FLUKE ®

Calibration

8588A/8558A
Reference Multimeter and 8 ½ Digit Multimeter

Remote Programmer's Manual

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Introduction

This document defines the remote interface commands for the Fluke Calibration 8588A Reference Multimeter and 8558A 8 ½ Digit Multimeter (the Product, DMM, or Instrument). These commands may be used by a computer connected through any of the remote interface ports to set settings, read measurement data, and control the operation of the instrument. Command syntax and names follow the IEEE-488.2 and SCPI standards.

Contact Fluke Calibration

To contact Fluke Calibration, call one of the following telephone numbers:

- Technical Support USA: 1-877-355-3225

- Calibration/Repair USA: 1-877-355-3225

- Canada: 1-800-36-FLUKE (1-800-363-5853)

- Europe: +31-40-2675-200

- Japan: +81-3-6714-3114

- Singapore: +65-6799-5566

- China: +86-400-810-3435

- Brazil: +55-11-3759-7600

- Anywhere in the world: +1-425-446-6110

To see product information and download the latest manual supplements, visit Fluke Calibration's website at www.flukecal.com.

To register your product, visit http://flukecal.com/register-product.

Remote Operation

When the Product is operated in remote control, all local controls, except **F5** (**Go To Local**) and **TRIG** are disabled.

The Product supports remote control GPIB, USBTMC-USB488, and Ethernet. When under remote control, the state of important conditions within the Product can be determined by reading status registers defined by IEEE488.2 and SCPI 1999.

Status Registers

The Product provides the standard IEEE 488.2 registers plus the extension to status reporting provided by SCPI. The Registers are shown in Figure 1.

When you operate any device by remote control it is good practice to start by clearing any states or queues that may be left over from previous operations. Example sequences to achieve are described in the relevant *Prepare the Product for…* section.
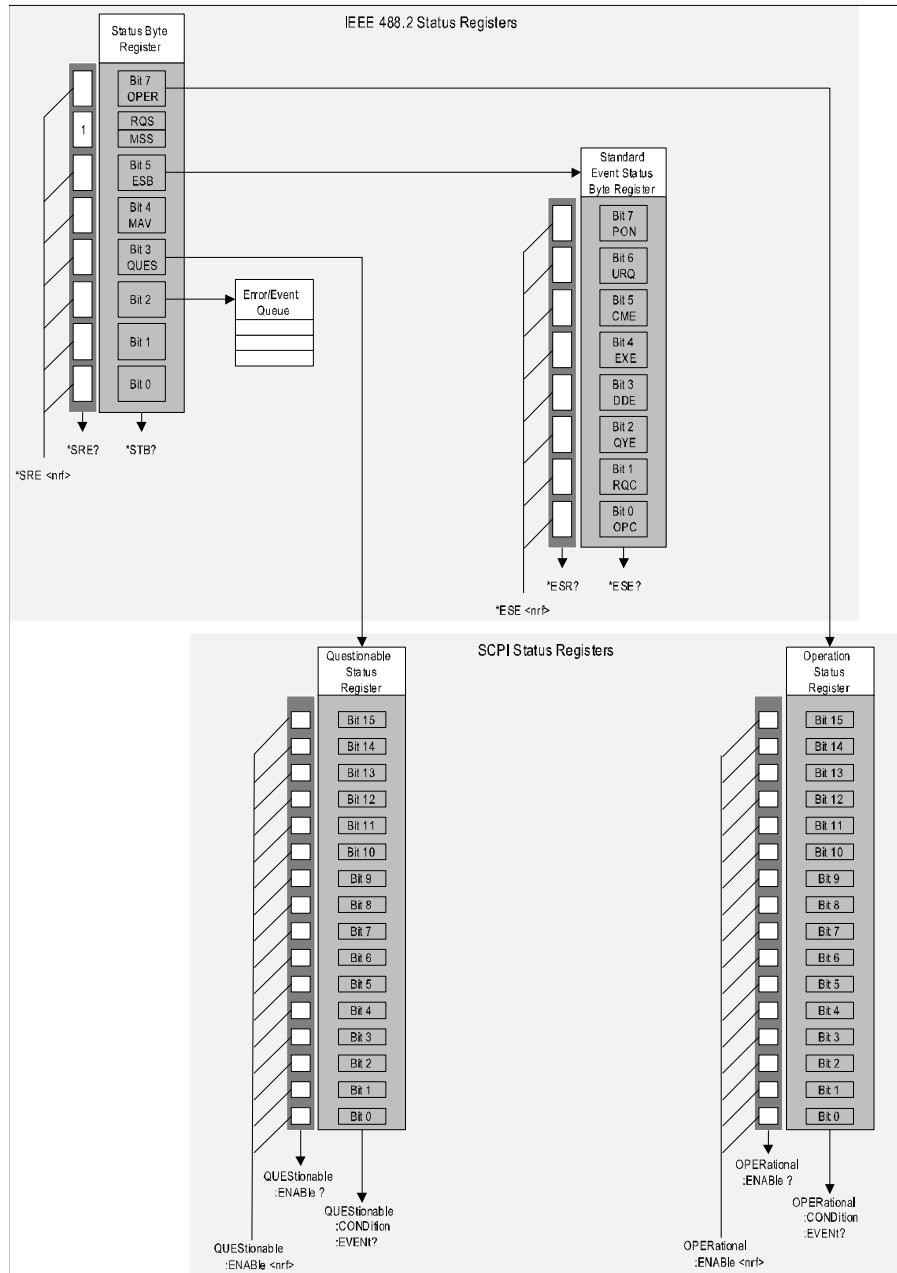
iei342.emf

Figure 1. Status Register Structure

IEEE 488.2 Registers

Table 1. Status Byte Register

Bit No.	Bit Value	IEEE 488.2 Meaning	8588A Meaning
0	1	Device dependent	Not used
1	2	Device dependent	Not used
2	4	Device dependent	Error/event queue not empty
3	8	QUES	QUESTionable summary bit
4	16	MAV	Message Available bit
5	32	ESB	Event status summary Bit
6	64	RQS|MSS	Request for service bit, or Master Status Summary bit
7	128	OPER	OPERation summary bit

Table 2. Standard Event Status Byte Register

Bit No.	Bit Value	IEEE 488.2 Meaning	8588A Meaning
0	1	Operation Complete	Set true if all operations pending from a *OPC command are complete.
1	2	Request Control	Not used, always set false
2	4	Query Error	Set true if the controller has followed an inappropriate message exchange protocol
3	8	Device Dependent Error	Set true when an internal operating error has occurred
4	16	Execution Error	Set true if a received command cannot be executed or parameters are out of bounds
5	32	Command Error	Set true if a command with incorrect syntax is received
6	64	User Request	Not used, always set false
7	128	Power On	Set true when power is applied

Service Request Line (SRQ)

Service Request (SRQ) is an IEEE-488.1 (GPIB) bus control line that the Product asserts to notify the controller that it requires some type of service. Service request is not available if the control interface is Ethernet. Many devices can be simultaneously connected to the bus, but they all share a single SRQ line. To determine which instrument set SRQ, the Controller normally does a serial poll of each instrument. A device connected to the same GPIB bus asserts an SRQ whenever the RQS bit in its Status Byte Register is 1. This bit informs the controller that the device was the source of the SRQ. The device clears its RQS register and clears the SRQ line when the controller does a serial poll of the device, sends *CLS, or when the MSS bit is cleared. The MSS bit is cleared only when ESB, MAV, OPER, QUES, and the Error/Event queue summary bits are 0, or they are disabled by their associated enable bits in the SRE register being set to 0.

The SCPI Status Registers are described in the STATus subsystem below.

Table 3. IEEE-488.2 (GPIB) Common Command Summary

*CLS	Clear status byte summary, and all event registers
*ESE <enable *value*>	Enable bits in standard event register
*ESE?	Retrieve standard event enable register
*ESR?	Retrieve standard event register
*IDN?	Retrieve meter's identification string
*OPC	Set 'Operation Complete" bit in Standard event reg.
*OPC?	Returns "1" in output buffer after command execution
*OPT?	Retrieve the options
*PSC {0|1}	Power-on status clear OFF or ON
*PSC?	Retrieve power-on status clear setting
*RST	Reset to power-on state
*SRE <enable *value*>	Enable bits in status byte register
*SRE?	Retrieve bits in status byte register
*STB?	Retrieve the status byte summary register
*TRG	Trigger a reading
*TST?	Perform self-test. Returns "0" if the test succeeds, "1" if the test fails
*WAI	Wait for operation complete

Prepare the Product for GPIB Remote Control

The subsequent sections provide instructions to prepare the Product for remote operation with the GPIB (488.2).

Equipment Connections

The Product connects to the IEEE 488 bus using a standard IEEE 488 cable (not supplied with the Product). To locate the connector, see *Rear Panel Features* in the *Operators Manual.*

⚠ Caution

To prevent equipment damage, remove power from both the Product and the IEEE 488 system before you connect or disconnect the Product to or from the IEEE 488 bus.

To connect the Product to an IEEE 488 system/controller:

1. Power down both the Product and the system/controller.

2. Connect one end of a standard IEEE 488 cable to the IEEE 488 connector on the rear of the Product.

3. Connect the other end of the IEEE 488 cable to the system/controller. Power up both the Product and the system/controller.

After completing the equipment connections, set the bus address for the Product as described in the subsequent sections.

About the Bus Address

Each instrument in an IEEE 488 system requires a separate and unique address so the Product can call and communicate with each instrument individually. These bus addresses are numeric and are within the range of 1 to 30, inclusive. They are considered primary addresses, and the user can assign any one of them to the Product.

Secondary addressing is not available on the Product. The source cannot respond to any address outside the range of 1 to 30. When a controller addresses the Product, it must also send data to define and instruct the Product as a talker or listener

Set the Product GPIB Bus Address

To set the Product GPIB buss address:

1. Push **INST SETUP** .

2. Push the **Remote Settings** softkey. If the second row does not show **GPIB**, use ▲ and ▼ to highlight the **Active Port** row.

3. Push **F1** (**GPIB)** and use ▲ and ▼ to highlight the **GPIB Address** row. Use the numeric keypad and **ENTER** to set the address as required.

4. Push **BACK** twice to exit the Product setup menu.

Clear IEEE488.2 Register States Left Over from Previous Remote Operation

Using the application of choice:

Check communications can be established:

>   Write *IDN?

>   Read the response

Note

The Product returns FLUKE for manufacturer, 8558A or 8588A for the model number, a 10 digit serial number, and the firmware version.

Clear registers and read the status byte:

>   Write: *CLS;*RST

>   Write *ESE 0

>   Write *SRE 191

>   Read the status byte (Serial POLL)

Before you proceed, set the event and status registers as required. See *Status Register*.

Prepare the Product for USBTMC-USB488 Remote Control

To prepare the Product for USBTMC-USB488 remote control:

1. Push **INST SETUP** and then select **Remote Settings**.

2. Use ▲ and ▼ to highlight the **Active Port** row.

3. Select **F3** (**USB)**.

4. Connect a USB cable between the Product and controlling PC. A message may appear on the PC that states that a driver is being installed.

5. Check that the Product has been detected, right click on the Windows Start Icon and select **Device Manager**.

    There should be an item labelled **USB Test and Measurement Devices** and under that, an item called **USB Test and Measurement Device (IVI)**.

6. Close the Device Manager on the PC.

Note

To ensure the most efficient use of the Service Request (SRQ) mechanism provided by USBTMC-USB488, first check that the RQS bit in the Status Byte is clear. To do this, perform a serial poll of the Product before you send any commands that could generate SRQ events. This only needs to be done once in your program/procedure.

Check communications can be established:

Write *IDN?

Read the response

Clear registers and read the status byte:

Write: *CLS;*RST

Write *ESE 0

Write *SRE 191

Read the status byte (Serial POLL)

Before you proceed, set the event and status registers as required.

Prepare the Product for Ethernet Remote Control

To prepare the Product for Ethernet remote control?

1. Push **INST SETUP** and select **Remote Settings**.

2. Use ▲ and ▼ to highlight the **Active Port** row.

3. Select **F2** (**Ethernet**).

4. Use ▲ and ▼ to highlight **Ethernet: Settings** and push **SELECT** .

   The following items can now be configured:

DHCP

- Set to **F1** (**OFF**) for a direct Product to PC connection or if a fixed IP address is required.

- Set to **ON** to allow automatic allocation of the IP address by a DHCP server.

Ethernet IP Address

- Unique address for the Product. This will be automatically allocated if **DHCP** is set to **ON** otherwise this must be manually set if **DHCP** is **OFF**.

- The default is 127.000.000.001 which is the loopback internet protocol or **localhost** which cannot be used for external connections.

Gateway

Default: 192.168.001.001

Subnet Mask

    Default: 255.255.255.000

Port

    Default: 3490

Remote Interface

    Default: **Computer**, can be set to **Terminal**

EOL

    Default: **LF** can also be set to **CR CRLF**

Example: Direct Product to Controlling Computer Connection Configuration

Product configuration

    DHCP: OFF

    Ethernet IP Address: 192.168.0.250

    Gateway: 192.168.001.001

    Subnet Mask: 255.255.255.000

    Port: 3490

    Remote Interface: Computer

    EOL: LF

Controlling computer configuration:

1. Right click on the Windows Start Icon and select **Network Connections**

2. Select **Network and Sharing Center**.

3. Select **Change adapter settings**.

4. Right click on the interface and select **Properties**.

5. Highlight **Internet Protocol Version 4 (TCP/IPv4)** and select **Properties**.

6. On the **General** tab, select **Obtain an IP address automatically**.

7. Select **Alternative Configuration** tab.

8. Select **User Configured**.

    IPv4 Address: 192.168.0.250

    Subnet mask: 255.255.255.0

    Default Gateway: 192.168.0.1

9. Check that communications can be established:

    Write *IDN?

    Read the response

    Clear registers

    Write: *CLS;*RST

10. Before you proceed, set the event and status registers as required.

Introduction to SCPI Syntax

The Standard Commands for Programmable Instruments (SCPI) standard is a syntax and set of commands used to control test and measurement devices. SCPI command headers may consist of several keywords separated by a colon (:).The SCPI command tree structure is explained under *Command Tree*.

Most commands are described in this manual with a mixture of upper and lower case letters. The upper case portion indicates the short form of a command. When a command is sent to the device, the case is irrelevant. For example, in this document, CURR is the short form of CURRent. Curr, current, curR and cURRENT will all be accepted by the Product. CUR, curre and other forms not matching the long or short form of the command will cause a syntax error to be reported by the product.

Commands Parameters

Some IEEE488.2 standard and SCPI commands require parameters. Valid parameter types are defined below in Table 4**.**

Parameter data, can be numeric, string, Boolean, or character program data. These data forms are tabulated below.

Table 4. Parameter Types

Parameter Form	Definition
<boolean>	Boolean data, which is ON or OFF, but allows numeric values also (zero is interpreted as OFF, and any non-zero value as ON).
<cpd>	Character Program Data: Select a parameter name from a listed group.
<string>	String program data type (enclosed in double quotes).
<nrf>	Numeric representation format: Number can be expressed as an integer (for example 123), real number (for example 123.4) or an exponent (for example 1.234E6).

Command Tree

SCPI command headers may consist of several keywords separated by the colon character (:) as shown in Figure 2.

command tree.jpg

Figure 2. Command Tree

Each keyword in a SCPI command header represents a node in the SCPI command tree. The leftmost keyword (CALCulate in the example above) is the root-level keyword, representing the highest hierarchical level in the command tree. The keywords following represent subnodes under the root node.

Command Trees like this one are used to document the SCPI command set in this manual. The keyword CALCulate is the name of the CALCulate subsystem and is on the root level of the CALCulate command tree.

AVERage and is the second-level node in the CALCulate subsystem, COUNt and STATe are the lowest nodes or end nodes in the hierarchical tree. *<nrf> and <boolean>* in the example tree are parameters to the end node.

Each colon in the command header moves the current path down one level from the root in the command tree. Once you reach the leaf node level in the tree, you can add several leaf node commands without having to repeat the path from the root level as long as you comply with these simple rules:

- The header path of the new leaf-node is the same as that of the previous one. If not, the full header path must be given starting with a colon.

- Additional commands are concatenated using a semi-colon (;)

- The first command in a new program message must start from the root.

Using the tree example in Figure 2, both COUNt and STATe could be set with:

> :CALCulate:AVERage:COUNT 32;:STATe ON (note the semi-colon).

As a DMM is primarily a sensor, the root mnemonic CALCulate is optional. SCPI represents this optionality thus:

> [:CALCulate]:AVERage:COUNT 32;STATe ON (note the semi-colon).

The square brackets indicate that exactly the same behaviour will result from:

> :AVERage:COUNT 32;STATe ON (note the semi-colon).

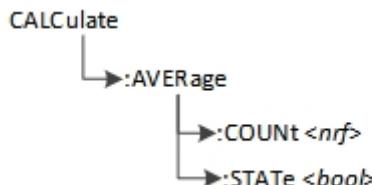This is the same as the two lines:

> :AVERage:COUNT 32
> :AVERage:STATe ON

Parameters

Parameter data, can be numeric, string, boolean or character program data. These data forms are tabulated in Table 4.

The command to set DCV range is structured:

SENSe:VOLTage:DC:RANGe *<nrf>*|MINimum|MAXimum|DEFault

The *<nrf>* would be a value betwen 2.03 and 20.02 to select the 10 V range. For example:

SENSe:VOLTage:DC:RANGe 10

A *<cpd>* parameter can also be used with range selection for example:

SENSe:VOLTage:DC:RANGe MIN or

SENSe:VOLTage:DC:RANGe MAX or

SENSe:VOLTage:DC:RANGe DEF

An example use of a Boolean parameter is: DISPlay *<boolean>*. This command turns on the display:

DISPlay ON or DISPlay 1

To turn the display off:

DISPlay OFF or DISPlay 0

Either ON|OFF or 1|0 can be used but ON|OFF may be preferred as it is more readable.

The SENSe:<meter_fn> *<string>* command is an example of string parameter. This command selects DCV:

SENSe:<meter_fn> "VOLTage:DC".

Query Commands

All the command forms above configure the device. Use Query commands to read back information from the device. For example, this command returns the status of the display:

DISPlay?

The response will be either 1 or 0.

Note

Although either ON|OFF or 1|0 are used as alternative forms of Boolean data when sending, the Boolean data response to a query command is always 1 or 0.

Some query commands have one or more parameters. The MEASure command configures the Product and returns a measurement. The MEASure? command is in this form:

MEASure[:SCALar]:<meter_fn>? [<parameters>]

The square brackets indicate that the parameters are optional. The Product always returns Scalar values so [:SCALar] is always superfluous. If there are more than one parameter, they are separated by commas. An example of a DMM command with two optional numeric parameters:

MEASure:VOLTage:DC? [<*range*>MIN|MAX|DEF[,<*resolution*>|MIN|MAX|DEF]]

The square brackets show that these commands will be accepted by the DMM.

MEASure:VOLTage:DC? 10,MAX	Sets DCVolts, 10 V range and maximum resolution
MEASure:VOLTage:DC? 10	Sets DCVolts, 10 V range and leaves resolution unchanged.
MEASure:VOLTage:DC?	Sets DCVolts and leaves range and resolution unchanged.
MEASure:VOLTage:DC? MAX	Will be interpreted as set DCV range to maximum, do not change resolution.

The rule for optional parameters is that they must be omitted from right to left. That is, starting with the inner square brackets and working outwards.

Command Execution Rules

Command execution rules are:

- Commands execute in the order that they are presented in the command message.

- An invalid command generates an error message and is not executed.

- Valid commands that precede an invalid command in a command message are executed.

- Valid commands that follow an invalid command in a command message are ignored.

SCPI Commands Reference

The Measurement group is a set of high-level instructions for the acquisition of data from the DMM. With the exception of CONFigure, the Measurement instructions both command an action and retrieve the resulting data. CONFigure has two distinct forms and can be a command or a query. The command form sets the DMM into a particular state including setting the trigger subsystem. The query form of CONFigure returns the DMM state when it was last configured ready for a measurement.

CONFiguration commands

Configure acts as a short-cut to some common DMM operations. The SCPI :SENSe tree, provides full functionality.

Configuration and measurement commands for the Product are of the general form:

:CONFigure:<meter_fn>[<parameter1>[,<parameter2>]]

Note

The square brackets are not sent as part of the command but indicate options. The arrangement of the square brackets above means the following forms of command are all valid:

: CONFigure:<meter_fn>

: CONFigure:<meter_fn> <parameter1>

: CONFigure:<meter_fn> <parameter1>, <parameter2>

In the command set below, the short form of parameters MINimum, MAXimum and DEFault are used for brevity, the long form can be used if preferred.

CONFig:<meter_fn>	<parameters>
:CONFigure:CAPacitance	[<*range*>|MIN|MAX|DEF [,<*resolution*>|MIN|MAX|DEF]]
:CONFigure:CURRent:AC	[<*range*>|MIN|MAX|DEF [,<*resolution*>|MIN|MAX|DEF]]
:CONFigure:CURRent:DC	[<*range*>|MIN|MAX|DEF [,<*resolution*>|MIN|MAX|DEF]]
:CONFigure:XCURrent:AC	[<*range*>|MIN|MAX|DEF [,<*resolution*>|MIN|MAX|DEF]]
:CONFigure:XCURrent:DC	[<*range*>|MIN|MAX|DEF [,<*resolution*>|MIN|MAX|DEF]]
:CONFigure:VOLTage:AC	[<*range*>|MIN|MAX|DEF [,<*resolution*>|MIN|MAX|DEF]]
:CONFigure:VOLTage:DC	[<*range*>|MIN|MAX|DEF [,<*resolution*>|MIN|MAX|DEF]]
:CONFigure:RESistance	[<*range*>|MIN|MAX|DEF [,<*resolution*>|MIN|MAX|DEF]]
:CONFigure:FRESistance	[<*range*>|MIN|MAX|DEF [,<*resolution*>|MIN|MAX|DEF]]
:CONFigure:FREQuency	[DEFault[,*gate_time*|MIN|MAX|DEF]]
:CONFigure:PERiod	[DEFault[,*gate_time*|MIN|MAX|DEF]]
:CONFigure:POWer	*no parameters*
:CONFigure:TEMPerature[:*TRANsducer*]:TCouple	[<type>[,DEFault[,<*resolution*>|MIN|MAX|DEF]]]
:CONFigure:TEMPerature[:*TRANsducer*]:RTD	[<DEFault >[,DEFault[,<*resolution*>|MIN|MAX|DEF]]]
:CONFigure:TEMPerature[:*TRANsducer*]:TRTD	[<DEFault >[,DEFault[,<*resolution*>|MIN|MAX|DEF]]]
:CONFigure:TEMPerature[:*TRANsducer*]:FRTD	[<DEFault >[,DEFault[,<*resolution*>|MIN|MAX|DEF]]]
CONFigure?	Returns the setup configured by the last CONFigure or MEASure? See Note [6].

Notes for These Commands

Note 1:

CONFigure:<meter_fn> <parameters> forces the trigger system state to:

- INITiate:CONTinuous OFF
- ARM:LAYer2:SOURce IMMediate
- ARM:LAYer2:DELay 0 (ARM2:DELay:AUTo is set to OFF)
- ARM:LAYer2:COUNt 1
- ARM:LAYer1:SOURce IMMediate
- ARM:LAYer1:COUNt 1
- ARM:LAYer1:DELay 0 (ARM2:DELay:AUTo is set to OFF)
- TRIGger:SOURce IMMediate
- TRIGger:COUNt 1
- TRIGger:DELay 0.0 (TRIGger:DELAY:AUTO is set to OFF)
- TRIGger:HOLDoff AUTO

Note 2:

There are no CONFigure commands for the DIGitize function; MEASure:DIGitize? is an invalid command.

Note 3:

<range> is is a scientific floating point value, (in base units), these are the same values as used with the :SENSe:<*meter_fn*>:<*range*> commands. <*resolution*> is the absolute resolution value and is the same value used in "SENSe" commands.

Note 4:

- The fuctions FREQuency & PERiod Counter commands () do not have settable range. If used, DEFault must be the first parameter to these configurations.

- The second parameter sets the gate time.

Note 5:

For CONFigure:TEMPerature

- The SCPI template is :TEMPerature [<*transducer*>[,*type*>[,*expected_value*>[,*resolution*>]]]]. <*type*> and <*expected_value*> are only required if the <*resolution*> parameter is used.

- If used, the <*resolution*> parameter can be one of: 0.0001, 0.001, MINimum, MAXimum or DEFault.

- If used, the <*expected_value*> parameter must be entered as DEFault.

- Where <TRANsducer> is "TC"; <type> must be one of J|R|E|N|U|C|L|T|B|K|S.

- Where <transducer> is " RTD", "TRTD" or "FRTD"; if used, DEFault must be entered as the <type> parameter (the product implements only the industrial standard Callendar-van Dusen coefficients; that is <*type*> = 85).

Note 6:

CONFigure query responses.

The response to CONFige? for the functions CAPacitance, CURRent:AC, CURRent:DC, FRES, RES, VOLTage:AC, VOLTage DC, XCURrent:AC and XCURrent:DC is: "<meter_fn> <range>,<resolution>" (note that the quotes are part of the response).

> Where:

>> <meter_fn> is the short-form of the SCPI function.

>> <range> is a scientific floating-point value.

>> <resolution> is the absolute resolution as a scientific floating-point value.

> For example, sending: CONF:VOLT 1.0,DEF;:CONF? returns: "VOLT +1.0E+0,+1.0E-4"

The response to CONFigure? For the FREQuency and PERiod functions do not map to the default syntax because the CONFigure command sets the default signal routing to "BNC". Range selection is not available unless the front terminals are set by the appropriate SENSe:FREQuency|PERiod:ROUTe: commands are used.

This is because ranging is only supported when using the counter via the front terminals (see "SENSe:FREQency" and "SENSePERiod").

CONFigure? will respond with: "<meter_fn> <gate_time>"

Where:

<meter_fn> is FREQuency or Period.

<gate_time> is a scientific floating-point value, representing the counter gate-time in seconds.

For example, sending: CONF:PER;:CONF? returns: "PER +1.0E+0"

If the non-default *<gate_time>* is set, CONF:PER DEF,100.0E-3;:CONF? returns: "PER +1.0E-1"

The configuration function: CONFigure[:SCALar]:POWer does not take any parameters.

For example, sending: CONF:POW;:CONF? will return: "POW"

The configuration query commands for the Temperature functions RTD, FRTD, and TRTD do not map directly to the default configuration syntax because in the Product, the first two parameters, *<type>* and *<expected_value>*, can only be DEFault.

CONFigure? responds with: "<meter_fn> <resolution>"

Where:

<meter_fn> is the short-form of the SCPI function name mnemonic.

<resolution> is the absolute resolution as a scientific floating point value.

For example, sending: CONF:TEMP:RTD;:CONF? will return: "TEMP:RTD 1.0e-1"

The configuration query command for Thermocouple Is also non-standard, but unlike RTD does include the transducer type.

CONFigure? will respond with: "<meter_fn> <type>,<resolution>"

Where:

<meter_fn> is TC

<type> is the thermocouple type (J|R|E|N|U|C|L|T|B|K|S).

<resolution> is the absolute resolution as a scientific floating-point

For example, sending: CONF:TEMP:TC;:CONF? will return: "TEMP:TC K,+1.0E-1"

Measurement Commands

The result of a measurement is a <RESPONSE MESSAGE UNIT>.
<RESPONSE MESSAGE UNIT> may be a single value or a group of values. The
number of values in <RESPONSE MESSAGE UNIT> is determined by the
product of the numeric settings: TRIGger:COUNt * ARM1:COUNt *
ARM2:COUNt. See Table 5.

Table 5. Measurement Commands

Command	Description
:FETCh? [1|2|3|4|5] Notes: (1)(2)(3)(4)(5)	FETCh? retrieves the last valid measurement or block of measurements resulting from a single trigger system transition from Idle, through the ARM and Trigger layers back to Idle. The number of readings in <RESPONSE MESSAGE UNIT> are exactly the product of the ARM2:COUNt, ARM1:COUNt and TRIGger:COUNt values. The system will not respond if the number of triggers received is less than the product of the trigger and two arm count settings. FETCh? or FETCh? 1 returns the Primary result. If the active function provides a secondary reading this can be obtained with FETCh? 2. FETCh? 3 returns the value at the front terminals and 4 at the rear terminals in a Scan measurement. FETCh? 5 returns the timestamp offset. FETCh? does not remove results from reading memory. A return of 9.91E+37 indicates there is not a valid value to return.
:READ?	READ? is the same as sending the TRIGger commands: ABORt; INITiate:IMMediate;FETCh? command. INITiate:IMMediate puts the Product into the **wait-for-trigger** state. The trigger system arm and trigger layer conditions must be satisfied before a measurement is taken and returned.
:MEASure:<meter_fn>? <parameters> Notes: (5)(6)(7)	MEASure:<meter_fn>? <parameters> is identical to: :ABORt :CONFigure: <meter_fn> <parameters> :READ? Note that the configure command also sets the trigger system to a particular state - see CONFig.
:FNOW? *<num_readings>*	FNOW? [num_readings], recalls num_readings from memory. If less than num_readings exist or the parameter num_readings is not sent, all available readings are returned. Unlike FETCh?, the new commands remove data from memory.
:TALK?	TALK? Sets the GPIB interface into a mode where each request to talk from the controller triggers returns a measurement. The Product is not commanded to listen so time consuming GPIB reconfigurations are avoided. This command is only available in GPIB control and is provided for compatibility when emulating 3458A which is not IEEE 488.2 compliant.

Notes for the Measurement Commands:

Note 1:

Data becomes invalid when:

>   *RST is executed,

>   INITiate:IMMediate is executed,

>   the signal path is reconfigured or

>   an acquisition is in progress.

Note 2:

The secondary readings available for AC voltage and current are: "FREQuency", "PERiod", "PK to Pk", "Crest Factor", "Pos Peak", "Neg peak", "OFF" (turns off secondary readings). Additionally, for ACI external shunt and DCI external shunt, the secondary reading can be "Shunt Voltage" or "Power coefficient". See FETCh?.

Note 3:

If secondary readings are active, the <RESPONSE MESSAGE UNIT> returned by a FETCh? 2, READ? 2 or MEASure? 2 contains the same number of elements as the primary readings returned by FETCh?, READ? or MEASure?

Note 4:

Data returned by Fetch 2, 3, and 4 is valid only when the appropriate measurement function and Inputs mode are active. For example, you cannot get the values from the front and rear terminals unless you are in SCAN.

Note 5:

The command sequence MEAS:<meter_fn>?;:FETCH? returns two identical <RESPONSE MESSAGE UNIT> elements separated by a semicolon.

Note 6:

The response from *RST;MEAS:<meter_fn>? is a single value because *RST sets FORMat to ASCII, TRIGger:COUNt to 1, ARM1:COUNt and ARM2:COUNt to 1.

Note 7:

There are no CONFigure commands for DIGitize so MEASure:DIGitize? is invalid.

Commands by Subsystem

Table 6. Command Summary

Keyword	Description
CALCulate	
CALCulate:AVERage	AVER controls values displayed and returned by FETCH?
:STATe*<boolean>*	Turns State ON or OFF. Default OFF.
:STATe?	Return the state of AVERage
:COUNt*<nrf>*	Set the number in an AVERage. Default 16, Min 1, Max 10,000.
:COUNt?	Returns the number of readings averaged
:TCONtrol MOVing|REPeat	MOVing = rolling; REPeat = Block. Default MOVing.
:TCONtrol?	Returns the control setting (MOV or REP)
CALCulate:LIMit	
:CLEar:[IMMediate]	immediately clear all flags
:LOWer *<nrf>*	Set the lower limit. Default -1.99999999e+15
:LOWer?	Return the ower limit value
:LOWer:STATe*<boolean>*	Turn the lower limit ON or OFF. Default OFF.
:LOWer:STATe?	Return the lower limit state
:FAIL?	Returns: Outside limits = 1, within limits = 0
[:STATe]*<boolean>*	Turn Limits ON or OFF. Default OFF.
[:STATe]?	Return the limits state
:UPPer *<nrf>*	Set the upper limit. Default +1.999999999e
:UPPer?	Return the lower limit value
:UPPer:STATe *<boolean>*	Turn the upper limit ON or OFF. OFF.
:UPPer:STATe?	Return the upper limit state
CALCulate:MATH	Math calculates (mx - c)/z
:CFACtor *<nrf>*|LREading	Sets the c variable to a value or the last reading. Default 1, Min -9.9E+37, Max 9.9E+37.
:CFACtor?	Returns the c variable value
:CFACtor:STATe *<boolean>*	Turns the - c operation ON or OFF. Default OFF.
CFACtor:STATe?	Returns the state of c operation (I = On, 0 = Off)
:MFACtor *<nrf>*|LREading	Sets the m variable to a value or the last reading. Default 1, min -9.9E+37, Max 9.9E+37.
:MFACtor?	Returns the m variable value
:MFACtor:STATe *<boolean>*	Turns the multiply by m operation ON or OFF. Default OFF.
:MFACtor:STATe?	Returns the state of m operation (I = On, 0 = Off)

Table 6. Command Summary (cont.)

Keyword	Description
:MUNits PERCent|DB50|DB75|DB600|DB	Sets the Units for MATH calculations. Default +1.999999999e
	PERCent = Units of (mx - c) in percent of z
	dB50 =Relative to 1 mW in 50 Ω
	dB75 =Relative to 1 mW in 75 Ω
	dB600 =Relative to 1 mW in 600 Ω
	dB = Relative to 1
:MUNits?	Returns the MUNit parameter
:MUNits:STATe *<boolean>*	Turns MUNits ON or OFF. Default OFF.
:MUNits:STATe?	Returns the MUNits setting
:STATe *<Boolean>*	Turn Math ON or OFF. Default OFF.
:STATe?	Returns the Math state
:RESet	Reset Math factors to defaults
:ZFACtor <nrf>|LREading	Sets the z variable to a value or the last reading. Default 1, min -9.9E+37, Max 9.9E+37.
:ZFACtor?	Returns the z variable value
:ZFACtor:STATe *<boolean>*	Turns the - z operation ON or OFF. Default OFF.
:ZFACtor:STATe?	Returns the state of z operation (I = On, 0 = Off)
CALCulate:SSTatistics	
:AVERage?	
:COUNt?	Returns the count of elements in memory/record in the statistics calculation
:MAXimum?	Returns the maximum value
:MINimum?	Returns the minimum value
SDEViation [PPM]	Sets the Standard Deviation value (no parameter) or Standard Deviation in ppm
:SDEViation?	Returns the standard deviation
:SPAN?	Retuns the span of the readings
:STATe *<boolean>*	Turns statistics state ON or OFF. Default OFF.
:STATe?	Returns the statistics state

Table 6. Command Summary (cont.)

Keyword	Description
CALibration	
CALibration	
:COPY:BASeline	Copy the certified stores over the Baseline stores
:SECure?	Returns calibration adjustment mode "FACTory", "USER" or "NONe"
:SECure:EXIT	Exit from calibration adjustment mode
:SECure:PASSword *<string>*	Enables calibration adjustment mode
:STORe:DATe? <CERTified|BASeline>	Returns the date of the last calibration adjustment of the store <year>,<month>,<day>,<Hours>,<Minutes>,<seconds>
:STORe:USE <CERTified|BASeline>	Sets the active stores. Default CERTified.
:STORe:USE?	Returns the active stores "CERTified" or "BASeline"
:TARget:DESCription?	Returns the target name as a quoted string containing target point description
:TARGet:INPut?	Returns the target input field description as a quoted string
:TARGet:STEP *<nrf>*	Sets the calibration adjust step
:TARGet:VALue *<nrf>*	Sets the target value
:TARGet:VALue[?]	Returns the target value
:TRIGger?	Initiates the adjustment, returns 0 = success, 1 = failure
DISPlay Subsystem	
DISPlay[:STATe]<boolean>	Turn the display ON or OFF. Default ON.
DISPlay	
:BRIGhtness <nrf>	Set the display brightness. Default 50 %
:BRIGhtness?	:BRIGhtness? Retrieve Brightness setting
:DTIMe<nrf>	Set the display backlight timer in seconds. Default 1800 seconds (30 minutes)
:DTIMe?	Returns the time setting
DISPlay[:STATe]?	Returns the state of the display

Table 6. Command Summary (cont.)

Keyword	Description
FORMat Subsystem	
FORMat	
[:DATA]: ASCii|PACKed[,<length>]	Packed format is 2 or 4 bytes (integer) Default ASCII
[:DATA]?	Retrieve last set data format. "PACK" if 2 byte set, "PACK 4" if 4 byte set
[:DATA]:SCALE?	Retrieve scaling factor associated with binary data mode (always returns 1.0 when ASCII selected)
:BORDer NORMal|SWAPped	Change the byte order. Default NORMal (big-endian)
:BORDer?	Return the byte order
MEMory Subsystem	
MEMory	
:LOCation BUFFer|BINTernal	
	where:
	BUFFer or no parameter = Volatile Buffer (Default)
	BINTernal = Buffer and Volatile memory
LOCation?	
ROUTe Subsystem	
ROUTe	
:INPut:SCAN	Alternately measures at front and rear terminals reporting the Difference, Quotient, or Ratio. Difference = F-R, Quotient = F/R, Ratio = (F-R)/R.
:CALCulation DIFFerence|DIVision|RATio	
CALCulation?	Returns the SCAN calculation type
:INPut:FDELay <nrf>	Sets the Scanning front settling delay (seconds). Only apply in SCAN mode. Min = 0, Max = 65,000. Each Function and range has its own unique, optimized AUTO setting.
:INPut:FDELay?	
:INPut:FDELay:AUTO[:STATe] <boolean>	Configures the Scanning front settling AUTO delay to ON or OFF. Default OFF.
:INPut:FDELay:AUTO[:STATe]?	Returns the scanning front delay AUTO state: 0 = OFF, 1 = ON
:INPut:GUARd[:STATe] <boolean>	Configures External Guard ON or OFF. Default OFF.
:INPut:GUARd[:STATe]?	Returns the state of the External Guard: 0 = OFF, 1 = ON
:INPut:RDELay <nrf>	Sets the Scanning rear settling delay (seconds). Only apply in SCAN mode. Min = 0, Max = 65,000. Each Function and range has its own unique, optimized AUTO setting.
:INPut:RDELay?	Returns the rear settling delay
:INPut:RDELay:AUTO[:STATe] <boolean>	Configures the Scanning rear settling AUTO delay to ON or OFF. Default OFF.
:INPut:RDELay:AUTO[:STATe]?	Returns the scanning rear delay AUTO state: 0 = OFF, 1 = ON. Default AUTO.

Table 6. Command Summary (cont.)

Keyword	Description
:TOUTput OFF|ACO|APE|BCO|EVE|RCO	Configures the rear panel TRIG OUT waveform. Default ACO.
	OFF = Pulses disabled
	ACO = Pulse at end of acquisition, start of run down
	APE = Squarewave active during acquisition
	BCO = Multiple reading burst complete
	EVE = Limit exceeded
	RCO = ADC conversion complete
:TOUTput?	Returns the rear panel TRIG OUT setting
:TOUTput:ONCe	Causes a single pulse from the rear panel TRIG OUT connector
:TOUTput:SLOPe POSitive|NEGative	Sets the polarity of the rear panel TRIG OUT waveform. Default NEG
:TOUTput:SLOPe?	Returns the polarity of the rear panel TRIG OUT waveform
:TERMinals FRONt|REAR|SCAN|ISOLated	Sets the active terminals. Default FRONt .
:TERMinals?	Returns the active terminals

SENSe Subsystem

Note: In the SENSe subsystem tables below, the short form of parameters is used (for example, DEF for DEFault). The long form may be used if preferred. Default settings are at the end of the Sense summary table.

[:SENSe]:CAPacitance	
:LOWI[:STATe] *<boolean>*	Selects Low current ON or OFF
:LOWI[:STATe]?	Returns Capacitance Low Current mode, 0 = OFF, 1 = ON
:RANGe:AUTO[:STATe] *<boolean>*	Turns Auto range ON or OFF
:RANGe:AUTO[:STATe] ?	Returns 1 for Auto range ON, 0 for auto range OFF
:RANGe <range>|MIN|MAX|DEF	Set maximum expected value or min, max, or default range
:RANGe? [MIN|MAX|DEF]	Returns the selected range or, or if specified, the minimum, maximum or default range
:RESolution *<nrf>*|MIN|MAX|DEF	Set maximum expected value or min, max or default resolution; for example, range is 10 µF, Resolution *<nrf>*. = 0.000000001 (1 nF), the measurement is returned with a resolution of +1.000E-9
:RESolution? [MIN|MAX|DEF]	Returns the selected resolution, or, if specified, the minimum, maximum or default range

Table 6. Command Summary (cont.)

Keyword	Description
[:SENSe]:CURRent:AC	
COUNTer:BLIMit[:STATe] *<boolean>*	Turn the frequency path bandwidth limit ON or OFF
COUNTer:BLIMit[:STATe]?	Return the state of the frequency path bandwidth limit setting. Returns 1 for Auto range ON, 0 for auto range OFF
:COUNter:COUPling AC|DC	Set the frequency path coupling to ac or dc. Note: if signal path coupling is ac, frequency path coupling is forced to ac
:COUNter:COUPling?	Return the frequency path coupling setting
:COUNter:GATE:AUTO[:STATe] *<boolean>*	Turn Auto selection of counter gate ON or OFF
:COUNter:GATE:AUTO[:STATe]?	Return the state of the counter gate auto setting, 1 for Auto gate ON, 0 for auto gate OFF
:COUPling:AC|DC	Set the ac current signal path coupling to ac or dc. Note: if signal path coupling is ac, frequency path coupling is forced to ac
:COUPling?	Return the frequency path coupling setting
:FILTer *<nrf>*|MIN|MAX|DEF	Set filter value or min, max or default filter
:FILTer? [MIN|MAX|DEF]	Return the filter setting
:RANGe:AUTO[:STATe] *<boolean>*	Turns Auto range ON or OFF
:RANGe:AUTO[:STATe]?	Returns 1 for Auto range ON, 0 for auto range OFF
:RANGe *<nrf>*|MIN|MAX|DEF	Set maximum expected value or min, max or default range
:RANGe? [MIN|MAX|DEF]	Returns the selected range or, or if specified, the minimum, maximum or default range
:RESolution *<nrf>*|MIN|MAX|DEF	Set maximum expected value or min, max or default resolution; for example, range is 1 A, Resolution *<nrf>*. = 0.0001 (100 µA), the measurement is returned with a resolution of +1.000E-4
:RESolution? [MIN|MAX|DEF]	Returns the selected resolution, or if specified, the minimum, maximum or default range
:SECondary OFF|FREQuency| PERiod|PTP|PPEak|NPEak|CFACtor	Sets the secondary reading type

Table 6. Command Summary (cont.)

Keyword	Description
	OFF = Secondary reading is not shown
	FREQuency = Secondary reading is frequency
	PERiod = Secondary reading is period
	PTP = Secondary reading is peak-to-peak
	PPEak = Secondary reading is positive peak
	NPEak = Secondary reading is negative peak
	CFACtor = Secondary reading is the crest factor
:SECondary?	Returns the selected secondary reading setting
:SECondary:METHod MEASure|SINE| SQUare|TRIangle|TSINe	Set the method by which the secondary peak-to-peak value is calculated
	MEASured = The measured positive peak minus the measured negative peak value
	SINe = The peak to peak of a sine wave calculated from the rms value
	SQUare = The peak to peak of a square wave calculated from the rms value
	TRIange = The peak to peak of a triangle waveform calculated from the rms value
	TRUNcated = The peak to peak of a truncated sine wave calculated from the rms value
:SECondary:METHod?	Returns the method by which the secondary peak-to-peak value is calculated
[:SENSe]:CURRent:DC	
:APERture *<nrf>*|MIN|MAX|DEF	Sets the ADC aperture value in seconds, or to the MIN, MAX, or default setting
:APERture? [MIN|MAX|DEF]	Returns the aperture setting or the MIN, MAX, or default settings in seconds
:APERture:MODE AUTO|FAST|MANual	Sets the aperture mode
:APERture:MODE?	Returns the aperture mode
:NPLC <plcs>MIN|MAX|DEF	Sets the ADC aperture in number of power line cycles or to the MIN, MAX, or default plc setting
:NPLC? [MIN|MAX|DEF]	Returns the ADC aperture in number of power line cycles or to the MIN, MAX, or default plc setting
:RANGe:AUTO[:STATe] *<boolean>*	Turns Auto range ON or OFF

Table 6. Command Summary (cont.)

Keyword	Description
:RANGe:AUTO[:STATe] ?	Returns 1 for Auto range ON, 0 for auto range OFF
:RANGe *<nrf>*|MIN|MAX|DEF	Set maximum expected value or min, max or default range
:RANGe? [MIN|MAX|DEF]	Returns the selected range or, if specified, the minimum, maximum or default range
:RESolution *<nrf>*|MIN|MAX|DEF	Set maximum expected value or min, max or default resolution; for example, range is 1 A, Resolution *<nrf>*. = 0.0001 (100 µA), the measurement is returned with a resolution of +1.000E-4
:RESolution? [MIN|MAX|DEF]	Returns the selected resolution, or if specified, the minimum, maximum or default range

[:SENSe]:DIGitize	
:APERture *<nrf>*|MIN|MAX|DEF	Sets the ADC aperture value in seconds or to the MIN, MAX, or default setting
:APERture? [MIN|MAX|DEF]	Returns the aperture setting or, if specified, the MIN, MAX, or Default settings in seconds
:CURRent:COUPling AC|DC	Sets the current signal coupling path to ac or dc
:CURRent:COUPling?	Returns the current signal coupling path
:CURRent:RANGe <range>|MIN|MAX|DEF	Sets the maximum expected current value or the MIN, MAX, or Default range
:CURRent:RANGe? [MIN|MAX|DEF]	Returns the current range set
:FILTer OFF|100Khz|3MHZ	Sets the digitise Filter bandwidth to OFF, 100 kHz, or 3 MHz (default is 3 MHz)
:FILTer?	Return the Digitize low pass filter setting
:VOLTage:COUPling:SIGNal AC1M|AC10M|DC1M|DC10M|DCAuto	Set the voltage path coupling and input impedance
	AC1M = AC Coupling, 1 MΩ input impedance
	AC10M = AC Coupling, 10 MΩ input impedance
	DC1M = DC Coupling, 1 MΩ input impedance
	DC10M = DC Coupling, 10 MΩ input impedance
	DCAuto = DC Coupling, maximum available input impedance (>1 TΩ for ranges < 100 V; 10 MΩ, for the 100 V, and 1000 V ranges)
:VOLTage:COUPling:SIGNal?	Return the voltage path coupling and input impedance setting
:VOLTage:RANGe <range>|MIN|MAX|DEF	Sets the maximum expected voltage value or the MIN, MAX, or Default range
:VOLTage:RANGe? [MIN|MAX|DEF]	Returns the voltage range set

Table 6. Command Summary (cont.)

Keyword	Description
[:SENSe]:Frequency	
:COUPling AC|DC	Sets the frequency path to ac or dc coupled
:COUPling?	Returns the coupling setting
:BWLimit[:STATe] *<boolean>*	Sets the bandwidth limit ON or OFF
:BWLimit[:STATe]?	Returns the Bandwidth limit setting
:GATE *<nrf>*|MIN|MAX|DEF	Set gate time to the numeric value in seconds, or to the min, max or default setting
:GATE? [MIN|MAX|DEF]	Returns the selected gate setting, or if specified, the minimum, maximum or default gate setting in seconds
:ROUTe:BNC:IMPedance 50R|HIGH	Sets the impedance for the rear panel BNC input
:ROUTe: BNC:IMPedance?	Returns the impedance set for the rear panel BNC input
:ROUTe: BNC:THReshold <nrf>|MIN|MAX|DEF	Set Threshold to the numeric value or to the min, max or default threshold setting (-5.0 V to 5.0 V)
:ROUTe: BNC:THReshold? [MIN|MAX|DEF]	Return the Threshold numeric value or if specified, the min, max or default threshold setting
:ROUTe:CURRent:RANGe <nrf>|MIN|MAX|DEF	Sets the current range to be used if the input path is set to ACI signal
:ROUTe:CURRent:RANGe? [MIN|MAX|DEF]	Returns the current range setting
:ROUTe:CURRent:THReshold <numeric>|MIN|MAX|DEF	Set Threshold to the numeric value or to the min, max or default threshold setting (-200 % to 200 % of Range)
:ROUTe:CURRent:THReshold? [MIN|MAX|DEF]	Return the threshold setting
:ROUTe:SIGNal BNC|ACI|ACV	Sets the Frequency|Period input path
:ROUTe:SIGNal?	Returns the Frequency|Period input path setting
:ROUTe:VOLTage:RANGe <range>|MIN|MAX|DEF	Sets the voltage range to be used if the input path is set to ACV signal or to the MIN, MAX, or Default setting
:ROUTe:VOLTage:RANGe? [MIN|MAX|DEF]	Returns the voltage range setting or the MIN, MAX, or Default value
:ROUTe:VOLTage:THReshold <numeric>|MIN|MAX|DEF	Set Threshold to the numeric value or to the min, max or default threshold setting (-200 % to 200 % of Range)
:ROUTe:VOLTage:THReshold? [MIN|MAX|DEF]	Return the threshold setting

Table 6. Command Summary (cont.)

Keyword	Description
[:SENSe]:FRESistance	
:APERture <nrf>|MIN|MAX|DEF	Sets the ADC aperture value in seconds or to the MIN, MAX, or default setting
:APERture? [MIN|MAX|DEF]	Returns the aperture setting or the MIN, MAX, or Default settings in seconds
:APERture:MODE AUTO|FAST|MANual	Sets the aperture mode
:APERture:MODE?	Returns the aperture mode
:NPLC <nrf>MIN|MAX|DEF	Sets the ADC aperture in number of power line cycles or to the MIN, MAX, or Default plc setting
:NPLC? [MIN|MAX|DEF]	Returns the ADC aperture in number of power line cycles or to the MIN, MAX, or Default plc setting
:MODE NORMal|TRUE|HIV	Sets the 4-wire Ohms mode
:MODE?	Returns the 4-wire Ohms mode setting
:LOWI[:STATe] *<boolean>*	Sets the Low current mode ON or OFF
:LOWI?	Returns the low current mode setting
:RANGe:AUTO[:STATe] *<boolean>*	Sets Auto ranging ON or OFF
:RANGe:AUTO[:STATe] ?	Returns the Auto range setting
:RANGe <range>|MIN|MAX|DEF	Sets the expected maximum input resistance, or if selected, to the MIN, MAX, or Default setting
:RANGe? [MIN|MAX|DEF]	Returns the range setting, or if selected, the MIN, MAX, or Default setting
:RESolution <resolution>|MIN|MAX|DEF	Set maximum expected value or min, max or default resolution
:RESolution? [MIN|MAX|DEF]	Returns the selected resolution, or if specified, the MIN, MAX, or Default resolution
:FILTer[:STATe] *<boolean>*	Turns the input filter ON or OFF
:FILTer[:STATe]?	Returns the filter setting, 0 = OFF, 1 = ON
[:SENSe]:FUNCtion *<string>*	
(where *string* can be)	
"CURRent[:DC]"	Sets function to DCI
"CURRent:AC"	Sets function to ACI
"CAPacitance"	Sets function to Capacitance

Table 6. Command Summary (cont.)

Keyword	Description
"DIGitze:CURRent"	Sets function to digitize current
"DIGitze:VOLTage"	Sets function to digitize voltage
"FREQuency"	Sets function to Frequency
"FRESistance"	Sets function to 4-wire Resistance
"PERiod"	Sets function to Period
"POWer"	Sets function to Power
"RESistance"	Sets function to 2-wire Resistance
"TEMPerature:FRTD"	Sets function to 4-wire PRT
"TEMPerature:RTD"	Sets function to 2-wire PRT
"TEMPerature:TCouple"	Sets function to thermocouple
"TEMPerature:TRTD"	Sets function to 3-wire PRT
"VOLTage[:DC]"	Sets function to DCV
"VOLTage:AC"	Sets function to ACV
"XCURRent[:DC]"	Sets function to DCI with external shunt
"XCURRent:AC"	Sets function to ACI with external shunt
[:SENSe]:FUNCtion?	Returns selected function
[:SENSe]:Period	
:COUPling AC|DC	Sets the Period path to ac or dc coupled
:COUPling?	Returns the coupling setting
:BWLimit[:STATe] *<boolean>*	Sets the bandwidth limit ON or OFF
:BWLimit[:STATe]?	Returns the Bandwidth limit setting
:GATE *<nrf>*|MIN|MAX|DEF	Set gate time to the numeric value or to the MIN, MAX, or Default setting
:GATE? [MIN|MAX|DEF]	Returns the selected gate setting, or if specified, the MIN, MAX, or Default gate setting
:ROUTe:BNC:IMPedance 50R|HIGH	Sets the impedance for the rear panel BNC input
:ROUTe: BNC:IMPedance?	Returns the impedance set for the rear panel BNC input
:ROUTe: BNC:THReshold <numeric>|MIN|MAX|DEF	Set Threshold to the numeric value or to the MIN, MAX, or Default threshold setting (-5.0 V to 5.0 V)
:ROUTe: BNC:THReshold? [MIN|MAX|DEF]	Return the Threshold numeric value or if specified, the MIN, MAX, or Default threshold setting

Table 6. Command Summary (cont.)

Keyword	Description
:ROUTe:CURRent:RANGe <range>|MIN|MAX|DEF	Sets the current range to be used if the input path is set to ACI signal
:ROUTe:CURRent:RANGe? [MIN|MAX|DEF]	Returns the current range setting
:ROUTe:CURRent:THReshold <numeric>|MIN|MAX|DEF	Set Threshold to the numeric value or to the MIN, MAX, or Default threshold setting (-200 % to 200 % of Range)
:ROUTe:SIGNal BNC|ACI|ACV	Sets the Frequency|Period input path
:ROUTe:SIGNal?	Returns the Frequency|Period input path setting
:ROUTe:VOLTage:RANGe <range>|MIN|MAX|DEF	Sets the voltage range to be used if the input path is set to ACV signal or to the MIN, MAX, or Default setting
:ROUTe:VOLTage:RANGe? [MIN|MAX|DEF]	Returns the voltage range setting or the MIN, MAX, or Default value
:ROUTe:VOLTage:THReshold <numeric>|MIN|MAX|DEF	Set Threshold to the numeric value or to the MIN, MAX, or Default threshold setting (-200 % to 200 % of Range)
[:SENSe]:PERiod	
:COUPling AC|DC	Sets the frequency|Period path to AC or DC coupled
:COUPling?	Returns the coupling setting
:BWLimit[:STATe] *<boolean>*	Sets the bandwidth limit ON or OFF
:BWLimit[:STATe]?	Returns the Bandwidth limit setting
:GATE *<nrf>*|MIN|MAX|DEF	Set gate time to the numeric value or to the MIN, MAX, or Default setting
:GATE? [MIN|MAX|DEF]	Returns the selected gate setting, or if specified, the MIN, MAX, or Default gate setting
:ROUTe:SIGNal BNC|ACI|ACV	Sets the Frequency|Period input path
:ROUTe:SIGNal?	Returns the Frequency|Period input path setting
:ROUTe:BNC:IMPedance 50R|HIGH	Sets the impedance for the rear panel BNC input
:ROUTe: BNC:IMPedance?	Returns the impedance set for the rear panel BNC input
:ROUTe:CURRent:RANGe <range>|MIN|MAX|DEF	Sets the current range to be used if the input path is set to ACI signal
:ROUTe:CURRent:RANGe? [MIN|MAX|DEF]	Returns the current range setting
:ROUTe:VOLTage:RANGe <range>|MIN|MAX|DEF	Sets the voltage range to be used if the input path is set to ACV signal or to the MIN, MAX, or Default setting
:ROUTe:VOLTage:RANGe? [MIN|MAX|DEF]	Returns the voltage range setting or the MIN, MAX, or Default value

Table 6. Command Summary (cont.)

Keyword	Description
:THReshold *<nrf>*|MIN|MAX|DEF	Set Threshold to the numeric value or to the MIN, MAX, or Default threshold setting
:THReshold? [MIN|MAX|DEF]	Return the Threshold numeric value or if specified, the MIN, MAX, or Default threshold setting
[:SENSe]:POWer	
:AVERage *<nrf>*|AUTO	Set the number of readings to average
:AVERage?	Return the number of readings being averaged
:FREQuency *<nrf>*	Frequency at which to measure power
:FREQuency?	Returns the set power frequency
:IDENtity?	Returns the identity of the RF sensor
:RELative RELative	ABSolute	Selects Relative (True) or Absolute (False) measurements
:RELative?	Returns Relative (=1) or False (=0)
:RELative:REFerence *<value>*|LReading	Sets the reference value or the last reading as reference for relative measurements
:RELative:REFerence?	Returns the reference level
:UNITs DBM|WATTs|VRMS|VPPK|DBUV	
:UNITs?	Returns the selected units
[:SENSe]:RESistance	
:APERture <seconds>|MIN|MAX|DEF	Sets the ADC aperture value in seconds or to the MIN, MAX or default setting
:APERture? [MIN|MAX|DEF]	Returns the aperture setting or the MIN, MAX or Default settings in seconds
:APERture:MODE AUTO|FAST|MANual	Sets the aperture mode
:APERture:MODE?	Returns the aperture mode
:NPLC <plcs>MIN|MAX|DEF	Sets the ADC aperture in number of power line cycles or to the MIN, MAX or default plc setting
:NPLC? [MIN|MAX|DEF]	Returns the ADC aperture in number of power line cycles or to the MIN, MAX or default plc setting
:MODE NORMal|HIV	Sets the 2-wire Ohms mode
:MODE?	Returns the 2-wire Ohms mode setting
:LOWI [:STATe]*<boolean>*	Sets the Low current mode ON or OFF
:LOWI[:STATe]?	Returns the low current mode setting

Table 6. Command Summary (cont.)

Keyword	Description
:RANGe:AUTO[:STATe] <boolean>	Sets Auto ranging ON or OFF
:RANGe:AUTO[:STATe]?	Returns the Auto range setting
:RANGe <range>|MIN|MAX|DEF	Sets the expected maximum input resistance, or if selected, to the MIN, MAX, or Default setting
:RANGe? [MIN|MAX|DEF]	Returns the range setting or if selected the MIN, MAX, or Default setting
:RESolution <resolution>|MIN|MAX|DEF	Set maximum expected value or MIN, MAX, or Default resolution
:RESolution? [MIN|MAX|DEF]	Returns the selected resolution, or if specified, the MIN, MAX, or Default resolution
:FILTer[:STATe] <boolean>	Turns the input filter ON or OFF
:FILTer[:STATe]?	Returns the filter setting, 0 = OFF, 1 = ON
[:SENSe]:TEMPerature:RTD|TRTD|FRTD	
(RTD= 2-wire TRTD = three wire, FRTD = 4-wire Resistance temperature device)	
:APERture <seconds>|MIN|MAX|DEF	Sets the ADC aperture value in seconds or to the MIN, MAX, or Default setting
:APERture? [MIN|MAX|DEF]	Returns the aperture setting or the MIN, MAX, or Default settings in seconds
:APERture:MODE AUTO|FAST|MANual	Sets the aperture mode
:APERture:MODE?	Returns the aperture mode
:NPLC <plcs>|MIN|MAX|DEF	Sets the ADC aperture in number of power line cycles or to the MIN, MAX, or Default plc setting
:NPLC? [MIN|MAX|DEF]	Returns the ADC aperture in number of power line cycles or to the MIN, MAX, or Default plc setting
:RESistance:RO 25|100	Set the reference resistance value
:RESistance:RO?	Return the reference resistance value
:RESolution <resolution>|MIN|MAX|DEF	Set maximum expected value or min, max or default resolution. MAX or MIN sets resolution to maximum/minimum appropriate to the NPLC/Aperture setting.
:RESolution? [MIN|MAX|DEF]	Returns the selected resolution, or if specified, the MIN, MAX, or Default resolution
:SECondary[:STATe] <boolean>	Turns the secondary reading (voltage) ON or OFF
:SECondary[:STATe]?	Returns the state of the secondary reading (1 = ON, 0 = OFF
:UNITs C|CEL|F|FAR|K	Set units to Celsius (C, CE), Fahrenheit (F, FAR) or Kelvin
:UNITs?	

Table 6. Command Summary (cont.)

Keyword	Description
[:SENSe]:TEMPerature:TC	
:APERture <seconds>|MIN|MAX|DEF	Sets the ADC aperture value in seconds or to the MIN, MAX, or Default setting
:APERture? [MIN|MAX|DEF]	Returns the aperture setting or the MIN, MAX, or Default settings in seconds
:APERture:MODE AUTO|FAST|MANual	Sets the aperture mode
:APERture:MODE?	Returns the aperture mode
:NPLC <plcs>|MIN|MAX|DEF	Sets the ADC aperture in number of power line cycles or to the MIN, MAX, or Default plc setting
:NPLC? [MIN|MAX|DEF]	Returns the ADC aperture in number of power line cycles or to the MIN, MAX, or Default plc setting
:RESolution <resolution>|MIN|MAX|DEF	Set maximum expected value or min, max or default resolution. MAX or MIN sets resolution to maximum/minimum appropriate to the NPLC/Aperture setting.
:RESolution? [MIN|MAX|DEF]	Returns the selected resolution, or if specified, the MIN, MAX, or Default resolution
:SECondary[:STATe] <boolean>	Turns the secondary reading (voltage) ON or OFF
:SECondary[:STATe]?	Returns the state of the secondary reading (1 = ON, 0 = OFF)
:TYPE J|R|E|N|U|C|L|T|B|K|S	
:TYPE?	
:UNITs C|CEL|F|FAR|K	Set units to Celsius (C, CE), Fahrenheit (F, FAR) or Kelvin
:UNITs?	Returns the temperature units
[:SENSe]:VOLTage:AC	
:BWIDth WIDE|EHF	Sets operating mode to Wideband or Extended High Frequency
:BWIDth?	Returns operating mode
:COUNter:BLIMit[:STATe]<boolean>	Turns the Counter bandwidth limit ON or OFF
:COUNter:BLIMit[:STATe]?	Returns the counter bandwidth limit setting
:COUNter:COUPling AC | DC	Set the coupling path for the secondary frequency measurement. Forced to ac if the signal path coupling is ac
:COUNter:COUPling?	Returns the frequency path coupling setting
COUNTer:GATE:AUTO[:STATe] <boolean>	Turn Auto selection of counter gate ON or OFF
COUNTer:GATE:AUTO[:STATe]?	Return the state of the counter gate auto setting, 1 = Auto gate ON, 0 = auto gate OFF

Table 6. Command Summary (cont.)

Keyword	Description
:COUNter:GATE <range>|MIN|MAX|DEF	Sets the secondary frequency counter measurement gate
:COUNter:GATE? [MIN|MAX|DEF]	Returns the secondary frequency counter measurement gate
:COUPling:SIGNal AC1M|AC10m|DC1M|DC10m|DCAuto	Sets the coupling and input impedance of the signal path
:COUPling:SIGNal?	Returns the signal path coupling and bandwidth setting
:FILTer <*nrf*>|MIN|MAX|DEF	Sets the input filter to *value* or to the minimum, maximum or default setting. The filter setting range is 0.1 Hz to 1 kHz, the discrete settings are: 0.1 Hz, 1 Hz, 10 Hz, 40 Hz, 100 Hz, 1 kHz. The discrete setting closest to <nrf> will be selected.
:FILTer? [MIN|MAX|DEF]	Returns the Filter setting, or if specified, the MIN, MAX, or Default setting
:RANGe:AUTO[:STATe] <*boolean*>	Turns Auto range ON or OFF
:RANGe:AUTO[:STATe]?	Returns 1 for Auto range ON, 0 for auto range OFF
:RANGe <nrf>|MIN|MAX|DEF	Set maximum expected value or MIN, MAX, or Default range
:RANGe? [MIN|MAX|DEF]	Returns the selected range or, or if specified, the MIN, MAX, or Default range
:RESolution <nrf>|MIN|MAX|DEF	Set maximum expected value or min, max or default resolution; for example, range is 1 V, Resolution <*nrf*>. = 0.0001 (100 µV), the measurement is returned with a resolution of +1.000E-4
:RESolution? [MIN|MAX|DEF]	Returns the selected resolution, or if specified, the MIN, MAX, or Default range
:SECondary OFF|FREQuency|PERiod|PTP |PPEak|NPEak|CFACtor	Sets the secondary reading type
	OFF = Secondary reading is not shown
	FREQuency = Secondary reading is frequency
	PERiod = Secondary reading is period
	PTP = Secondary reading is peak-to-peak
	PPEak = Secondary reading is positive peak
	NPEak = Secondary reading is negative peak
	CFACtor = Secondary reading is the crest factor

Table 6. Command Summary (cont.)

Keyword	Description
:SECondary?	Returns the selected secondary reading setting
SECondary:METHod MEASure|SINE|SQUare|TRIangle|TSINe	Set the method by which the secondary peak-to-peak value is calculated
	MEASured = The measured positive peak minus the measured negative peak value
	SINe = The peak to peak of a sine wave calculated from the rms value
	SQUare = The peak to peak of a square wave calculated from the rms value
	TRIange = The peak to peak of a triangle waveform calculated from the rms value
	TRUNcated = The peak to peak of a truncated sine wave calculated from the rms value
:SECondary:METHod?	Returns the method by which the secondary peak-to-peak value is calculated
[:SENSe]:VOLTage:DC	
:APERture *<nrf>*|MIN|MAX|DEF	Sets the ADC aperture value in seconds or to the MIN, MAX, or Default setting
:APERture? [MIN|MAX|DEF]	Returns the aperture setting or the MIN, MAX, or Default settings in seconds
:APERture:MODE AUTO|FAST|MANual	Sets the aperture mode
:APERture:MODE?	Returns the aperture mode
:NPLC <plcs>MIN|MAX|DEF	Sets the ADC aperture in number of power line cycles or to the MIN, MAX, or Default plc setting
:NPLC? [MIN|MAX|DEF]	Returns the ADC aperture in number of power line cycles or to the MIN, MAX, or Default plc setting
:IMPedance AUTO|1M|10M	Sets the input impedance. Auto is > 1 T Ω if range is < 100 V, otherwise 10 MΩ
:IMPedance?	Returns the input impedance setting
:RANGe:AUTO[:STATe] *<boolean>*	Turns Auto range ON or OFF
:RANGe:AUTO[:STATe]?	Returns 1 for Auto range ON, 0 for auto range OFF
:RANGe *<nrf>*|MIN|MAX|DEF	Set maximum expected value or min, max or default range

Table 6. Command Summary (cont.)

Keyword	Description
:RANGe? [MIN|MAX|DEF]	Returns the selected range, or if specified, the MIN, MAX, or Default range
:RESolution <nrf>|MIN|MAX|DEF	Set maximum expected value or min, max or default resolution; for example, range is 1V, Resolution <nrf>. = 0.0001 (100 µV), the measurement is returned with a resolution of +1.000E-4
:RESolution? [MIN|MAX|DEF]	Returns the selected resolution, or if specified, the minimum, maximum or default range
[:SENSe]:XCURrent:AC	
:COUNter:BLIMit[:STATe] *<boolean>*	Turn the frequency path bandwidth limit ON or OFF
:COUNter:BLIMit[:STATe]*?*	Return the state of the frequency path bandwidth limit setting. Returns 1 for Auto range ON, 0 for auto range OFF.
:COUNter:COUPling AC | DC	Set the frequency path coupling to ac or dc. Note that if the signal path coupling is ac, frequency path coupling is forced to ac.
:COUNter:COUPling?	Return the frequency path coupling setting
:COUNter:GATE:AUTO[:STATe]*<boolean>*	Turn Auto selection of counter gate ON or OFF
:COUNter:GATE:AUTO[:STATe]?	Return the state of the counter gate auto setting, 1 for Auto gate ON, 0 for auto gate OFF
:COUNter:GATE *< nrf >*|MIN|MAX|DEF	Sets the secondary frequency counter measurement gate
:COUNter:GATE? [MIN|MAX|DEF]	Return counter gate setting, or if specified, the MIN, MAX, or Default setting
:COUPling AC|DC	Set the ac current signal path coupling to ac or dc. Note that if the signal path coupling is ac, frequency path coupling is forced to ac.
:COUPling?	Return the frequency path coupling setting
:FILTer *<nrf>*|MIN|MAX|DEF	Sets the input filter to *value* or to the minimum, maximum or default setting. The filter setting range is 0.1Hz to 1kHz, the discrete settings are: 0.1 Hz, 1 Hz, 10 Hz, 40 Hz, 100 Hz, 1 kHz. The discrete setting closest to <nrf> will be selected.
:FILTer? [MIN|MAX|DEF]	Return the filter setting

Table 6. Command Summary (cont.)

Keyword	Description
:RANGe:AUTO[:STATe]*<boolean>*	Turns Auto range ON or OFF
:RANGe:AUTO[:STATe]?	Returns 1 for Auto range ON, 0 for auto range OFF
:RANGe *< nrf >*|MIN|MAX|DEF	Set maximum expected value or MIN, MAX, or Default range
:RANGe? [MIN|MAX|DEF]	Returns the selected range or, or if specified, the MIN, MAX, or Default range
:RESolution *< nrf >*|MIN|MAX|DEF	Set maximum expected value or MIN, MAX, or Default resolution; for example, range is 1 A, Resolution *<nrf>*. = 0.0001 (100 µA), the measurement is returned with a resolution of +1.000E-4
:RESolution? [MIN|MAX|DEF]	Returns the selected resolution, or if specified, the MIN, MAX, or Default range
:SECondary OFF|CFACtor|FREQuency|NPEak|PERiod|PTP|PPEak|PUNCertainty|VOLTage	Sets the secondary reading type
	OFF = Secondary reading is not shown
	CFACtor = Secondary reading is the crest factor
	FREQuency = Secondary reading is frequency
	NPEak = Secondary reading is negative peak
	PERiod = Secondary reading is period
	PTP = Secondary reading is peak-to-peak
	PPEak = Secondary reading is positive peak
	PUNCertainty = additional Power Uncertainty
	VOLTage = the shunt output voltage
:SECondary?	Returns the selected secondary reading setting

Table 6. Command Summary (cont.)

Keyword	Description
:SECondary:METHod MEASure|SINE|SQUare|TRIangle|TSINe	Set the method by which the secondary peak-to-peak value is calculated
	MEASured = The measured positive peak minus the measured negative peak value
	SINe = The peak to peak of a sine wave calculated from the rms value
	SQUare = The peak to peak of a square wave calculated from the rms value
	TRIange = The peak to peak of a triangle waveform calculated from the rms value
	TRUNcated = The peak to peak of a truncated sine wave calculated from the rms value
:SECondary:METHod?	Returns the method by which the secondary peak-to-peak value is calculated
:SHUNt? [*list#*]	Returns {Asset#, Manufacturer, Model, Serial#, Resistance, Max Current, Power Ref Level, Power Coefficient} of the selected Shunt)
	Note1: The first four items are quoted strings; the remaining item are <nrf> format values.
	Note2: If the optional <list#> is supplied that record is returned, otherwise the active shunt record is returned.
	Note3: Index '0' is the 'Basic' shunt slot and is always available.
:SHUNt:ADD <list>	Add a new shunt as a comma-separated string of attributes {Asset#, Manufacturer, Model, Serial#, Resistance, Max Current, Power Ref Level, Power Coefficient}
	See notes to SHUNt?
:SHUNt:COUNt?	Note: will always return at least 1 as the 'Basic' shunt (slot '0') will be included.
:SHUNt:DIFFerence?	Returns list of ac-dc difference as {frequency, and difference in µA/A} for the selected shunt
:SHUNt:DIFFerence:ADD <frequency>,<difference>	Adds a new ac-dc difference pair to the list of the selected shunt.
:SHUNt:DIFFerence:REMove <*diff#*>	Remove the difference pair at <*diff#*> for the selected shunt. Note: <*diff#*> can be obtained with :SHUNt:DIFF?. <diff# > can be found from …SHUNt:DIFF? list.

Table 6. Command Summary (cont.)

Keyword	Description
:SHUNt:LIST?	Returns a comma-separated enumerated list of shunts as {List#, Asset#, Manufacturer, Model, Serial#, Resistance, Max Current, Power Ref Level, Power Coefficient}
	Note1: The first four items are quoted strings, the remaining item are NR3 format values.
	Note2: If the optional <list#> is supplied that record is returned, otherwise the active shunt record is returned.
	Note3: Index '0' is the 'Basic' shunt slot, and is always available.
SHUNt:MODify <list#>,< *list* >	<*list*> See notes to SHUNt?
:SHUNt:PICK <*list#*>	selects shunt by enumerated list number
:SHUNt:PICK?	Returns selected shunt number
:SHUNt:REMove <*list#*>	Remove the shunt at # in the list
SHUNt:SORT MCURrent|ASSet|SERial	Sort shunt list in either 'maximum current', 'asset number' or 'serial number' order
SHUNt:SORT?	Returns the sort order (MCUR|ASS|SER)
Note(1): External shunts data is common between SENSe:XCURrent:AC and SENSe:XCURrent:DC	
[:SENSe]:XCURrent:DC	
:APERture <*nrf*>|MIN|MAX|DEF	Sets the ADC aperture value in seconds or to the MIN, MAX, or Default setting
:APERture? [MIN|MAX|DEF]	Returns the aperture setting or the MIN, MAX, or Default settings in seconds
:APERture:MODE AUTO|FAST|MANual	Sets the aperture mode
:APERture:MODE?	Returns the aperture mode
:NPLC <*nrf*>MIN|MAX|DEF	Sets the ADC aperture in number of power line cycles or to the MIN, MAX, or Default plc setting
:NPLC? [MIN|MAX|DEF]	Returns the ADC aperture in number of power line cycles or to the MIN, MAX, or Default plc setting
:RANGe:AUTO[:STATe]<*boolean*>	Turns Auto range ON or OFF
:RANGe:AUTO[:STATe]?	Returns 1 for Auto range ON, 0 for auto range OFF
:RANGe <*nrf*>|MIN|MAX|DEF	Set maximum expected value or MIN, MAX, or Default range

Table 6. Command Summary (cont.)

Keyword	Description
:RANGe? [MIN|MAX|DEF]	Returns the selected range, or if specified, the minimum, maximum or default range
:RESolution <nrf>|MIN|MAX|DEF	Set maximum expected value or min, max or default resolution; for example, range is 1A, Resolution <nrf>. = 0.0001 (100 µA), the measurement is returned with a resolution of +1.000E-4
:RESolution? [MIN|MAX|DEF]	Returns the selected resolution, or if specified, the minimum, maximum or default range
:SECondary OFF|VOLTage|PUNCertainty	Sets the secondary reading type
	OFF = Secondary reading is not shown
	PUNCertainty = additional Power Uncertainty
	VOLTage = the shunt output voltage
:SHUNt? [list#]	returns {Asset#, Manufacturer, Model, Serial#, Resistance, Max Current, Power Coefficient, Power Ref Level} of the selected Shunt)
	Note1: The first four items are quoted strings; the remaining item are NR3 format values.
	Note2: If the optional <list#> is supplied that record is returned, otherwise the active shunt record is returned.
	Note3: Index '0' is the 'immediate' shunt slot and is always available.
:SHUNt:ADD <list>	Add a new shunt as a comma-separated string of attributes {Asset#, Manufacturer, Model, Serial#, Resistance, Max Current, Power Ref Level, Power Coefficient}
	See notes to SHUNt?
:SHUNt:COUNt?	Note: will always return at least 1 as the 'Basic' shunt (slot '0') will be included.
:SHUNt:LIST?	returns a comma-separated enumerated list of shunts as {List#, Asset#, Manufacturer, Model, Serial#, Resistance, Max Current, Power Ref Level, Power Coefficient }
	Note1: The first four items are quoted strings; the remaining item are NR3 format values.
	Note2: If the optional <list#> is supplied that record is returned, otherwise the active shunt record is returned.
	Note3: Index '0' is the 'Basic' shunt slot and is always available.

Table 6. Command Summary (cont.)

Keyword	Description
:SHUNt:MODify <list#>,< *list*>	<*list*> See notes to SHUNt?
:SHUNt:PICK <*list#*>	Selects active shunt by enumerated list number
:SHUNt:PICK?	Returns the list number of the active
:SHUNt:REMove <*list#*>	Remove the shunt at # in the list
SHUNt:SORT MCURrent|ASSet|SERial	Sort shunt list in either 'maximum current', 'asset number' or 'serial number' order
SHUNt:SORT?	Returns the sort order (MCUR|ASS|SER)
[SENSe:]	
ZERO? RANGe|ALL	Removes residual offsets, applies to active range or function.
	Returns '0' for success, and '1' for failure.
ZCLear? RANGe|ALL	Clears zero, applies to active range or function.
	Returns '0' for success, and '1' for failure.

Table 7. SENSe Subsystem Power On and Reset Default Settings

DCV	DCV is the default function Range: 1000 (Min 0.1, Max 1000) Resolution: 0.0001 (7 digits) (min 4 digits, max 8 digits, actual value is range dependent) Aperture: AUTO (default 1 second, Min 0, Max 10 seconds), NPLC Min = 0 Max = 600 Input impedance: AUTO
DCI	Range 30 Resolution 0.000001 (7 digits) (min 4 digits, max 7 digits, actual value is range dependent) Aperture: AUTO (default 1 second, Min 0, Max 10 seconds), NPLC Min = 0 Max = 600
ACV	Range: 1000 Resolution: 0.0001 (7 digits) (min 4 digits, max 7 digits, actual value is range dependent) RMS Filter: 40 Hz Signal path coupling/impedance: AC, 1MΩ Frequency path coupling: AC (Disabled) Frequency path bandwidth limit: OFF Secondary reading: Frequency Counter Gate: Auto Bandwidth Limit: Wideband Peak to Peak Method: Measured
ACI	Range: 30 A Resolution:0.00001 (6 Digits) (min 4 digits, max 7 digits, actual value is range dependent) RMS Filter: 40 Hz Signal Path Coupling: AC Secondary reading: Frequency Frequency path coupling: AC (Disabled) Frequency path bandwidth limit: OFF Counter Gate Time: Auto Peak to Peak Method: Measured (Disabled)

Table 8. SENSe Subsystem Power On and Reset Default Settings (cont.)

Resistance 2W Normal	Range: 10000 (10 kΩ) Resolution: 0.01 (7 digits) (min 4 digits, max 8 digits, actual value is range dependent) LOI: OFF Aperture: AUTO (default 1 second, Min 100 µs, Max 10 seconds), NPLC Min = 0 Max = 600 Filter: OFF
Resistance 4W Normal	Range: 10000 (10 kΩ) Resolution: 0.01 (7 digits) (min 4 digits, max 8 digits, actual value is range dependent) LOI: OFF Aperture: AUTO (default 1 second, Min 100 µs, Max 10 seconds), NPLC Min = 0 Max = 600 Filter: OFF
Resistance 4W Tru	Range: 10000 (10 kΩ) Resolution: 0.01 (7 digits) (min 4 digits, max 8 digits, actual value is range dependent) LoI: OFF Aperture: AUTO (default 1 second, Min 100 µs, Max 10 seconds), NPLC Min = 0 Max = 600 Filter: OFF
Resistance 2W HV	Range: 10000000 (10 MΩ) Resolution: 1.0 (7 digits) (min 4 digits, max 8 digits, actual value is range dependent) Aperture: AUTO (default 1 second, Min 100 µs, Max 10 seconds), NPLC Min = 0 Max = 600 Filter: OFF
Resistance 4W HV	Range: 10000000 (10 MΩ) Resolution: 1.0 (7 digits) Aperture: AUTO (default 1 second, Min 100 µs, Max 10 seconds), NPLC Min = 0 Max = 600 Filter: OFF
Capacitance	Range: 1 mF Resolution: 5 digits (min 4 digits, max 5 digits, actual value is range dependent) LoI OFF

Table 8. SENSe Subsystem Power On and Reset Default Settings (cont.)

Frequency Counter	Gate time: 100 ms Input Impedance: 50 Ω Coupling: AC Bandwidth Limit: OFF Threshold: 0.0V Input Path: Rear BNC
DCI Ext Shunt	Range: 1 V Resolution:0.000001 (6 digits) (min 4 digits, max 7 digits, actual value is range dependent) Aperture: Auto, (default 1 second, Min 0, Max 10 seconds), NPLC Min = 0 Max = 600 Second reading: OFF Shunt: Basic Value Shunt Corrections ON
ACI Ext Shunt	Range: 1 V Resolution:0.00001 (5 digits) (min 4 digits, max 7 digits, actual value is range dependent) RMS Filter: 4 0Hz Signal Path Coupling: AC Second reading: Shunt Voltage Frequency path coupling: AC (Disabled) Frequency path bandwidth limit, OFF Counter Gate: Auto Peak to Peak Method: Measured (Disabled) Shunt Corrections ON Shunt: Basic Value
RTD, TRTD, FRTD	Probe R0: 100 Ohm Resolution: Default = 0.1 (5 Digits) Max - 0.01 (6 Digits) Probe: 2Wire Units: Celsius Aperture: Auto, (default 100 ms Min 100 µs, Max 10 seconds)

Table 8. SENSe Subsystem Power On and Reset Default Settings (cont.)

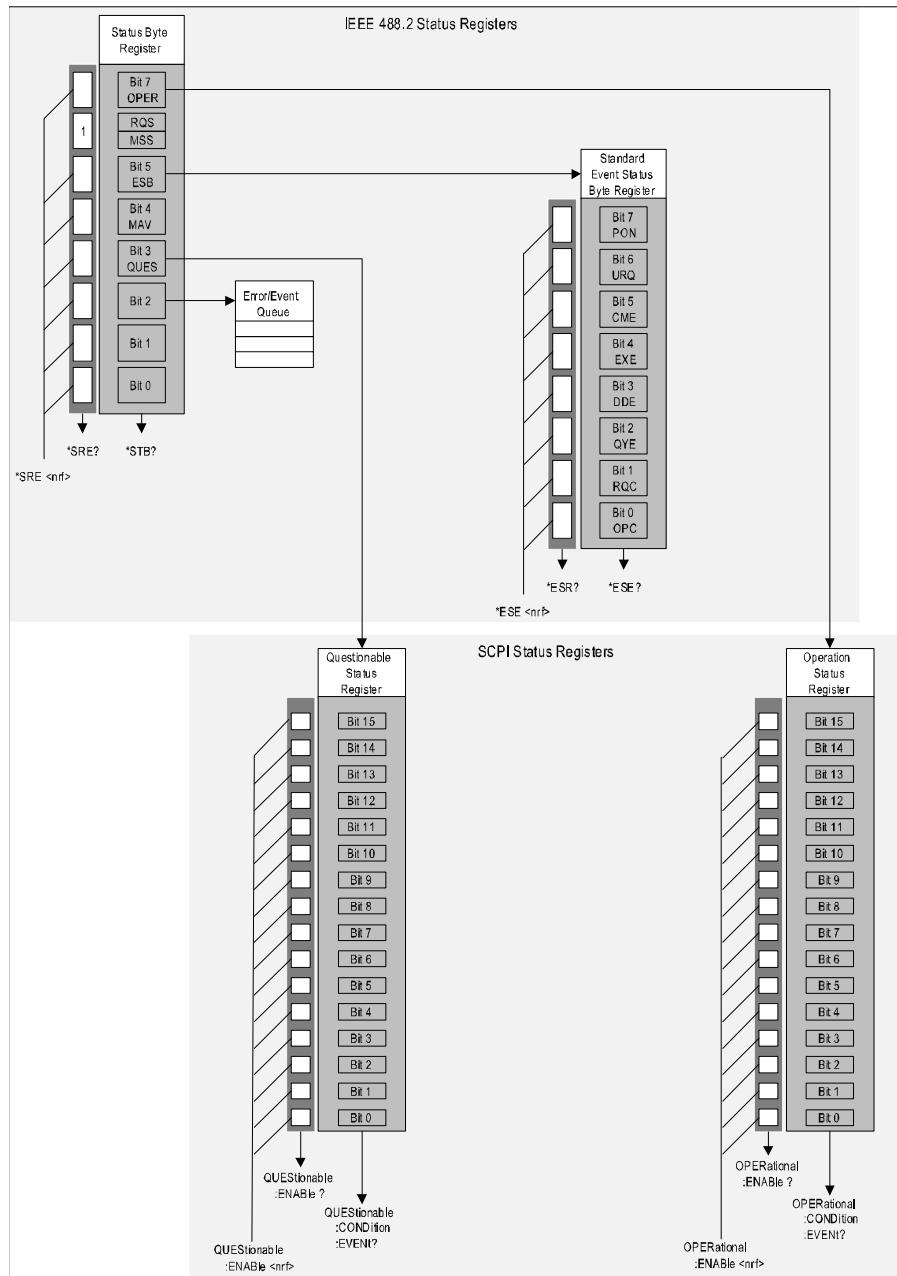|	
Thermocouple	Type: K Second Reading: ON Resolution: Default = 0.1 (5 Digits) Max = 0.01 (6 Digits) Units: Celsius Aperture: Auto, (default 100 ms, Min 0, Max 10 seconds)
Digitize	V or I: Volts Range: 1000 Coupling/Zin: DC, Auto Aperture: default 0, Min 0, Max 0.003 seconds Low Pass Filter: 3MHz
RF Power	Reading: Absolute Average: Auto Units: dBm Reference Frequency: 0.0 Hz Reference Level: -99.0 dBm

Figure 3. STATus Subsystem SCPI Status Registers

iei342.emf

IEEE 488.2 Registers

Table 8. Status Byte Register

Bit No.	Bit Value	IEEE 488.2 Meaning	8588A Meaning
0	1	Device dependent	Not used
1	2	Device dependent	Not used
2	4	Device dependent	Error/event queue not empty
3	8	QUES	QUEStionable summary bit
4	16	MAV	Message Available bit
5	32	ESB	Event status summary Bit
6	64	RQS|MSS	Request for service bit, or Master Status Summary bit
7	128	OPER	OPERation summary bit

Table 9. Standard Event Status Byte Register

Bit No.	Bit Value	IEEE 488.2 Meaning	8588A Meaning
0	1	Operation Complete	Set true if all operations pending from a *OPC command are complete
1	2	Request Control	Not used, always set false
2	4	Query Error	Set true if the controller has followed an inappropriate message exchange protocol
3	8	Device Dependent Error	Set true when an internal operating error has occurred
4	16	Execution Error	Set true if a received command cannot be executed or paramers are out of bounds
5	32	Command Error	Set true if a command with incorrect syntax is received
6	64	User Request	Not used, always set false
7	128	Power On	Set true when power is applied

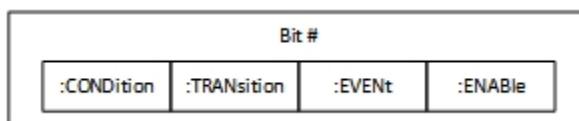Each bit of the OPERational and QUEStionable registers have sub registers as shown in Figure 4.

subregisters.jpg

Figure 4. Sub Registers

The Transition register is not used in the Product. The state of the other three registers is accessed with the STATus commands as shown in Table 10.

Table 10. STATus Commands

Command	Description
STATus	
:OPERation	
:CONDition?	Returns the contents of the Operation Condition register. The only OPERational:CONDition sub-register implemented in the Product is that of Bit 4 "MEASuring". This sub register is false if the Trigger system is in the Idle state; true if the trigger system is initiated.
[:EVENt]?	Set true if the event has occurred. Only used in bits 4, 5, 6, 8, 9, 10, and 11.
:ENABle \<nrf>	Set which OPERational register bits cause the OPER bit (7) in the Status byte to be set true. *Nrf* is the sum of bit values to be set; for example: *nrf* = 80 set bits 4 and 6 to enabled. Min= 0, Max = 32768
:ENABle?	Returns the sum of the bit values of the enabled bits.
:PRESet	Sets Enable bits both OPERational and QUEStionable registers to False.
:QUEStionable	
:CONDition?	The Condition sub register is not used in the Product
[:EVENt]?	Set true if the event has occurred. Not used in bits 0, 1, 2, 6, 7, 8, 13, 14 and 15
:ENABle \<*nrf*>	Set which QUEStionable register bits cause the QUES bit (3) in the Status byte to be set true. *Nrf* is the sum of bit values to be set; for example: *nrf* = 2056 set bits 3 (8) and 11 (2048) to enabled. Min = 0, Max = 32768
:ENABle?	Returns the sum of the bit values of the enabled bits

SCPI OPERation Status Register

Bit No.	Bit Value	SCPI Defined	8588A Meaning
0	1	CALibrating	Not Used
1	2	SETTing	Not Used
2	4	RANGing	Not Used
3	8	SWEeping	Not Used
4	16	MEASuring	STATus:CONDition is false when the Trigger system in IDLE state, true when not IDLE STATUS:EVENt is true when one or more readings are available
5	32	Waiting for TRIGger	Waiting for TRIGger
6	64	Waiting for ARM	Waiting for ARM
7	128	CORRecting	Not Used
8	256	Available to Designer	Low Limit
9	512	Available to Designer	High Limit
10	1024	Available to Designer	Ext. Ref. clock unlock
11	2048	Available to Designer	Signal clipping (Digitize & AC)
12	4096	Available to Designer	Not Used
13	8192	INSTrument Summary	Not Used
14	16384	PROGram Running	Not Used
15	32768	NOT USED	

SCPI QUEStionable Status Register

Bit No.	Bit Value	SCPI Defined	8588A Meaning
0	1	VOLTage	Over-range
1	2	CURRent	Over-range
2	4	TIME	Not Used
3	8	POWER	Over-range (when RF sensor fitted)
4	16	TEMPerature	Over-range (PRT and Thermocouple)
5	32	FREQuency	Over-range (Counter)
6	64	PHASe	Not Used
7	128	MODulation	Not Used
8	256	CALibration	Not Used
9	512	Available to Designer	Under range (All functions)
10	1024	Available to Designer	Over range (All functions)
11	2048	Available to Designer	Trigger too fast
12	4096	Available to Designer	Measurement too fast
13	8192	INSTrument Summary	Not Used
14	16384	Command Warning	Not Used
15	32768	NOT USED	

Table 11. SYSTem Subsystem

Keyword	Description
SYSTem	
:DATe <year>,<Month>,<date>	<year>: rounded to 4 digit integer number
	<month>: rounded to Integer in range 1 to 12
	<day>: rounded to Integer in range 1 to max days in month for <year> & <day>
DATe?	Retrieves the date in same format as set above
:ERRor[:NEXT]?	Returns the meter's error queue. In the form: <Error number>,"<Error/Event description>[;<Device dependent description>]". See Error Codes list below.
:LFRequency <nrf>	Sets line frequency to the nearest of 50 Hz or 60 Hz to <nrf>
:LFRequency:AUTO 0|1|ONCE	Auto detect ON or OFF. ONCE measures and sets line frequency then turns AUTO off. Default AUTO.
:LFRequency?	Return the line frequency setting
:MLEVel?	Returns the hardware Modification level
:PRESet [NORMal|FAST]	FAST sets all conditions for special high-speed mode. NORMal or no parameter sets the normal operating conditions (as after *RST). Default NORM.
:TIME <hour>,<minute>,<second>	Set <hour>: rounded to Integer from 0 to 23
	Set <minute>: rounded to Integer from 0 to 59
	Set <second>: rounded to number with resolution of the RTC from 0 to <60
:TIME?	Returns the current RTC time
:TIME:TIMer[:STATe] <boolean>	Turn reading time stamps ON or OFF
:TIME:TIMer[:STATe]?	Return the state of reading time stamps
:VERSion?	Returns the SCPI version in the form YYY.V where YYY represents the year and V the version
:LOCal See note (1)	Put system into local
:REMote See note (1)	Put system into remote
:RWLock See note (1)	Put system into lock out mode TBD

Table 11. SYSTem Subsystem (cont.)

Keyword	Description
:TEMPerature?	Returns internal temperatures in form x,y
	x = temperature in degrees Celsius measured on the analogue assembly
	x = temperature in degrees Celsius measured on the Digital assembly
:COMMunicate:ENABLE USB|GPIB | ENET	Selects active remote port (no query available for this command)
:COMMunicate:GPIB:ADDress <value>	Set GPIB address
:COMMunicate:GPIB:ADDress?	Query the GPIB bus address
:COMMunicate:LAN:CONTrol <port>	Set or query the port
:COMMunicate:LAN:CONTrol?	
:COMMunicate:LAN:DHCP[:STATE] *<boolean>*	Turn DHCP ON or OFF
:COMMunicate:LAN:DHCP[:STATE]?	
:COMMunicate:LAN:GATeway <ipaddress>	<ipaddress> is in the form xxx.xxx.xxx.xxx, i.e. 192.168.1.190
:COMMunicate:LAN:GATeway?	Returns the address
:COMMunicate:LAN:IPADdress <ipaddress>	
:COMMunicate:LAN:IPADdress?	
:COMMunicate:LAN:MAC?	Returns the MAC address
:COMMunicate:LAN:SMASk <ipmask>	<ipmask> is in the form xxx.xxx.xxx.xxx, i.e. 255.255.255.0
:COMMunicate:LAN:SMASk?	Returns the IP mask.
Note (1): Only a valid command when the Active Port is Ethernet. The commands cause an error if the Active Port is GPIB or USB.	

Trigger Subsystem

Keyword	Description
Abort	
The :ABORt command is at the root level in the command hierachy but included with the Trigger subsystem commands because of their close functional relationships. The ABORt command resets the trigger system and places it in the IDLE state. Actions related to the trigger system that are in progress, such as acquiring a measurement, will be aborted as quickly as possible.	
INITiate	
:CONTinuous [:STATe] <boolean>[1]	Determines what happens when the triggering process enters the Initiate layer. CONTinuous ON causes the trigger system to exit the Initiate layer on the downward path without entering the Idle state. CONTinuous OFF causes the trigger system to enter the Idle state.
:CONTinuous [:STATe]?	Returns the state of INITiate:CONTinuous, 1 = ON, 0 = OFF
:EPOCh:STARt <yyyy,mm,dd,hh,mm,ss>	Sets Epoch start time. If Continuous is OFF at Epoch start time, CONTinuous is set to ON
:EPOCh:STARt?	Returns the Epoch start time
:EPOCh:STOP < yyyy,mm,dd,hh,mm,ss >	Sets Epoch stop time. If Continuous is ON at Epoch stop time, Continuous is set to OFF
:EPOCh:STOP?	Returns the Epoch Stop time
[:IMMediate]	INITiate:IMMediate causes exit from the idle state. CONTinuous state is not affected. Note that INITiate and INITiate:IMMediate produce identical behaviour.
Note: The INIT:CONT state is ignored when the Digitize function is active. In Digitize the INIT: layer is permanently INIT:CONT OFF.	

Keyword	Description

ARM[:SEQuence]:LAYer2
 	
  ARM[:SEQuence]:LAYer1
  (The two ARM layers have identical commands)	

:COUNt *<nrf>*	Specifies the number of passes through *layer* and subordinate layers before control flows up to the superior layer. Default = 1, Max = 10000000
:COUNt?	Returns the Count setting
:COUPling DC|AC	Sets the coupling used with :SOURce:INTernal. See also :LEVel and :SLOPe. Default = AC
:COUPling?	Returns the coupling setting
:DELay:AUTO *<boolean>*	When ON, the time delay between *source event* detection and flow passing to the subordinate layer is determined automatically (the DMM sets an appropriate delay needed for settling after a configuration change). Default = ON
:DELAY:AUTO?	Returns the auto delay setting, 1 = ON, 0 = OFF
:DELay *<nrf>*	Set the time delay between *source event* detection and flow passing to the subordinate layer.
:DELay?	Returns the delay setting in seconds
:ECOunt *<nrf>*	*numeric* is an integer value to specify how many ARM events must be recognised before DELay is started on the downwards transit through the layer. ECOunt provides ARM event division. Default = 1, Max = 10000000
:ECOunt?	Returns the Ecount setting
:EXTernal POSitive|NEGative [,TTL|BIPolar]	Sets the polarity of the External trigger edge and optionally signal type to TTL or Bipolar. Default = Negative, TTL
:EXTernal?	Returns the external edge polarity and edge type settings
:FILTer *<boolean>*	Turns the filter in the event detector path ON or OFF. The filter affects both the signal and event detector paths. Default = OFF
:FILTer?	Returns the filter state
:IMMediate	Modifies event detection behaviour. If the system is waiting for an event in this layer, this one-time command bypasses event detection ECOUNT and DELay causing immediate exit from the layer on the downward path. If not waiting at the event detector the command is ignored and error -221 issued.
:LEVel *<nrf>*	Sets the percentage of range at which arming occurs when Source is INTernal. Default = 0%, Min -200 %, Max = 200 %

Keyword	Description
:LEVel?	Returns the level setting as a percentage of range.
:SIGNal	Modifies event detection behaviour. If the system is waiting for an event in this layer this one-time command bypasses event detection. Otherwise, the command is ignored and error -221 issued.
:SLOPe POSitive|NEGative	Sets the signal slope that causes the event detector to be satisfied if Soure is Internal. See also LEVel and COUPling. Default = POSitive
:SOURce BUS|EXTernal|HOLD |IMMediate|INTernal|LINE|MANual|SYNChronous|TIMer	Source of ARM signal
	BUS = Receipt of *TRG or GET
	EXTernal = Conforming rear panel trigger edge
	HOLD = Arming cannot occur unless a ARM:LAYer[1|2]:IMMediate or :SIGnal command is received
	IMMediate = The process does not stop at the event detector in this layer
	INTernal = Trigger from the signal being measured at the Level on the Slope set by the ARM:LAYer[1|2]:LEVel *<nrf>* and ARM:LAYer[1|2]:SLOPe POS|NEG commands. See also ARM:LAYer[1|2]:COUPling AC|DC
	LINE = trigger derived from the mains input. Triggers occur at the line frequency rate or multiples of that rate if the trigger system cycle time exceeds the line frequency.
	MANual = when the TRIG key is pushed
	SYNChronous = Arms when the multimeter's output buffer is empty, and the controller requests data.
	TIMer = at the interval set by ARM:LAYer[1|2]: TIMer *<nrf>*. On the first of ARM:LAYer[1|2]:COUNt *<nrf>* passes, arming is immediate, subsequent arms occur at TIMer intervals
:SOURce?	Returns the source setting
:TIMer *<nrf>*	Sets the interval between TIMer events. Only active if Source = timer. Default 2E-8 (20 ns).
:TIMer?	Returns the timer setting

Keyword	Description
TRIGger[:SEQuence]	
:COUNt *<nrf>*	Specifies the number of acquisitions before control flows up to the superior layer. Default = 1, Max = 1000000
:COUNt?	Returns the Count setting
:COUPling DC|AC	Sets the coupling used with :SOURce:INTernal. See also :LEVel and :SLOPe. Default = AC
:COUPling?	Returns the coupling setting
:DELay:AUTO *<boolean>*	When ON, the time delay between *source event* detection and the start of an acquisition is determined automatically (the DMM sets an appropriate delay needed for settling after a configuration change). Default = ON
:DELAY:AUTO?	Returns the auto delay setting, 1 = ON, 0 = OFF
:DELay *<nrf>*	Set the time delay between *source event* detection and the start of an acquisition
:DELay?	Returns the delay setting in seconds
:ECOunt *<nrf>*	*numeric* is an integer value to specify how many TRIGger events must be recognised before DELay is started. ECOunt provides TRIGger event division. Default = 1, Max = 10000000
:ECOunt?	Returns the Ecount setting
:EXTernal POSitive|NEGative [,TTL|BIPolar]	Sets the polarity of the External trigger edge and optionally, signal type to TTL or Bipolar. Default = Negative, TTL
:EXTernal?	Returns the external edge polarity and edge type settings
:FILTer *<boolean>*	Turns the filter in the event detector path ON or OFF. The filter affects both the signal and event detector paths. Default = OFF
:FILTer?	Returns the filter state
:HOLDoff:AUTO[:STATe] OFF|ON	When ON, the holdoff period is set Automatically
:HOLDoff:AUTO[:STATe] ?	Returns the state of HOLDoff:AUTO (1 = ON, 2 = OFF)
:HOLDoff *<nrf>*	Manually sets the HOLDoff period. Default 0, Maximum 100 s
:HOLDoff?	Return the HOLDoff period
:IMMediate	Modifies event detection behaviour. If the system is waiting for an event in this layer, this one-time command bypasses event detection, ECOunt and DELay. An acquisition is immediately started. If not waiting at the event detector the command is ignored and error -221 issued.
:LEVel *<nrf>*	Sets the percentage of range at which arming occurs when Source is INTernal. Default = 0 %, Min = -200, Max = 200
:LEVel?	Returns the level setting as a percentage of range.
:RESet	Reset the trigger system to default settings. :RESet does not change the state of INIT:CONT

Keyword	Description
:SIGNal	Modifies event detection behaviour. If the system is waiting for an event in this layer this one-time command bypasses event detection. Otherwise, the command is ignored and error -221 issued.
:SLOPe POSitive|NEGative	Sets the signal slope that causes the event detector to be satisfied if Source is Internal. See also LEVel and COUPling. Default = POSitive
:SOURce BUS|EXTernal|HOLD| IMMediate|INTernal|LINE|MANu al|SYNChronous|TIMer	Source of ARM signal
	BUS = Receipt of *TRG or GET
	EXTernal = Conforming rear panel trigger edge
	HOLD = Arming cannot occur unless a TRIGger:IMMediate or TRIGger:SIGnal command is received
	IMMediate = The process does not stop at the event detector in this layer
	INTernal = Trigger from the signal being measured at the Level on the Slope set by the ARM:LAYer[1|2]:LEVel *<nrf>* and ARM:LAYer[1|2]:SLOPe POS|NEG commands. See also ARM:LAYer[1|2]:COUPling AC|DC
	LINE = trigger derived from the mains input. Triggers occur at the line frequency rate or multiples of that rate if the trigger system cycle time exceeds the line frequency.
	MANual = the TRIG key is pushed
	SYNChronous = Initiates an acquisition when the multimeter's output buffer is empty, and the controller requests data.
	TIMer = at the interval set by ARM:LAYer[1|2]: TIMer *<nrf>*. On the first of ARM:LAYer[1|2]:COUNt *<nrf>* passes, arming is immediate, subsequent arms occur at TIMer intervals
:SOURce?	Returns the source setting
:TIMer *<nrf>*	Sets the interval between TIMer events. Only active if Source = timer. Default 2E-8 (20 ns).
:TIMer?	Returns the timer setting

Trigger Subsytem Default Settings

Trigger system default settings are shown in Table 12.

Table 12. Trigger System Default Settings

The default for the INITiate layer is INIT:CONTinuous ON [1] (The DMM takes and displays readings continuously)			
	ARM:LAYer2	**ARM:LAYer1**	**Trigger layer**
:SOURce	:IMMediate	:IMMediate	:IMMediate
:COUNt	1	1	1
:COUPling	DC	DC	DC
:DELay:AUTO [2]	ON	ON	ON
:DELay [2]	0	0	0
:ECOunt	1	1	1
:EXT FALLing,TTL [3]	Falling, TTL	Falling, TTL	Falling, TTL
:FILTer	OFF	OFF	OFF
:HOLDoff:AUTO [4]	-	-	ON
:HOLDoff [4]	-	-	0
:LEVEL [5]	0 %	0 %	0 %
:SLOPe POSitive [3]	Positive	Positive	Positive
:TIMer	200 ns	200 ns	200 ns

1. INITiate:CONTinuous is set to OFF if

    a) the Digitize function is selected

      or

    b) when the Product is put into remote control

2. The:DELay:AUTO ON setting in the ARM2 and ARM1 layers is zero seconds. in the trigger layer, :Delay:AUTO ON provides a dynamic delay to allow settling after a configuration change to ensure a valid measurement is obtained. The actual delay depends on the change to function, range or signal coupling path. The Delay is zero once the settling period has expired. Set :DELay to 0 and :DELay:AUTO OFF if the time between receipt of a trigger and start of acquisition is critical. When the setting is TRIGger:DELay:AUTO OFF, it is the users responsibility to wait an appropriate period between an instrument configuration change and issuing a trigger. Alternatively, :DELay can be set to an appropriate non-zero value but that delay period will be implemented after every trigger event.

3. When :SOURce is :EXTernal, the type of edge can be rising or falling, TTL or Bipolar. These two parameters are common for all three event layers. If a parameter is changed in one layer, the change also applies in the other two event layers.

4. :HOLDoff is a Trigger layer only setting. :HOLDoff:AUTO ON pauses the trigger cycle until the acquisition is complete. TRIGger:HOLDoff:AUTO OFF causes the trigger cycle to pause for the :HOLDoff value setting which can be between 0.000 000 0 and 100 seconds. The setting resolution of HOLDoff is 100 ns up to 1 ms and 1 ms from 1 ms up to 100 seconds.

5. When :SOURce is :INTernal, :LEVel sets the point (level) on the input waveform the trigger event will occur. If :LEVel is changed in one layer, the change also applies in the other two event layers. :LEVel may be set between -200 % and +200 % of Range.

Remote Command Examples

On power up or after the *RST reset command, the DMM is in this state:

Function: DCV

Range: 1000V

Resl:1.000E-04 (100 μV)

Aperture:/NPLC 50 PLC

IMP: Auto (10 MΩ while in the 1000 V range)

Remote measurement response format: ASCII

Result bit order = Swapped

MATH and **LIMIT** checking OFF

Memory Location: Volatile Buffer only

ROUTe:TERMinals Front

ROUT:TOUTput = Signal Acquired

ROUTe:INPut:GUARd = OFF

CALCulate:AVERage = 1, OFF

Product settings:

Display: Unchanged

Line Frequency: Auto

Ext Ref Clock: Off

Remote settings:

Emulation: Unchanged

Active Port: Unchanged

GPIB Address: Unchanged

Ethernet settings: Unchanged

Trigger settings:

INITiate:CONTinuous: OFF if *RST sent remotely, ON if Power cycled or Reset from front panel.

See Table 12 for other settings.

INITiate:CONTinuous default is OFF in remote control and when Digitize is the active function. Otherwise the default is ON. The Trigger subsystem can be reset to the default state with the command :TRIGger:RESet does not change the state of INITiate:CONTinuous.

The default settings for ARM:LAYer2, ARM:LAYer1 and TRIGer following Power ON, *RST, or TRIGger:RESet commands are as in Table 12.

Measure AC Current

Objective/Actions
To measure AC Current:
1. Select the ac current function.
2. Select the 100 mA range and set resolution to 100 nA (6.5 digits).
3. Set secondary reading to Pk to Pk.

Example	Result/Comments

`SENSe:<meter_fn> "CURRent:AC"`
`SENSe:CURRent:AC:RANGe 0.1`
`SENSe:CURRent:AC:RESolution`
`1.000E-7`
`SENSe:CURRent:AC:SECondary PTP`
	The same could be achieved by tree walking (using shortform commands and omitting the optional SENSe keyword for brevity):
	`:FUNC "CURRent:AC";:CURR:AC:RANG`
	`0.1;RES 1.000E-7;SEC PTP`
	
	Note
	
	Entering commands via the GPIB places the DMM in Remote control. This causes the Trigger system to enter the IDLE state (INITiate:CONTinuous OFF). The DMM must be triggered before a reading can be retrieved.

Retrieve a measurement manually - method 1

Push `F5` (**Go to Local**) and then push `TRIG` to trigger a reading. Read the value on the DMM display.

Retrieve a measurement - method 2

Send command: INITiate:IMMediate (or INIT without the optional :IMMediate leaf node) to trigger the reading followed by :FETCh? to retrieve it.

Retrieve a measurement - method 3

Send command :READ? This triggers the DMM and retrieves the result.

Retrieve a measurement - method 4

Send command :MEASure? This triggers the DMM and retrieves the result.

The full Measure command could be used to set up the function, range and resolution. Switching to DCI, the function, range and resolution could be combined in the command to fetch the measurement result with 1 A range, and 100 µA resolution:

```
:MEASure:CURRent:DC? 1, 0.0001
```

Take a Reading Using External Trigger

Objective/Actions
To take a reading using External Trigger:
1. Take a reading from the rising edge of a bipolar trigger edge at the rear BNC input.
2. Set up for external trigger and configure the active edge required.
3. Setup the trigger delay by setting the trigger to zero so the acquisition starts on receipt of the conforming edge.

Example	Result/Comments
1. TRIGger:RESet	Reset the trigger system to defaults
2. TRIGGER:SOURce EXTernal TRIGGER:EXT POSitive,BIPolar	
3. TRIGGER:DELay:AUTO OFF TRIGGER:DELay 0	

Multiple Readings

Objective/Actions
To manually trigger a batch of 50 readings with 10-second intervals:
1. Enter the commands below.
2. Push **F5** (**Go to Local**) to exit remote control.
3. Push **TRIG** .

Example	Result/Comments
TRIGger:RESet	Resets the trigger system to defaults
TRIGger:SOURce TIMer	Trigger on the timer
TRIGger:TIMer 10	Set the timer to 10 seconds
TRIGger:COUNt 50	Take 50 readings before reverting to the Idle state
TRIGger:DELay:AUTO OFF TRIGGER:DELay 0	Turn auto delay off Set Delay to 0.000

Multiple Readings with Initial Delay

Objective/Actions
To manually trigger a batch of 25 readings with 5 second intervals starting 15 seconds after **TRIG** is pushed: 1. Enter the commands below. 2. Push **TRIG** to start the 15-second delay.

Example	Result/Comments
`TRIGger:RESet` `ARM:LAYer1:DELay:AUTO OFF`	Reset the trigger system to defaults
`ARM:LAYer1:DELay 15`	Trigger subsystem waits for 15 seconds before entering the trigger layer
`RIGger:SOURce TIMer`	Trigger on the timer
`TRIGger:TIMer 5`	Set the timer to 5 seconds
`TRIGger:COUNt 25`	Take 25 readings before reverting to the Idle state
`TRIGger:DELay:AUTO OFF`	Turn auto delay off
`TRIGGER:DELay 0`	Set Delay to 0.000

DIGITIZE with External Trigger Using Trigger Dividing

Objective/Actions
Aperture required = 6 µs. Use 10 MHz off-air reference clock divided by 100 to yield trigger interval of 10 µs to capture 2000 samples.

Example	Result/Comments
`:FUNC "DIGitize:VOLTage"`	Select the digitize function
`:DIGitize:VOLTage:RANGe 1`	1 V range
`:DIGitize:APERture 6E-6`	Aperture = 6 µs
`TRIGger:RESet`	Reset the trigger system to defaults
`TRIGGER:SOURce EXTernal`	Default setting is TTL, NEGative edge
`TRIGGER:COUNT 2000`	2000 samples to be captured
`TRIGGER:ECOunt 100`	One acquisition for every 100 trigger edges
`TRIGger:DELay:AUTO OFF`	Turn auto delay off
`TRIGGER:DELay 0`	Set Delay to 0.000
`READ?`	Starts the capture and returns the data
	Note *The first acquisition starts (ECount - 1) * trigger edge period after the :READ? command is sent {(100 - 1) * 10 µs = 990 µs}.*

Using EPOCH to Control Start of Reading Capture

Objective/Actions
Note
In Epoch mode, the trigger subsystem is switched to Initiate Continuous On at the start of the Epoch (equivalent to sending INIT:CONT ON). In this example the Epoch expires 1 second after start (equivalent to sending INIT:CONT OFF). The three day timing is controlled in one of the ARM layers.
To use the Epoch mode to start taking groups of 50 readings spaced at 30 second intervals starting on the hour every hour for 3 days enter the commands below.

Example	Result/Comments
`:TRIGger:RESet`	Reset the trigger system to defaults
`:INITiate:EPOCh:STARt 2022,11,30,00,00,00`	Start the sequence
`:INITiate:EPOCh:STOP: 2022,11,30,00,00,01`	1 second later
`:ARM1:TIMer 3600`	Arm every 1 hour
`:ARM1:COUNT 72`	ARM 72 times - process runs for 72 hours
`:TRIGGER:SOURce TIMer`	
`:TRIGGER:COUNT 50`	Take 50 readings for each ARM event
`:TRIGGER:TIMer 30`	30 seconds between each of the 50 readings
`:TRIGger:DELay:AUTO OFF`	Turn auto delay off
`:TRIGGER:DELay 0`	Set Delay to 0.000

Compare Two Resistance Values using SCAN

Objective/Actions
To compare two resistances using SCAN:
1. Connect two resistances 100 Ω on the rear, 1 kΩ on the front.
2. Run the commands below.

Example	Result/Comments
`*RST`	Reset the Product
`:RESistance:MODE NORMal`	Set 2 wire Ohms
`:RESistance:RANGe 10000000`	Set the 10 kΩ range, leaving other settings as defaults
`:ROUTe:INPut:SCAN:CALCulation RATio`	
`READ?`	(Calculation of (Front-Rear) / Rear) yields approximately 9)
`:ROUTe:INPut:SCAN:CALCulation DIVision`	
`READ?`	(Calculation of (Front / Rear) yields approximately 10)
`:ROUTe:INPut:SCAN:CALCulation DIFFerence`	
`READ?`	(Calculation of Front-Rear yields approximately 900)

Emulation Modes

To select an emulation mode push `INST SETUP`. Select Emulation. Push `F2` for 8508A or `F3` for 3458A. The active port will be forced to GPIB. Select the required bus address. Refer to the documentation for the product being emulated for the details of the remote commands for that product.

Note

The Product only responds correctly to commands appropriate to the Emulation mode selected (None, 8508A, or 3458A).

8508A Command Emulation

The 8508A command shown in Table 13 will be accepted by the Product but will cause no action.

Table 13. 8508A Command Emulation

8508A Command	8508A Parameters
PRT	"*identity*"

The 8508A commands shown in Table 14 below will cause error -102 to be returned.

Table 14. 8508A Commands that cause Error -102

8508A Command	8508A Parameters
SPOT?	
PRT?	
PRT_CHR	*identity,type,wires*
PRT_COEF	
PRT_DATA?	"*identity*"
PRT_DEL	"*identity*"
ENBCAL	EXTNL|SPECIAL
CAL?	*<numeric>*
SELSPOT	<numeric>,SET, <numeric>
*PUD	Various forms of up to 5 parameters
EXITCAL	["*datestring*"|'*datestring*']
SERIAL	*<12 ascii characters>*
CLRMEM	ALL|HFTRIM

3458A Command Emulation

The 3458A commands shown in Table 15 below will be accepted by the Product but cause no action.

Table 15. 3458A Command Emulation

3458A Command	3458A Parameters
ACAL	[*type*][,*security_code*]
AZERO	OFF|ON|ONCE
BEEP	OFF|ON|ONCE
DEFEAT	mode
DEFKEY	number,string|DEFAULT]
DELSUB	name
DIAGNOST	
INBUF	[control]
LOCK	control
MENU	mode
MFORMAT	format
PAUSE	
SCRATCH	
SECURE	old_code,new_cod[,acal_secure]
SETACV	[type]
SMATH	[register][,number]
SSTATE	name
TEST	
TONE	

The 3458A commands shown in Table 16 will cause error 102 to be returned.

Table 16. 3458A Commands that cause Error -102

3458A Command	3458A Parameters
CAL	
CALL	
CALSTR	*string*[,*security_code]*
COMPRESS	name
CONT	
DIAGNOST	
MATH	operation_a[,operation_b]
MCOUNT?	
MEM	mode
MENU	mode
MMATH	
SCAL	
SSPARM?	
SSRC	[source][,mode]
SSRC?	
SUB	name
SUBEND	
TBUFF	[control]

Error Codes

List of IEEE 488.2 and SCPI Error codes

```
0,   "No error",
```

SCPI command errors - (-199, -100)

```
-102, "Syntax error",
-104, "Data type error;Wrong type of parameter(s)",
-104, "Data type error;Parameter is not a numeric type",
-104, "Data type error;Parameter is not a boolean type",
-115, "Unexpected number of parameters",
-120, "Numeric data error;Invalid numeric format",
-120, "Numeric data error;Unexpected negative value",
-120, "Numeric data error;Unexpected real value",
-120, "Numeric data error;Value has overflowed its storage",
-120, "Numeric data error;Invalid dimensions for channel list",
-120, "Numeric data error;Too many dimensions for channel list",
-130, "Suffix error",
-131, "Invalid suffix;Too many suffixes",
-131, "Invalid suffix;Invalid unit",
-150, "String data error;Unmatched quote",
-150, "String data error;Length more than 12 characters",
-151, "Invalid string data",
-150, "String data error;Not a quoted string",
-150, "String data error;Not an unquoted string",
-171, "Invalid expression;Unmatched bracket",
-171, "Expression error;List entry not found",
```

SCPI execution errors - (-299, -200)

-200, "Execution Error;Operation unavailable in this context",

-211, "Trigger ignored",

-213, "Init ignored",

-214, "Trigger deadlock",

-200, "Execution error;Operation aborted",

-201, "Invalid while in local",

-203, "Command protected;Security level invalid for PUD operation",

-221, "Settings conflict;Unsupported or invalid context for operation",

-221, "Settings conflict;Operation only available when using ethernet port",

-221, "Settings conflict;Factory settings unavailable",

-221, "Settings conflict;Security level invalid for calibration operation",

-221, "Settings conflict;Shunt index is not available",

-221, "Settings conflict;The 'Basic' shunt slot cannot be deleted",

-221, "Settings conflict;Shunt ac-dc difference entry already exits",

-221, "Settings conflict;Maximum number of shunt ac-dc difference entries exceeded",

-221, "Settings conflict;Maximum number of shunt entries exceeded",

-221, "Settings conflict;Shunt already exits",

-221, "Settings conflict;Adjustment action not possible;clear stores first",

-221, "Settings conflict;Certified stores not activated",

-222, "Data out of range;Adjustment outside limits",

-222, "Data out of range",

-222, "Data of range;Parameter suffix out of range",

-222, "Data out of range;Invalid shunt resistance",

-222, "Data out of range;Maximum shunt current outside limits",

-222, "Data out of range;Invalid shunt power reference level",

```
-222, "Data out of range;Invalid shunt power coefficient",
-222, "Data out of range;Frequency invalid for shunt ac-dc
       difference entry",
-222, "Data out of range;Shunt ac-dc difference value invalid",
-222, "Data out of range;Port value is out of range (1024 to
       65535)",
-222, "Data out of range;Numeric value cannot be zero",
-222, "Data out of range;Ethernet hostname too long",
-223, "Too much data;Input buffer full",
-223, "Too much data;Line too long (greater than 350 characters)",
-223, "Too much data;Command Buffer Overflow",
-224, "Illegal parameter value;Ethernet MAC address not valid",
-224, "Illegal parameter value;Ethernet address not valid",
-224, "Illegal parameter value;Ethernet hostname not valid",
-224, "Illegal parameter value",
-224, "Illegal parameter value;RTC/System time format invalid",
-224, "Illegal parameter value;RTC/System date format invalid",
-224, "Illegal parameter value;Invalid shunt asset name",
-224, "Illegal parameter value;Invalid shunt manufacturer",
-224, "Illegal parameter value;Invalid shunt model",
-224, "Illegal parameter value;Invalid shunt serial number",
-224, "Illegal parameter value;Invalid secure code",
-224, "Illegal parameter value;Adjustment target invalid",
-230, "Data corrupt or stale",
-240, "Hardware Error;Adjustment action not possible;invalid
       instrument model",
-250, "Mass storage error;Could not save setting",
-250, "Mass storage error;Failed to delete shunt ac-dc difference
       item",
-250, "Mass storage error;Failed to delete shunt properties",
-250, "Mass storage error;Shunt properties cannot be saved",
-250, "Mass storage error;Unknown NV constant",
-250, "Mass storage error;Empty NV constant",
-291, "Out of memory",
```

SCPI device specific errors - (-399, -300)

-300, "Device-specific error;GPIB Controller not found",

-300, "Device-specific error;GPIB Primary address not accepted",

-300, "Device-specific error;Bad GPIB controller read operation",

-300, "Device-specific error;Bad GPIB controller send operation",

-300, "Device-specific error;GPIB DOS Error",

-300, "Device-specific error;Specified GPIB Interface Board is not active controller",

-300, "Device-specific error;GPIB interface Board has not been addressed properly",

-300, "Device-specific error;GPIB invalid argument",

-300, "Device-specific error;GPIB specified GPIB Interface Board is not System Controller",

-300, "Device-specific error;GPIB I/O operation aborted (time-out)",

-300, "Device-specific error;GPIB non-existent GPIB board",

-300, "Device-specific error;GPIB routine not allowed during asynchronous I/O operation",

-300, "Device-specific error;GPIB no capability for operation",

-300, "Device-specific error;GPIB file System Error",

-300, "Device-specific error;GPIB command byte transfer error",

-300, "Device-specific error;GPIB serial poll status byte lost",

-300, "Device-specific error;GPIB SRQ stuck in ON position",

-300, "Device-specific error;GPIB table problem",

-300, "Device-specific error;Range or function zero operation failed",

-300, "Device-specific error;Zeroing of input failed",

-300, "Device-specific error;Calibration data corrupt",

```
-300, "Device-specific error;Failed to write to non-
       volatile calibration storage",

-300, "Device-specific error;Adjustment measurement noisy",

-300, "Device-specific error;Error occurred reading
       characters from USBTMC controller",

-300, "Device-specific error;Error occurred sending
       characters to USBTMC controller",

-300, "Device-specific error;Could not open the ethernet
       port",

-300, "Device-specific error;Error occurred reading
       characters from Ethernet port",

-310, "System error; Undefined error encountered",

-350, "Queue overflow",
```

SCPI query errors - (-499, -400)

```
-410, "Query INTERRUPTED",

-420, "Query UNTERMINATED",

-430, "Query DEADLOCK",

-440, "Query UNTERMINATED after indefinite response",
```