BNC and to return the value, the controller could simply use:

```
:MEASURE:FREQUENCY?
```

The DSO attempts to set vertical and horizontal ranges to accommodate the signal, and to return the resultant measured frequency. If no signal is found, then no result is returned, but error -231 (Data corrupt or stale) will be placed in the error queue.

If the controller then wishes to take another frequency measurement but without the DSO re-configuring itself, it may send:

```
:READ:FREQUENCY?
```

whereupon the DSO will simply re-acquire, make a fresh frequency measurement and return the new result.

This may be useful where the controller requires the measurement to be taken under slightly different conditions to those determined by the DSO. (The DSO attempts to make the frequency measurement over 3 to 5 cycles, but the controller may wish at least 10 cycles to be used). For example, the controller might issue the MEASure command, read the timebase range from the DSO using :SENSe: SWEep [:TIME]?, change the range, and then request the frequency measurement to be made using READ?

If more tight control of measurements is required, then the controller may use the CONFigure command followed by the READ? query. For example,

```
:CONFIGURE:FREQUENCY
:READ:FREQUENCY?
```

Note that CONFigure will attempt to configure the DSO ready to make the given measurement, but without actually making the measurement and returning the result. Again, the controller might tailor the measurement set-up according to requirements, and then issue the READ? query.

Once the DSO is configured for a particular measurement, it may be able to return other measurement results. For example, the DSO is able to return period and duty-cycle results when configured for frequency, without having to re-acquire data. The FETch? query is used to achieve this. For example, MEASURE:FREQUENCY? will return the frequency, and :FETCH:PERIOD? may then be used to obtain the period measurement result from the same acquisition. The table below details which measurements are available for which basic configurations.

Configured Measurement	Other Measurement Results Available
AC	-
AREA	-
DCYCLE	FREQuency & PERiod
FALL:OVERshoot	FALL:PREShoot
FALL:PREshoot	FALL:OVERshoot
FTIME	-
FREQuency	PERiod & DCYCLE
MAXimum	MINimum
MINimum	MAXimum
NWIDth	PWIDth
PERiod	FREQuency & DCYCLE
PTPeak	-
PWIDth	NWIDth
RISE:OVERshoot	RISE:PREShoot
RISE:PREshoot	RISE:OVERshoot
RTIME	-
RVOLTage	-

Some measurement commands require parameters. For example, PWIDth requires a parameter to specify the reference level at which the measurement is to be made. Assuming that the DSO has already been configured for PWIDth (using MEASure? or CONFigure), then READ:PWIDth? 45 will return the 45% pulse-width.

Some MEASure? and CONFigure measurement commands require an additional parameter giving the expected value of the measurement result. This is to allow the DSO to directly select a suitable range on which to make the measurement. For example, if the signal is known to have a risetime of approximately 10µs then the following query would return the actual risetime measured between 15% and 75% points.

```
:MEASURE:RTIME? 15,75,10E-6
```

All parameters for commands and queries in this sub-system may be defaulted by specifying DEFault in the respective parameter field. The defaults are defined in the table below.

Risetime low reference	10%
Risetime high reference	90%
Expected risetime	10µs
Falltime low reference	10%
Falltime high reference	90%
Expected falltime	10µs
Pulse-width reference	50%
Expected pulse-width	10µs

Table 7. Default Settings

For example,

```
:MEASURE:RTIME? DEF,DEF,DEF
```

would return the measured 10% to 90% risetime of a signal having an expected risetime of approximately 10µs.

## Single-shot signals

The measurement commands MEASure and CONFigure use the instrument's auto-setup feature to set the vertical and horizontal ranges based on the applied signal. Therefore, these commands cannot correctly configure the instrument unless a continuous signal is applied. To make measurements on a single pulse the responsibility for setting the vertical and horizontal ranges rests mainly with the instrument programmer. The following example shows how this works out in practise.

The aim is to measure the width of a single pulse whose amplitude is thought to be about 100mV. Its width is expected to be about 3s. The controller begins by sending:

```
:CONFIGURE:PWIDTh 40,3E-6
```

This tells the DSO to prepare to make a pulse width measurement between 40% reference points with an expected result of 3s. The DSO attempts to set vertical and horizontal ranges using auto-setup, but fails as no signal is found. However, it selects a horizontal range (2s in this case) which will be suitable for measuring the 3s pulse and sets the pulse width measurement threshold to 40%.

To set the vertical range to 20mV/DIV (160mV full scale) and position to -2.5 DIV the controller sends:

```
:SENSE:PTPEAK 160E-3;OFFSET -2.5
```

To horizontally centre the captured pulse and ensure that the DSO will trigger only on the pulse, the controller selects 50% pre-trigger and normal trigger mode as follows:

```
:TRIGGER:PTRIGGER 50;MODE NORMAL
```

The controller then initiates the measurement by sending:

```
:READ:PWIDTh? 40
```

When the DSO is triggered by the pulse, the precise value of its width will be calculated and returned to the controller.

## 7.1 CONFigure Subsystem

This subsystem sets up the instrument in order to perform the measurement specified by the function. The execution of a CONFigure command may affect the value of any other setting of the instrument. A subsequent READ? operation will perform the specified function.

If the instrument state has changed through receiving commands other than CONFigure or MEASure?, the information returned by a CONFigure? query may not reflect the actual measurement conditions.

KEYWORD	PARAMETER FORM	NOTES
CONFigure		(no query)
[:SCALar]		
[:VOLTage]		
:AC		
:AREA		
:DCYCLe		
:FALL		
[:OVERshoot]	<expected_value>	
:PREShoot	<expected_value>	
:FTIME	<lower reference>,<upper reference>,<expected_value>	
[:FREQuency]		
:MAXimum		
:MINimum		
:NWIDTH	<reference>,<expected_value>	
:PERiod		
:PTPeak		
:PWIDth	<reference>,<expected_value>	
:RISE		
[:OVERshoot]	<expected_value>	
:PREShoot	<expected_value>	
:RTIME	<lower reference>,<upper reference>,<expected_value>	
:RVOLTage		

### CONFigure

[:SCALar]

A SCALar or single value of the desired measurement is taken. SCALar has no associated parameters, and is a default node at this level.

[:VOLTage]

Measures the voltage characteristics of the signal.

:AC

Measures the AC RMS characteristic of the signal between the time datum and the cursor.

:AREA

Calculates the area bounded by datum lines, cursor and trace.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## **:FALL**

This node specifies measurements on the falling edge of a waveform. This node has no associated parameters. This node assumes the first falling edge of the waveform.

### **[ :OVERshoot ] <expected\_value>**

The difference between the LOW signal level and the negative peak amplitude to which the instantaneous pulse waveform initially falls, expressed as a percentage of the waveform amplitude. The <expected\_value> parameter relates to the fall time of the signal, not the overshoot itself.

### **:PREShoot <expected\_value>**

The difference between the HIGH signal level and the positive peak amplitude to which the instantaneous pulse waveform initially rises, expressed as a percentage of the waveform amplitude. The <expected\_value> parameter relates to the fall time of the signal, not the preshoot itself.

## **:FTIME <lower reference>, <upper reference>, <expected\_value>**

The time interval during which the instantaneous amplitude of a pulse decreases from the high reference to the low reference of the normal pulse amplitude.

See table 7 for default settings.

## **:FREQuency**

Measures the frequency of the signal between the time datum and the cursor.

## **:MAXimum**

Measures the maximum voltage of the signal between the cursor and the time datum.

## **:MINimum**

Measures the minimum voltage of the signal between the cursor and the time datum.

## **:NWIDTH <reference>, <expected\_value>**

The negative width expressed in seconds from the first falling edge reference to the next rising edge reference. The same reference is used for the rising and falling edges.

See table 7 for default settings.

## **:PERiod**

The period (1/frequency) of a signal between the time datum and the cursor.

## **:PTPeak**

Calculates the difference between MAXimum and MINimum.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:PWIDTH <reference>, <expected\_value>**

The positive width expressed in seconds from the first rising edge reference to the next falling edge reference. The same reference is used for the rising and falling edges.

See table 7 for default settings.

**:RISE**

This node specifies measurements on the rising edge of a waveform. This node has no associated parameters. This node assumes the first rising edge of the waveform.

**[:OVERshoot] <expected\_value>**

The difference between the HIGH signal level and the positive peak amplitude to which the instantaneous pulse waveform initially rises, expressed as a percentage of the waveform amplitude. The <expected\_value> parameter relates to the rise time of the signal, not the overshoot itself.

**:PREShoot <expected\_value>**

The difference between the LOW signal level and the negative peak amplitude to which the instantaneous pulse waveform initially falls, expressed as a percentage of the waveform amplitude. The <expected\_value> parameter relates to the rise time of the signal, not the preshoot itself.

**:RTIME <lower reference>, <upper reference>, <expected\_value>**

The time interval during which the instantaneous amplitude of a pulse increases from the low reference to the high reference of the normal pulse amplitude.

See table 7 for default settings.

**:RVOLTage**

Voltage with respect to voltage datum.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## 7.2 FETCh Subsystem

This subsystem retrieves the measurements taken by the INITiate command and places them into the DSO's output buffer. By specifying a function as part of a compound header, the DSO will retrieve the value of the function requested, derived from the data taken by the latest INITiate command. The FETCh? query will return data any time that the last reading is valid. Data becomes invalid under the following conditions:

- When \*RST is executed,
- When an INITiate is executed,
- When there is any re-configuration of measurement function and/or trigger blocks,
- When the DSO begins a new acquisition.

KEYWORD	PARAMETER FORM	NOTES
FETCh		(query only)
[:SCALar]		
[:VOLTage]		
:AC		
:AREA		
:DCYCLe		
:FALL		
[:OVERshoot]		
:PREShoot		
:FTIME	<lower reference>,<upper reference>	
[:FREQuency]		
:MAXimum		
:MINimum		
:NWIDth	<reference>	
:PERiod		
:PTPeak		
:PWIDth	<reference>	
:RISE		
[:OVERshoot]		
:PREShoot		
:RTIME	<lower reference>,<upper reference>	
:RVOLTage		

## FETCh

[:SCALar]

A SCALar or single value of the desired measurement is taken. SCALar has no associated parameters, and is a default node at this level.

[:VOLTage]

This subsystem measures the voltage characteristics of the signal.

:AC

Measures the AC RMS characteristic of the signal between the time datum and the cursor.

:AREA

Calculates the area bounded by datum lines, cursor and trace.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.



**:DCYCLe**

Calculates the duty cycle of the waveform as a ratio of PWIDth to PERiod.

**:FALL**

This node specifies measurements on the falling edge of a waveform. This node has no associated parameters. This node assumes the first falling edge of the waveform.

**[ :OVERshoot ]**

The difference between the LOW signal level and the negative peak amplitude to which the instantaneous pulse waveform initially falls, expressed as a percentage of the waveform amplitude.

**:PREShoot**

The difference between the HIGH signal level and the positive peak amplitude to which the instantaneous pulse waveform initially rises, expressed as a percentage of the waveform amplitude.

**:FTIME <lower reference>,<upper reference>**

The time interval during which the instantaneous amplitude of a pulse decreases from the high reference to the low reference of the normal pulse amplitude.

See table 7 for default settings.

**[ :FREQuency ]**

Measures the frequency of the signal between the time datum and the cursor.

**:MAXimum**

Measures the maximum voltage of the signal between the cursor and the time datum.

**:MINimum**

Measures the minimum voltage of the signal between the cursor and the time datum.

**:NWIDth <reference>**

The negative width expressed in seconds from the first falling edge reference to the next rising edge reference. The same reference is used for the rising and falling edges.

See table 7 for default settings.

**:PERiod**

The period (1/frequency) of a signal between the time datum and the cursor.

**:PTPeak**

Calculates the difference between the MAXimum and MINimum.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:PWIDTH <reference>**

The positive width expressed in seconds from the first rising edge reference to the next falling edge reference. The same reference is used for the rising and falling edges.

See table 7 for default settings.

**:RISE**

This node specifies measurements on the rising edge of a waveform. This node has no associated parameters. This node assumes the first rising edge of the waveform.

**[ :OVERshoot ]**

The difference between the HIGH signal level and the positive peak amplitude to which the instantaneous pulse waveform initially rises, expressed as a percentage of the waveform amplitude.

**:PREShoot**

The difference between the LOW signal level and the negative peak amplitude to which the instantaneous pulse waveform initially falls, expressed as a percentage of the waveform amplitude

**:RTIME <lower reference>, <upper reference>**

The time interval during which the instantaneous amplitude of a pulse increases from the low reference to the high reference of the normal pulse amplitude.

See table 7 for default settings.

**:RVOLTage**

Voltage with respect to voltage datum.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

### 7.3. MEASure Subsystem

This subsystem provides a complete measurement sequence, including configuration and reading of the data. MEASure is used when the generic measurement is acceptable and fine adjustment of the DSO's settings is not required.

The MEASure? query is identical to:

```
ABORT;
CONFigure:<function>
READ:<function>
```

The format of the returned data is determined by the FORMat command.

KEYWORD	PARAMETER FORM	NOTES
MEASure		(query only)
[:SCALar]		
[:VOLTage]		
:AC		
:AREA		
:DCYClc		
:FALL		
[:OVERshoot]	<expected_value>	
:PREShoot	<expected_value>	
:FTIME	<lower reference>,<upper reference>,<expected_value>	
[:FREQuency]		
:MAXimum		
:MINimum		
:NWIDth	<reference>,<expected_value>	
:PERiod		
:PTPeak		
:PWIDth	<reference>,<expected_value>	
:RISE		
[:OVERshoot]	<expected_value>	
:PREShoot	<expected_value>	
:RTIME	<lower reference>,<upper reference>,<expected_value>	
:RVOLTage		

#### MEASure (query only)

[:SCALar]

A SCALar or single value of the desired measurement is taken. SCALar has no associated parameters, and is a default node at this level.

[:VOLTage]

Measures the voltage characteristics of the signal.

:AC

Measures the AC RMS characteristic of the signal between the time datum and the cursor.

:AREA

Calculates the area bounded by datum lines, cursor and trace.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:FALL**

This node specifies measurements on the falling edge of a waveform. This node has no associated parameters. This node assumes the first falling edge of the waveform.

**[ :OVERshoot ] <expected\_value>**

The difference between the LOW signal level and the negative peak amplitude to which the instantaneous pulse waveform initially falls, expressed as a percentage of the waveform amplitude. The <expected\_value> parameter relates to the fall time of the signal, not the overshoot itself.

**:PREShoot <expected\_value>**

The difference between the HIGH signal level and the positive peak amplitude to which the instantaneous pulse waveform initially rises, expressed as a percentage of the waveform amplitude. The <expected\_value> parameter relates to the fall time of the signal, not the preshoot itself.

**:FTIME <lower reference>,<upper reference>,<expected\_value>**

The time interval during which the instantaneous amplitude of a pulse decreases from the high reference to the low reference of the normal pulse amplitude.

See table 7 for default settings.

**[ :FREQuency ]**

Measures the frequency of the signal between the time datum and the cursor.

**:MAXimum**

Measures the maximum voltage of the signal between the cursor and the time datum.

**:MINimum**

Measures the minimum voltage of the signal between the cursor and the time datum.

**:NWIDTH <reference>, <expected\_value>**

The negative width expressed in seconds from the first falling edge reference to the next rising edge reference. The same reference is used for the rising and falling edges.

See table 7 for default settings.

**:PERiod**

The period (1/frequency) of a signal between the time datum and the cursor.

**:PTPeak**

Calculates the difference between MAXimum and MINimum.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:PWIDTH <reference>, <expected\_value>**

The positive width expressed in seconds from the first rising edge reference to the next falling edge reference. The same reference is used for the rising and falling edges.

See table 7 for default settings.

**:RISE**

This node specifies measurements on the rising edge of a waveform. This node has no associated parameters. This node assumes the first rising edge of the waveform.

**[ :OVERshoot ] <expected\_value>**

The difference between the HIGH signal level and the positive peak amplitude to which the instantaneous pulse waveform initially rises, expressed as a percentage of the waveform amplitude. The <expected\_value> parameter relates to the rise time of the signal, not the overshoot itself.

**:PREShoot <expected\_value>**

The difference between the LOW signal level and the negative peak amplitude to which the instantaneous pulse waveform initially falls, expressed as a percentage of the waveform amplitude. The <expected\_value> parameter relates to the rise time of the signal, not the preshoot itself.

**:RTIME <lower reference>, <upper reference>, <expected\_value>**

The time interval during which the instantaneous amplitude of a pulse increases from the low reference to the high reference of the normal pulse amplitude.

See table 7 for default settings.

**:RVOLTage**

Voltage with respect to voltage datum.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## 7.4 READ Subsystem

This subsystem provides a method of performing a fetch operation on fresh acquisition data.

The READ? query is identical to:

```
ABORt;
INITiate;
FETCh[:<function>?]
```

A common application is to use the READ? function in conjunction with the CONFigure command in order to provide a MEASure? capability when it is required to make fine adjustments to the DSO's settings to provide the exact measurement needed.

The format of the returned data is determined by the FORMat command.

KEYWORD	PARAMETER FORM	NOTES
READ		(query only)
[:SCALar]		
[:VOLTage]		
:AC		
:AREA		
:DCYCLe		
:FALL		
[:OVERshoot]		
:PREShoot		
:FTIME	<lower reference>, <upper reference>	
[:FREQuency]		
:MAXimum		
:MINimum		
:NWIDth	<reference>	
:PERiod		
:PTPeak		
:PWIDth	<reference>	
:RISE		
[:OVERshoot]		
:PREShoot		
:RTIME	<lower reference>, <upper reference>	
:RVOLTage		

### READ (query only)

[:SCALar]

A SCALar or single value of the desired measurement is taken. SCALar has no associated parameters, and is a default node at this level.

[:VOLTage]

Measures the voltage characteristics of the signal.

:AC

Measures the AC RMS characteristic of the signal between the time datum and the cursor.

:AREA

Calculates the area bounded by datum cursor and trace.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:DCYcle**

Calculates the duty cycle of the waveform as a ratio of PWIDth to PERiod.

**:FALL**

This node specifies measurements on the falling edge of a waveform. This node has no associated parameters. This node assumes the first falling edge of the waveform.

**[:OVERshoot]**

The difference between the LOW signal level and the negative peak amplitude to which the instantaneous pulse waveform initially falls, expressed as a percentage of the waveform amplitude.

**:PREShoot**

The difference between the HIGH signal level and the positive peak amplitude to which the instantaneous pulse waveform initially rises, expressed as a percentage of the waveform amplitude.

**:FTIME <lower reference>,<upper reference>**

The time interval during which the instantaneous amplitude of a pulse decreases from the high reference to the low reference of the normal pulse amplitude.

See table 7 for default settings.

**[:FREQuency]**

Measures the frequency of the signal between the time datum and the cursor.

**:MAXimum**

Measures the maximum voltage of the signal between the cursor and the time datum.

**:MINimum**

Measures the minimum voltage of the signal between the cursor and the time datum.

**:NWIDTH <reference>**

The negative width expressed in seconds from the first falling edge reference to the next rising edge reference. The same reference is used for the rising and falling edges.

See table 7 for default settings.

**:PERiod**

The period (1/frequency) of a signal between the time datum and the cursor.

**:PTPeak**

Calculates the difference between MAXimum and MINimum.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:PWIDTH <reference>**

The positive width expressed in seconds from the first rising edge reference to the next falling edge reference. The same reference is used for the rising and falling edges.

See table 7 for default settings.

**:RISE**

This node specifies measurements on the rising edge of a waveform. This node has no associated parameters. This node assumes the first rising edge of the waveform.

**[ :OVERshoot ]**

The difference between the HIGH signal level and the positive peak amplitude to which the instantaneous pulse waveform initially rises, expressed as a percentage of the waveform amplitude.

**:PREShoot**

The difference between the LOW signal level and the negative peak amplitude to which the instantaneous pulse waveform initially falls, expressed as a percentage of the waveform amplitude.

**:RTIME <lower reference>, <upper reference>**

The time interval during which the instantaneous amplitude of a pulse increases from the low reference to the high reference of the normal pulse amplitude.

See table 7 for default settings.

**:RVOLTage**

Voltage with respect to voltage datum.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.



8. CALibration Subsystem

This subsystem has the function of performing instrument calibration.

KEYWORD	PARAMETER FORM	NOTES
CALibration :AUTO	<Boolean>	

:AUTO <Boolean>

AUTO sets whether or not the instrument Auto-calibrations are enabled or not. 1 enables Auto-calibration and 0 disables auto-calibrations.

At \*RST, this function is set to ON.

## 9. DISPlay Subsystem

This subsystem controls the selection and presentation of the instrument's display functions and features.

KEYWORD	PARAMETER FORM	NOTES
DISPlay		
:CURSor		
[:POSition]	<numeric_value>	
:TRACe	OFF TRACe1 TRACe2 REFerence	
:DATum		
:X		
[:POSition]	<numeric_value>	
:Y		
[:POSition]	<numeric_value>	
:DJOin <Boolean>		
:HOLD[12]	<Boolean>	
:LIMit	<Boolean>	
:MEASurement[123]	<measurement_name>	
:MENU		
[:NAME]	<menu_name>	
:MODE	ROLL REFResh XY	
:PWIDth		
[:REFerence]		
:HIGH	<numeric_value>	
:LOW	<numeric_value>	
:REFerence		
[:STATe]	<Boolean>	
:REStore		No query form
:RTIME		
[:REFerence]		
:HIGH	<numeric_value>	
:LOW	<numeric_value>	
[:WINDow]		
:GRATicule		
:BRIGhtness	<Boolean>	
:TEXT		
:CLEar		No query form.
[:DATA]	<string>	
:LOCate	<row>,<column>	
:TRACe		
:PERStistence		
:CYCLes	<numeric_value>	
MODE	OFF CYCLes TIME	
[:TIME]	<numeric_value>	
:X		
:MAGNify <numeric-value>		
[:SCALE]		
:CENTer	<numeric_value>	

**DISPlay****:CURSor**

This subsystem is used to control the cursor.

**:POSition <numeric\_value>**

This command is used to select the cursor's horizontal position. The numeric value is units of divisions from 0 to 10 where 0 corresponds to the left-hand edge of the display and 10 corresponds to the right-hand edge of the display.

At \*RST, this function is set to 9.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:TRACe OFF|TRACe1|TRACe2|REFerence**

This command selects the trace onto which the cursor is placed. This cursor trace is the trace used for waveform measurements. The cursor can be placed on TRACe1, TRACe2 or REFerence. OFF turns the cursor off.

At \*RST, the trace is set to be TRACe1.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**DISPlay****:DATum**

This subsystem is used to select the positions of the datum lines.

**:X**

This node is used to position the horizontal datum.

**[ :POSition ] <numeric\_value>**

This command is used to set the position of the horizontal datum. The numeric value is units of divisions from 0 to 10 where 0 corresponds to the left-hand edge of the display and 10 corresponds to the right-hand edge of the display.

At \*RST, this function is set to 1.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:Y**

This node is used to position the vertical datum.

**[ :POSition ] <numeric\_value>**

This command is used to set the position of the vertical datum. The numeric value is units of divisions from -4.3 to 4.2 where 0 corresponds to the center of the display and 4.2 corresponds to the top edge of the display.

At \*RST, this function is set to 0.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## DISPlay

### :DJOin <Boolean>

This command is used to control the display dot join feature.

At \*RST, this function is set to 1.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## DISPlay

### :HOLD[12] <Boolean>

This command is used to select individual channel holds on the 2 input channels.

At \*RST, this function is set to 0.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## DISPlay

### :LIMit <Boolean>

This command sets whether or not limits testing is enabled.

At \*RST, this function is set to 0.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## DISPlay

### :MEASurement[123] <measurement\_name>

Selects the measurement to be carried out for each of the three possible measurements. Once a measurement has been selected for one of the three, it cannot be re-selected for a second or third measurement.

The <measurement\_name> is one of:

OFF  
VTime  
PTPeak  
MMIN  
RTIME  
OVERshoot  
PWIDth  
FPDCycle  
RMS  
AREA

At \*RST, this function is set to MEASurement1 VTime, MEASurement2 OFF, and MEASurement3 OFF.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## DISPlay

### :MENU

This subsystem is used to select either traces or a menu to be displayed.

**[[:NAME]] <menu\_name>**

This command specifies the menu to be displayed.

Where <menu\_name> is one of:

Menu Name	Function
TRACes	Menus off; Trace display
CMAster	Control Master Menu
STATus	Status Menu
DACquisition	Display and Acquisition Menu
DINTensity	Display Intensity Menu
RTRace	Ref Trace Menu
IOINterface	I/O Interface Menu
SFUNctions	Special Functions Menu
PSMaster	Post Storage Master Menu
STRace	Save Trace menu
RMEMory	Recall Memory Menu
PLOT	Plot Menu
CMEasurement	Cursor Measurements Menu
TMANipulate	Trace Manipulation Menu
TARithmetic	Trace Arithmetic Menu
PLTesting	Persistence & Limits Testing Menu

At \*RST, this function is set to TRACes.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

9

## DISPlay

### :MODE ROLL|REFResh|XY

This command selects the display mode which can be either ROLL, REFResh or XY.

At \*RST, this function is set to REFResh.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## DISPlay

### :PWIDTH

This subsystem is used to define the high and low reference points for pulsewidth measurements.

**[[:REference]]**

**:HIGH <numeric\_value>**

This command is used to define the high reference point for pulsewidth measurements in units of %, from 5 to 95.

At \*RST, this function is set to 50.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## DISPlay

### :PWIDTH

#### [[:REFERENCE]

##### :LOW <numeric\_value>

This command is used to define the low reference point for pulsewidth measurements in units of %, from 5 to 95.

At \*RST, this function is set to 50.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## DISPlay

### :REFERENCE

This command controls the reference trace display.

##### :STATE <Boolean>

This command determines the state of the reference trace display.

At \*RST, this function is set to 0.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

9

## DISPlay

### :RESTore

This command has no query mode, it simply restores the display to that before the last post-storage operation.

This command is an event and therefore has no associated \*RST condition.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## DISPlay

### :RTIME

This subsystem is used to define the high and low reference points for risetime measurements.

#### [[:REFERENCE]

##### :HIGH <numeric\_value>

This command is used to define the high reference point for risetime measurements in units of %, from 51 to 95.

At \*RST, this function is set to 90.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

##### :LOW <numeric\_value>

This command is used to define the low reference point for risetime measurements in units of %, from 5 to 49.

At \*RST, this function is set to 10.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

This subsystem controls the display characteristics.

**DISPlay****[[:WINDow]****:GRATicule**

This command controls the display graticule.

**:BRiGhtness <Boolean>**

This command controls the state of the display graticule. 0 is graticule off and 1 is graticule on.

At \*RST, this function is set to 1.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**DISPlay****[[:WINDow]****:TEXT**

This subsystem controls the on screen alphanumerics.

**:CLEar**

This command has no query form and is used to clear all the alpha numeric information from the instrument's trace display.

This command is an event and therefore has no associated \*RST condition.

**[[:DATA] <string>**

This command is used to display custom information on the instrument's trace display. Only the first 31 characters of the string are displayed.

**:LOCate <row>,<column>**

This command is used to define the screen position for custom data. The row and column numbers are unitless and are in the ranges: <row> 1 to 15 (bottom) and <column> 1 to 31 (right-hand edge).

**DISPlay**

[:WINDow]

:TRACe

This subsystem controls the displayed traces.

:PERSistence

This subsystem controls the persistence function.

:CYCLes &lt;numeric\_value&gt;

This command determines the number of persistence cycles to be displayed. The numeric\_value is one of 10, 20, 50, 100, 200, 500, INFINITY.

At \*RST, this function is set to 10.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**MODE OFF|CYCLes|TIME**

This command sets the Persistence Mode which can be either TIME or CYCLes or it can be turned OFF.

At \*RST, this function is set to OFF.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

[:TIME] &lt;numeric\_value&gt;

This command determines the persistence time in seconds. The numeric\_value is one of 0.5, 2, 5, 15, 30, 90, INFINITY.

At \*RST, this function is set to 0.5.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**DISPlay**

[:WINDow]

TRACe

:X

This subsystem controls the variable X parameters of the display.

:MAGNification &lt;numeric\_value&gt;

This command controls X magnification of the displayed traces and can be set to be no magnification or x10 magnification by setting a numeric\_value of 1 or 10 respectively.

At \*RST, this function is set to 1.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

[:SCALE]

:CENTer &lt;numeric\_value&gt;

This command controls the X or horizontal shift of the displayed traces relative to the graticule. The numeric\_value is in units of divisions in the range -5 to 5.

At \*RST, this function is set to 0.



**10. FORMat Subsystem**

This subsystem sets the data format for transferring trace data between the DSO and the controller.

KEYWORD	PARAMETER FORM	NOTES
FORMat [:DATA]	ASCIi HEXadecimal OCTal BINary PACKed	

**FORMat**

**[:DATA] ASCIi|HEXadecimal|OCTal|BINary|PACKed**

This command selects the data format for trace data. The DATA types are four "textual" types (ASCIi, HEXadecimal, OCTal and BINary) and one raw data type (PACKed):

ASCIi	Numeric data transferred as ASCIi bytes in <NR1> format with the numbers separated by commas as defined in IEEE 488.2.
HEXadecimal	Data is encoded as a non-decimal numeric ASCII bytes, base 16 preceded by "#H" as specified in IEEE 488.2.
OCTal	Data is encoded as a non-decimal numeric ASCII bytes, base 8 preceded by "#O" as specified in IEEE 488.2.
BINary	Data is encoded as a non-decimal numeric ASCII bytes, base 2 preceded by "#B" as specified in IEEE 488.2.
PACKed	Data is transferred in <DEFINITE LENGTH ARBITRARY BLOCK RESPONSE DATA> as defined in IEE 488.2 section 8.7.9, which consists of four fields: <ol style="list-style-type: none"> <li>1. a single # character</li> <li>2. a single character from 1, 2, ...9 which specifies the length of field 3.</li> <li>3. 1 to 9 characters which define the number of bytes of data to follow</li> <li>4. up to 501 bytes of data.</li> </ol>

The advantage of PACKed format transfers over the four textual type formats is their speed. Each item of data transferred is sent as an 8 bit value. Apart from the overhead of the header, there is a one to one relationship between the length of data requested (see TRACE:START and TRACE:STOP) and the number of bytes sent. Effectively, trace data from the DSO is transferred to a controller without translation to ASCII textual format first.

This type of transfer is incompatible with RS423 communications with XON/XOFF handshaking because the special control characters used to implement XON/XOFF can appear as part of the trace or set-up data, causing the transfer to fail. Either RTS/CTS handshaking or textual transfers should be used instead.

At \*RST, this function is set to ASCIi.

## 11. **HELP? Subsystem**

This subsystem is used to obtain lists of valid command names from the DSO.

KEYWORD	PARAMETER FORM	NOTES
HELP?	<name>	

### **HELP? <name>**

This query causes the instrument to return the portion of the command tree starting at the top level word <name>. If <name> is not supplied the entire command tree is returned. If the <name> supplied does not exist as a top level name, nothing is returned.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## 12. INPut Subsystem

This subsystem controls the characteristics of the DSO's two input channels.

KEYWORD	PARAMETER FORM	NOTES
INPut[12]		
:COUPling	AC DC GROund	
:GAIN	<numeric_value>	
[:STATe]	<Boolean>	

### INPut[12]

Defines the channel to be acted upon by the sub-commands.

#### :COUPling AC|DC|GROund

This command is used to set the input coupling of an input channel.

At \*RST, this function is set to AC.

#### :GAIN <numeric\_value>

Controls invert on/off. Valid values are -1 for invert on, 1 for invert off.

Coupled to STATe – see below.

At \*RST, this value is set to 1.

#### [:STATe] <Boolean>

Coupled to GAIN such that when STATe is set to OFF, GAIN gets set to +1. Also if GAIN is set to -1, STATe gets set to ON.

At \*RST, this function is set to ON.

**13. PLOT Subsystem**

This subsystem controls all aspects of the DSO's plot output.

KEYWORD	PARAMETER FORM	NOTES
<b>PLOT</b>		
:ABORt		
:APAPer		
:CURSor	<Boolean>	
:DESTination	INTernal GPiB SERial	
:GRATicule		
[:STATe]	<Boolean>	
:TYPE	SOLid BROKEn	
[:INITiate]		no query
:MODE	SINGle AUTO	

**PLOT****:ABORt**

Aborts the plot currently in progress.

This command is an event and therefore has no associated \*RST condition.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**PLOT****:APAPer**

When asserted, this command is equivalent to a single press of the paper advance button on the DSO, and will advance the plotter paper approximately 10mm.

This command is an event and therefore has no associated \*RST condition.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**PLOT****:CURSor <Boolean>**

This command is used to turn the cursor on and off on plots.

At \*RST, this function is set to OFF.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**PLOT****:DESTination INTernal|GPiB|SERial**

This command is used to determine the destination of plots generated by the DSO. The destination can be to an internal color plotter, or to an external HPGL plotter via the RS423 or GPIB interface.

At \*RST, this function is unaffected.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**PLOT****:GRATicule**

This subsystem is used to control the plotted graticule parameters.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**[[:STATe] <Boolean>**

This command is used to determine whether or not the graticule is included in plots produced by the DSO.

At \*RST, this function is set to OFF.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:TYPE SOLid|BROKEn**

This command is used to determine the graticule type to be plotted if the GRATicule:STATe command is set to 1. The graticule can either be plotted using solid or broken lines.

At \*RST, this function is set to SOLid.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**PLOT****[[:INITiate]**

This command is an event and therefore has no associated \*RST condition.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**PLOT****:MODE SINGLE|AUTO**

This command is used to define the plot mode as either SINGLE or AUTO.

At \*RST, this function is set to SINGLE.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

14. SENSE Subsystem

This subsystem and its subsystems deals with controls that affect the instrument settings but which are not signal related.

KEYWORD	PARAMETER FORM	NOTES
SENSe		
:AVERage		
:COUNT	<numeric_value>	
[:STATe]	<Boolean>	
:CORRection[12]		
:GAIN		
[:INPut]		
[:MAGNitude]	<numeric_value>	
:SWEEp		
[:TIME]	<numeric_value>	
[:VOLTag[12]]		
[:DC]		
:ADD	<Boolean>	
:MMIN	<Boolean>	
[:RANGe]		
:OFFset	<numeric_value>	
:PTPeak	<numeric_value>	
:UNCalibrated	<Boolean>	
:VARIABLE	<numeric_value>	

SENSe

:AVERage

This subsystem controls the averaging function.

:COUNT <numeric\_value>

This command is used to set the number of acquisitions used to produce the averaged display. Valid values are 2, 4, 8, 16, 32, 64, 128, 256 acquisitions.

At \*RST, this function is set to 2.

This command is not found in SCPI 1991.0 but in the additions approved for 1992.0 manual.

[:STATe] <Boolean>

This command is used to activate and deactivate the averaging function.

At \*RST, this function is set to OFF.

This command is not found in SCPI 1991.0 but in the additions approved for 1992.0 manual.

**SENSe****:CORRection[12]**

This subsystem is used to set the displayed voltages to suit the magnification factor of the probes in use.

**:GAIN****[:INPut]****[:MAGNitude] <numeric-value>**

This command is used to set the probe gain of the probes in use so that the displayed voltages on the DSO display correctly reflect the input voltages. Valid values are 1, 10, 100 for x1, x10 and x100 probes respectively.

At \*RST, this function is set to 1.

**SENSe****:SWEep**

This subsystem is used to set the horizontal sweep rate of the DSO.

**[:TIME] <numeric\_value>**

This command sets the duration of the horizontal sweep in seconds. The permitted <numeric\_value> for the sweep ranges are:

5E2 to 5E-6 in a 1-2-5 sequence, 2.5E-6, 1E-6, 5E-7 and 2.5E-7

At \*RST, this function is set to 100E-6.

**SENSe****[:VOLTage[12]]**

This subsystem is used to control the input channel's performance

**[:DC]****:ADD <Boolean>**

This command is used to add channel 1 and channel 2 acquisitions together and display a single resultant trace.

Both ADD commands (:VOLTage1:ADD and VOLTage2:ADD) are coupled together. ADD is also coupled to INPut[12]:STATE such that when ADD is set to ON, INPut\*:STATE is also set to ON and remains on even if ADD is then set to OFF.

At \*RST, this function is set to OFF.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:BLIMit <Boolean>**

This command is used to turn the 20MHz bandwidth limit filter on and off.

At \*RST, this function is set to OFF.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:MMIN <Boolean>**

This command controls the Maxmin function of the DSO.

At \*RST, this function is set to OFF.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## SENSe

**[[:VOLTage[12]]**

**[[:DC]**

**[[:RANGe]**

This subsystem controls the vertical settings of the input channels.

**:OFFset <numeric\_value>**

This command is the vertical shift control in divisions. Valid values are from -12 to 12.

At \*RST, this function is set to 0.

**:PTPeak <numeric\_value>**

This command sets the vertical sensitivity of the input channel and is in volts per screen. Valid values are in 16-40-80 sequence from 16E-3 to 4E1. Therefore a setting of 4E1 (40V) is equivalent to a sensitivity of 5V/division (40÷8).

At \*RST, this function is set to 4E1.

**:UNCalibrated <Boolean>**

This command turns vertical variable gain on and off.

At \*RST, this function is set to 0.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:VARiable <numeric\_value>**

This command sets the variable gain factor used if UNCalibrated is set to on. It is a unitless ratio, in the range 1 to 0.4.

At \*RST, this function is set to 1.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.



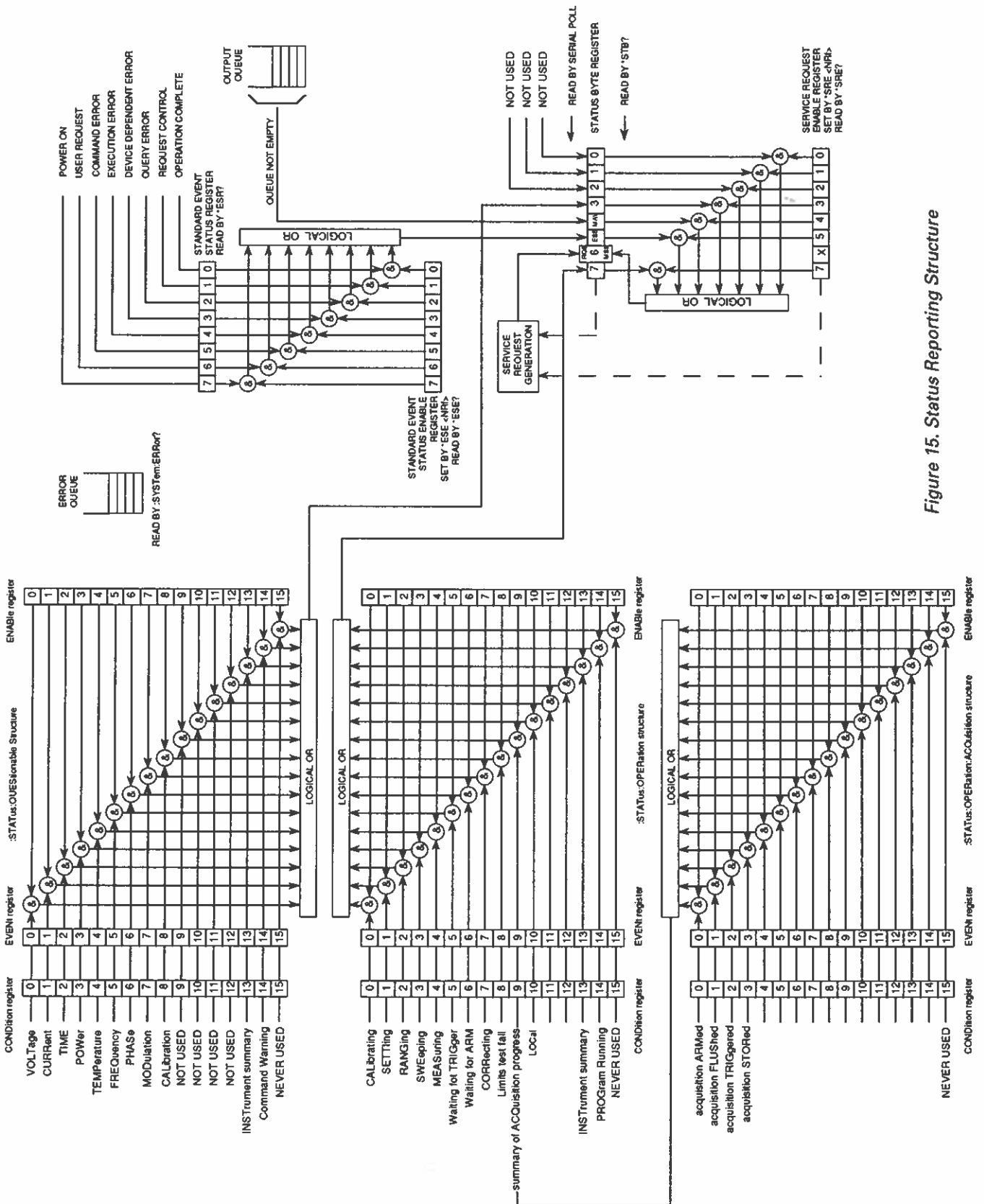


Figure 15. Status Reporting Structure

## 15. STATus Subsystem

This subsystem controls the SCPI-defined status-reporting structures. The SCPI-defined registers used by the DSO are QUESTIONable and OPERATION both of which comprise a condition register, an event register and an enable register as shown in figure 15. Additionally, various IEEE 488.2-defined status registers are used. These are also shown in figure 15.

Status registers keep a note of the current instrument status. By examining the status registers, the user can find out whether an operation has been completed, whether a command has caused an error and other information about the instrument. See figure 15 for the contents and names of the status bytes on the DSO.

Bits in the EVENT registers respond only to positive transitions of the corresponding bits in the CONDITION registers. For example, bit 3 in the :STATus:OPERation:ACQuisition:EVENT register will go high when acquisition STOREd changes from low to high and will stay high until the controller reads this EVENT register.

In addition to the STATus subsystem, some common commands are used to examine and control the DSO's status registers.

KEYWORD	PARAMETER FORM	NOTES
STATus		
:OPERation		
:ACQuisition		
:CONDition?		Query only
:ENABle <NRf>		
[:EVENTt]?		Query only
:CONDition?		Query only
:ENABle <NRf>		
[:EVENTt]?		Query only
:PRESet		
:QUESTIONable		
:CONDition?		Query only
:ENABle <NRf>		
[:EVENTt]?		Query only

### STATus

#### :OPERation

##### :ACQuisition

##### :CONDition?

This query returns the contents of the OPERATION:ACQuisition:CONDition register. Reading the register does not change the contents of the register.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

##### :ENABle <NRf>

This command sets the enable mask which allows the true conditions in the OPERATION:ACQuisition:EVENT register to be reported in the summary bit. If a bit is set to 1 in the OPERATION:ACQuisition:ENABle register and its associated event bit transitions to true, a positive transition will occur in the associated summary bit.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

##### [:EVENTt]?

This query returns the contents of the OPERATION:ACQuisition:EVENT register. Using this command to read the register clears the register.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**STATus****:OPERation****:CONDition?**

This query returns the contents of the OPERATION:CONDition register. Reading the register does not change the contents of the register.

**:ENABLE <NRf>**

This command sets the enable mask which allows the true conditions in the OPERATION:EVENT register to be reported in the summary bit. If a bit is set to 1 in the OPERATION:ENABLE register and its associated event bit transition to true, a positive transition will occur in the associated summary bit.

**[:EVENT]?**

This query returns the contents of the OPERATION:EVENT register. Using this command to read the register clears the register.

**STATus****PRESet**

The preset command is an event that configures the SCPI QUESTIONable:ENABLE, the OPERATION:ENABLE registers to be all 0s and the OPERATION:ACQuisition:ENABLE register to be all 1s

**STATus****:QUESTIONable****:CONDition?**

This query returns the contents of the QUESTIONable:CONDition register. Reading the register does not change the contents of the register.

**:ENABLE <NRf>**

This command sets the enable mask which allows the true conditions in the QUESTIONable:EVENT register to be reported in the summary bit. If a bit is set to 1 in the QUESTIONable:ENABLE register and its associated event bit transition to true, a positive transition will occur in the associated summary bit.

**[:EVENT]?**

This query returns the contents of the QUESTIONable:EVENT register. Using this command to read the register clears the register.

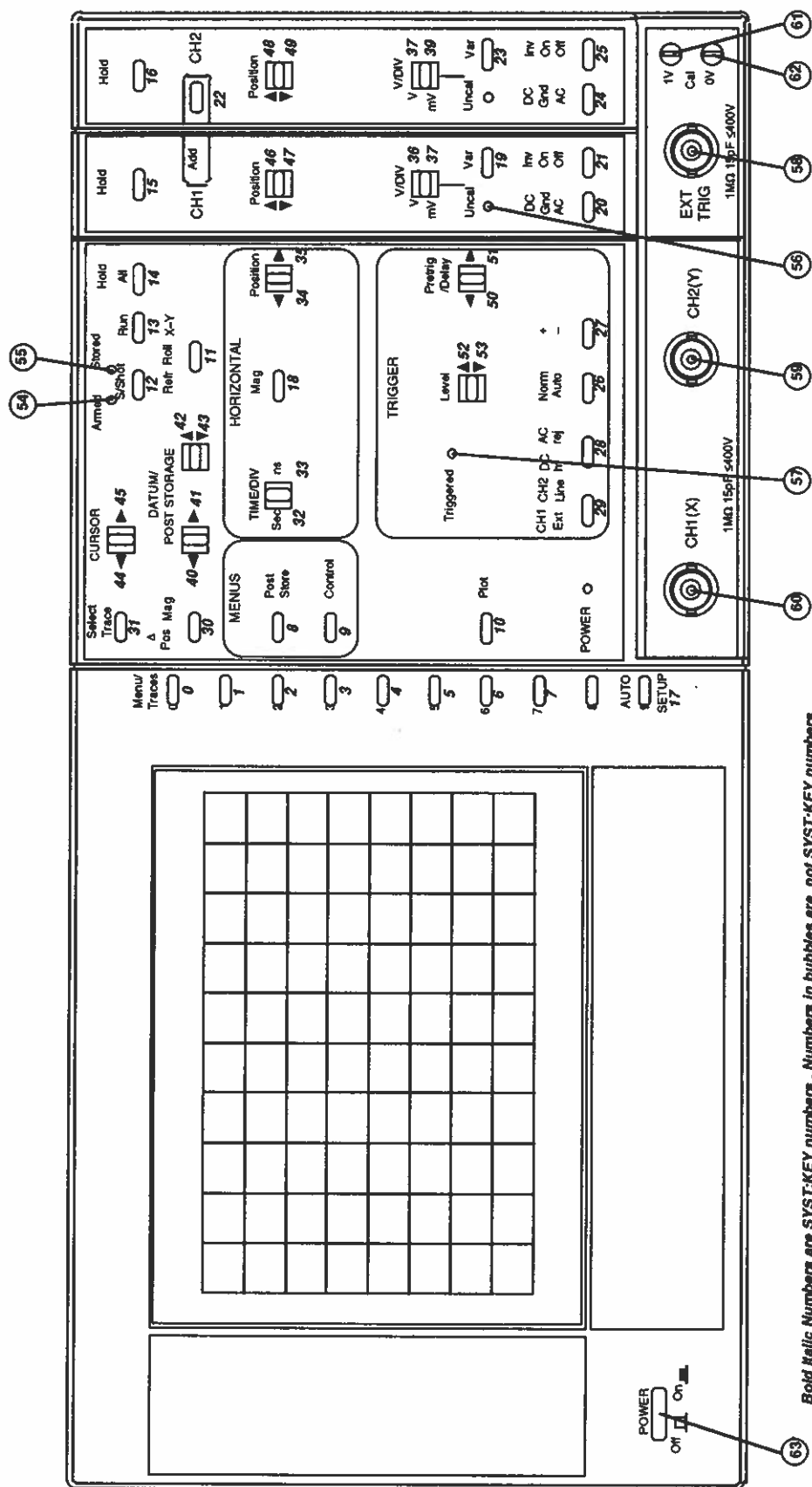


Figure 16. SYST:KEY Numbers

## 16. SYSTem Subsystem

This subsystem contains commands that are not related to instrument performance, but relate to general commands and global configurations.

Note that GPIB parameters cannot be changed over the GPIB interface and RS423 parameters cannot be changed over the RS423 interface. If either of these operations is attempted, an "Settings conflict" error is generated.

KEYWORD	PARAMETER FORM	NOTES
SYSTem		
:COMMunicate		
:GPIB		
:ADDRess	<numeric_value>	
:EOI	<Boolean>	
:SERial		
:CONTRol		
:RTS?		
:EPRompt	<Boolean>	
:PSCHeme	NONE HARDware SOFTWARE	
[:RECeive]		
:BAUD	<numeric_value>	
:BITS?		
:PACE?		
:PARity		
[:TYPE]?		
:SBITS?		
:TRANsmit		
:BAUD	<numeric_value>	
:BITS?		
:PACE?		
:PARity		
[:TYPE]?		
:SBITS?		
:DATE	<year>,<month>,<day>	
[:ERRor]?		
:KEY	<numeric-value>	see notes below
:TIME	<hour>,<minute>,<second>	
:VERSion?		

### SYSTem

#### :COMMunicate

This subsystem contains the commands for the configuration of the various control/communication interfaces.

#### :GPIB

This subsystem is used for controlling the GPIB interface parameters.

**:ADDRess** <numeric\_value>

This command is used to define the GPIB address of the DSO. Valid values from 0 to 30.

At \*RST, this function is unaffected.

**:EOI** <Boolean>

This command enables and disables the use of EOI.

At \*RST, this function is unaffected.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## SYSTem

### :COMMunicate

#### :SERial

This subsystem controls the physical configuration of the RS423 serial port. Any commands to change the settings takes effect immediately upon receipt of the Program Message Termination.

#### :CONTrol

##### :RTS?

This query is used to determine the hardware pacing system in use and always returns IBFull.

#### :EPRompt <Boolean>

This command is used to activate or deactivate the Echo and Prompt features of RS423 communication. EPRompt ON is useful when communicating with the DSO via a terminal or terminal emulator. Each character sent will be echoed back and a prompt provided for a new command. This prompt will normally be a '>' but will change to '?' whne an error is pending. The error(s) may be cleared by using SYST:ERR?

At \*RST, this function is unaffected.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

#### :PSCHeme NONE|HARDware|SOFTware

Selects pacing scheme to use.

At \*RST, this function is is unaffected.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

#### [ :RECeive]

This subsystem sets and queries the parameters of the RS423 port for received data.

##### :BAUD <numeric\_value>

Sets the Baud rate for receiving RS423 communications. Valid values are: 75, 150, 300, 600, 1200, 2400, 4800 and 9600 and are coupled to :TRANsmit:BAUD.

At \*RST, this function is unaffected.

##### :BITS?

This query is used to determine the received bits. Since the DSO is not configurable, this query always returns 8.

##### :PACE?

This query returns the software pacing scheme employed, which is fixed at XON.

##### :PARity

###### [ :TYPE]?

Since the DSO employs no parity generation or checking, this query always returns NONE.

##### :SBITS?

Since the DSO always uses 1 stop bit, this query always returns 1.

**SYSTem****:COMMunicate****:SERial****:TRANsmit**

This subsystem sets the parameters of the RS423 port for transmitted communications.

**:BAUD <numeric\_value>**

Sets the Baud rate for transmitting RS423 communications. Valid values are: 75, 150, 300, 600, 1200, 2400, 4800 and 9600 and are coupled to [:RECEive]:BAUD.

At \*RST, this function is unaffected.

**:BITS?**

This query is used to determine the transmitted bits. Since the DSO is not configurable, this query always returns 8.

**:PACE?**

This query returns the software pacing scheme employed, which is fixed at XON.

**:PARity****[:TYPE]?**

Since the DSO employs no parity generation or checking, this query always returns NONE.

**:SBITS?**

Since the DSO always uses 1 stop bit, this query always returns 1.

**SYSTem****:DATE <year>,<month>,<day>**

This command sets or queries the DSO's internal real-time clock date. Where: <year> is a NR1 value in the range 1990 to 2089; <month> is a NR1 value in the range 1 to 12 and <day> is a NR1 value in the range 1 to 31.

At \*RST, this function is unaffected.

**SYSTem****[:ERRor]?**

The queue query message is a request for the next entry from the DSO's error/event queue.

The integer returned (in the range -32768 to 32768) indicates the particular error.

If there has been no error/event and the queue is empty, the DSO responds with:

0, "No error"

Error codes generated by the DSO are listed below:

-100	Command error
-103	Invalid separator
-104	Data type error
-108	Parameter not allowed
-109	Missing parameter
-112	Program mnemonic too long
-113	Undefined header
-120	Numeric data error
-121	Invalid character in number
-123	Exponent too large
-124	Too many digits
-130	Suffix error
-140	Character data error
-141	Invalid character error
-150	String data error
-160	Block data error
-161	Invalid block data
-170	Expression error
-171	Invalid expression
-200	Execution error
-211	Trigger ignored
-221	Settings conflict
-222	Data out of range
-230	Data corrupt or stale
-241	Hardware missing
-350	Queue overflow
-410	Query INTERRUPTED
-420	Query UNTERMINATED
-430	Query DEADLOCKED



**SYSTem****:KEY <numeric-value>**

This command in its query form will return the code of the last key pressed. Sending this command with an appropriate <numeric\_value> simulates the pressing of that key.

The <numeric\_value> for each key is a decimal value RRKK where KK is the key number as indicated on figure 16 and RR is the key rate.

Keys 0–31 are one-touch keys, the rate is therefore irrelevant.

Keys 32–39 are two touch keys and takes rates of 0 (slowest), 1 or 2.

Although rates 1 & 2 are accepted for all these keys, the instrument only responds to these rates for the trace position keys and the V/Div keys when in variable gain mode.

Keys 40–53 are PHGF keys and take rates 0–15.

At \*RST, this function is unaffected.

**SYSTem****:TIME <hour>,<minute>,<second>**

This command sets or queries the DSO's internal real-time clock time. Where: <hour> is a NR1 value in the range 0 to 23; <minute> is a NR1 value in the range 0 to 59; <second> is a NR1 value in the range 0 to 59.

At \*RST, this function is unaffected.

**SYSTem****:VERSion?**

This query is used to obtain the SCPI version implemented by the DSO and currently returns 1991.0.

## 17. TRACe Subsystem

This subsystem is used to control the parameters used for trace data transfer between the DSO and host computer. These commands are used in conjunction with the :FORMat command.

When transferring data from the controller to the DSO, it is necessary to ensure that no acquisitions are in progress otherwise the transferred data may be immediately overwritten.

To transfer trace data from the DSO to a controller, the controller must take the following steps:

1. Select the range of data required using the :STARt and STOP commands,
2. Select the data format required using the :FORMat command,
3. Issue the [:DATA] command for the required trace.

For example, the following sequence will cause the DSO to transmit the first five bytes of TRACE1 as NR1 decimal values.

```
:TRAC:STAR 0
:TRAC:STOP 4
:FORM ASC
:TRAC? TRACE1
```

The response would be of the form:

```
12,34,56,78,90
```

If :FORMat had been set to HEXadecimal, the response to the above query would be of the form:

```
#HC,#H22,#H38,#H4E,#H5A
```

To transfer data to the DSO from a controller, the TRACe[:DATA] command can be used in one of three ways.

1. To set all the data points in a trace to the same value, the following commands could be used. Both these examples would set all data points in TRACE2 to decimal 123:
 

```
:TRAC TRACE2,123
:TRAC TRACE2,#Q173
```
2. To transmit a number of different ASCII-encoded data points to a trace store, the point at which the first data value is to be written must first be specified using the :STARt command and the last point set with the :STOP command. The data itself must then be sent. The following example could be used to transmit 5 bytes to the DSO starting at the 10th store location for TRACE1:
 

```
:TRAC:STAR 9;STOP 13
:TRAC TRACE1,90,78,56,34,12
```
3. To transmit a number of different PACKed data points, the procedure is the same as for ASCII-encoded data points except that the <block> format of the command is used as shown below:

```
:TRAC:STAR 9;STOP 13
:TRAC TRACE1,#15pqrst
```

where pqrst represents the five binary values.

Note that when transferring data to the DSO, the format of the data is implicit, therefore the FORMat command is not required.

One of the most common errors encountered when transferring data to and from the DSO is an unexpectedly short transfer. This is often the case when the "transfer window" required has not explicitly set. In general, the STARt and STOP points should be set to the required values prior to performing transfers rather than assuming that the DSO was last used with the required settings.

KEYWORD	PARAMETER FORM	NOTES
TRACe		
:CATalog?		
:COPY	<trace_name>, <trace_name>	
[[:DATA]	<trace_name>,<block> <numeric_value>{,<numeric_value>	
:RANGe		
:X	<trace_name>,<numeric-value>	
:Y	<trace_name>,<numeric-value>	
:START	<numeric_value>	
:STOP	<numeric_value>	

**TRACe****:CATalog?**

This query returns all valid <trace\_name>s as a comma-separated string as:  
TRACE1,TRACE2,REFERENCE,LOWER,UPPER,MEMORY1,MEMORY2.

(There are no short forms for trace names).

**TRACe****:COPY <trace\_name>, <trace\_name>**

This command copies the data to the first <trace\_name> from the second <trace\_name>.

For example;

```
:TRACe:COPY REFERENCE,TRACE1
```

will copy the data currently in TRACE1 into the trace named REFERENCE

This command is an event and therefore has no query form and no associated \*RST condition.

**TRACe****[[:DATA] <trace\_name>,<block>|<numeric\_value>{,<numeric\_value>**

This command is used to transfer store data between the controller and the DSO.

The command form is used to transfer data from a controller to the DSO

The query form of this command is used to transfer data from the DSO to a controller and returns the data values for <trace\_name>, according to the format defined by FORMat.

This command is an event and therefore has no associated \*RST condition.

**TRACe****:RANGe**

This subsystem defines the scaling of stored traces.

**:X <trace\_name>,<numeric\_value>**

This command sets the X scaling for stored traces. For example;

```
:TRACe:RANGe:X TRACE1,100E-6
```

will set the X scaling of TRACE1 to 100µs per sweep (10µs/div)

At \*RST, this function is unaffected.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**:Y <trace\_name>,<numeric\_value>**

This command sets the Y scaling for stored traces. For example;

**:TRACE:RANGE:Y TRACE2,4E-1**

will set the Y scaling of TRACE2 to 40V full scale (5V/div)

At \*RST, this function is unaffected.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## TRACe

**:START <numeric\_value>**

This command defines the start point in the data store used for trace data transfers to and from the DSO. Valid values are in the range 0 to 499.

At \*RST, this function is set to 0.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## TRACe

**:STOP <numeric\_value>**

This command defines the stop point in the data store used for trace data transfers to and from the DSO. Valid values are in the range 1 to 500.

At \*RST, this function is set to 500.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

**18. TRIGger Subsystem**

This subsystem has the function of controlling the instrument trigger system parameters.

KEYWORD	PARAMETER FORM	NOTES
ABORt		No query form
INITiate		
:CONTinuous	<Boolean>	
[:IMMediate]		
TRIGger		
:COUPling	AC DC	
:DELaY	<numeric_value>	
:FILTer		
[:LPASs]		
[:STATe]	<Boolean>	
[:IMMediate]		No query form
:LEVel	<numeric_value>	
:MODE	NORMallAUTO	
:PTRigger	<numeric_value>	
:SLOPe	POSitive NEGative	
:SOURce	EXTernal INTernal1 INTernal2 LINE	

**ABORt**

This command resets the trigger system and places all trigger sequences into the IDLE state. Any sweep or measurement acquisition in progress will be completed. If INITiate:CONTinuous was set to ON prior to receiving an ABORt command, it will remain ON and the trigger system will exit the IDLE state on receipt of the next valid trigger event.

This command is an event and therefore has no associated \*RST condition.

**INITiate**

**:CONTinuous** <Boolean>

This is the same as pressing Run on the DSO's front panel.

At \*RST, this function is set to OFF.

**[:IMMediate]**

Equivalent to S/Shot. When asserted, :CONTinuous is set to OFF.

In order to ensure proper controller/device synchronization it is important to note that the effect of this command is precisely the same as if the front panel S/Shot button had been pressed. This means that if the DSO is already acquiring (due to a previous INITiate[:IMMediate] or INITiate:CONTinuous 1 command) then a fresh acquisition will not be started but acquisitions will stop when the current acquisition ends.

This command is an event and therefore has no associated \*RST condition.

**TRIGger**

**:COUPling** AC|DC

This command sets the trigger coupling.

At \*RST, this function is set to AC.

**TRIGger**

**:DELaY** <numeric\_value>

This command sets the trigger delay in units of seconds. Valid values are from 0 to 5E11 in steps of 1E-10. If this command is set to value other than 0, :PTRigger is set to 0.

At \*RST, this function is set to 0.

## TRIGger

**:FILTer**

This subsystem controls trigger filtering.

**[[:LPASs]**

**[[:STATe] <Boolean>**

This command controls the state of the low pass filter in the trigger path.

At \*RST, this function is set to 0.

## TRIGger

**[[:IMMediate]**

This command forces a trigger into the system if the system is currently triggerable. This command has no query form.

This command is an event and therefore has no associated \*RST condition.

## TRIGger

**:LEVel <numeric\_value>**

This command sets the trigger level in units of screen divisions. Value is in range -10 to 10 where 0 is approximately equivalent to the center of the screen.

At \*RST, this function is set to 0.

## TRIGger

**:MODE NORMAl|AUTO**

This command sets the trigger mode to be either AUTO or NORMAl.

At \*RST, this function is set to AUTO.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## TRIGger

**:PTRigger <numeric\_value>**

This command sets the pretrigger percentage. Valid values are from 0 to 98. If this command is set to a value other than 0, :DELay is set to 0.

At \*RST, this function is set to 0.

This command is not found in either SCPI 1991.0 or additions approved for 1992.0, but has been created following SCPI rules.

## TRIGger

**:SLOPe POSitive|NEGative**

This command defines the slope of the signal upon which the trigger system will trigger.

At \*RST, this function is set to POSitive.

## TRIGger

**:SOURce EXTernal|INTernal1|INTernal2|LINE**

This command defines the source of the trigger signal used by the DSO. The internal signals are derived from the channel inputs.

At \*RST, this function is set to INTernal1.

## 19 SCPI Instrument Models

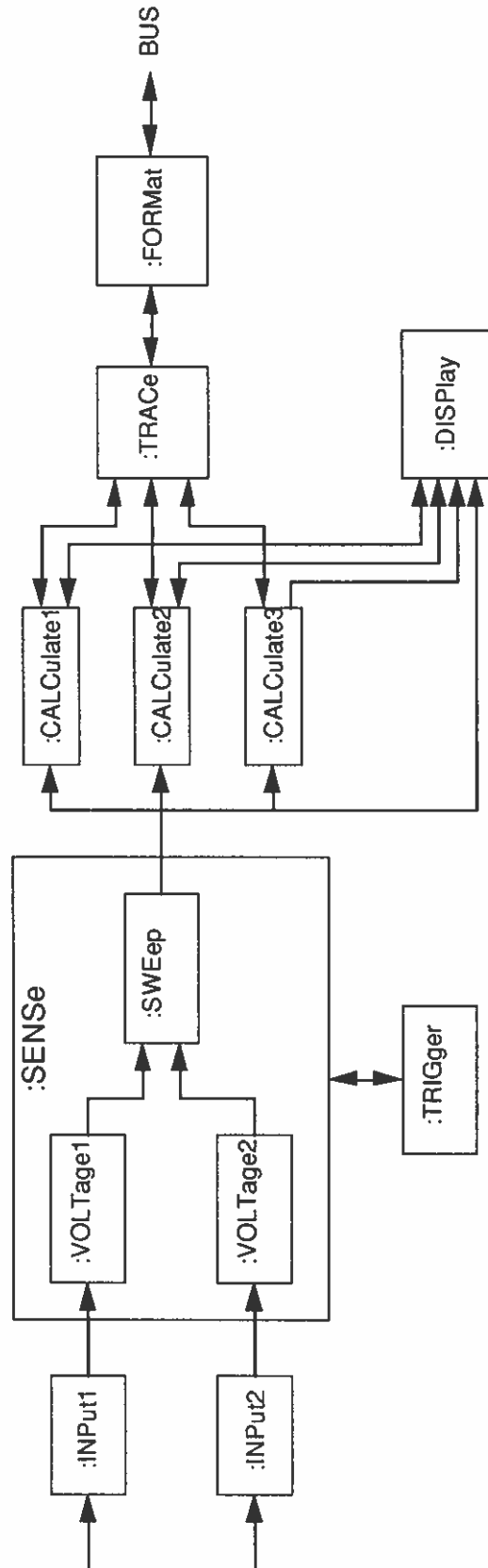


Figure 19.1 SCPI Instrument Model

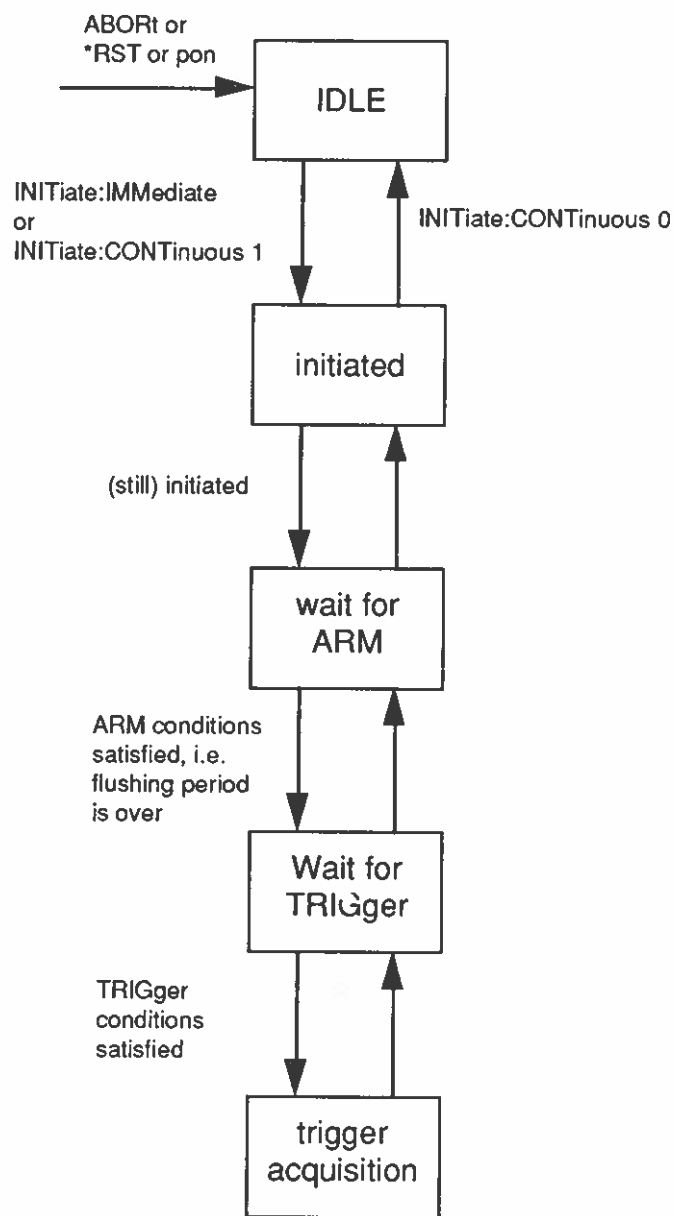


Figure 19.2 Basic ARM-Trigger Model



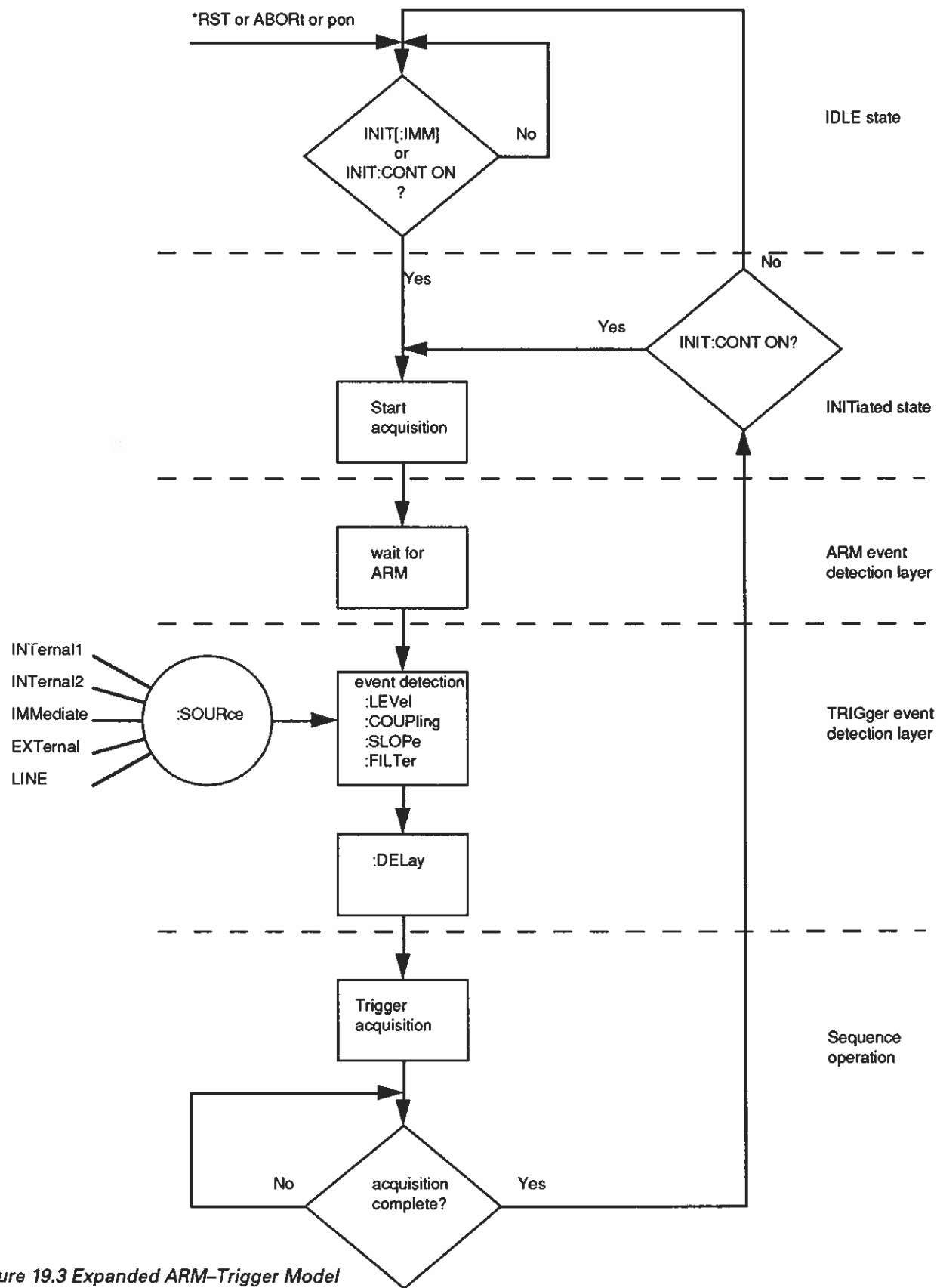


Figure 19.3 Expanded ARM-Trigger Model

## 20 Command Index

To assist those making the transition to SCPI, the following index and figure 20, SCPI commands for Button functions, allows SCPI commands to be quickly found for most functions on the DSO. For clarity, the precise syntax of each command is not shown in the table or figure. However, the command subtree will be identified, and where further detail is required, reference should be made to the detailed command descriptions in the Operator Manual.

Function	Command	PageNo.	Function	Command	PageNo.
<i>Abort plot</i>	:PLOT:ABORt	42	<i>Graticule, On/Off</i>	:DISPlay:GRATicule :BRIGhtness	37
<i>Add mode</i>	:SENSe:ADD	45	<i>Graticule, plot</i>	:PLOT:GRATicule	43
<i>Addition, post storage</i>	:CALCulate:MATH	15	<i>Help</i>	:HELP	40
<i>Annotation of trace</i>	:DISPlay:TEXT	37	<i>Hold trace</i>	:DISPlay:HOLD	34
<i>Area measurement</i>	:MEASure:AREA	25	<i>Input, coupling</i>	:INPut:COUPling	41
<i>Arm</i>	:INITiate	59	<i>Integration</i>	:CALCulate:INTEgrate	14
<i>Auto set-up</i>	:ASETup	12	<i>Invert, post storage</i>	:CALCulate:INVert	15
<i>Auto/normal trigger</i>	:TRIGger:MODE	60	<i>Invert, pre-storage</i>	:INPut:GAIN	41
<i>Autocal enable</i>	:CALibration:AUTO	31	<i>Limit testing</i>	:CALCulate:LIMit	15
<i>Bandwidth limit</i>	:SENSe:BLIMit	45	<i>Magnify, X</i>	:DISPlay:TRACe:X:MAGNify	38
<i>Channel selection</i>	:INPut:STATe	41	<i>Max or min measurement</i>	:MEASure:MAX or :MEASure:MIN	26
<i>Clock, real time</i>	:SYSTem:DATE or :SYSTem:TIME	53 55	<i>Max/Min capture</i>	:SENSe:MMIN	45
<i>Copy, trace</i>	:TRACe:COPI	57	<i>Menu selection</i>	:DISPlay:MENU	35
<i>Coupling, input</i>	:INPut:COUPling	41	<i>Multiplication, post storage</i>	:CALCulate:MATH	15
<i>Coupling, trigger</i>	:TRIGger:COUPling	59	<i>Overshoot, pulse measurement</i>	:MEASure:RISE:OVERshoot or :MEASure:FALL:OVERshoot	27 26
<i>Cursor position and trace</i>	:DISPlay:CURSor	33	<i>Peak to peak measurement</i>	:MEASure:PTPeak	26
<i>Data display, remote controlled</i>	:DISPlay:TEXT	37	<i>Period measurement</i>	:MEASure:PERiod	26
<i>Data transfer format</i>	:FORMat	39	<i>Persistence</i>	:DISPlay:TRACe:PERsistence	38
<i>Datum position</i>	:DISPlay:DATum	33	<i>Plot abort</i>	:PLOT:ABORt	42
<i>Delayed trigger</i>	:TRIGger:DELay	59	<i>Plot start</i>	:PLOT:INITiate	43
<i>Dot join</i>	:DISPlay:DJOin	34	<i>Plot destination</i>	:PLOT:DESTination	42
<i>Duty cycle measurement</i>	:MEASure:DCYCle	25	<i>Plot graticule</i>	:PLOT:GRATicule	43
<i>Expansion, Y, post storage</i>	:CALCulate:Y:MAGNify	16	<i>Plot mode</i>	:PLOT:MODE	43
<i>Expansion, X</i>	:DISPlay:TRACe:X:MAGNify	38	<i>Position, X</i>	:DISPlay:TRACe:X:CENTer	38
<i>Fall-time measurement</i>	:MEASure:FTIME	26	<i>Position, Y, post storage</i>	:CALCulate:Y:POSition	16
<i>Filter, post storage</i>	:CALCulate:FILTer :FREQuency	13	<i>Position, Y, pre-storage</i>	:SENSe:OFFSet	46
<i>Filter, trigger</i>	:TRIGger:FILTer	60	<i>Pre-trigger</i>	:TRIGger:PTRigger	60
<i>Format of data transfer</i>	:FORMat	39	<i>Preshoot, pulse measurement</i>	:MEASure:RISE:PREShoot or :MEASure:FALL:PREShoot	27 26
<i>Frequency measurement</i>	:MEASure:FREQuency	26	<i>Probe scaling</i>	:SENSe:CORRection:GAIN	45

<b>Function</b>	<b>Command</b>	<b>PageNo.</b>
<i>Pulse width measurement</i>	:MEASure:PWIDth or :MEASure:NWIDth	27 26
<i>Real time clock</i>	:SYSTem:DATE or :SYSTem:TIME	53 55
<i>Recall trace</i>	:TRACe:COPI	57
<i>Refresh mode</i>	:DISPlay:MODE	35
<i>Remote trace data transfer</i>	:TRACe	56
<i>Reset</i>	*RST	8
<i>Rise-time measurement</i>	:MEASure:RTIME	27
<i>RMS measurement</i>	:MEASure:AC	25
<i>Roll mode</i>	:DISPlay:MODE	35
<i>Run mode</i>	:INITiate:CONTinuous	59
<i>Save trace</i>	:TRACe:COPI	57
<i>Sensitivity, Y</i>	:SENSe:RANGe:PTPeak	46
<i>Sensitivity, Y, variable</i>	:SENSe:RANGe:VARiable	46
<i>Shift, X</i>	:DISPlay:TRACe:X:CENTer	38
<i>Shift, Y, post storage</i>	:CALCulate:Y:POSition	16
<i>Shift, Y, pre-storage</i>	:SENSe:OFFset	46
<i>Single shot mode</i>	:INITiate	59
<i>Status reporting</i>	:STATus	48
<i>Subtraction, post storage</i>	:CALCulate:MATH	15
<i>Text display</i>	:DISPlay:TEXT	37
<i>Timebase range</i>	:SENSe:SWEep:TIME	45
<i>Trace selection</i>	:DISPlay:CURSor:TRACe	33
<i>Trigger coupling</i>	:TRIGger:COUPling	59
<i>Trigger delay</i>	:TRIGger:DELay	59
<i>Trigger source</i>	:TRIGger:SOURce	60
<i>Trigger filter</i>	:TRIGger:FILTer	60
<i>Trigger level</i>	:TRIGger:LEVel	60
<i>Trigger, force</i>	:TRIGger:IMMediate	60
<i>Trigger slope</i>	:TRIGger:SLOPe	60
<i>V/Div</i>	:SENSe:RANGe:PTPeak	46
<i>Voltage, cursor measurement</i>	:MEASure:RVOLTage	27
<i>XY mode</i>	:DISPLay:MODE	35



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Equipment returned for servicing must be adequately packed, preferably in the box in which the product was supplied and shipped, with transportation charges prepaid. We accept no responsibility for instruments arriving damaged.

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Contents

Introduction

1 About GPIB & RS423

2 About Comands

3 Common Commands

4 ALL Subsystem

5 ASETup Subsystem

6 CALCulate Subsystem

7 Measurement Instructions

8 CALibration Subsystem

9 DISPlay Subsystem

10 FORMat Subsystem

11 HELP? Subsystem

12 INPut Subsystem

13 PLOT Subsystem

14 SENSE Subsystem

15 STATus Subsystem

16 SYSTem Subsystem

17 TRACe Subsystem

18 TRIGGer Subsystem

19 Instrument Models

20 Command Index

21 Service Centers