4. REMOTE CONTROL

The 6530 Teraohm Bridge-Meter operates directly from the front panel or under remote control of an instrument controller, computer or terminal. Remote control can be interactive, with the user controlling each step from a terminal, or under the control of a computer running the 6530 in an automated system. It is also possible to connect a printer to the remote interface of the 6530 and have the 6530 output some or all of the measurements taken to the printer for a permanent record.

This chapter describes the interfaces and the commands to which the 6530 will respond. The setting of the IEEE-488 address and mode is described in OM6530 Section 4.8.1.

4.1. INTERFACES

The model 6530 has two interfacing standards available:

- A parallel interface conforming to IEEE-488.2.
- A serial interface conforming to RS-232C.

The IEEE-488 connector is mounted to the rear panel. The IEEE-488 address defaults to a factory setting of 04. This setting can be viewed and set to a valid address using the front panel controls.

The RS-232C connector is mounted on the rear panel but it has to be configured from the front panel.

The 6530 can be operated in a system where both RS-232C and IEEE-488 interfaces are being used. It can be controlled with an IEEE-488 bus and a printer connected to the RS-232C output for permanent records of measurements.

In a system containing more than one controller, only one controller can exercise control while the other stays in dormant state until control is transferred.

4.2. IEEE-488 (GPIB) INTERFACE

The 6530 is fully programmable for use on the IEEE standard 488.1 interface bus (also known as the General Purpose Interface Bus (GPIB). The interface is also designed in compliance with the supplemental standard IEEE-488.2. Devices connected to the bus in a system are designated as talkers, listeners, talker/listeners, or controllers. The 6530 can be operated on the IEEE-488 bus as a talker or under the control of an instrument controller as a talker/listener.

This manual assumes that the user is familiar with the basics of the IEEE-488 interface bus. The IEEE-488 interfacing standard applies to the interface of instrumentation systems or portions of them, in which the:

1. Data exchanged among the interconnected apparatus is digital.
2. Number of devices that may be interconnected by one contiguous bus does not exceed 15.
3. Total transmission path length over interconnecting cables does not exceed the lesser of either 20 meters or 2 meters times the number of devices on the bus.
4. Data rate across the interface on any signal line does not exceed 1 megabit per second.

4.2.1. CONTROLLER

There can be only one designated controller in charge on the IEEE-488 bus. This device exercises overall bus control and is capable of both receiving and sending data. The rest of the devices can be designated as listener, talker or talker/listener.

The controller can address other devices and command them to listen, address one device to talk and wait till the data is sent. The controller sets data routes but it need not take part in the data interchange.

All controller query and command sequences should be terminated with the line-feed character (0x0A) and/or optionally; the controller should assert the EOI data byte control signal.

4.2.2. IEEE-488 RESPONSES

The reply to any IEEE-488 query command will be a sequence of ASCII characters followed by a line-feed character (0x0A). The line-feed character may also be expressed as $0A_{16}$ or 10_{10} or 12_{8} or Ctrl-J. Throughout this manual we will use the "C" programming language notation for expressing numbers in base 16, specifically 0x0A indicates that 0A is to be interpreted in base 16 (hex).

4.2.3. INTERCONNECTING CABLE AND IEEE-488 CONNECTOR

The interconnecting cable of IEEE-488 1978 consists of 24 conductors, 16 conductors are for carrying signals and 8 for grounding. An individual cable assembly may be up to 4 meters long and should have both a plug and a receptacle connector type at each end of the cable. Each connector assembly is fitted with a pair of captive locking screws.

4.2.4. TYPICAL SYSTEM

Data Input/Output Lines - The 8 data I/O lines form the data bus over which data between the various devices is transmitted under the supervision of the controller. The message bytes are carried on Data I/O signal lines in a bit parallel byte serial form, asynchronously and generally in a bi-directional manner.

Handshake or Data Byte Control - the three interface signals are used to effect the transfer of each byte of data on the DIO signal lines from a talker or controller or one or more listeners.

1. DAV (DATA VALID) is used to indicate the condition of (availability and validity) information on the DIO signal lines.
2. NDAC (NOT DATA ACCEPTED)
3. NRFD (NOT READY FOR DATA) is used to indicate the condition of readiness of devices to accept data.
4. SRQ (SERVICE REQUEST) is used by a device to indicate the need for attention and to request an interruption of the current sequence of events.
5. REN (REMOTE ENABLE) is used (by a controller) in conjunction with other messages to select between two alternate sources of device programming data.
6. EOI (END OR INDENTIFY) is used (by a talker) to indicate the end of a multiple byte transfer sequence or in conjunction with ATN (by a controller) to execute a polling sequence.
7. ATN (ATTENTION)
8. IFC (INTERFACE CLEAR)

4.2.5. ADDRESS AND TALK/LISTEN SELECTION

The IEEE-488 Address and Talk/Listen status can be set using the front panel controls as directed by the operator menu system. If there is no controller and the 6530 is hooked up to a printer for hard copy then Talk Only mode should be selected as the preferred mode of operation.

4.2.6. IEEE-488 ELECTRICAL INTERFACE

The 6530 meets the subsets of the IEEE-488 interface specification IEEE-488.1 shown in Table 4-1. The pin connections on the IEEE-488 interface connector are shown in Table 4-2.

Pin Connection	Name	Function
Source Handshake	SH1	complete source handshake capabilities.
Acceptor Handshake	AH1	complete acceptor handshake capabilities.
Talker	T5	has a talker capability with a single primary address in the range 0 to 30. Extended addressing is not implemented. Talk only.
Listener	L4	supports basic listener with unaddressed if MTA(My Talk Address) is received. The talk and listen addresses will always be the same. Does not support extended listen addresses. Does not support Listen Only.
Service Request	SR1	complete service request generation capabilities.
Remote Local	RL1	all functions on the front panel can be locked out by the IEEE-488 controller.
Parallel Poll	PP0	no parallel poll capabilities.
Device Clear	DC1	full device clear capabilities.
Device Trigger	DT0	no device trigger capabilities.
Controller	C0	can never become the bus controller.
Electrical Interface	E2	all required electrical interface capability.

Table 4-1 : IEEE-488 Device Capabilities

Pin	Name	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
5	EIO	End or Identify
6	DAV	Data Valid
7	NRFD	Not Ready for Data
8	NDAC	Not Data Accepted
9	IFC	Interface Clear
10	SRQ	Service Request
11	ATN	Attention
12	SHIELD	Screening on Cable (connected to safety ground)
13	DIO5	Data Input Output Line 5
14	DI06	Data Input Output Line 6
15	DIO7	Data Input Output Line 7
16	DIO8	Data Input Output Line 8
17	REN	Remote Enable
18	GND6	Ground wire of twisted pair with DAV
19	GND7	Ground wire of twisted pair with NRFD
20	GND8	Ground wire of twisted pair with NDAC
21	GND9	Ground wire of twisted pair with IFC
22	GND10	Ground wire of twisted pair with SRQ
23	GND11	Ground wire of twisted pair with ATN
24	GND	Logic Ground

Table 4-2 : IEEE-488 Pin Designations

4.2.7. IEEE-488 INPUT BUFFERING

The IEEE-488 input buffer is 256 bytes long. The input full bit is set when the buffer is above 75% full (64 bytes remaining), hence if the programmer limits messages sent to the 6530 to 32 bytes and checks the IFL bit in the status register before sending each message, then under normal operating conditions the buffer should never overflow. If the buffer is full and the programmer sends more data, the 6530 will perform the necessary handshaking as per usual, but the data will be lost, this is done for two reasons:

If the buffer is full, the fault must have originated with the controller, since the 6530 interprets most commands in fewer than 15 milliseconds. This prevents the 6530 from locking up the IEEE-488 bus.

4.2.8. IEEE-488 OUTPUT BUFFERING

Output from query commands are placed into a 256 byte output buffer. When the controller reads data from the 6530 the responses will come from the output buffer in, first-in first-out order. If for some reason the controller does not read the responses from its query commands the output buffer will overflow, in this case the first data into the buffer will still be valid and the later data will be lost. When output data is lost the query error bit in the status register will be set. When the output buffer is not empty then the message available (MAV) bit will be set in the status register.

4.2.9. IEEE-488 DEADLOCK

If the controller demands a byte of data from the 6530 and the buffer is empty, the 6530 will set the Query Error flag in the Event Status Register.

4.3. RS-232C INTERFACE

The 6530 has an RS-232C interface which can be connected to a controller or to a simple printer. The controller (which can be almost any computer with an RS-232C interface) can control the 6530 through a variety of commands that allow setting the instruments operating parameters, and analyzing the measurements made by the 6530. The simple printer interface can be used to log any or all of the measurements taken by the 6530 during normal operation.

When using the RS-232C port to remotely control the 6530, either interactively with a terminal or under computer control, operation is the same as using an IEEE-488 controller connected to the IEEE-488 port for control, with the following exceptions:

1. The program message terminator is Carriage Return (0x0D).
2. There is no SRQ capability when using serial remote control. The status registers still behave as described in this chapter, but the 6530 serial interface does not have a way to perform the SRQ function.

3. There is no direct way to perform IEEE-488 hardware interface functions such as DCL (Device Clear) or SDC (Selected Device Clear).

Pin	Name	Function	Direction
1	CHG	Chassis Ground	IN/OUT
2	TxD	Transmit Data	IN
3	RxD	Receive Data	OUT
4	RTS	Request To Send	IN
5	CTS	Clear To Send	OUT
6	DSR	Data Set Ready	OUT
7	GND	Signal Ground	IN/OUT
8	DCD	Data Carrier Detect	OUT
20	DTR	Data Terminal Ready	IN
All other pins not used or connected			

Table 4-3 : RS232 Pin Designations

The 6530 Teraohm Bridge-Meter is data communication equipment (DCE) so TxD is an input (the data which the modem is to transmit).

4.3.1. RS-232C RESPONSES

The reply to any RS-232C query command will be a sequence of ASCII characters followed by a Carriage-Return character (0x0D) and then a Line-Feed character (0x0A). The Line-Feed character may also be expressed as $0A_{16}$ or 10_{10} or 12_{8} or Ctrl-J. Throughout this document we will use the "C" programming language notation for expressing numbers in base 16, specifically 0x0A indicates that 0A is to be interpreted in base 16 (hex).

4.4. COMMAND LANGUAGE

The commands for IEEE-488 and RS-232C mainly correspond to the labels assigned to the front panel menus. Throughout this document when examples are given they apply to commands through the RS-232C interface or through the IEEE-488 interface. The examples will not show the termination characters since these differ for each of the interfaces (See Sections 4.2.2 and 4.3.1).

4.4.1. GENERAL SYNTAX FOR COMMANDS

The 6530 uses a sophisticated command parser which can usually determine which command was desired, even if the command is entered incorrectly. Some care should be taken when sending commands such as SYSTem:VERBose and SYSTem:VERSion? Since the parser may not be able to decide which command was desired in the event of a gross misspelling (such as using VERBion instead of VERSion).

No command used in the 6530 has an embedded space in its name; spaces (0x20) are used only to separate command names from their parameters.

The comma "," must delimit all multiple arguments used in a command sequence. Throughout this manual some of the command names will have an UPPER case portion and a lower case portion. The command may be shortened such that only the portion of the command name that was presented in UPPER case characters is present. The command parser of the 6530 is case insensitive (i.e. the letter case of commands sent to the 6530 does not matter), both UPPER case letters and lower case letters may be used.

4.4.2. GENERAL SYNTAX FOR NUMBERS

Numeric parameters may have up to 30 characters, and although the 6530 will accept numeric parameters in the range ±2.2E-308 through ±1.8E308, the useful range of numbers is between ±1.0E-8 and ±1.0E5.

The portion of the command parser that interprets numeric input will correctly recognize most common forms of numeric input, for example the following are all valid methods of expressing the number 123.4:

- 123.4
- 123.4e00
- 0.1234E3
- 1234e-1
- 0000123.4

The following are examples of invalid forms of expressing a number:

- 123.4 e00 — space between mantissa and exponent letter
- 1234D-1 — exponent not e or E
- n123.4 — letter in front of the first digit
- e34 — missing mantissa

Multipliers (such as µ, m, k, and M) are not permitted on commands, all numbers must be entered in the base units, for example 100 mV can be expressed as 100e-3 or 0.100. Expressions (for example 7 + 20 X 3) are not allowed as parameters.

4.5. REMOTE AND LOCAL OPERATION

The 6530 can be operated using the front panel keys or it can be operated remotely using a remote controller.:

4.5.1. LOCAL

The 6530 responds to local and remote commands. This is also called "Front Panel Operation". Only remote commands that do not affect the state of the 6530 are allowed to execute. (For example the command SENSe:CAPacitor? is allowed to operate but the command SENSe:CAPacitor 27 which would change the instrument state is not allowed.) If the controller sends a command which would affect the instrument state while in local, the command will be ignored, and an Execution Error indication will be given.

4.5.2. REMOTE

When the Remote Enable (REN) line is asserted and the controller addresses the 6530 as a listener, the 6530 enters the remote state.

Front panel operation is restricted to the use of the **<remote>** key. Pressing the **<remote>** key or sending the GTL (Go To Local) interface message returns the 6530 to the local state.

4.5.3. REMOTE WITH LOCKOUT

The remote with lockout state can be entered from remote or local with lockout, but not directly from local. Remote with lockout is similar to the remote state but restricted: the **<remote>** key will not return to the local state. To return the 6530 to the local state the controller must send a GTL interface command. To return the 6530 to the local state the controller must unassert the REN control line. Table 4-4 summarizes the possible Remote/Local state transitions.

From	To	IEEE-488 Interface Command	RS-232C Interface Command
Local	Remote	MLA + REN	REMOTE
	Remote / Lockout	LLO + REN	LOCKOUT
Remote	Local	GTL	LOCAL
	Remote / Lockout	LLO + REN	LOCKOUT

Table 4-4 : Remote/Local State Transitions

4.6. PROGRAMMING COMMAND SUMMARY

A brief description of each of the possible remote RS232 and IEEE-488 commands and their syntax in BNF (Backus Naur Form) follows:

- words inside angle brackets (i.e. <digit>) are defined items
- :== means "is defined to be"
- {|} means "or"
- words inside square brackets (i.e. [+]) means optional
- Required letters are shown in upper case but may be upper or lower case.

<d>	:== {0|1|2|3|4|5|6|7|8|9}	
<l>	:== {A|B|C|...|Z|a|b|c|...|z}	
<s>	:== {<l> | <l><s>}	
<b>	:== {0|1}	
<u>	:== {<d> | <d><u>}	
<n>	:== [{+|-}]<u>	
<f>	:== <n>[.[<u>]][E<n>]	
<?>	:== {<l> | <d>}	
<*>	:== {<?> | <?><*>}	(not to be confused with *)
<DD>	:== <u>	(limited to range 1...31)
<MM>	:== <u>	(limited to range 1...12)
<YYYY>	:== <u>	(limited to ranges 0...38 and 2000...2038)
<hh>	:== <u>	(limited to range 0...23)
<mm>	:== <u>	(limited to range 0...59)
<ss>	:== <u>	(limited to range 0...59)

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4.6.1. Standard System Commands

*CLS	; clear event status register, empty input queue
*ESE <enable value (no units)>	; clear event status register, empty input queue
*ESE?	; report event status enable
*ESR?	; report event status register
*IDN?	; report identity of unit
*OPC	; set operation complete bit in event status register
*OPC?	; report operation complete
*OPT?	; report any reportable options
*RST	; reset the instrument to a known defined state
*SRE <enable value (no units)>	; set the service request mask
*SRE?	; report service request mask
*STB?	; report status byte
*TRG	; trigger the next reading when in BUS mode
*TST?	; report results of self test
*WAI	; wait for pending operations to complete

System Commands

SYSTem:ATMospheric:PRESsure?

SYSTem:CHECk:SUM?

SYSTem:COMMunications:GPIB <address>, TALK Only | TALK Listen | DISable

address 0-31

:GPIB?

SYSTem:COMMunications:SERial <baud>, <data>, <stop>, <parity>, <echo>, <flow control>, <mode>

baud 1200 | 2400 | 4800 | 9600 | 19200 | 38400

databits 7 | 8

stop 1 | 2

parity NONE | ODD | EVEN

echo ON | OFF

flowcontrol NONE | XON | RTS

mode TALK Only | TALK Listen | DISable

:SERial?

SYSTem:DATE <YYYY, MM, DD>

:DATE?

SYSTem:HUMidity?

SYSTem:KEY?

SYSTem:MODE NATIVE | TRACE

:MODE?

SYSTem:STATe LOCAL | REMote | LOCKout

:STATe?

SYSTem:SERial:NUMBer <value>
:SERial:NUMBer?

SYSTem:TEMPerature?

SYSTem:TIME <hh,mm,ss>
:TIME?

SYSTem:TERSe

SYSTem:VERBose

SYSTem:VERSion?

Calibration Commands

CALibration:CAPacitor 27 | 270 | 2700 , <calibration coefficient (ppm)>
:CAPacitor?

CALibration:DATE <yyyy,mm,dd,hh,mm,ss>
:DATE?

CALibration:OUTPut:VOLTage +1 | +2 | +5 | +10 | +20 | +50 | +100 | +200 | +500 | +1000 |
-1 | -2 | -5 | -10 | -20 | -50 | -100 | -200 | -500 | -1000 ,
<calibration coefficient (ppm)>
:OUTPut:VOLTage?

CALibration:PARameters:PROTection <variance (ppm)> , <standard deviation (ppm)> ,
<sample size> , <maximum sample count>

:PARameters:PROTection?

CALibration:PARameters:RESistor
<variance (ppm)> , <std dev (ppm)> , <sample size>, ; 27pF
<variance (ppm)> , <std dev (ppm)> , <sample size>, ; 270pF
<variance (ppm)> , <std dev (ppm)> , <sample size>, ; 2700pF
<variance (ppm)> , <std dev (ppm)> , <sample size>, ; 0.1V
<variance (ppm)> , <std dev (ppm)> , <sample size>, ; 1.0V
<maximum sample count>

:PARameters:RESistor?

CALibration:PROTection:RESistor <value> ; 80K – 120K
:PROTection:RESistor?

CALibration:REFerence:RESistor <value> ; 80M - 12G
:REFerence:RESistor?

CALibration:SERial:NUMber <string> ; maximum length is 20
:SERial:NUMber?

CALibration:SPEC:CLEar

CALibration:SPEC?

CALibration:THReshold:VOLTage 0.1 | 1.0, <calibration coefficient (ppm)>
:THReshold:VOLTage?

CALibrate:SYSTem:COEFficient <nominal value>, <volts>,
<pos coefficient>, <neg coefficient>
:SYSTem:COEFficient? <nominal value>, <volts>

CALibrate:SYSTem:PARameters <nominal value>, <volts>,
<sample count>, <sample size>, <sample window>
:SYSTem:PARameters? <nominal value>, <volts>

4.6.2. Configuration Commands

CONFigure:TEST:VOLTage START | CONTinue | DISable

4.6.3. Measurement Commands

MEASure ON | OFF
MEASure?

MEASure:UNITs OHMS | AMPS | SURFACE resistivity | VOLume Resistivity
:UNITs?

MEASure:WINDow <value> ; MEAS:REV:COUNT * 2
:WINDow?

MEASure:REVersal:COUNt <value> ; 1 – 50 if MEAS:WINDOW > 0 else > 0
REVersal:COUNt?

MEASure:TERA:COUNt <value> ; 0 – 500

TERA:COUNt?		
MEASure:TERA:SIZE MEASure:TERA:SIZE?	<value>	; MEAS:TERA:COUNT - 2
MEASure:TERA:THReshold :TERA:THReshold?	<value>	; 0.0 – 0.9e+15
MEASure:STABilize:SIZE :STABilize:SIZE?	<value>	; 0 – 100
READ:RESistance?		
READ:CURRent? :SURface:RESistivity? :VOLume:RESistivity?		
SENSe:ATMospheric:PRESsure?		
SENSe:CAPacitor :CAPacitor?	27 | 270 | 2700	
SENSe:HUMidity?		
SENSe:INTegration:TIME?		
SENSe:INTegrator:THReshold :THReshold?	0.1 | 1.0 | 10.0	
SENSe:MAXimum:VOLTage :VOLTage?	1 | 3 | 10 | 30 | 100 | 300 | 1000	
SENSe:OUTput:VOLTage :VOLTage?	1 | 3 | 10 | 30 | 100 | 300 | 1000	
SENSe:POLarity :POLarity?	POSitive | NEGative | AUTO	
SENSe:RANGe :RANGe?	AUTO | MANual	
SENSe:REMote:INTerlock SENSe:REMote:INTerlock?	ON | OFF	

SENSe:RESistivity:THICkness <value>
:THICkness?

SENSe:RESistivity:AREA <value>
:AREA?

SENSe:RESistivity:PERimeter <value>
:PERimeter?

SENSe:RESistivity:DISTance <value>
:DISTance?

SENSe:TEMPerature?

4.6.4. Trace Commands

TRACe:CLEar

TRACe:DATA? ; dump buffer

TRACe:DIAGnostics ON | OFF | SENSORS
:DIAGnostics?

TRACe:ELEMents TIMEstamp , HUMidity , TEMPerature , ATMOSpheric Pressure , NONE , ALL , RELative Time , RTClock
:ELEMents?

TRACe:MODE CLEAR | PROMPT | KEEP
:MODE?

TRACe:TRENd:DATA? ; dump summary buffer

TRACe:TRENd:SUM? ; dump summary statistics

TRACe:TRENd:CLEar ; clear summary statistics

TRACe:TSTamp:TYPE RELative | RTClock
:TSTamp:TYPE?

4.6.5. Trigger Commands

TRIGger:SOURce MANual | BUS | EXTernal | CONTinuous
:SOURce?

TRIGger:DELay <value> ; 0-999999.999 seconds
:DELay?

TRIGger:SOAK <value> ; 0-999999.999 seconds
:SOAK?

TRIGger:SENSor:TIMer <value> ; 0-999 seconds
:SENSor_TIMer?

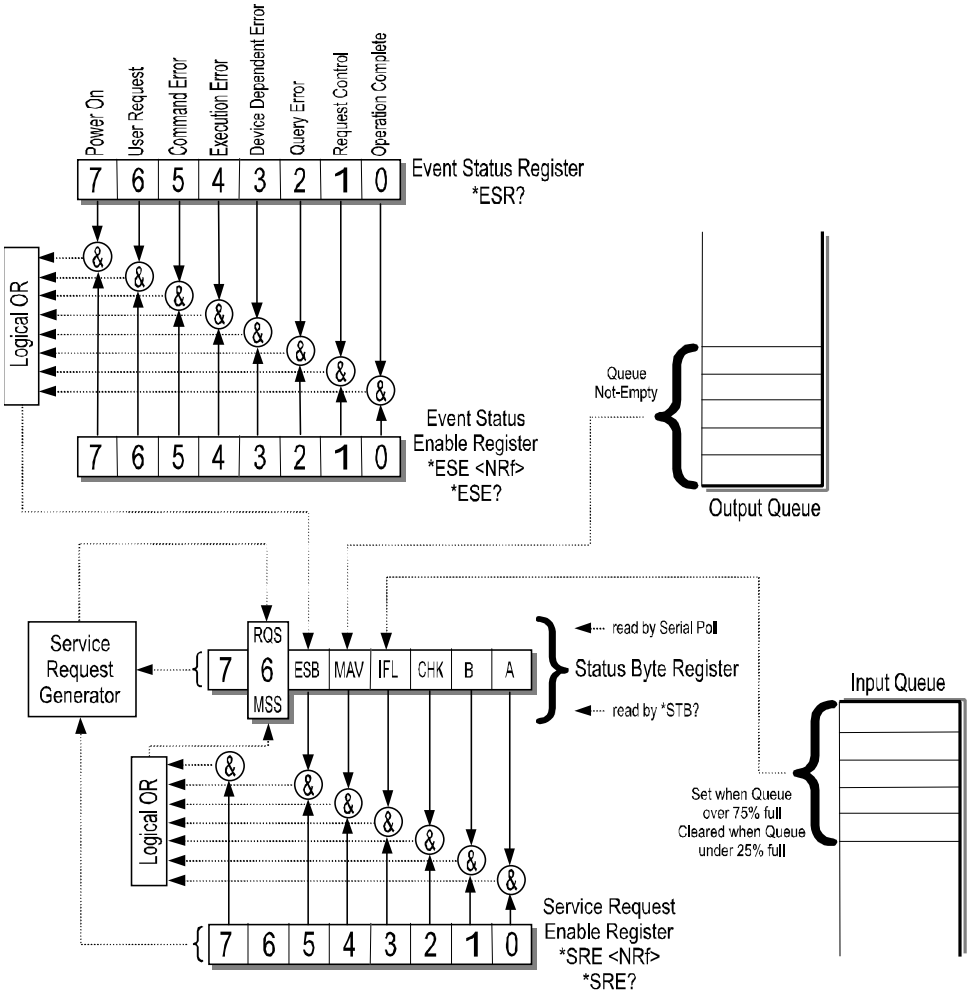

Figure 4-1 : Event Status Bit Operation

4.7. REMOTE COMMANDS

This section details all the valid commands that may be sent over either the IEEE-488 or the RS-232C interface port. The responses listed below are the verbose response.

If the numeric parameter to the command is missing or unrecognizable the CME (CoMmand Error) bit in the Event Status Register (see Figure 4-1) will be set. If the unrecognizable command was sent over the RS-232C interface, the 6530 will respond with “Unrecognized Command”.

If the numeric value is out of range then the EXE (EXecution Error) bit will be set for a program data element out of range error. If the out of range value was sent over the RS-232C interface, the 6530 will respond with “Invalid Parameter”.

Unless otherwise indicated, the terse response is that portion of the response printed in bold.

4.7.1. *CLS - CLEAR STATUS COMMAND

This command clears all Event Status Registers summarized in the status byte register. All queues, except the Output Queue, that are summarized in the status byte register are emptied. The 6530 is forced into the Operation Complete Idle State and the Operation Complete Query Idle state.

4.7.2. *ESE <u> - SET EVENT STATUS ENABLE REGISTER

This command sets the standard event status enable register bits. When the bits in the Event Status Enable (ESE) register are "ANDed" with the bits in the Event Status Register (ESR) if the result is non-zero then the Event Status Bit (ESB) in the Status Byte (STB) register is set.

The values accepted for the *ESE command are between 0 and 255, all other values are considered to be an error. The default value for the Event Status Enable (ESE) register at power on is zero (0).

4.7.3. *ESE? - EVENT STATUS ENABLE QUERY

This command reports the current value of the Event Status Enable Register. The value returned will be between 0 and 255.

4.7.4. *ESR? - EVENT STATUS REGISTER QUERY

This query allows the programmer to determine the current contents of the event status register. Reading the Event Status Register clears it.

Bit	Location	Name	Description
0	LSB	OPC	OPeration Complete. This event bit is generated in response to the *OPC or *OPC? command. It indicates that the 6530 has completed any pending operations and that the parser is ready to accept more program messages.
1		RQC	ReQuest Control. This event bit indicates to the GPIB controller that the 6530 is requesting permission to become the controller in charge. The 6530 will never set this bit.
2		QYE	QuerY Error. This bit indicates that an attempt is being made to read data from the output queue when no output is either present or pending, or that data in the output queue has been lost (queue over-flow). See also GPIB Deadlock.
3		DDE	Device Dependent Error. Not Used.
4		EXE	EXecution Error. Set when (1)a program data element is evaluated to be outside the legal input range or is inconsistent with the 6530's capabilities, (2)a valid program message could not be properly processed.
5		CME	CoMmand Error. Set when (l)a syntax error has been detected by the parser, (2)a semantic error has occurred indicating that an unrecognized header has been received, (3)A Group Execute Trigger was entered into the input buffer inside a program message.
6		URG	User Request. Set when any key is depressed on the 6530 keyboard.
7	MSB	PON	Power ON. This bit is set after the 6530 is powered up.

Table 4-5 : Event Status Register

4.7.5. *IDN? - IDENTIFICATION QUERY

This command causes the 6530 to reply with an identification string. The identification string is built up of four (4) fields delimited by commas (,). The first field is the manufacturer (i.e. Guildline Instruments), the second field is the model (i.e. 6530), the third field is the serial number (i.e. 55065), and the final field is the firmware revision (i.e. E). A typical response might read:

Guildline Instruments, 6530, 55065, E

4.7.6. *OPC - OPERATION COMPLETE

This command will cause the 6530 to set the Operation Complete bit (bit 0) in the Event Status Register. Since the 6530 processes all commands sequentially, the operation complete bit will be set as soon as the command is parsed.

4.7.7. *OPC? - OPERATION COMPLETE QUERY

This query will place a numeric 1 in the output buffer indicating that all pending operations are complete.

4.7.8. *OPT? - REPORT AVAILABLE OPTIONS

This query command reports the presence or absence of various options. The format of the reply is a series of arbitrary ASCII response fields separated by commas. The 6530 will always report the value 0.

4.7.9. *RST - DEVICE RESET

This command is intended to return the 6530 to a known state, specifically a return to terse mode. This command will not affect the following:

1. The output queue.
2. The state of the IEEE-488 interface.
3. The selected address of the 6530.
4. The *SRE setting.
5. The *ESE setting.
6. Calibration data that affects device specifications.

The *RST command will perform the following actions:
Clear the key-press buffer.
Make remote responses terse.
Set the measurement units to degrees Celsius.
Set the measurement display to the Aux Channel.

*RST is a MANDATORY IEEE-488.2 command.

4.7.10. *SRE <u> - SERVICE REQUEST ENABLE COMMAND

The service request enable command allows the 6530 to generate a service request on the IEEE-488 interface under a limited set of conditions. The limitations on the conditions are defined by the numeric parameter following the *SRE command. The numeric parameter is a decimal integer in the range 0-255. The numeric parameter when expressed in base 2 (binary) represents the bit values of the Service Request Enable Register. For all bits (except bit 6) a bit value of one (1) indicates an enabled condition and a bit value of zero (0) represents a disabled condition. *SRE? is the companion query command.

4.7.11. *SRE? - SERVICE REQUEST ENABLE QUERY

This command allows a programmer to determine the current contents of the Service Request Enable Register. A decimal number between 0 and 63 or between 128 and 191 will be returned.

4.7.12. *STB? - STATUS BYTE QUERY

This command allows the programmer to read the status byte and master summary bits (shown in Table 4-6.).

Bit	Location	Name	Description
0	LSB	INT	Interlock status. 0=enabled, 1=disabled.
1		RDY	Reading complete.
2		min_max	Minimum/Maximum timeout error if set.
3		IFL	Input FuLl. This bit is set when the input queue is over 75% full and cleared when the queue drops below 25% full.
4		MAV	Message AVailable. This bit is set when the output queue is not empty.
5		ESB	Event Summary Bit. This bit is set when the result of a bitwise AND of the Event Status Enable register is not zero.
6		RQS	ReQuest for Service. This bit is set when the result of a bit-wise AND of the Status Byte Register and the Service Request Enable register is not zero.
7	MSB	RES	Resistivity Input. 0=volume, 1=surface.

Table 4-6 : Status Byte Register

The response from this command is a decimal integer in the range 0-255. This decimal integer when expressed in base 2 (binary) represents the bit values in the Status Byte Register. Note that the Master Summary Status bit and Not RQS is reported in bit 6.

The Status Byte Register can also be read with the Read Serial Poll hardware command on the IEEE-488 interface.

This Register can be read by Serial Poll or by the *STB? command.

4.7.13. *TST? - QUERY RESULTS OF SELF TEST

This command is intended to report the status of any self-tests performed by the 6530. If the 6530 passes all of its self-tests then the reply will be 0.
The possible failure codes are :

Error Status. Bit 0 – Non-Volatile checksum failure
Bit 1 – Rom checksum failure. Could be ROM/Aux ROM.
Bit 2 – Analog failure.
Bit 3 - +5 volts
Bit 4 - -5 volts
Bit 5 - +15 volts
Bit 6 - -15 volts
Bit 7 – Precharge
Bit 8 – High voltage monitor
Bit 9 – 10 volt reference
Bit 10 - Ramp
Bit 11 – Digital failure.
Bit 12 - +5 volts
Bit 13 - -5 volts
Bit 14 - +15 volts
Bit 15 - -15 volts

4.7.14. *WAI - WAIT-TO- CONTINUE COMMAND

This command is intended to suspend the execution of any further commands until all pending operations have been completed. Since the 6530 does not implement a new command until the last operation has been completed, this command has no effect. It is included in the list of remote commands because it is a mandatory IEEE-488.2 command.

4.7.15. SYSTem:ATMospheric:PRESsure? – DISPLAY ATMOSPHERIC PRESSURE

Typical response: 104

4.7.16. SYSTem:CHECk:SUM? – DISPLAY CHECKSUMS

This command displays the ROM checksum, the AUX ROM checksum and the Non-Volatile SRAM checksum.

Typical response: 17574, -12954, 1065

4.7.17. SYSTem:COMMunications:GPIB – UPDATE GPIB CONFIG

<address>, <mode>

address 0-31
mode TALK Only | TALK Listen | DISable

If Disable is selected then GPIB will not work until it has been enabled by the RS232 serial interface or the Instrument
Talk Only will output measurement values as well as the selected trace elements (i.e. Humidity) to the GPIB interface.

4.7.18. SYSTem:COMMunications:GPIB?

Typical response: 4, Talk Listen

4.7.19. SYSTem:COMMunications:SERial

<baud>, <data>, <stop>, <parity>, <echo>, <flow control>, <mode>

baud 1200 | 2400 | 4800 | 9600 | 19200 | 38400 | 115200
databits 7 | 8
stop 1 | 2
parity NONE | ODD | EVEN
echo ON | OFF
flowcontrol NONE | XON | RTS
mode TALK Only | TALK Listen | DISable

Talk Only will output measurement values as well as the selected trace elements (i.e. Temperature) to the RS232 interface.
N.B. Use of this command from the remote RS232 interface will change the configuration immediately. This will require the Remote Communications package which you are using to also be reconfigured to comply with your changes.

4.7.20. SYSTem:COMMunications:SERial?

Typical response: 9600, 8, 1, None, On, None, Talk Only

4.7.21. SYSTem:DATE – UPDATE SYSTEM DATE

<YYYY, MM, DD>

YYYY (limited to ranges 0...38 and 2000…2038)
MM (limit range to 1...12)
DD (limit range to 1…31)

4.7.22. SYSTem:DATE? – DISPLAY SYSTEM DATE

Typical response: 2003, 08, 22

4.7.23. SYSTem:HUMidity? – DISPLAY HUMIDITY

Typical response: 45

4.7.24. SYSTem:KEY? – DISPLAY LAST KEY STROKE

Typical response: 4, e, 2

4.7.25. SYSTem:MODE – SET SYSTEM MODE

NATIVE | TRACE

4.7.26. SYSTem:MODE? – DISPLAY SYSTEM MODE

Typical response: NATIVE

4.7.27. SYSTem: SERial:NUMBer – SET SYSTEM SERIAL NUMBER

<value>

value (limit range to 0...99999)

4.7.28. SYSTem:SERial:NUMBer? – DISPLAY SYSTEM SERIAL NUMBER

Typical response: 67630

4.7.29. SYSTem:STATe - UPDATE SYSTEM STATE

LOCAL | REMote | LOCKout

4.7.30. SYSTem:STATe? – DISPLAY SYSTEM STATE

Typical response: LOCAL

4.7.31. SYSTem:TEMPerature? – DISPLAY TEMPERATURE

Typical response: 23

4.7.32. SYSTem:TERSe – SET SYSTEM TO TERSE

Set the system to only display data on responses. (no text description)

4.7.33. SYSTem:TIME – SET SYSTEM TIME

<hh, mm, ss>

hh (limit range to 0...23)
mm (limit range to 0...59)
ss (limit range to 0...59)

4.7.34. SYSTem:TIME? – DISPLAY SYSTEM TIME

Typical response: 15, 10, 20

4.7.35. SYSTem:VERSion? – DISPLAY SYSTEM VERSION

Typical response: 2

4.7.36. SYSTem:VERBose – SET SYSTEM TO VERBOSE

Set the system to display a text description of displayed responses.

4.7.37. CALibration:CAPacitor – UPDATE COEFFICIENT

27 | 270 | 2700 , <error coefficient (ppm)>

The error coefficient is a long integer and cannot exceed ±100,000.

4.7.38. CALibration:CAPacitor? – DISPLAY COEFFICIENTS

This will display all three (3) capacitors and their coefficients.
Typical response: 27pf, 21254 270pf,-9871,2700pf, 12926

4.7.39. CALibration:DATE – UPDATE LAST CALIBRATION DATE

<YYYY, MM, DD, hh, mm, ss>

This is the date and time of the last calibration which was done on the instrument.

4.7.40. CALibration:DATE? – DISPLAY LAST CALIBRATION DATE

Typical response: 2003, 08, 21, 15, 30, 0

4.7.41. CALibration:OUTPut:VOLTage – UPDATE COEFFICIENTS

+1 | +3 | +10 | +30 | +100 | +300 | +1000 |
-1 | -3 | -10 | -30 | -100 | -300 | -1000, <error coefficient (ppm)>

The error coefficient is a long integer and cannot exceed ±100,000.

4.7.42. CALibration:OUTPut:VOLTage? – DISPLAY COEFFICIENTS

Typical response:

-1 V, 1.000189
-3 V, 3.000033
-10 V, 9.999963
-30 V, 29.99993
-100 V, 100.0014
-300 V, 299.9957
-1000 V, 999.916
+1 V, .999921
+3 V, 2.999948
+10 V, 9.999989
+30 V, 29.99966
+100 V, 99.9994
+300 V, 299.9964
+1000 V, 999.929

4.7.43. CALibration:PARameters:PROTection

<variance (ppm)> , ; 1.0 – 1000.0
<standard deviation (ppm)> , ; 1.0 – 250.0
<sample size> , ; 25 - 500
<maximum sample count> ; >= 125

4.7.44. CALibration:PARameters:PROTection?

Typical response: 200.00 , 100.00 , 25 , 1000

4.7.45. CALibration:PARameters:RESistor

27pF Capacitor

<variance (ppm)> , ; 1.0 – 1000.0
<standard deviation (ppm)> , ; 0.01 – 250.0
<sample size> , ; 25 – 500

270pF Capacitor

<variance (ppm)> , ; 1.0 – 1000.0
<standard deviation (ppm)> , ; 0.01 – 250.0
<sample size> , ; 25 – 500

2700pF Capacitor

<variance (ppm)> , ; 1.0 – 1000.0
<standard deviation (ppm)> , ; 0.01 – 250.0
<sample size> , ; 25 – 500

0.1V Threshold

<variance (ppm)> , ; 1.0 – 1000.0
<standard deviation (ppm)> , ; 0.01 – 250.0
<sample size> , ; 25 - 500

1.0V Threshold

<variance (ppm)> , ; 1.0 – 1000.0
<standard deviation (ppm)> , ; 0.01 – 250.0
<sample size> , ; 25 - 500

<maximum sample count> ; >= 125

4.7.46. CALibration:PARameters:RESistor?

Typical response: 3.00 , 0.75 , 100 , 7.00 , 2.00 , 60 , 3.00 , 1.50 , 30 , 7.00 , 2.00 , 100 , 2.00 , 0.75 , 60 , 3000

4.7.47. CALibration:PROTection:RESistor

<value> ; 80K – 120K

4.7.48. CALibration:PROTection:RESistor?

Typical response: 100083

4.7.49. CALibration:REFerence:RESistor

<value> ; 80M - 12G

4.7.50. CALibration:REFerence:RESistor?

Typical response: 100001800

4.7.51. CALibration:SERial:NUMBer

<string> ; maximum length is 20

4.7.52. CALibration:SERial:NUMBer?

Typical response: 62153

4.7.53. CALibration:SPEC:CLEar

4.7.54. CALibration:SPEC?

Typical response:

"Date",,"Coefficient","Count","Sample","Variance","Std Dev",,"Temperature","Humidity","Atmospheric Pressure"
2005/03/31 05:03:12, 27pF,-22926,97,30,26.389,7.951, 0.0, 0.0, 0.0
2005/03/30 22:41:39, 27pF,-22908,111,30,21.759,6.067, 0.0, 0.0, 0.0
2005/03/31 04:36:20, 270pF,6298,88,30,21.991,5.333, 0.0, 0.0, 0.0
2005/03/30 22:10:54, 270pF,6345,93,30,13.519,3.062, 0.0, 0.0, 0.0
2005/03/31 04:08:42,2700pF,6951,142,30,4.528,1.216, 0.0, 0.0, 0.0
2005/03/30 21:41:42,2700pF,6972,76,30,3.245,0.972, 0.0, 0.0, 0.0
2005/03/31 05:32:57, 0.1V,161,30,30,117.470,35.551, 0.0, 0.0, 0.0
2005/03/30 23:27:34, 0.1V,150,44,30,114.250,33.791, 0.0, 0.0, 0.0
2005/03/31 05:24:35, 1.0V,1,68,30,19.678,5.378, 0.0, 0.0, 0.0
2005/03/30 23:15:18, 1.0V,-4,107,30,16.896,4.242, 0.0, 0.0, 0.0

4.7.55. CALibration:SYSTem:COEFficient

<nominal value>, <volts>, <pos coefficient)>, <neg coefficient>

4.7.56. CALibration:SYSTem:COEFficient?

Typical response: 90k to 200k, 1V, 273,273

4.7.57. CALibration:SYSTem:PARameters

<nominal value>, <volts>, <sample count>, <sample size>, <sample average>,<sample window>

4.7.58. CALibration:SYSTem:PARameters?

Typical response: 90k to 200k, 1V, 90, 100, 1, 2

4.7.59. CALibration:SYSTem:REV

<user rev>

4.7.60. CALibration:SYSTem:REV?

Typical response: <user rev> / <system rev>

4.7.61. CALibration:THReshold:VOLTage

0.1 | 1.0 <calibration coefficient (ppm)>

4.7.62. CALibration:THReshold:VOLTage?

Typical response: 0.1V, 37, 1.0V, -160

4.7.63. CONFigure:TEST:VOLTage

START | CONTinue | DISable

When the system is in remote or lockout then it is necessary to send a **<CONTinue>** command within twenty (20) seconds when measuring resistance or resistivity. This is a safety precaution to prevent the high voltage section from remaining active when the remote controlling device is not in a known operating state.

4.7.64. MEASure – START/STOP MEASUREMENT

ON | OFF

This is used to start or stop a measurement from a remote device (RS232 or GPIB)

4.7.65. MEASure?

Typical response: Off

4.7.66. MEASure:UNITS – SET CURRENT MEASUREMENT MODE

OHMS | AMPS | SURFACE resistivity | VOLume Resistivity

4.7.67. MEASure:UNITS? – DISPLAY MEASUREMENT MODE

Typical response: Ohms

4.7.68. READ:RESistance?

Typical response: 1.13499232e+16

4.7.69. READ:CURRent?

Typical response: 1.13499232e+16

4.7.70. READ:SURFace:RESistivity?

Typical response: 1.13499232e+16

4.7.71. READ:VOLume:RESistivity?

Typical response: 1.13499232e+16

4.7.72. SENSe:ATMospheric:PRESSure?

Typical response: 101.2

4.7.73. SENSe:CAPacitor – SET CURRENT CAPACITOR

27 | 270 | 2700

4.7.74. SENSe:CAPacitor? – DISPLAY CURRENT CAPACITOR

Typical response: 2700pf

4.7.75. SENSe:HUMidity?

Typical response: 80

4.7.76. SENSe:INTegration:TIME?

Typical response: 1.1036

This is the time in seconds that it took to take the last measurement.

4.7.77. SENSe:INTEGrator:THREShold

0.1 | 1.0 | 10.0

4.7.78. SENSe:INTegrator:THREShold?

Typical response: 10.0V

4.7.79. SENSe:MAXimum:VOLTage

1 | 3 | 10 | 30 | 100 | 300 | 1000

4.7.80. SENSe:MAXimum:VOLTage?

Typical response: 1V

4.7.81. SENSe:OUTput:VOLTage

1 | 3 | 10 | 30 | 100 | 300 | 1000

4.7.82. SENSe:OUTput:VOLTage?

Typical response: 10V

4.7.83. SENSe:POLarity

POSitive | NEGative | AUTO

4.7.84. SENSe:POLarity

Typical response: Auto

4.7.85. SENSe:RANGe

AUTO | MANual

4.7.86. SENSe:RANGe?

Typical response: Auto

4.7.87. SENSe:REMote:INTerlock

ON | OFF

This will enable or disable the interlock function while controlling the 6530 remotely.

4.7.88. SENSe:REMote:INTerlock?

Typical response: ON

4.7.89. SENSe:RESistivity:THICkness

<value>

This is the thickness of the material being measured. It should be entered in either inches or centimetres depending on the current resistivity unit.

4.7.90. SENSe:RESistivity:THICkness?

Typical response: 0.125

4.7.91. SENSe:RESistivity:AREA

<value>

This is the area coefficient. It is normally zero (0) but can be set to another value if you are using the custom mode of measuring resistivity.

4.7.92. SENSe:RESistivity:AREA?

Typical response: 0.0

4.7.93. SENSe:RESistivity:PERimeter

<value>

This is the perimeter. It is normally set to 0.125 if unit is inches but can be set to another value if you are using the custom mode of measuring resistivity.

4.7.94. SENSe:RESistivity:PERimeter?

Typical response: 0.125

4.7.95. SENSe:RESistivity:DISTance

<value>

This is the distance. It is normally set to 0.125 if unit is inches but can be set to another value if you are using the custom mode of measuring resistivity.

4.7.96. SENSe:RESistivity:DISTance?

Typical response: 0.125

4.7.97. SENSe:TEMPerature?

Typical response: 23.1

4.7.98. TRACe:CLEar – CLEAR DETAIL TRACE BUFFER

This will clear the detail trace buffer and the detail totals of the summary.

4.7.99. TRACe:DATA? – DUMP TRACE BUFFER

Typical response:

1.13499232e+16,2003/07/30 10:28:04,82, 22.1, 80.0, 101.0,27pf,0.1V,Auto,1000
1.13953412e+16,2003/07/30 10:33:54, 5, 22.4, 80.1, 101.2,27pf,0.1V,Auto,1000

4.7.100.TRACe:DIAGnostics

ON | OFF | SENSORS

This is normally set to off. **<On>** provides a means to automatically output the Digital Diagnostics or the Analog Diagnostics to the remote device as well as the display while this diagnostic is running. **<Sensors>** adds the state of the internal instrument temperature to the remote trace data when the remote device is set to Talk Only.

4.7.101.TRACe:DIAGnostics?

Typical response: Off

4.7.102.TRACe:MODE

CLEAR | PROMPT | KEEP

This is normally set to KEEP which will retain the data stored in the trace buffer upon the start of a new measurement. **<CLEAR>** provides a means to automatically clear the trace buffer upon the start of a new measurementt. **<PROMPT>** will prompt the user upon the start of a new measurement asking to "Clear" or "Keep" the trace buffer data. While in remote this mode assumes "Keep".

4.7.103.TRACe:MODE?

Typical response: Keep

4.7.104.TRACe:ELEMents

TIMEstamp , HUMidity , TEMPerature , ATMOSpheric Pressure , NONE , ALL , RELative Time , RTClock

4.7.105.TRACe:ELEMents?

Typical response: None

4.7.106.TRACe:TRENd:DATA? – DUMP SUMMARY BUFFER

4.7.107.TRACe:TRENd:SUM? - DUMP SUMMARY STATISTICS

4.7.108.TRACe:TRENd:CLEar – CLEAR SUMMARY STATISTICS

This will clear the summary trace buffer and the summary totals.

4.7.109.TRACe:TSTamp:TYPE

RELative | RTClock

This allows the time of each entry in the trace buffer to be displayed either as the date and time or as relative time from the last **<TRACe:CLEar>** command or the last detail clear on the instrument.

4.7.110.TRACe:TSTamp:TYPE?

Typical response: RTClock

4.7.111.TRIGger:SOURce

MANual | BUS | EXTernal | CONTinuous

<BUS> is used if individual measurements wish to be controlled with the **<*TRG>** remote command.

4.7.112.TRIGger:SOURce?

Typical response: Continuous

4.7.113.TRIGger:DELay

<value> ; 0-999999.999 seconds

This allows the instrument to provide any internal delay between each measurement. It is normally set to zero (0) but is used to create a delay between measurements especially if they are very fast measurements.

4.7.114.TRIGger:DELay?

Typical response: 0.0

4.7.115.TRIGger:SOAK

<value> ; 0-999999.999 seconds

This allows the instrument to allow additional settling time between reversals of polarity.

4.7.116.TRIGger:SOAK?

Typical response: 0.0

4.7.117.TRIGger:SENSor:TIMer

<value> ; 0-999 seconds

This sets the rate for the instrument to take automatic readings of the Temperature, Humidity and Atmospheric Pressure. It is normally set to three (3) seconds.

4.7.118.TRIGger:SENSor:TIMer?

Typical response: 3