FLUKE ®

8845A/8846A
Digital Multimeter

Programmers Manual

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Remote Operation

Introduction

Remote operation of the 8845A or 8846A Digital Multimeters (hereafter “the Meter”) from a host, that is, a terminal, controller, PC, or computer, is accomplished by sending commands to it through one of its remote interfaces. This manual describes how to setup, configure, and operate the Meter through each of the remote interfaces.

The Meter is controlled remotely using either Standard Commands for Programmable Instruments (SCPI) or Fluke 45 commands. Detailed information on the SCPI command set, and how the Meter processes those commands is included in this manual. Fluke 45 command limitations are covered in Appendix B in this manual.

Note

For more information regarding the SCPI programming language, visit http://www.scpiconsortium.org. A free copy of the SCPI standard can be found at http://www.scpiconsortium.org/SCPI-99.pdf.

The level of detail in this chapter is based on the assumption that the reader is familiar with the basics of data communication interface, and the IEEE 488 bus.

Safety Information

This section addresses safety considerations and describes symbols that may appear on the Meter or in the manual.

A ⚠⚠ **Warning** statement identifies conditions or practices that could result in injury or death.

A ⚠ **Caution** statement identifies conditions or practices that could result in damage to the Meter or equipment to which it is connected.

⚠⚠ Warning

To avoid electric shock, personal injury, or death, carefully read the information under “Safety Information” before attempting to install, use, or service the Meter.

Symbols

Table 1 is a list of safety and electrical symbols that appear on the Meter or in this manual.

Table 1. Safety and Electrical Symbols

Symbol	Description	Symbol	Description
⚠	Risk of danger. Important information. See manual	⏻	Display ON / OFF
⚠	Hazardous voltage. Voltage > 30 V dc or ac peak might be present	⏚	Earth ground
∼	AC (Alternating Current)	⊣⊢	Capacitance
⎓	DC (Direct Current)	▶|	Diode
≂ or ⩳	AC or DC (Alternating or Direct Current)	▭	Fuse
		⎍	Digital signal
•)))	Continuity test or continuity beeper tone	🔧	Maintenance or Service
ϟ	Potentially hazardous voltage	CAT II	IEC 61010 Overvoltage (installation or measurement) Category 2.
⧈	Double insulated	♻	Recycle
⚠	Static awareness. Static discharge can damage part(s)	⊠	Do not dispose of this product as unsorted municipal waste. Go to Fluke’s website for recycle information.

Local and Remote Operation

When the Meter is operated from a host, it is said to be operated *remotely*. When operated from the front panel, it is said to be operated *locally*.

Most operations that can be performed locally can also be performed remotely over the remote interface. Some operations, like setting communications parameters for the RS-232 interface, and addressing the Meter for IEEE 488 operations can only be set through the front panel.

⚠⚠ Warning

To avoid electric shock, turn off the signal source to the Meter before touching the test leads. The front panel display may not indicate the true input voltage while in remote mode. Always assume lethal voltages exist on the front-panel inputs.

Computer Interfaces

Both the 8845A and 8846A Multimeters come equipped with an RS-232, Ethernet, and IEEE 488 interface. Only one remote interface can be enabled at a time. Using any of the interfaces turns the Meter into a fully programmable instrument that can be integrated into an automated instrumentation system. For a PC with only USB ports, Fluke makes a cable (Fluke PN 2675479) that converts between USB and RS-232 ports.

Note

The remote interface port and settings can be changed only through the Meter's front-panel controls.

Enabling or selecting a port for remote operation is a separate process from setting the various parameters associated with a remote interface. An interface does not have to be selected to set its parameters; the baud rate of the RS-232 port can be set while the Meter has the LAN port enable, as the remote control port.

Optimizing System Speed for IO Operation

Several factors affect the remote system speed of the 8845A/46A. To make the fastest measurements, it is best to store the measurements in internal memory before transferring across the IO bus. This is particularly true if you want to collect a large number of samples per measurement. Set up all of the parameters (i.e. function, range, filters, etc...) prior to the measurements. Use the internal trigger. Set the trigger delay to zero. Turn off the display. If operating with RS232, use the fastest baud rate available. The commands that will run the fastest are the "INIT" and "FETCH?" combination.

One example of taking the fastest voltage readings is:

```
*cls                # This clears all error prior to initiating readings

conf:volt:dc 0.1    # Set the DC range to manual and 100 mV.

volt:dc:nplc 0.02   # Set the NPLC to faster reading rate 4 1/2 digits.

zero:auto 0         # Turn Autozero off.

trig:sour imm       # Set immediate trigger.

trig:del 0          # Set trigger delay to zero.

trig:coun 1         # Set trigger count to one or specify a larger number.

disp off            # Turn display off. This may slightly improve reading rate.

syst:rem            # Put the 8846 in remote. Only needed for RS-232 or Ethernet
                    #(required for READ?)

samp:coun 100       # Set the sample count from 1 to 5000.

:INIT; *OPC?        # "*OPC?" returns 1 indicating that the measurements have been
                    taken and are ready to be transferred to the computer using the
                    FETCH? command.

:FETCH?
```

Note

For any sample count greater than 1, measurements are returned comma separated.

Selecting the Remote Interface Port

To enable or select a port for remote control of the Meter:

1. Press INSTR SETUP.
2. Press PORT IF.
3. Press SELECT PORT.
4. Press the soft key labeled with the desired port: RS-232C, IEEE488, or LAN.

Port selection is non-volatile. Therefore, the selected port will remain active until another port is selected through the front panel.

Configuring the IEEE-448 Port

The IEEE 488 interface is designed in compliance with supplemental standard IEEE 488.2. Devices connected to the bus in a system are designated as talkers, listeners, talker/listeners, or controllers. The connector for connecting the Meter to the IEEE 488 bus is located on the rear panel. Under control of an instrument controller, the Meter operates exclusively as a talker/listener on the IEEE 488 bus.

The Meter conforms to the Standard Specification IEEE 488.1 – 1987: *IEEE Standard Digital Interface for Programmable Instrumentation*, and to IEEE 488.2 - 2004: *Codes, Formats, Protocols, and Common Commands*.

IEEE 488 Operating Limitations

The following limitations govern the IEEE 488 remote interface:

- A maximum of 15 instruments may be connected in a single IEEE 448 bus system.
- The maximum length of IEEE 488 cable used on a single IEEE 488 system must be the lesser of 20 meters, or 2 meters times the number of devices in the system.

Setting the IEEE 488 (GPIB) Port Address

Before the Meter will accept commands through the IEEE 488 remote interface, IEEE 488 must first be enabled or selected as the active interface port. This can only be done through the Meter's front panel.

A controller uses an address between 1 and 32 to identify a specific instrument on the bus. The Meter is shipped from the factory with the IEEE 488 port address set to 1. To change the IEEE 488 address:

1. Press INSTR SETUP.
2. Press PORT IF.
3. Press IEEE488.
4. Use the soft keys to set the address as follows.

   Select the address digit to adjust by pressing either <-- or -->.

   With the desired digit selected, press the soft key labeled -- to decrement the digit or ++ to increment the character.
5. With the desired address set, press ENTER.

Capability Commands

To conform to the IEEE 488.1 standard specification, it is not essential for a device to encompass the full range of bus capabilities. The IEEE 488.1 document describes and codes the standard bus features, so that manufacturers may give brief coded descriptions of their own interfaces' overall capability.

The codes that apply to the Meter are given in Table 1 below, together with short descriptions. These codes conform to IEEE 488.2 requirements.

Appendix C of the IEEE 488.1 document contains a complete description of each code.

Table 2. IEEE 488 Compatibility Codes

IEEE 488 Subset	Interface Functions
SH1	Source Handshake Capability
AH1	Acceptor Handshake Capability
T5	Talker (basic talker, serial poll, unaddressed to talk if addressed to listen)
L4	Listener (basic listener, unaddressed to listen if addressed to talk)
SR1	Service Request Capability
RL1	Remote/Local Capability (includes local lockout)
PP0	No Parallel Poll Capability
DC1	Device Clear Capability
DT1	Device Trigger – Supports group trigger (GET).
C0	No Controller Capability
E2	Open-Collector and Three-State Drivers

Interconnections

Instruments fitted with an IEEE 488 interface communicate with each other through a standard set of interconnecting cables, as specified in the *IEEE 488.1 Standard* document.

The IEEE 488 interface connector is located on the Meter's rear panel.

Configuring the RS-232 Port

The RS-232 Communication Interface allows ASCII, asynchronous, serial communication between the Meter and a host or terminal. The following sections describe the process of configuring the RS-232 port. To make the RS-232 port the active port for remote operation, see the "Selecting the Remote Interface Port" section above.

Table 3 lists the RS-232 parameter settings when the Meter leaves the factory.

Table 3. Factory Settings of RS-232 Communications Parameters

Parameter	Factory Setting
Baud Rate	9600
Parity	None (Parity bit 0)
Number of Data Bits	8 (7 data bits plus 1 parity bit)
Number of Stop Bits	1
Flow Control	None

To access the RS-232 setup menu:

1. Press INSTR SETUP.
2. Press the PORT IF soft key.
3. Press the RS232 soft key.

   At this point, all the RS-232 settings are made available.

Note

All RS-232 port parameter settings are non-volatile and remain set until changed.

Setting RS-232 Baud Rate

To set the baud rate:

1. With the RS-232 set up menu displayed, press BAUD RATE.

   There are eight pre-defined settings: 1200, 2400, 4800, 9600, 19200 38400, 57600, 115200, and 230400. These selections are displayed in two separate menus. When first entering baud rate selection, baud rates 9600 to 1200 are displayed. To get to the next five higher baud rates, press MORE. To get back to the lower baud rates, press BACK.

2. With the desired baud rate displayed, press the soft key under the chosen baud rate.

Setting RS-232 Parity and Data Bits

To set the data bits:

1. With the RS-232 set up menu displayed, press PARITY DATA BIT.
2. Press the soft key under the desired parity, and data bit parameter.

NONE 8B DATA = No parity with 8 data bits
ODD 7B DATA = Odd parity with 7 data bits
EVEN 7B DATA = Even parity with 7 data bits

Setting RS-232 Stop Bits

To set the stop bits:

1. With the RS-232 set up menu displayed, press PARITY DATA BIT.
2. Press the soft key labeled 2 STOP BITS to toggle between 1 and 2 stop bits.

Note

When 2 STOP BITS is highlighted, the interface is configured to use 2 stop bits.

Setting RS-232 Flow Control

To set flow control:

1. With the RS-232 set up menu displayed, press FLOW CONTROL.
2. Press the soft key under the desired flow control.

NONE = No flow control
XON = Software flow control Xon (hex 11) and Xoff (hex 13)
RTS = Hardware flow control, RTS/DTS

Setting RS-232 End-Of-Line Character

To set the End-Of-Line (EOL) character:

1. With the RS-232 set up menu displayed, press EOL.
2. Press the soft key labeled with the desired End-Of-Line character(s).

CR = Carriage return only
LF = Line Feed only
CR LF = Carriage Return and Line Feed

Enabling and Disabling Fluke 45 Emulation Echo

Although you can turn echo on or off at anytime, the selection is used only when the Meter’s command mode is set to Fluke 45 emulation.

To enable or disable Echo for the RS-232 port:

1. With the RS-232 set up menu displayed, press COMP/TERM ECHO.
2. Press either the ECHO or NO ECHO soft key.

RS-232 Modes of Operation

RS-232 communication is slightly different between the 884X and Fluke 45 emulation modes. Switching between these two commands sets is covered in the “Selecting the Programming Language” section later in this manual. The following sections explain the differences in communications protocol and how to set the Meter and computer parameters for proper operation.

884X Mode

There are two modes of RS-232 operation when the Meter has the 884X command set selected: TERMINAL and COMPUTER. The *terminal* mode is an interactive mode where an operator inputs commands, with immediate returns for requested information (queries) and interface messages. In terminal mode, characters sent to the Meter are echoed on the host’s display screen and a command prompt (for example 3>) is returned after the CR/LF is entered by the terminal. If you send a character to the Meter over the RS-232 interface, pressing the <DELETE> or <BACKSPACE> key deletes the previous character. A backspace is echoed to the host terminal.

Note

^C (CNTRL C) is the RS-232 equivalent of IEEE 488 DCI (device clear), causing “1>” followed by a carriage return and line feed to be output.

The *computer* mode is used when the Meter is operated by computer program. In this mode, requested information is returned by query, and interface messages are queued and returned by command. Characters are not echoed on the host computer and command prompts are suppressed. The <DELETE> or <BACKSPACE> keys are ignored.

Selecting Between Computer and Terminal Mode

Although you can select between Computer and Terminal mode at any time, the selection is used only when the Meter’s command mode is set to 884X.

To select computer or terminal mode from the front panel:

1. Press INSTR SETUP and then PORT IF.

Note

If the RS232 port is not already highlighted, press SELECT PORT *and then* RS232*.*

2. Press either RS232, COMP/TERM ECHO and select either COMPUTER or TERMINAL.

Fluke 45 Mode

In the Fluke 45 Command emulation mode, there are two modes of RS-232 operation: ECHO or NO ECHO. In *Echo* mode, characters sent to the Meter are echoed on the host’s display screen. In *No Echo* mode, characters sent are not echoed.

To set the echo parameter, refer to the "Enabling and Disabling RS-232 Echo" section earlier in this manual. If you send a character to the Meter over the RS-232 interface, pressing the <DELETE> or <BACKSPACE> key deletes the previous character. A backspace is echoed to the display screen if Echo On mode is set.

In either mode, when the host sends a command to the Meter over the RS-232 interface, the Meter parses and executes the command, and returns a response if appropriate, and sends one of three prompts:

=> No errors were detected and the command was successfully parsed and executed.

?> A Command Error was detected. The command was not executed because it was not understood. For instance, this prompt would be returned if the Meter was sent an input string that contained a syntax error.

!> An Execution Error was detected. The command was understood but not executed (i.e., a device-dependent error). For instance, this prompt would be returned if you attempted to use the decibels modifier (dB) on a frequency measurement (FREQ).

Note

^C (CNTRL C) is the RS-232 equivalent of IEEE-488 DCI (device clear), causing "=>" followed by a carriage return and line feed to be output.

Terminations for the end of line can be set to carriage return (CR), line feed (LF), or both (CRLF). Terminations for the end of line can be set in the <Instr SETUP><PORT IF><RS232C> selection.

To change the Meter into Fluke 45 Emulation Mode, setup the remote interface for RS232 or IEEE488 (Fluke 45 mode will not work over Ethernet):

For RS232

1. Press INSTR SETUP
2. Press PORT IF softkey.
3. Press the SELECT PORT softkey.
4. Press the RS-232 softkey.

Set the baud rate to 9600 as follows:

1. Press INSTR SETUP
2. Press PORT IF softkey.
3. Press the RS-232 softkey.
4. Press the BAUD RATE softkey.
5. Press the 9600 softkey.

Set the RS232 port to non-echo as follows:

1. Press INSTR SETUP
2. Press PORT IF softkey.
3. Press the RS-232 softkey.
4. Press the COMP/TERM ECHO
5. Press the NO ECHO softkey.

For IEEE488

1. Press INSTR SETUP
2. Press PORT IF softkey.
3. Press the SELECT PORT softkey.
4. Press the IEEE-488 softkey.

Set the IEEE488 address to a system compatible value as follows:

1. Press INSTR SETUP
2. Press PORT IF softkey.
3. Press the IEEE-488 softkey.
4. Use the soft keys to set the address as follows.

   Select the address digit to adjust by pressing either <-- or -->.

   With the desired digit selected, press the soft key labeled -- to decrement the digit or ++ to increment the character.
5. With the desired address set, press ENTER.

To set the Meter to Fluke 45 emulation:

1. Press INSTR SETUP
2. Press the COMMANDS softkey.
3. Press the Fluke 45 softkey.

Operating with FlukeView Forms'

When first powered up, FlukeView Forms sends remote commands to the serial port asking an instrument to identify itself. Because the Meter does not recognize the commands for the other instruments, an error indication (Syntax error [-102]) is shown on the Meter's front panel. This is considered normal operation. See FlukeView Forms documentation for information on setting up that application. When controlling the Meter with FlukeView Forms, ECHO must be set to NO ECHO.

Interconnections

The Meter communicates with a host through a DB-9 interface connector on the rear panel of the Meter. Connect the Meter to the host or terminal using a cable appropriate to your application that is less than 50 feet (15 meters) long. Longer cables are permitted, providing that the load capacitance measured at the interface point (including the signal terminator) does not exceed 2500 picofarads.

Figure 1 shows the pin-out of the Meter's RS-232 port, and two possible cable connections for communicating with a PC.

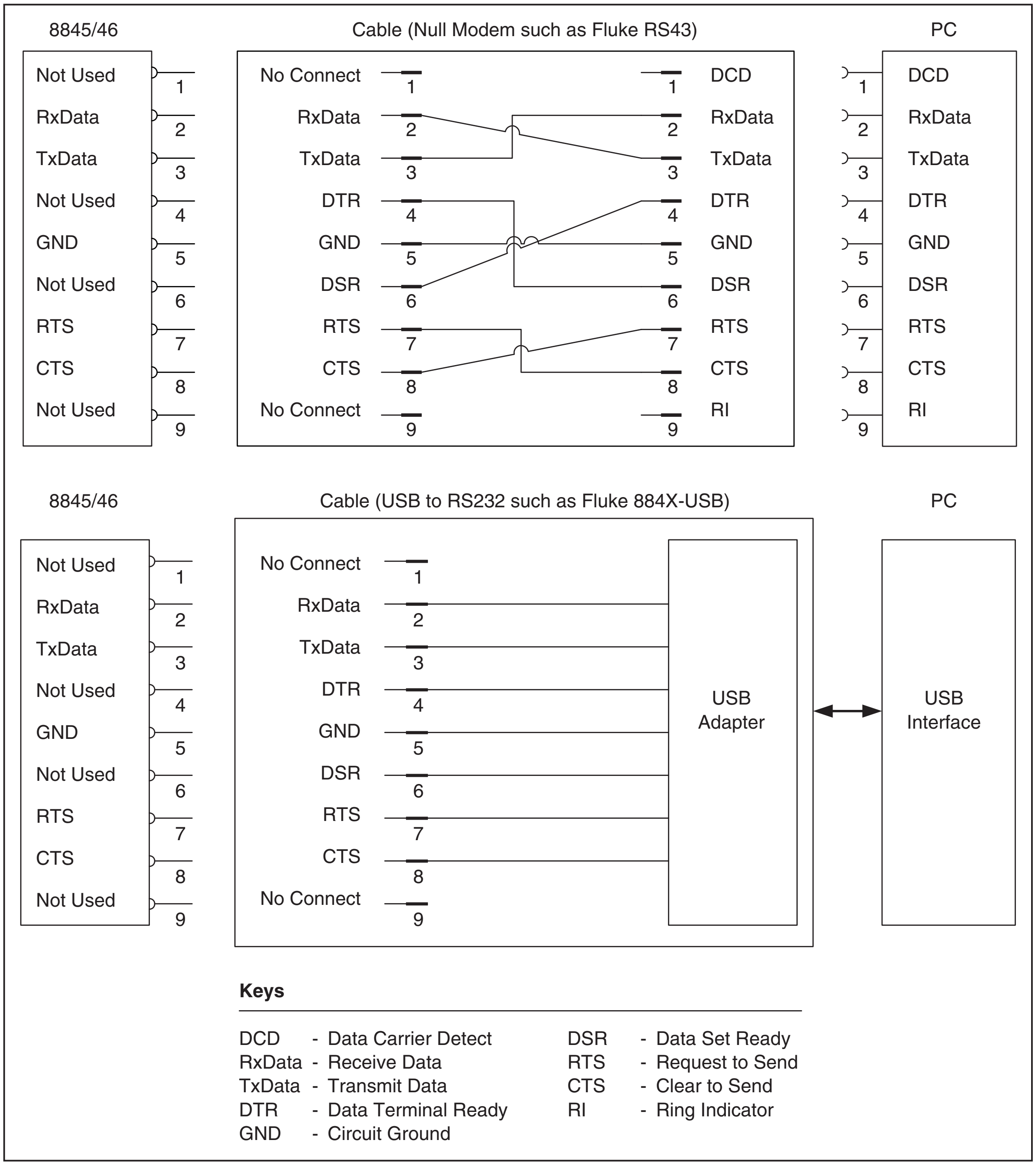


Figure 1. RS-232 Pin-out and Cable Interconnect

Configuring the Ethernet (LAN) Port

The Meter can be remotely controlled through the LAN port on the Meter’s rear panel. To select the LAN port as the remote control port, see the “Selecting the Remote Interface” above.

Configuring the LAN port is accomplished through the Instrument Setup function. The selectable LAN port parameters are: DHCP (Dynamic Host Configuration Protocol), IP Address, Net mask, Host Name, Mac Address, Gateway, Port number, and Domain.

When setting IP addresses, subnet masks, and default gateways on the Meter, keep in mind they are stored as 32-bit binary numbers and expressed as four 3-digit segments in dot-notation form. For example, xxx.xxx.xxx.xxx where xxx is a byte value.

To set the LAN port parameters:

1. Press INSTR SETUP.
2. Press the PORT IF soft key.
3. Press the LAN soft key.

Note

When addressing some LAN addresses, computers will often interpret 0's in the IP address as OCTAL values. As an example, if you configure your IP address from the front panel as 129.196.017.023 and then attempt to establish a connection to the meter, you should connect using the IP address 129.196.17.23. Attempting to establish a connection to 129.196.017.023 may result in a connection request to 129.196.15.19.

Setting the IP Address

An internet (IP) address is required for all internet and TCP/IP communications. If DHCP is enabled, the Meter will use the dynamic address supplied by the DHCP server. However, if the DHCP server fails to supply the address, or DHCP is disabled, the currently configured static IP address will be used.

Selecting Dynamic Host Configuration Protocol (DHCP)

Dynamic Host Configuration Protocol (DHCP) is a client-server protocol that eliminates having to manually set permanent/static IP addresses. The DHCP server provides configuration parameters (dynamic IP address, subnet mask, and default gateway IP addresses) which are required for a client host to participate in an IP network.

Using DHCP is the easiest way to configure the Meter for remote communication through the LAN interface. DHCP is enabled when the Meter is shipped from the factory. When connected to a network, and the LAN port enabled, the Meter will try and retrieve the parameters from a DHCP server necessary for communications. If the parameters can't be obtained, the Meter switches to the parameters that were manually entered into the Meter.

To disable or enable DHCP on the Meter:

From the PORT IF menu, press LAN. If DHCP is already enabled, then DHCP will be highlighted in the display. Pressing DHCP will toggle between enabled and disabled.

Note

After changing any Ehternet setting, the Meter must be powered off and on again to make the change active.

Setting a Static Internet Address

The Meter comes from the factory with 000.000.000.000 in the static IP address register.

Note

If you are planning to use the Meter on a corporate LAN and do not wish to use DHCP, contact your network administrator for a static IP address to be used exclusively in your Meter. DHCP must be disabled to set a static IP address.

To change the Meter's static IP Address:

1. From the LAN Port setup menu, press the IP_ADDR soft key.
2. Use the soft keys to set the IP Address as follows:

   To select the address character to adjust, press either <-- or -->.

   With the desired digit selected, press the soft key labeled -- to decrement the digit or ++ to increment the character.
3. Press the ENTER soft key.

Note

*The IP address is stored in non-volatile memory, and does not change when power is removed and reapplied to the Meter or receives an *RST command.*

Setting the LAN Subnet Mask

If communication between the host computer and the Meter passes through a router or gateway, and DHCP is disabled, you must set the subnet mask and default gateway address on both the host computer and the Meter. Get the correct subnet mask and gateway address from your network administrator.

The LAN Subnet Mask is a 32-bit number. This number is represented as four 3-digit segment numbers on the front-panel display. The default subnet mask set at the factory is 255.255.254.0.

To change the Meter's subnet mask:

1. From the LAN Port setup menu, press the NETMASK soft key.
2. Use the soft keys to set the subnet mask as follows:

   To select the mask character to adjust, press either <-- or -->.

   With the desired digit selected, press the soft key labeled -- to decrement the digit or ++ to increment the character.
3. Press the ENTER soft key.

The new Subnet Mask will not take effect until the Meter has been powered down and back up again using the rear-panel power switch.

Reading the Domain Name

The Domain Name is supplied by the DHCP server and can not be changed. To read the domain name:

1. From the LAN Port setup menu, press MORE.
2. Press the DOMAIN soft key.
3. Press BACK to return to the LAN Port setup menu.

Configuring the Host Name

The Host Name is the host portion of the domain name, which is translated into an IP address. The Meter's default host name is "test1".

To change the Host Name:

1. From the LAN Port setup menu, press the HOSTNAME soft key.
2. Use the soft keys to set the Host Name as follows:

   To select the mask character to adjust, press either <-- or -->.

   With the desired digit selected, press the soft key labeled -- to decrement the digit or ++ to increment the character.
3. Press the ENTER soft key.

The new Host Name will not take effect until the Meter has been powered down and back up again using the rear-panel power switch.

Reading the MAC Address

The MAC Address is set at the factory and cannot be changed. To read the MAC Address:

1. From the LAN Port setup menu, press MORE.
2. Press the MAC_ADDR soft key.
3. Press BACK to return to the LAN Port setup menu.

Configuring the LAN Default Gateway

The default gateway IP address is the IP address of a gateway (router) attached to the same network as the device. When the instrument detects that a host computer is not on the same network (using the network number), the data is sent through the gateway to reach the host computer.

The default for the Meter is “0” (no gateway, and subnetting is not being used).

To set the LAN Default Gateway:

1. From the LAN Port setup menu, press MORE.
2. Press GATEWAY.
3. To select the digit to adjust, press either <-- or -->.

   With the desired digit selected, press the soft key labeled -- to decrement the digit or ++ to increment the character.
4. Press the ENTER soft key.

The new gateway address will not take effect until the Meter has been powered down and back up again using the rear-panel power switch.

Configuring the General Network Socket Port

In order to communicate with each other, a host computer and the Meter must use the same socket port number. The default port is 3490. Typically, the default port does not need to be changed. If the socket port must be changed, enter the Socket Port number supplied by your network administrator.

To change the port:

1. From the LAN Port setup menu, press the MORE soft key.
2. Press the PORT # soft key.

3. To select the digit to adjust, press either <-- or -->.

   With the desired digit selected, press the soft key labeled -- to decrement the digit or ++ to increment the character.

4. Press the ENTER soft key.

The Network Socket Port becomes effective immediately.

Note

The Network Socket Port Number is stored in non-volatile memory.

Establishing an Ethernet Connection

The easiest method of establishing an Ethernet connection with the Meter is through the commonly available program: Telnet. Telnet is a client-server protocol, based on TCP. The Telnet Protocol provides a fairly general, bi-directional, eight-bit byte oriented communications facility. Telnet is available on all UNIX servers and on most PCs.

Telnet clients typically connect to hosts on socket port 23. The LAN connection to the Meter must be established using the specified Network Socket Port. See the “Configuring the General Network Socket Port” section above. When the remote interface port is changed to LAN from the Meter’s front panel, a LAN server is initiated in the Meter which listens for client connections on the socket port at the specified IP address.

To establish a LAN connection to the Meter from a PC using either UNIX or MS-DOS command prompt, perform the following procedure:

1. On the Meter’s front panel, change the remote interface port to LAN

2. At the Unix or DOS command prompt on the client PC, enter:

   ```
   telnet   IP Address    Socket Port
   ```

   Alternatively, if you are using DHCP and would like to connect using the host name rather than the IP address, from the Unix or DOS command prompt enter:

   ```
   telnet   Domain Name    Socket Port
   ```

As an example, if you know the IP address is 129.196.136.131 and the Socket Port is set to 3490, enter the following at a UNIX or DOS command prompt from any client PC:

```
telnet   129.196.136.131  3490
```

If you are using DHCP and the host name is **test1** and the fully qualified domain name is **test1.na.flukecorp.com** and the Socket Port is set to **3490**, enter the following at the UNIX or DOS command prompt:

```
telnet   test1.na.flukecorp.com  3490
```

Once the internal LAN server connects with the client computer, the LAN server will reject any other connection attempts by other computers and will “tunnel” a channel to the connected computer. This prevents multiple computers from trying to control the Meter.

Terminating an Ethernet Connection

When you wish to terminate the Ethernet connection, you may do so one of two ways:

1. Change the Meter's remote interface port to something other than LAN
2. Terminate the Telnet session on the client computer

If you have established a LAN connection to the Meter using Telnet and change the remote interface port using the Meter's front panel, the LAN server in the Meter will automatically terminate the Telnet session on the client computer.

On the other hand, you may wish to terminate the Telnet session on the client computer but maintain the current LAN remote interface port configuration. To do this, you terminate the Telnet session on the client computer. Client Telnet session termination can vary from computer to computer, but typically terminating the shell (or command window in DOS) will terminate the telnet session. When the client terminates the Telnet session, the LAN server in the Meter will go back into *listen* mode waiting for a new client to make a LAN connection request.

Selecting the Programming Language

The Meter's remote command set is switchable between 8845 and Fluke 45 commands. The Meter's standard remote command set (8845) is compatible with Agilent's 34401A command set. Although every effort was made to make the Meter compatible with Fluke 45 commands, there are some commands that are not compatible. See Appendix B, "Fluke 45 Emulation Limitations" for details on commands that are not compatible with this Meter.

To change the Meter's remote command set:

1. Press INSTR SETUP.
2. Press the COMMANDS soft key.
3. Press the soft key labeled with the desired command set.

Getting Started With an Installation Test

After the Meter has been cabled to a host, and prepared to communicate with it via the RS-232 or IEEE 488 interface (as described above), test the system to verify that it is operational.

Installation Test for RS-232 Connections

The procedure below illustrates how the Meter performs a computer interface command and, at the same time, confirms that the Meter has been properly set up and connected for RS-232 remote operations:

1. Press the POWER button in to turn the Meter on.
2. Start up a computer terminal program.
3. Verify that the computer interface parameters (e.g., baud, parity) are set correctly.
4. Send the Meter the following command.

   *IDN? <CR>

5. Verify that the Meter sends the following response:

In Fluke 8845 mode (includes 8846A):
Fluke, 884XA, nnnnnnnm, mm/dd/yy – tt:tt

In Fluke 45 mode:
FLUKE, 45, nnnnnnn, n.n Dn.n

Of these results, *nnnnnnn* is your Meter's serial number; *n.n* identifies the main software version; and *Dn.n* identifies the display software version.

Installation Test for IEEE 488 Connections

The procedure below illustrates how the Meter performs a computer interface command and, at the same time, confirms that the Meter has been properly set up, and connected for IEEE 488 operations:

1. Turn the Meter on.
2. Verify that the meter's IEEE 488 address is set correctly.
3. Turn on the host or controller.
4. Enter the following at the host:

Note

This is a BASIC program to give an idea of how the test could be done. Syntax may vary with the host.

```
INIT PORT 0<CR>
CLEAR PORT 0<CR>
PRINT @<address of meter>, "*IDN?"<CR>
INPUT LINE @<address of meter>, A$<CR>
PRINT A$<CR>
```

5. Verify that the meter sends the following response

In Fluke 8845 mode (includes 8846A):
Fluke, 884XA, nnnnnnnm, mm/dd/yy – tt:tt

In Fluke 45 mode:
FLUKE, 45, nnnnnnn, n.n Dn.n

Of these results, *nnnnnnn* is your meter's serial number, *n.n* identifies the main software version, and *Dn.n* identifies the display software version.

If Test Fails

If the Meter does not respond to the test procedure as indicated:

1. Check all cable connections.
2. Check to see the remote interface has been properly enabled and addressed.

How the Meter Processes Input

The following paragraphs summarize how the Meter processes input that is received from a host or stand-alone terminal.

Note

In this manual input *means a string sent to the Meter from a host.* Output *means a string sent from the meter through the computer interface to the host.*

Input Strings

The meter processes and executes valid *input strings* sent by the host. A valid input string is one or more syntactically correct commands followed by an *input terminator*.

When the meter receives input, it stores it in a 350-byte input buffer.

Note

Input strings received over the RS-232 interface are not executed or checked for proper syntax until an input terminator is received or the input buffer becomes full.

The Meter accepts alphabetic characters in either upper- or lower-case. If a command cannot be understood (i.e. the equivalent of an IEEE 488 *Command Error*), the remainder of the command line is ignored.

Input Terminators

An input terminator is a character or command (IEEE 488.1) sent by the host that identifies the end of a string.

In RS-232 applications, when the Meter receives an input terminator, it executes all commands entered since the last terminator was received on a first-in, first-out basis.

As input characters are processed and executed, space is made available in the input buffer for new characters. In RS-232 applications, if a communications error (e.g., parity, framing, over-run) is detected, a device-dependent error is generated, and the input string discarded. If the Meter's input buffer becomes full when it is used with the RS-232 interface, a device-dependent error is generated (see "Event Status and Event Status Enable Register"), and the input string is discarded. If, on the other hand, the input buffer becomes full when the IEEE 488 interface is used, the Meter stops accepting characters until there is room in the buffer. Characters in the input buffer cannot be over-written with the IEEE 488 interface.

Valid terminators for the RS-232 interface are:

- LF (Line Feed)
- CR (Carriage Return)
- CR LF (Carriage Return/ Line Feed)

Valid terminators for the IEEE 488 interface are:

- EOI (End or Identity) on any character
- LF (Line Feed)

In some instances, a terminator is automatically transmitted at the end of the host's output string (i.e., the Meter's input string). For example, in Fluke BASIC, the PRINT statement finishes with a CR LF pair.

Typical IEEE 488 Input Strings

Two typical strings that could be sent to the Meter over the IEEE 488 interface are shown in Figure 2. These strings are written in Fluke BASIC to be sent from a Fluke 1722A Instrument Controller.

Sending Numeric Values to the Meter

Numeric values can be sent to the Meter as integers, real numbers, or real numbers with exponents, as shown in the following examples:

EXAMPLE	EXPLANATION
+12345689	Sends the signed integer +12345689
-1.2345E2	Sends -1.2345 x 10^2

Sending Command Strings to the Meter

Observe the following rules when you construct strings to be sent to the Meter over the computer interface:

- RULE 1: READ METER'S OUTPUT BUFFER ONLY ONCE FOR EACH QUERY COMMAND.

  The Meter's output buffer is cleared after it has been read. This prevents previously read data from being read a second time by mistake. If you attempt to read the meter's output buffer twice without an intervening query, the Meter will not respond to the second read.

- RULE 2: READ QUERY RESPONSES BEFORE SENDING ANOTHER QUERY COMMAND STRING.

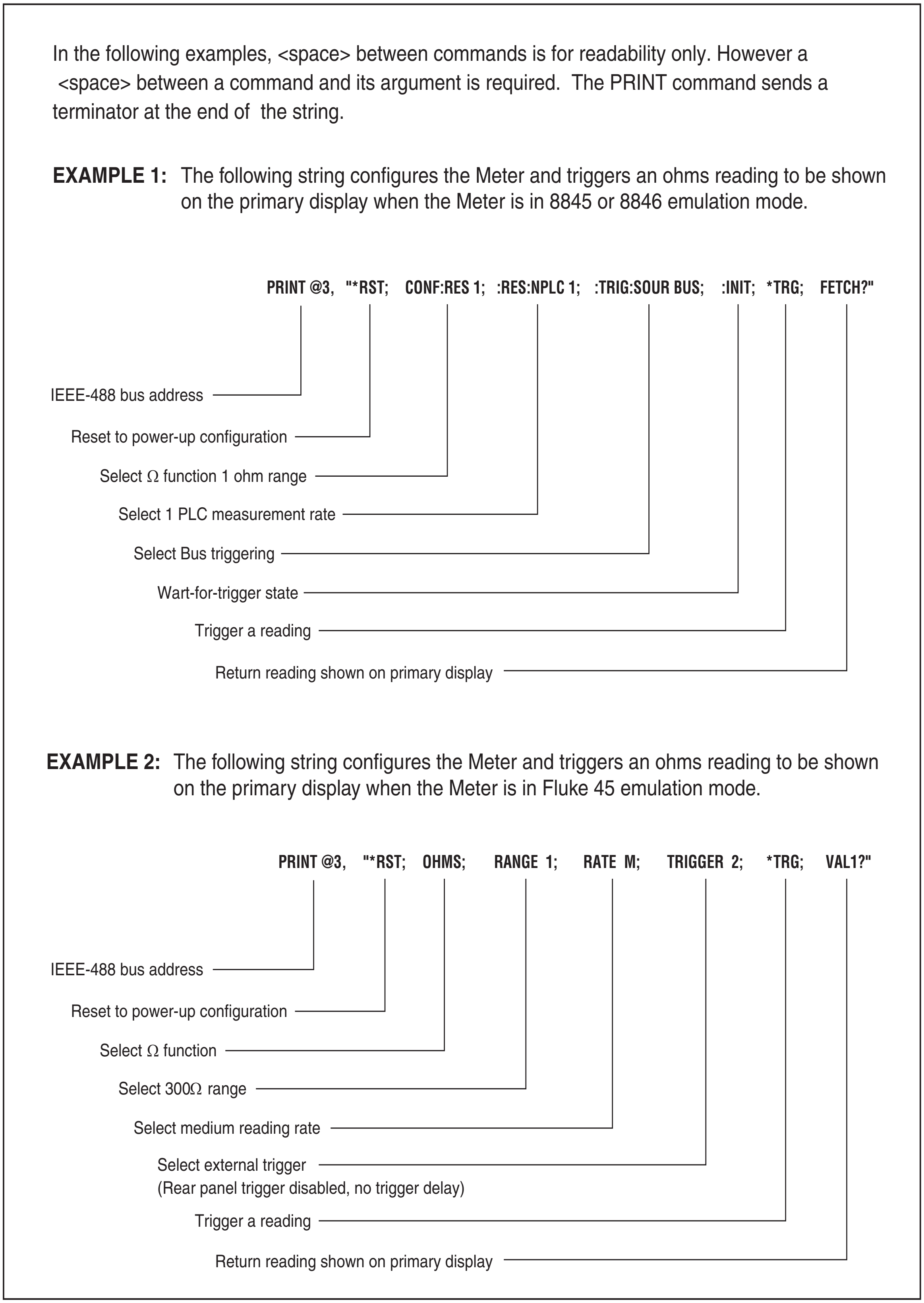
  Output data remains available in the output buffer until read by the host or until the next command string is received by the Meter. This means the Meter's output buffer must be read by the host before, rather than after, the next command string is sent to the Meter.

- RULE 3: THE METER EXECUTES EACH COMMAND COMPLETELY, IN THE ORDER RECEIVED, BEFORE MOVING ON TO THE NEXT COMMAND.

  If an input string contains a trigger, enter the commands in the following order, that is, from left to right, as written:

  1. Commands (if any) to configure the Meter.
  2. The trigger command.
  3. Commands to read the result of a triggered measurement (FETCh? or READ? for the 884XA and VAL? for the Fluke 45 emulation), or to reconfigure the instrument (if any).
  4. The terminator.

Figure 2 gives two examples of a command string for the Meter. The first example is a command recognized by the Meter in the 8845 or 8846 command mode. The second example is for the Fluke 45 command mode.



In the following examples, <space> between commands is for readability only. However a <space> between a command and its argument is required. The PRINT command sends a terminator at the end of the string.

EXAMPLE 1: The following string configures the Meter and triggers an ohms reading to be shown on the primary display when the Meter is in 8845 or 8846 emulation mode.

```
PRINT @3, "*RST; CONF:RES 1; :RES:NPLC 1; :TRIG:SOUR BUS; :INIT; *TRG; FETCH?"
```

IEEE-488 bus address
Reset to power-up configuration
Select Ω function 1 ohm range
Select 1 PLC measurement rate
Select Bus triggering
Wart-for-trigger state
Trigger a reading
Return reading shown on primary display

EXAMPLE 2: The following string configures the Meter and triggers an ohms reading to be shown on the primary display when the Meter is in Fluke 45 emulation mode.

```
PRINT @3, "*RST; OHMS; RANGE 1; RATE M; TRIGGER 2; *TRG; VAL1?"
```

IEEE-488 bus address
Reset to power-up configuration
Select Ω function
Select 300Ω range
Select medium reading rate
Select external trigger
(Rear panel trigger disabled, no trigger delay)
Trigger a reading
Return reading shown on primary display

aam19f.eps

Figure 2. Typical IEEE 488 Input String

How the Meter Processes Output

The following paragraphs summarize how the Meter processes output. The Meter outputs an alphanumeric string in response to a query command from the host. Query commands are easily identified because they all end with "?". An output string is terminated by a Carriage Return and Line Feed (<CR><LF>) for RS-232 or Ethernet applications, or a Line Feed with End or Identity (<LF><EOI>) for IEEE 488.

After sending the Meter a query command via the RS-232 interface, wait for the Meter to return a prompt before sending another query command. Although the Meter will accept and process all commands other than a query command, a device-dependent command error is generated; and the second command is discarded if it is a query command.

If the Meter is part of an IEEE 488 bus system, the output data is not actually sent onto the bus until the host addresses the Meter as a talker. When the output buffer is loaded, the Message Available (MAV) bit in the Status Byte Register is set true. (For more information, see "Status Byte Register.")

Numeric output from the Meter is displayed as shown in the following examples:

EXAMPLE	EXPLANATION
+1.2345E+0	Measured value of 1.2345
+1.2345E+6	Measured value of 1.2345 x 10^6

Triggering Input

While under remote control, the Meter must be placed in a *wait-for-trigger* state before a measurement can be triggered. The INITiate and READ? commands set the Meter in to a wait-for-trigger state. The number of measurements (samples) and the number of triggers the Meter will accept after being put in a wait-for-trigger state are variables set using remote commands. The defaults for these variables are one sample per trigger and one trigger per wait-for-trigger state. See the Trigger and Sample remote commands to set these values.

All available trigger methods fall into two basic categories:

- *Internal* triggering uses the Meter's internal trigger circuit for a continuous source of triggers.
- *External* triggering comes from a source outside the Meter controlled by the user.

Internal Triggering

When the Meter's trigger source is set to immediate, measurements are triggered by the Meter's internal trigger circuit. As an example, with the sample count set to 5 and the trigger count set to 2, the Meter will collect 10 measurements after it receives an INITiate or READ? command and then stop taking measurements. The READ? command will return all 10 readings immediately while the INITiate command must be followed by a FETCh? command to retrieve the measurements.

External Triggering

There are three methods of triggering the Meter externally:

- A trigger signal applied to the external trigger jack on the Meter's rear panel.

  When the Meter's trigger source is set to external and the Meter is in a wait-for-trigger state, a negative-going signal on the external trigger jack will trigger a measurement cycle.

- IEEE 488.1 GET command (IEEE Interface only)
- *TRG command

  When the Meter's trigger source is set to BUS and the Meter is in a wait-for-trigger state, either a *TRG or bus GET command will trigger the Meter to take measurements.

Service Requests (IEEE 488 Only) and Status Registers

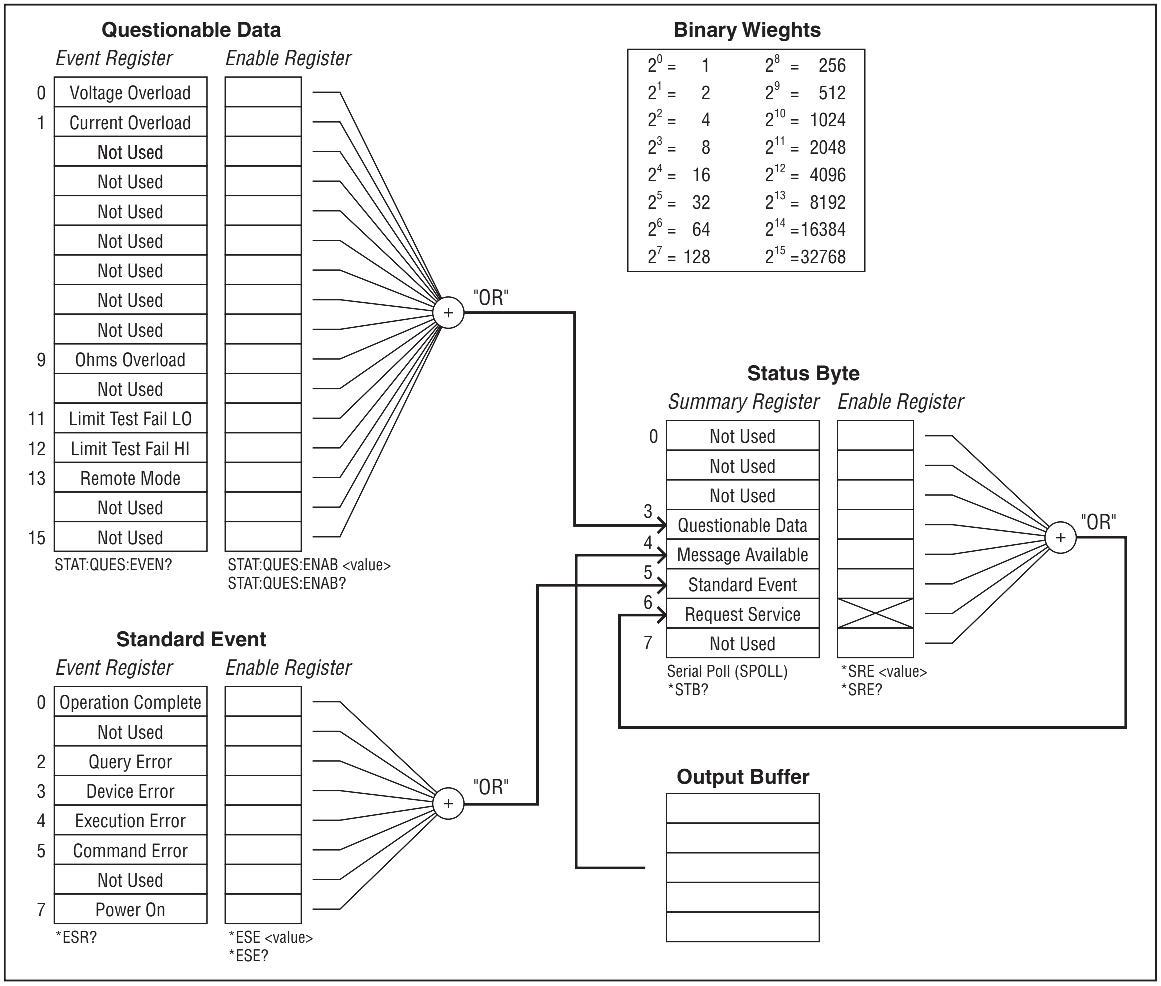
Service requests let an instrument on the IEEE 488 bus get the attention of the host. Service requests are sent over the service request (SRQ) bus line.

If more than one instrument on the bus is capable of sending service requests, the host can determine which instrument made the request by taking a *serial poll*. Each instrument on the bus responds to the poll by sending the contents of its Status Byte Register. If an instrument on the bus has made a service request, the request service bit (RQS, bit 6) of its Status Byte Register will be set to 1, identifying it as an instrument that requested service.

The contents of the Status Byte Register (STB) is determined by the Service Request Enable Register (SRE), Standard Event Status Register (ESR), Standard Event Status Enable Register (ESE), Questionable Data Event Register, Questionable Data Enable Register, and the output buffer. These status registers are discussed below, and summarized in Table 4. Figure 3 shows the relationship of these registers.

Table 4. Status Register Summary

Register	Read Command	Write Command	Enable Register
Status Byte Resister	*STB?	None	SRE
Status Byte Enable Register	*SRE?	*SRE	None
Standard Event Register	*ESR?	None	ESE
Standard Event Enable Register	*ESE?	*ESE	None
Questionable Data Event Register	STAT:QUES:EVEN?	None	Questionable Data Enable Register
Questionable Data Enable Register	STAT:QUES:ENAB?	STAT:QUES:ENAB <value>	None



2^0 = 1	2^8 = 256
2^1 = 2	2^9 = 512
2^2 = 4	2^{10} = 1024
2^3 = 8	2^{11} = 2048
2^4 = 16	2^{12} = 4096
2^5 = 32	2^{13} = 8192
2^6 = 64	2^{14} =16384
2^7 = 128	2^{15} =32768

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Figure 3. Overview of Status Data Structure

Standard Event Status and Standard Event Status Enable Registers

The Standard Event Status Register (ESR) assigns events to specific bits (see Figure 3 and Table 5). When a bit in the ESR is set (for example, 1), the event that corresponds to that bit has occurred since the register was last read or cleared. For example, if bit 3 (DDE) is set to 1, a device-dependent error has occurred.

The Standard Event Status Enable Register (ESE) is a mask register that allows the host to enable or disable (mask) each bit in the ESR. When a bit in the ESE is 1, the corresponding bit in the ESR is enabled. When any enabled bit in the ESR changes from O to 1, the Standard Event bit in the Status Byte Register also goes to 1. When the ESR is read (using the *ESR? command) or cleared (using the *CLS command), the Standard Event bit in the Status Byte Register returns to 0.

Table 5. Description of Bits in ESR and ESE

Bit No.	Name	True (Set to 1) Conditions
0	Operation Complete (OPC)	All commands previous to receipt of an *OPC command have been executed. Interface is ready to accept another message.
1	Not used	Always set to zero.
2	Query Error (QYE)	Attempt has been made to read data from the Meter's output buffer when no output is present or pending. Possibly a new command line has been received before a previous query has been read or both input and output buffers are full.
3	Device-Dependent Error (DDE)	Incorrect input during calibration, or RS-232 input buffer overflow.
4	Execution Error (EXE)	Command was understood but could not be executed. Results from, for example, an inappropriate parameter.
5	Command Error (CME)	Command not executed because it was not understood. This condition might occur when, for example, a command sent to the meter contained a syntax error.
6	Not used	Always set to zero.
7	Power On	(PON) Power has been cycled off and on since the last time the ESR was read or cleared.

Questionable Data Event Register and Questionable Data Enable Register

The Questionable Data Event Register provides information about the Meter’s measurements. Information such as overload conditions, high/low limits, and whether or not the Meter is in remote mode or not can be reported through the questionable data summary bit. Once a bit is set by the Meter, it remains set until it is read from the register or is cleared. The sixteen bits of the Questionable Data Event Register are described in Table 6.

The Questionable Data Enable Register determines which of the bits in the Questionable Data Event Register will be used to the set the Questionable Data Summary bit in the Meter’s Status Byte. When a bit in the Questionable Data Enable Register is 1, the corresponding bit in the Questionable Data Event Register is enabled. When any enabled bit in the Questionable Data Event Register changes from 0 to 1, the Questionable Data bit in the Status Byte Register also goes to 1. When the Questionable Data Event Register is read (using the STAT:QUES:EVEN? command) or cleared (using the *CLS command), the Questionable Data bit in the Status Byte Register returns to 0.

Table 6. Description of Bits in the Questionable Data Register

Bit No.	Name	True (Set to 1) Condition
0	Voltage Overload	Input voltage has exceeded the upper limit of the range.
1	Current Overload	Input current has exceeded the upper limit of the range.
2 – 8	Not Used	
9	Ohms Overload	The resistance measurement has exceeded the upper limit of the range.
10	Not Used	
11	Limit Test Fail Lo	The measurement is below the low end of the test limit.
12	Limit Test Fail Hi	The measurement is above the high end of the test limit.
13	Remote Mode	The Meter is set in remote mode.
14 – 15	Not Used	

Status Byte Register

The Status Byte Register (STB) is a binary-encoded register that contains eight bits. Note that the Service Request Enable Register (SRE) uses bits 1 through 5, and bit 7 to set, the request service (RQS) bit 6, as enabled by the SRE. When the RQS bit is set true (l), the Meter sets the SRQ line true (1), which generates a service request. The eight bits of the Status Byte Register (as read by the *STB? command) are described in Table 7.

Reading the Status Byte Register

The host can read the Status Byte Register by performing a serial poll, or sending the Meter a ***STB?** query. The value of the status byte is not affected by the ***STB?** query. When the Status Byte Register is read, an integer is returned. This integer is the decimal equivalent of an 8-bit binary number. For example 48 is the decimal equivalent of the binary 00110000, and means that bit 4 (Message Available) and bit 5 (Standard Event) are set to “1”.

If the status byte is read by serial poll, bit 6 is returned as a request service (RQS); if it is read with an ***STB?** query, bit 6 is returned as Master Summary Status (MSS).

EXAMPLE	EXPLANATION
*STB?	Reads the Status Byte Register. Assume that “32” is returned. Converting 32 to the binary 00100000 indicates that bit 5 (Standard Event) is set to 1. To determine the event status, you would have to read the Standard Event Register in the same manner, using the ***ESR?** command.

Table 7. Description of Bits in the Status Byte Register

Bit No.	Name	True (Set to 1) Condition
0	Not used	Always set to 0.
1	Not used	Always set to 0.
2	Not used	Always set to 0.
3	Questionable Data	One or more of the enabled events in the Questionable Data Event Register have occurred. To determine which Questionable Data events have occurred, send the Meter **STAT:QUES:EVEN?** to read the Questionable Data Event Register.
4	Message Available (MAV)	Data is available in the output buffer. Bit set to 1 when response to query placed in output buffer. Bit cleared (set to 0) when output terminator sent to host.
5	Standard Event Status (ESB)	One or more of the enabled events in the Event Status Register have occurred. To determine which events have occurred, send the Meter ***ESR?** to read the Event Status Register.
6	Master Summary Status[†] (MSS)	Set to 1 if any enabled bit in the STB (MSS) register is set to 1, otherwise set to 0. Status of MSS bit returned by ***STB?** query command.
		Request Service (RQS) Set to 1 if service requested from front panel, or MSS set to 1. Status of bit returned by serial poll, which clears RQS.
7		Not Used.

† As read by ***STB?** command. If the Status Byte Register is read by a serial poll, bit 6 is returned as RQS.

Service Request Enable Register

The SRE Register is an 8-bit register that enables or disables (i.e., masks) corresponding summary messages in the Status Byte Register.

The Meter may be programmed to make a service request on errors, questionable data, or when output is available. Conditions that trigger a service request are specified by writing a binary weighted value to the SRE Register, using the ***SRE** command.

EXAMPLE	EXPLANATION
***SRE 16**	Enables the generation of an SRQ when bit 4 (Measurement Available) in the Status Byte Register is set to 1. 16 is the decimal equivalent of 00010000 binary. This means that bit 4 in SRE Register (that corresponds to the Measurement Available bit in the Status Byte Register) is 1, and all other bits are 0.

EXAMPLE	EXPLANATION
***SRE 48**	Enables the generation of an SRQ when bits 4 or 5 (Measurement Available or Standard Event) in the Status Byte Register are set to 1. The binary equivalent of 48 is 00110000, indicating that bits 4 and 5 are set to 1.

If any bit in the SRE is set to 1, the RQS bit (bit 6) in the Status Byte Register is enabled, meaning a service request can be generated when the appropriate bits in STB become 1.

Use the ***SRE?** query (see Table 10) to read the SRE Register. The Meter returns a binary-weighted integer that represents the enabled bits in the register. (The value of bit 6 will always be zero.) Convert the returned value to binary to determine the status of register bits.

EXAMPLE	EXPLANATION
***SRE?**	Reads the value of the SRE Register. Assume "32" is returned. Converting 32 to the binary 00100000 indicates that bit 5 in the SRE is set to 1.

Supported SCPI Commands

This section explains the SCPI (*Standard Commands for Programmable Instruments*) commands available to program the Meter. This section includes the following information:

- A list of the supported SCPI Commands
- A discussion of how to use the command set
- A detailed description of each command in the set
- Error handling for the 8845/8846

Note

Throughout this document, the following conventions are used for SCPI command syntax. Square brackets (**[ ]** *) indicate optional keywords or parameters. Braces (* **{ }** *) enclose parameters within a command string. Triangle brackets (* **< >** *) indicate that you must substitute a value for the enclosed parameter.*

SCPI Command Summary

Tables 7 through 16 summarize the SCPI commands implemented in the 8845A and 8846A Digital Multimeters.

Table 8. CALibration Command Summary

Command	Description
CALibration? [{on|off}]	Perform a calibration
CALibration	Path to the calibration function
:COUNt?	Retrieves number of times Meter has been calibrated
:RECord	Records calibration values
:SECure	Path to calibration security function
:CODE <new code>	Change security code
:STATe {off|on}, <code>	Unsecure / secure calibration mode
:STATe?	Retrieves state of security mode
:STRing <quoted string>	Record calibration information
:STRing?	Retrieves calibration information
:DATE <date>	Set the calibration date
:DATE?	Retrieve the calibration date
:VALue <value>	Specify calibration signal value
:VALue?	Retrieves calibration signal value
:STEP <step #>[,Reference]	Set the calibration step and reference
:STEP?	Retrieve the calibration step

Table 9. CONFigure Command Summary

Command	Description
CONFigure[:SCALar]	Subsystem to set Meter function
[:VOLTage]	Path to set voltage function
[:DC [{range}[, {resolution}]]]	Selects dc volts function
:AC [{range}[, {resolution}]]	Selects ac volts function
:CURRent	Path to set current function
[:DC[{range}][, {resolution}]]]	Selects dc current function
:AC [{range}][, {resolution}]]	Selects ac current function
:RESistance [{range}[, {resolution}]]	Selects resistance function
:FRESistance [{range}[, {resolution}]]	Selects 4-wire resistance function
:FREQuency [{range}[, {resolution}]]	Selects frequency function
:PERiod [{range}[, {resolution}]]	Selects period function
:CAPacitance [{range}[, {resolution}]]	Selects capacitance function
:TEMPerature:FRTD [{<RTD Type>}]	Selects 4-wire temperature function
:TEMPerature:RTD [{<RTD Type>}]	Selects 2-wire temperature function
:CONTinuity	Selects continuity function
:DIODe [{low current}][, {high voltage}]]	Selects diode function
CONFigure?	Retrieves present Meter configuration

Table 10. IEEE 488.2 Common Command Summary

Command	Description
*CLS	Clear status byte summary, and all event registers
*ESE <enable value> *ESE?	Enable bits in standard event register Retrieve standard event enable register
*ESR?	Retrieve standard event register
*IDN?	Retrieve meter’s identification string
*OPC *OPC?	Set ‘Operation Complete” bit in Standard event reg. Returns “1” in output buffer after command execution.
*PSC {0|**1**} *PSC?	Power-on status clear Retrieve power-on status clear setting
*RST	Reset Meter to its power-on state
*SRE <enable value> *SRE?	Enable bits in status byte register Retrieve bits in status byte register
*STB?	Retrieve the status byte summary register
*TST	Perform self-test. Returns “0” if the test succeeds, “1” if the test fails.
*TRG	Trigger a measurement

Table 11. Math Command Summary

Command	Description
CALCulate	Path to the math functions
:AVERage	Path to MIN-MAX function
:MINimum?	Retrieves the recorded minimum value
:MAXimum?	Retrieves the recorded maximum value
:AVERage?	Retrieves the recorded average value
:COUNt?	Retrieves the number of readings during MIN-MAX run
:DB	Path to DB function
:REFerence {<value>|MINimum|MAXimum}	Store relative value in relative register
:REFerence?	Retrieves the relative value from the relative register
:DBM	Path to DBM function
:REFerence {<value>|MINimum|MAXimum}	Select dBm reference value
:REFerence?	Retrieves the present dBm reference value
:FUNCtion {NULL|DB|DBM|AVERage|LIMIt}	Sets the math function
:FUNCtion?	Retrieves the present math function
:KMATh	Path to math functions
:STATe { on|off}	Disables/enables mx+b calculations
:MMFactor{<value>}	Sets the value of “m” for mx+b
:MMFactor?	Reads the value of “m” for mx+b
:MBFactor{<value>}	Sets the value of “b” for mx+b
:MBFactor?	Reads the value of “b” for mx+b
:MUNits{<name>}	Sets the units name for mx+b
:MUNits?	Reads the units name for mx+b
:LIMit	Path to limit testing function
:LOWer{<value>|MINimum|MAXimum}	Set the lower limit for limit testing
:LOWer?	Retrieves the lower limit
:UPPer{<value>|MINimum|MAXimum}	Set the upper limit for limit testing
:UPPer?	Retrieves the upper limit
:NULL	Path to null function
:OFFSet {<*value*>|MINimum|MAXimum}	Sets the offset value
:OFFSet? [MINimum|MAXimum]	Retrieves set or maximum or minimum offset value.
:STATe {ON|OFF}	Disable/enable selected math function
:STATe?	Retrieves the state of the math function
DATA	Path to storing readings taken with INITiate command
:FEED RDG_STORE, {“CALCulate”|” ”}	Enables/disables storing of INITiate readings
:FEED?	Retrieves state of storing INITiate readings

Table 12. MEASure Command Summary

Command	Description
MEASure[:SCALar]	Path to measure control
:CAPacitance? [{<range>|MIN|MAX|DEF}[{,<resolution>|MIN|MAX|DEF}]]	Preset and make capacitance measurement
:CONTinuity?	Make a continuity measurement
:CURRent	Path to measure current
:DC? [{<range>|MIN|MAX|DEF}[, {<resolution>|MIN|MAX|DEF}]]	Make a dc current measurement
:AC?	Make an ac current measurement

Table 12. MEASure Command Summary (cont.)

Command	Description
[{<range>|MIN|MAX|DEF}[{,<resolution>|MIN|MAX|DEF}]]	
:DIODe? [{low current}][, {high voltage}]]	Make a diode measurement
:FREQuency?	Make a frequency measurement
:FRESistance?	Make a 4-wire resistance measurement
[{<range>|MIN|MAX|DEF}[{,<resolution>|MIN|MAX|DEF}]]	
:PERiod?	Make a period measurement
[{<range>|MIN|MAX|DEF}[{,<resolution>|MIN|MAX|DEF}]]	
:RESistance?	Make a 2-wire measurement
[{<range>|MIN|MAX|DEF}[{,<resolution>|MIN|MAX|DEF}]]	
:TEMPerature:FRTD? [{<RTD Type}]	Make a 4-wire temperature measurement
:TEMPerature:RTD? [{<RTD> Type>}]	Make a 2-wire temperature measurement
:VOLTage	Path to voltage measurements
:AC?	Make an ac voltage measurement
[{<range>|MIN|MAX|DEF}[{,<resolution>|MIN|MAX|DEF}]]	
[:DC]?	Make a dc voltage measurement
[{<range>|MIN|MAX|DEF}[{,<resolution>|MIN|MAX|DEF}]]	

Table 13. Measurement Configuration Command Summary

Command[1]	**Description**
[SENSe:]	Path to Meter configuration
FUNCtion[1/2] “CAPacitance”	Select capacitance function
FUNCtion[1/2] “CONTinuity”	Select continuity function
FUNCtion[1/2] “CURRent:AC”	Select ac current function
FUNCtion[1/2] “CURRent:DC”	Select dc current function
FUNCtion[1/2] “DIODe”	Select diode function
FUNCtion[1/2] “FRESistance”	Select 4-wire resistance function
FUNCtion[1/2] “FREQuency”	Select frequency function
FUNCtion[1/2] “PERiod”	Select period function
FUNCtion[1/2] “RESistance”	Select 2-wire resistance function
FUNCtion[1/2] “TEMPerature:FRTD”	Select 4-wire temperature function
FUNCtion[1/2] “TEMPerature:RTD”	Select 2-wire temperature function
FUNCtion[1/2] “VOLTage:DC”	Select dc voltage function
FUNCtion[1/2] “VOLTage:AC”	Select ac voltage function
FUNCtion[1/2] ?	Retrieve present measurement function
FUNCtion2 “None”	Turn off secondary display
VOLTage	Path to configure voltage measurement range
:AC	Path to ac voltage range
:BANDwidth {3|20|200|MINimum|MAXimum}	Select filter
:BANDwidth?	Retrieve present filter setting
:RANGe {<range>|MINimum|MAXimum}	Set ac voltage range
:AUTO {OFF|**ON**}	Disable/Enable Autoranging
:AUTO?	Retrieve present autorange setting
:RANGe? [MINimum|MAXimum]	Retrieve the present range setting
:RESolution {<resolution>|MINimum|MAXimum}	Set resolution for ac voltage measurement
:RESolution? [MINimum|MAXimum]	Retrieve ac voltage measurement resolution
[:DC]	Path to dc voltage range
:FILTer	Path to analog filter
[:STATe] {OFF|ON}	Activates or deactivates 3-pole analog filter
[:STATe]?	Retrieve the present analog filter setting

Table 12. Measurement Configuration Command Summary (cont.)

Command[1]	Description
:DIGItal	Path to digital filter
[:STATe]{OFF|ON}	Activates or deactivates digital filter
[:STATe]?	Retrieve the present digital filter setting
:IMPedance	Path to input impedance selection
:AUTO {OFF|ON}	Turn auto-impedance mode off or on
:AUTO?	Retrieve present setting of auto impedance
:NPLCycles {0.02|0.2|1|**10**|100| MINimum|MAXimum}	Set integration time for selected function
:NPLCycles? [MINimum|MAXimum]	Retrieve integration time for selected function
:RANGe {<range>|MINimum|MAXimum}	Set dc voltage range
:AUTO {OFF|**ON**}	Disable/enable Autoranging
:AUTO?	Retrieve present autorange setting
:RANGe? [MINimum|MAXimum]	Retrieve the present range setting
:RESolution {<resolution>|MINimum|MAXimum}	Set resolution for dc voltage measurement
:RESolution? [MINimum|MAXimum]	Retrieve dc voltage measurement resolution
CURRent	Path to configure current measurement range
:AC	Path to ac current range
:BANDwidth {3|20|200|MINimum|MAXimum}	Select filter
:BANDwidth?	Retrieve present filter setting
:RANGe {<range>|MINimum|MAXimum}	Set ac current range
:AUTO {OFF|**ON**}	Disable/enable Autoranging
:AUTO?	Retrieve present autorange setting
:RANGe? [MINimum|MAXimum]	Retrieve the present range setting
:RESolution {<resolution>|MINimum|MAXimum}	Set resolution for ac current measurement
:RESolution? [MINimum|MAXimum]	Retrieve ac current measurement resolution
[:DC]	Path to dc current range
:FILTer	Path to analog filter
[:STATe] {OFF|ON}	Set analog filter off or on
[:STATe]?	Retrieve the present analog filter setting
:DIGItal	Path to digital filter
[:STATe]{OFF|ON}	Activates or deactivates digital filter
[:STATe]?	Retrieve the present digital filter setting
:NPLCycles {0.02|0.2|1|**10**|100| MINimum|MAXimum}	Set integration time for selected function
:NPLCycles? [MINimum|MAXimum]	Retrieve integration time for selected function
:RANGe {<range>|MINimum|MAXimum}	Set dc current range
:AUTO {OFF|**ON**}	Disable/enable Autoranging
:AUTO?	Retrieve present autorange setting
:RANGe? [MINimum|MAXimum]	Retrieve the present range setting
:RESolution {<resolution>|MINimum|MAXimum}	Set resolution for dc current measurement
:RESolution? [MINimum|MAXimum]	Retrieve dc current measurement resolution
RESistance	Path to 2–wire resistance measurement range
:FILTer	Path to analog filter
[:STATe] {OFF|ON}	Set the analog filter off or on
[:STATe]?	Retrieve the present analog filter setting
:DIGItal	Path to digital filter
[:STATe]{OFF|ON}	Activates or deactivates digital filter
[:STATe]?	Retrieve the present digital filter setting
:NPLCycles {0.02|0.2|1|**10**|100| MINimum|MAXimum}	Set integration time for selected function
:NPLCycles? [MINimum|MAXimum]	Retrieve integration time for selected function

Table 12. Measurement Configuration Command Summary (cont.)

Command[1]	Description
:RANGe {<range>|MINimum|MAXimum}	Set resistance measurement range
:AUTO {OFF|**ON**}	Disable/enable Autoranging
:AUTO?	Retrieve present autorange setting
:RANGe? [MINimum|MAXimum]	Retrieve the present range setting
:RESolution {<resolution>|MINimum|MAXimum}	Set resolution for resistance measurement
:RESolution? [MINimum|MAXimum}	Retrieve resistance measurement resolution
FRESistance	Path to 4–wire resistance measurement range
:FILTer	Path to abalog filter
:STATe {OFF|ON}	Set analog filter off or on
:STATe?	Retrieve the present analog filter setting
:DIGItal	Path to digital filter
[:STATe]{OFF|ON}	Activates or deactivates digital filter
[:STATe]?	Retrieve the present digital filter setting
:NPLCycles {0.02|0.2|1|**10**|100| MINimum|MAXimum}	Set integration time for selected function
:NPLCycles? [MINimum|MAXimum]	Retrieve integration time for selected function
:RANGe {<range>|MINimum|MAXimum}	Set resistance measurement range
:AUTO {OFF|**ON**}	Disable/enable Autoranging
:AUTO?	Retrieve present autorange setting
:RANGe? [MINimum|MAXimum]	Retrieve the present range setting
:RESolution {<resolution>|MINimum|MAXimum}	Set resolution for resistance measurement
:RESolution? [MINimum|MAXimum}	Retrieve resistance measurement resolution
FREQuency	Path to frequency measurement range
:APERture {0.01|**0.1**|1|MINimum|MAXimum}	Set aperture time for frequency function
:APERture? [MINimum|MAXimum]	Retrieve aperture time for frequency function
:VOLTage	Path to frequency range configuration
:RANGe {<range>|MINimum|MAXimum}	Set frequency measurement range
:AUTO {OFF|**ON**}	Disable/enable Autoranging
:AUTO?	Retrieve present autorange setting
:RANGe? [MINimum|MAXimum]	Retrieve the present range setting
PERiod	Path to period measurement range
:APERture {0.01|**0.1**|1|MINimum|MAXimum}	Set aperture time for period function
:APERture? [MINimum|MAXimum]	Retrieve aperture time for period function
:VOLTage	Path to period range configuration
:RANGe {<range>|MINimum|MAXimum}	Set period measurement range
:AUTO {OFF|**ON**}	Disable/enable Autoranging
:AUTO?	Retrieve present autorange setting
:RANGe? [MINimum|MAXimum]	Retrieve the present range setting
CAPacitance	Path to capacitance measurement range
:RANGe {<range>|MINimum|MAXimum}	Set capacitance measurement range
:AUTO {OFF|**ON**}	Disable/enable Autoranging
:AUTO?	Retrieve present autorange setting
:RANGe? [MINimum|MAXimum]	Retrieve the present range setting
:RESolution {<resolution>|MINimum|MAXimum}	Set resolution for capacitance measurement
:RESolution? [MINimum|MAXimum}	Retrieve capacitance measurement resolution
TEMPerature	Path to temperature measurement
:RTD	Path to 2-wire temperature measurement
:ALPHa <alpha value>	Set RTD alpha parameter
:ALPHa?	Retrieve the present RTD alpha parameter
:NPLCycles {0.02|0.2|1|**10**|100| MINimum|MAXimum}	Set integration time for selected function

Table 12. Measurement Configuration Command Summary (cont.)

Command[1]	Description
:NPLCycles? [MINimum|MAXimum]	Retrieve integration time for selected function
:R0 <R0 value>	Set resistance at 0 °C
:R0?	Retrieve present 0 °C setting
:TYPe {PT100_385|PT100_392|CUST1}	Set the type of RTD
:TYPe?	Retrieve the present RTD type (385|CUSTOM)
:FRTD	Path to 4-wire temperature measurement
:ALPHa <alpha value>	Set RTD alpha parameter
:ALPHa?	Retrieve the present RTD alpha parameter
:NPLCycles {0.02|0.2|1|**10**|100| MINimum|MAXimum}	Set integration time for selected function
:NPLCycles? [MINimum|MAXimum]	Retrieve integration time for selected function
:R0 <R0 value>	Set resistance at 0 °C
:R0?	Retrieve present 0 °C setting
:TYPe {PT100_385|PT100_392|CUST1}	Set the type of RTD
:TYPe?	Retrieve the present RTD type (385|CUSTOM)
FILTer	Path to filter selection
[:DC]	Path to analog filter
[:STATe] {OFF|ON}	Set analog filter off or on for dc functions
[:STATe]?	Retrieve the present analog filter setting
:DIGital	Path to digital filter
[:STATe]{OFF|ON}	Activates or deactivates digital filter
[:STATe]?	Retrieve the present digital filter setting
DETector	Path filter selection
:BANDwidth {3|**20**|200|MINimum|MAXimum}	Set the input signal filter
:BANDwidth? [MINimum|MAXimum]	Retrieve the present filter setting
ZERO	Path to configuring the autozero mode
:AUTO {OFF|ONCE|**ON**}	Set the autozero mode
:AUTO?	Retrieve the present autozero mode
INPut	Path to input impedance
:IMPedance	Path to input impedance configuration
:AUTO {**OFF**|ON}	Disable/enable auto input impedance select
:AUTO?	Retrieve auto input impedance mode
ROUTe	Path to input terminal configuration
:TERMinals?	Retrieve input terminal selection (front or rear)

[1] Default parameters are shown in **bold**

Table 14. RS-232 Interface Command Summary

Command	Description
SYSTem	Path to RS-232 Interface commands
:LOCal	Set Meter to local mode
:REMote	Set Meter to remote mode for RS-232 operation
:RWLock	Set Meter to remote mode (lock out front panel)

Table 15. Status Reporting Command Summary

Command	Description
*CLS	Clear status byte summary and all event registers
*ESE <enable value>	Enable bits in standard event register
*ESE?	Retreive standard event enable register
*ESR?	Retrieve standard event register
*OPC	Set Operation Complete bit in standard event register
*OPC?	Returns “1” in output buffer after command exec.
*PSC {0|1}	Power-on status clear
*PSC?	Retrieve power-on status clear setting
*SRE <enable value>	Enable bits in status byte register
*SRE?	Retrieve bits in status byte register
*STB?	Retrieve the status byte summary register
SYSTem	Path to meter’s error queue
:ERRor?	Retreive meter’s error queue
STATus	Path to meter’s status system
:PRESet	Clear questionable data enable register
:QUEStionable	Path to questionable data register
:ENABle <enable value>	Enable bits in questionable data enable register
:ENABle?	Retrieve questionable data register
:EVENt?	Retrieve questionable data enable register

Table 16. System-Related Command Summary

Command[1]	Description
FETCh[1|2]?	Transfer stored readings to output buffer
READ?	Set trigger system to ‘wait-for-trigger’
DISPlay {OFF|**ON**} :TEXT <quoted string> :CLEar :TEXT?	Turn display off or on Write message to display Clear message from display Retreive displayed message
DISPlay?	Retrieve display setting
SYSTem :BEEPer :STATe {OFF|**ON**} :STATe? :DATE <mm/dd/yyy> :DATE? :ERRor? :ERRor:BEEPer {OFF|**ON**} :ERRor:BEEPer? :TIME <hh:mm:ss> :TIME? :VERSion?	Path to system controls Issue a single beep Disable/enable beeper for limit, and diode testing Retrieve state of beeper Sets the Meter’s date Retrieves the Meter’s date Retrieve meter’s error queue Enable/disable beeper for errors Retrieve beeper state for errors Sets the Meter’s time Retrieves the Meter’s time Retrieve meter’s SCPI version
DATA :POINts?	Path to meter’s memory Retrieve the number of stored readings
*RST	Reset Meter to its power-on state
*IDN [ON|OFF], [Quoted String]	Enables or disables a secondary indentification defined by the quoted string. When disabled, ***IDN?** will return the indentification set by the Meter’s manufacturer.
*IDN?	Retrieve meter’s identification string
L1 L2	Set the command set to 8845 Set the command set to Fluke 45

[1] Default parameters are shown in **bold**

Table 17. Triggering Command Summary

Command[1]	Description
INITiate	Set trigger system to wait-for-trigger
DATA	Path to storing readings taken with INITiate command
:FEED RDG_STORE, {“CALCulate”|” ”}	Enables/disables storing of INITiate readings
:FEED?	Retrieves state of storing INITiate readings
READ?	Set trigger system to wait-for-trigger
SAMPle	Path to sample count
:COUNt {<value>|MINimum|MAXimum}	Set number of samples per trigger
:COUNt? [MINimum|MAXimum]	Retrieve sample count
TRIGger	Path to trigger control
:COUNt {<value>|MINimum|MAXimum|INFinite}	Set the number of triggers Meter will accept
:COUNt? [MINimum|MAXimum]	Retrieve the number of tiggers Meter will accept
:DELay {<seconds>|MINimum|MAXimum}	Set the delay between trigger and measurement
:AUTO {OFF|ON}	Disable/Enable automatic trigger delay
:AUTO?	Retrieve automatic trigger delay status
:DELay? [MINimum|MAXimum]	Retreive present trigger delay value
:SOURce {Bus|**IMMediate**|EXTernal}[1]	Set meter’s trigger source
:SOURce?	Retrieve the meter’s present trigger source

[1] **Bold** type denotes default parameter.

SCPI Command Details

All SCPI commands recognized by the Meter are listed in the following sections along with description and syntax rules.

Using the MEASure? Command

The MEASure? command provides the quickest and simplest program method for getting the Meter to make a single measurement through remote control. However, MEASure? does not provide control over all possible parameters associated with a measurement function. With the exception of function, range, and resolution, the MEASure? command does not allow changing settings before the measurement is taken. Instead, the Meter uses predefined settings for each function (See Table 18) and makes a measurement as soon as the command is received. The measurement is immediately sent to the output buffer.

A MEASure? command is the same as using a CONFigure command followed by the READ? Command.

MEASure[:SCALar][:<function>]?[<range> or <RTD type> or <low current> [,<resolution> or <high voltage>]]

Description Sets the Meter function with the preset parameters (See Table 18), and makes the measurement using the specified range, and resolution. The reading is placed in the output buffer. For the temperature function, the range variable is replaced by the RTD type variable.

Note

The dc portion of the function keyword is optional, as is the VOLTage portion. For instance, MEAS:AC? will be interpreted by the Meter as meaning Volts ac function.

Parameters	<function>	=	CAPacitance	Capacitance
			CURRent:AC	AC current[1]
			CURRent:DC	DC current
			VOLTage:AC	AC voltage[1]
			VOLTage:DC	DC voltage
			RESistance	2-wire resistance
			FRESistance	4-wire resistance
			FREquency	Frequency[2]
			PERiod	Period[3]
			TEMPerature:RTD	2-wire temperature[4]
			TEMPerature:FRTD	4-wire temperature[4]
			DIODe	Diode[5]
			CONTinuity	Continuity[6]
	<range>	=	a number between the upper and lower limits of the function.	
			MIN	Lowest range of the function
			MAX	Highest range of the function
			DEF	Autorange
	<low current>	=	ON or 1	Sets diode current to 0.1 mA
			OFF or 0	Sets diode current to 1 mA
	<high voltage>		ON or 1	Sets diode voltage to 10 V
			OFF or 0	Sets diode voltage to 5 V.
	<resolution>	=	a number in the same units, *not in number of digits,* as the measurement function,.	
			MIN	Smallest value acceptable
			MAX	Largest value acceptable
			DEF	5½ digits

Note

Issuing a MEASure? command without specifying a function, puts the Meter into volts dc and triggers a measurement. You must specify a range to use a resolution parameter.

Example	MEAS:volt:ac? 10	=	Returns a measurement after configuring the Meter for volts ac and setting the range to the 10 volt range.
	MEAS:diod? ON	=	Sets diode function using low current and returns the diode measurement. 9.90000000E+37 is the value returned for an open diode.

Notes

[1] For ac measurements, resolution is fixed at 6½ digits. The resolution parameter only affects the front panel display.

[2] For frequency measurements, the multimeter uses one “range” for all inputs between 3 Hz, and 300 kHz. With no input signal applied, frequency measurements return zero.

[3] For period measurements, the multimeter uses one “range” for all inputs between 0.33 seconds, and 3.3 μsec. With no input signal applied, period measurements return zero.

[4] The range and resolution are fixed for temperature measurements. However, placing PT100_385 or PT100_392 into the range field will set the RTD type. Placing CUST1 into the range field will cause the Meter to use the values set into the R_0 and Alpha parameters.

[5] The range and resolution are fixed for diode test: 1 Vdc range and 5½ digits. When set to ON, the low current parameter sets the diode test current to 0.1 mA. When OFF, the current is 1 mA. When set to ON, the high voltage parameter sets the diode test voltage to 10 volts. When OFF, the voltage is 5 volts. To specify a diode test voltage, you must also include ON or OFF for the low current parameter.

[6] The range and resolution are fixed for continuity tests: 1 kΩ range and 5½ digits.

Using the CONFigure Command

The CONFigure command allows more configuration control than the MEASure command. As with the MEASure command, the CONFigure command presets the Meter’s parameters for the desired configuration (See Table 18). However, a measurement does not start automatically, and therefore affords the opportunity to change measurement parameters prior to triggering a measurement.

The CONFigure command is very useful when most of the parameters preset by CONFigure are what you want and you only need to change one or two parameters. The SENSe:FUNCtion command provides a means of changing a function’s parameters. Other commands, such as INPut, SENSe, CALCulate, and TRIGger allow for more detailed control of the Meter’s parameters.

The CONFigure command does not initiate a measurement and will need to be followed by READ? command, or the INITiate and FETCh? commands.

CONFigure[:SCALar][:<function>] [<range |MIN|MAX|DEF> or <RTD type> or <low current>][,<resolution |MIN|MAX|DEF> or <high voltage>]]

Description Sets the Meter function with the preset parameters (See Table 18) and configure the Meter using the specified range, and resolution. This command must be followed by a READ? command, or the INITiate and FETCh? commands to cause the Meter to take a measurement. For the temperature function, the range variable is replaced by the RTD type variable.

Note

The dc portion of the function keyword is optional, as is the VOLTage portion. For instance, CONF:AC will be interpreted by the Meter as meaning Volts ac function.

Parameters	<function> =	CAPacitance	Capacitance
		CURRent:AC	AC current[1]
		CURRent:DC	DC current
		VOLTage:AC	AC voltage[1]
		VOLTage:DC	DC voltage
		RESistance	2-wire resistance
		FRESistance	4-wire resistance
		FREquency	Frequency[2]
		PERiod	Period[3]
		TEMPerature:RTD	2-wire temperature[4]
		TEMPerature:FRTD	4-wire temperature[4]
		DIODe	Diode[5]
		CONTinuity	Continuity[6]
	<range> =	a number between the upper and lower limits of the function.	
		MIN	Lowest range of the function
		MAX	Highest range of the function
		DEF	Autorange
	<low current> =	ON or 1	Sets diode current to 0.1 mA
		OFF or 0	Sets diode current to 1 mA.
	<low voltage> =	ON or 1	Sets diode voltage to 5 volts
		OFF or 0	Sets diode voltage to 10 volts.
	<resolution> =	a number in the same units, *not in number of digits,* as the measurement function,.	
		MIN	Smallest value acceptable
		MAX	Largest value acceptable
		DEF	5½ digits

Note

You must specify a range whenever specifying a resolution parameter.

Notes

[1] For ac measurements, resolution is fixed at 6½ digits. The resolution parameter only affects the front panel display.

[2] For frequency measurements, the Meter uses one range for all inputs between 3 Hz, and 300 kHz. With no input signal applied, frequency measurements return zero.

[3] For period measurements, the Meter uses one range for all inputs between 0.33 seconds, and 3.3 µsec. With no input signal applied, period measurements return zero.

[4] The range and resolution are fixed for temperature measurements. However, placing PT100_385 or PT100_392 into the range field will set the RTD type. Placing CUST1 into the range field will cause the Meter to use the values set into the R_0 and Alpha parameters.

[5] The range and resolution are fixed for diode test: 1 Vdc range and 5½ digits. When set to ON, the low current parameter sets the diode test current to 0.1 mA. When OFF, the current is 1 mA. When set to ON, the high voltage parameter sets the diode test voltage to 10 volts. When OFF, the voltage is 5 volts. To specify a diode test voltage, you must also include ON or OFF for the low current parameter.

[6] The range and resolution are fixed for continuity tests: 1 kΩ range and 5½ digits.

Table 18. Preset Conditions for the MEASure? and CONFigure Commands

Parameter	Setting
AC Filter (DET:BAND)	20 Hz
Autozero (ZERO:AUTO)	OFF if NPLC <1, ON if NPLC >=1
DC Digital Filter	ON
Input Impedance (INP:IMP:AUTO)	OFF
Samples per trigger (SAMP:COUN)	1
Trigger count (TRIG:COUN)	1
Trigger delay (TRIG:DEL)	Automatic
Trigger source (TRIG:SOUR)	Internal (immediate)
Math Function (CALCulate subsystem)	OFF

Setting Range and Resolution Parameters

The MEASure? and CONFigure commands incorporate parameters for setting the Meter’s function, its range, and its resolution. Placing the input signal’s expected amplitude into the range value causes the Meter to select a range appropriate for the supplied signal amplitude.

Although the frequency and period functions use a single range for all inputs between 3 Hz and 300 kHz, it is necessary to specify a range whenever specifing a resolution setting for these functions. When specifying resolution, specify it in the *units* of the function instead of *number of digits*. For ac or dc volts, specify the resolution in volts. The resolution specification for frequency is in hertz.

Note

A range parameter is required when specifying the resolution parameter.

Using the READ? Command

READ?

Description READ? causes the Meter to take a measurement the next time the trigger condition is met after the READ? command is received. After the measurement is taken, the reading is placed in the output buffer. The READ? command will not cause readings to be stored in the Meter's internal memory.

All measurements are sent to the output buffer until the buffer becomes full, at which point the Meter stops taking measurements. To keep the measurements running, measurements must be continually read out of the output buffer.

Note

Always process the reading(s) from the output buffer after each READ? command. Failure to do so may cause some of the data from the previous READ? command to appear in the response for the last READ? command. For those times the buffer cannot be read after a READ? command, send a device clear (DC1) before issuing another READ? command.

Using the INITiate Command

Once the Meter has been configured for a measurement, the INITiate command causes the Meter to take a measurement when the trigger conditions have been met. The measurement reading(s) are placed in the Meter's internal memory (up to 5,000 readings) to be read at a later time with the FETCh? command.

With one exception, the INITiate command stops the Meter from accepting any other remote commands until the Meter has completed both taking the measurement and storing the reading. The exception occurs when the trigger source is set to BUS with the TRIGger:SOURce command. Under this condition, the *TRG command or the IEEE 488 Group Execute Trigger will be processed to start the measurement.

Using the FETCh? Command

To process readings from the Meter's internal memory to the output buffer, send the Meter a FETCh? command. With readings in the output buffer, a bus controller can then retreieve the readings over the bus.

Using the SENSe Subsystem to Configure the Meter

Setting Meter functions and function parameters are controlled through the SENSe subsystem of commands. Both primary and secondary display functions are set using the FUNCtion commands. The parameters of each Meter function are also controlled through this subsystem of commands.

[SENSe]:FUNCtion[1/2] "<function>"

Description Sets the Meter to the measurement function listed in the function parameter. The function must be enclosed in quotes in the command string (`FUNC "VOLT:DC"`).

Parameters

[1/2][1]	=	Use 1 for primary display, and 2 for secondary display	
<function>	=	CAPacitance	Capacitance
		CURRent:AC	AC current
		CURRent:DC	DC current
		VOLTage:AC	AC voltage
		VOLTage:DC	DC voltage
		RESistance	2-wire resistance
		FRESistance	4-wire resistance
		FREQuency	Frequency
		PERiod	Period
		TEMPerature:RTD	2-wire temperature
		TEMPerature:FRTD	4-wire temperature
		DIODe	Diode
		CONTinuity	Continuity
		NONe[2]	Turn off secondary display

Examples FUNC “VOLT:DC” Sets the Meter to volts dc

FUNC1 “VOLT:DC”; FUNC2 “VOLT:AC” Dual function command

Query FUNCtion[1/2]? Query measurement function

Note

FUNC2? will return the measurement mode selected for the secondary display (assuming its been enabled using the FUNC2 command). FUNC1? or FUNC? will return the measurement mode for the primary display.

Notes [1] Using FUNC without a 1 or 2 will default to 1 for the primary display.

[2] Valid only when used with FUNC2.

[SENSe:]<function>

The SENSe subsystem allows configuring the Meter’s functions.

Parameters

<function>	=	CAPacitance	Capacitance
		CURRent:AC	AC current
		CURRent[:DC]	DC current
		VOLTage:AC	AC voltage
		VOLTage[:DC]	DC voltage
		RESistance	2-wire resistance
		FRESistance	4-wire resistance
		FREQuency	Frequency
		PERiod	Period
		TEMPerature:RTD	2-wire temperature
		TEMPerature:FRTD	4-wire temperature
		DIODe	Diode
		CONTinuity	Continuity
		NONe[1]	Turn off secondary display

Notes [1] Valid only when used with FUNC2.

[SENSe:]<function>:RANGe(?) <n>

Description Sets the range according to the value supplied for *n*, of the Meter function specified in the variable <function>. Not having selectable ranges, an error is returned when using temperature, diode test, or continuity as the function in the RANGe command. This setting is stored in volatile memory

For the frequency and period functions, the range command value refers to the signal's input voltage and not the range of the frequency or period measurement. Also, the word VOLTage must follow the function before the RANGe command. See examples below.

Parameters	<n>	=	value of reading	Expected reading in volts, amps or ohms
			MINimum	Lowest range
			MAXimum	Highest range

Examples	VOLT:RANG 10	Sets the Meter's dc volts to the 10 volt range.
	CURR:AC:RANG 1e-3	Sets the Meter's ac amps to the 100 mA range.
	RES:RANG 20e3	Sets the Meter's ohms to the 100 kΩ range.
	FREQ:VOLT:RANG 5	Sets the voltage input range to the 10 volt range while making a frequency measurement.

Query	VOLT:RANG?	Returns the set range for dc volts.
	VOLT:RANG? MIN	Returns the minimum range of the dc volts function. (1.00000000E-01 or 100 mV)
	RES:RANG? MAX	Returns the maximum range of the 2-wire resistance function. (1.00000000E+09 or 1 GΩ)

[SENSe:]<function>:RANGe:AUTO(?) {OFF|ON}

Description Switches the Meter between autoranging and manual ranging. Not having selectable ranges, an error is returned when the temperature, diode test, or continuity function is used with the RANGe:AUTO function. This setting is stored in volatile memory

For the frequency and period functions, the RANGe:AUTO command refers to the signal's input voltage and not the range of the frequency or period measurement. Also, the word VOLTage must follow the function before the RANGe command. See examples below.

Note

Autorange thresholds are set down range with readings <10 % of range and up range with readings >120 % of range.

Examples	VOLT:RANG:AUTO ON	Sets the Meter's dc volts to autorange.
	CURR:AC:AUTO OFF	Sets the Meter's ac amps manual ranging.
	FREQ:VOLT:RANG ON	Sets the Meter's voltage input to autorange while making a frequency measurement.

Query	VOLT:RANG:AUTO?	Returns the dc volts autorange state. A zero for off and a one for on.

[SENSe:]<function>:RESolution(?) <n>

Description Sets the resolution according to the value supplied for *n*, of the Meter function specified in the variable <function>. Resolution is specified in the same units as the function. i.e., volts for the volts ac and dc functions. This setting is stored in volatile memory

Not having selectable ranges, an error is returned when using frequency, period, temperature, diode test, or continuity as the function in the RESolution command.

Parameters

<n>	=	resolution value	Desired resolution in volts, amps, ohms, and farads.
		MIN	Highest resolution
		MAX	Lowest resolution

Examples

VOLT:RES 1e-4	Sets the dc volts resolution to 100 µV.
CURR:AC:RES 1e-8	Sets the ac amps resolution to the 10 pA.

Query

VOLT:RES?	Returns the set resolution for dc volts.
VOLT:RES? MIN	Returns the minimum resolution of the dc volts function.

[SENSe:]<function>:NPLCycles(?) <n>

Description Sets the Meter's integration time for the function specified in <function>, based on the number of power line cycles. This setting is stored in volatile memory

This command is only valid for dc voltage, dc current, temperature, and resistance (2-wire and 4-wire) functions.

Parameters

<n>	=	0.02 to 100	sets integration time to a preset value of a power line cycle (0.02, 0.2, 1, 10, and 100)
		MIN	0.02 NPLC
		MAX	100 NPLC

Examples

VOLT:DC:NPLC .2	Sets the dc volts integration time to 0.2 of a power line cycle.

Query

VOLT:NPLC?	Returns the integration time for dc volts.
CURR:NPLC? MIN	Returns the minimum integration time for the dc current function.

[SENSe:]TEMPerature:[TRANsducer:]<subfunction>:R0(?) <n>

Description Sets the resistance at zero degrees C specified by <n> for the R0 parameter of the temperature function. This setting is stored in volatile memory.

Parameters

<subfunction>	=	RTD	2-wire RTD
		FRTD	4-wire RTD
<n>	=	0 to 1010	Resistance at 0 °C

Examples

TEMP:RTD:R0 120	Sets the resistance a 0 °C to 120 ohms.

Query

TEMP:RTD:R0?	Returns the set resistance a 0 °C.

[SENSe:]TEMPerature:[TRANsducer:]<subfunction>:TYPe(?) <n>

Description Sets the RTD type for the temperature function. This setting is stored in volatile memory.

Parameters

<subfunction>	=	RTD	2-wire RTD
		FRTD	4-wire RTD

<n>	=	PT100_385	Sets the RTD type to PT100 385
		PT100_392	Sets R0 to 100 and Alpha to 392
		CUST1	Sets the RTD type to be set by R0 and Alpha settings.

Examples TEMP:RTD:TYP PT100_385 Sets the RTD type to PT100 385.

Query TEMP:RTD:TYP? Returns 385 or CUSTOM.

[SENSe:]TEMPerature:[TRANsducer:]<subfunction>:ALPHa(?) <n>

Description Sets the alpha variable for the temperature function. This setting is stored in volatile memory.

Parameters

<subfunction>	=	RTD	2-wire RTD
		FRTD	4-wire RTD

<n>	=	.00374 to .00393	Sets the alpha parameter

Examples TEMP:RTD:ALPH 392 Sets the alpha parameter to 392.

Query TEMP:RTD:ALPH? Returns the alpha setting of the temperature function.

[SENSe:]FREQuency:APERature(?) <n>

Description Sets the gate time for the frequency function to the value spedified by <n>. This setting is stored in volatile memory.

Parameters

<n>	=	0.01	Gate time of 10 ms (4½ digits)
		0.1 (default)	Gate time of 100 ms (5½ digits)
		1	Gate time of 1 second (6½ digits)
		MIN	Gate time of 10 ms (4½ digits)
		MAX	Gate time of 1 second (6½ digits)

Examples FREQ:APER 0.1 Sets the frequency measurement gate time to 100 ms.

Query FREQ:APER? Returns the gate time for the frequency function.

[SENSe:]PERiod:APERature(?) <n>

Description Sets the gate time for the period function to the value spedified by <n>. This setting is stored in volatile memory.

Parameters

<n>	=	0.01	Gate time of 10 ms (4½ digits)
		0.1 (default)	Gate time of 100 ms (5½ digits)
		1	Gate time of 1 second (6½ digits)
		MIN	Gate time of 10 ms (4½ digits)
		MAX	Gate time of 1 second (6½ digits)

Examples PER:APER 0.1 Sets the period measurement gate time to 100 ms.

Query PER:APER? Returns the gate time for the period function.

[SENSe:]CURRent:AC:BANDwidth(?) <n>

Description Sets the appropriate filter for the frequency specified by <n>. This setting is stored in volatile memory.

Parameters				
	<n>	=	3	Selects slow filter
			20 (default)	Selects medium filter
			200	Selects fast filter
			MIN	Selects slow filter
			MAX	Selects fast filter

Examples	CURR:AC:BAND 200	Sets the filter for ac current to fast.
Query	CURR:AC:BAND?	Returns the filter selection.

[SENSe:]VOLTage:AC:BANDwidth(?) <n>

Description Sets the appropriate filter for the frequency specified by <n>. This setting is stored in volatile memory.

Parameters				
	<n>	=	3	Selects slow filter
			20 (default)	Selects medium filter
			200	Selects fast filter
			MIN	Selects slow filter
			MAX	Selects fast filter

Examples	VOLT:AC:BAND 20	Sets the filter for ac voltage to medium.
Query	VOLT:AC:BAND?	Returns the filter selection.

[SENSe:]DETector:BANDwidth(?) <n>

Description Sets the appropriate filter for the frequency specified by <n>. This setting is stored in volatile memory and sets the filter for all functions that use an ac filter.

Parameters				
	<n>	=	3	Selects slow filter
			20	Selects medium filter
			200	Selects fast filter
			MIN	Selects slow filter
			MAX	Selects fast filter

Examples	DET:BAND 20	Sets the filter to medium.
Query	DET:BAND?	Returns the filter selection.
	DET:BAND? MAX	Returns +2.00000000E+02 to indicate the slow filter.

[SENSe:]FILTer[:DC][:STATe](?) <n>

Description Activates or deactivates the 3-pole analog filter to improve noise immunity for dc functions. This setting is stored in volatile memory.

Parameters				
	<n>	=	OFF or 0	Turns the analog dc voltage filter off.
			ON or 1	Turns the analog dc voltage filter on.

Examples	FILT ON	Turns the analog dc voltage filter on.
Query	FILT?	Returns the analog dc voltage filter setting.

[SENSe:]FILTer[:DC]:DIGital[:STATe](?) <n>

Description Activates or deactivates the digital averaging filter to improve noise immunity for dc functions. This setting is stored in volatile memory.

Parameters	<n>	=	OFF or 0	Turns the digital averaging filter off.
			ON or 1	Turns the digital averaging filter on.

Examples	FILT:DIG ON	Turns the digital averaging filter on.
Query	FILT:DIG?	Returns the digital averaging filter setting. (0 = OFF and 1 = ON)

[SENSe:]VOLTage[:DC]:FILTer[:STATe](?) <n>

Description Activates or deactivates the 3-pole analog filter to improve noise immunity for dc functions. This setting is stored in volatile memory.

Parameters	<n>	=	OFF or 0	Turns the analog dc voltage filter off.
			ON or 1	Turns the analog dc voltage filter on.

Examples	VOLT:FILT ON	Turns the analog dc voltage filter on.
Query	VOLT:FILT?	Returns the analog dc voltage filter setting.

[SENSe:]VOLTage[:DC]:FILTer:DIGital[:STATe](?) <n>

Description Activates or deactivates the digital averaging filter to improve noise immunity for dc functions. This setting is stored in volatile memory.

Parameters	<n>	=	OFF or 0	Turns the digital averaging filter off.
			ON or 1	Turns the digital averaging filter on.

Examples	VOLT:FILT:DIG ON	Turns the digital averaging filter on.
Query	VOLT:FILT:DIG?	Returns the digital averaging filter setting. (0 = OFF and 1 = ON)

[SENSe:]CURRent[:DC]:FILTer[:STATe](?) <n>

Description Activates or deactivates the 3-pole analog filter to improve noise immunity for dc functions. This setting is stored in volatile memory.

Parameters	<n>	=	OFF or 0	Turns the analog dc voltage filter off.
			ON or 1	Turns the analog dc voltage filter on.

Examples	CURR:FILT ON	Turns the analog dc voltage filter on..
Query	CURR:FILT?	Returns the analog dc voltage filter setting. (0 = OFF and 1 = ON)

[SENSe:]CURRent[:DC]:FILTer:DIGital[:STATe](?) <n>

Description Activates or deactivates the digital averaging filter to improve noise immunity for dc functions. This setting is stored in volatile memory.

Parameters	<n>	=	OFF or 0	Turns the digital averaging filter off.
			ON or 1	Turns the digital averaging filter on.

Examples	CURR:FILT:DIG ON	Turns the digital averaging filter on.
Query	CURR:FILT:DIG?	Returns the digital averaging filter setting. (0 = OFF and 1 = ON)

[SENSe:]RESistance[:DC]:FILTer[:STATe](?) <n>

Description Activates or deactivates the 3-pole analog filter to improve noise immunity for dc functions. This setting is stored in volatile memory.

Parameters	<n>	=	OFF or 0	Turns the analog dc 2-wire resistance filter off.
			ON or 1	Turns the analog dc 2-wire resistance filter on.

Examples	RES:FILT ON	Turns the analog dc 2-wire resistance filter on.
Query	RES:FILT?	Returns the analog dc 2-wire resistance filter setting. (0 = OFF and 1 = ON)

[SENSe:]RESistance[:DC]:FILTer:DIGital[:STATe](?) <n>

Description Activates or deactivates the digital averaging filter to improve noise immunity for dc functions. This setting is stored in volatile memory.

Parameters	<n>	=	OFF or 0	Turns the digital averaging filter off.
			ON or 1	Turns the digital averaging filter on.

Examples	RES:FILT:DIG ON	Turns the digital averaging filter on.
Query	RES:FILT:DIG?	Returns the digital averaging filter setting. (0 = OFF and 1 = ON)

[SENSe:]FRESistance[:DC]:FILTer[:STATe](?) <n>

Description Activates or deactivates the 3-pole analog filter to improve noise immunity for dc functions. This setting is stored in volatile memory.

Parameters	<n>	=	OFF or 0	Turns the analog dc 4-wire resistance filter off.
			ON or 1	Turns the analog dc 4-wire resistance filter on.

Examples	FRES:FILT ON	Turns the analog dc 4-wire resistance filter on.
Query	FRES:FILT?	Returns the analog dc 4-wire resistance filter setting. (0 = OFF and 1 = ON)

[SENSe:]FRESistance[:DC]:FILTer:DIGital[:STATe](?) <n>

Description Activates or deactivates the digital averaging filter to improve noise immunity for dc functions. This setting is stored in volatile memory.

Parameters

<n>	=	OFF or 0	Turns the digital averaging filter off.
		ON or 1	Turns the digital averaging filter on.

Examples	FRES:FILT:DIG ON	Turns the digital averaging filter on.
Query	FRES:FILT:DIG?	Returns the digital averaging filter setting. (0 = OFF and 1 = ON)

[SENSe:]UNIT:TEMPerature(?) <units>

Description Sets the temperature units for the temperature function. This setting is stored in volatile memory.

Parameters

<units>	=	Cel	Sets temperature units to Celsius
		Far	Sets temperature units to Fahrenheit
		Kel	Sets temperature units to Kelvin

Examples	UNIT:TEMP C	Sets temperature units to Celsius.
Query	UNIT:TEMP?	Returns the temperature units setting. (C = Celsius, F = Fahrenheit, and K = Kelvin)

[SENSe:]ZERO:AUTO <n>

Description Activates (default) or deactivates the autozero mode. This setting is stored in volatile memory.

Parameters

<n>	=	OFF	Turns Autozero mode off.
		ON	Turns autozero mode on.
		ONCE	Initiates a zero measurement immediately.

Examples	ZERO:AUTO ON	Turns autozero mode on.
Query	ZERO:AUTO?	Returns the state of the autozero mode. (0 = OFF and 1 = ON)

[SENSe:]VOLTage[:DC]:IMPedance:AUTO(?) <n>

Description Activates or deactivates (default) the automatic input impedance mode for dc voltage measurements. With AUTO OFF, the input impedance is fixed at 10 MΩ for all ranges. With AUTO ON, the input impedance is set to >10 GΩ for the 100 mV, 1 V, and 10 V ranges. This setting is stored in volatile memory.

Parameters

<n>	=	OFF or 0	Turns off automatic input impedance.
		ON or 1	Turns on automatic input impedance.

Examples	VOLT:IMP:AUTO ON	Turns on automatic input impedance.
Query	VOLT:IMP:AUTO?	Returns the state of the input impedance mode. (0 = OFF and 1 = ON)

INPut:IMPedance:AUTO(?) <n>

Description Activates or deactivates (default) the automatic input impedance mode for dc voltage measurements. With AUTO OFF, the input impedance is fixed at 10 MΩ for all ranges. With AUTO ON, the input impedance is set to >10 GΩ for the 100 mV, 1 V, and 10 V ranges. This setting is stored in volatile memory.

Parameters <n> = OFF or 0 Turns off automatic input impedance.
ON or 1 Turns on automatic input impedance.

Examples IMP:AUTO ON Turns on automatic input impedance.

Query IMP:AUTO? Returns the state of the input impedance mode. (0 = OFF and 1 = ON)

ROUTe:TERMinals?

Description A query that returns the state of the front to rear panel input terminals switch.

Examples ROUT:TERM? Returns “FRON” or “REAR”.

Programming for Math Operations

Of the five possible Meter math functions, only one can be enabled at a time. Once a math function is selected, it stays selected until the Meter is powered down, or another math function is set. A reset command received through the remote interface will also disable the math function. Presetting some math registers are possible.

Table 19 is a matrix indicating which math functions work with each Meter function. Selecting a math function that is not allowed with a Meter function causes math to be disabled. Selecting a math function that is not allowed after selecting an allowed math function will result in a “Setting Conflict” error.

Note

Math must be enabled before writing to the zero (null) or dB measurement registers.

Table 19. Allowed Math/Measurement Function Combinations

	DCV	ACV	DCI	ACI	2W	4W	Freq	Period	Cont	Diode	Temp	Cap
Null	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	**Yes**	**Yes**
Average	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	**Yes**	**Yes**
dB	No	**Yes**	No	No	No	No	No	No	No	No	No	No
dBm	No	**Yes**	No	No	No	No	No	No	No	No	No	No
Limit	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	No	No	**Yes**	**Yes**

CALCulate:FUNCtion(?) {NULL|DB|DBM|AVERage|LIMit}

Description Selects one of five math functions. This setting is stored in volatile memory. Selecting a math function disables any math function which may have been set previously. For the selected math function to take effect, the CALCulate:STATe must be ON.

Parameters	<n>	=	NULL	Uses the present reading as an offset to zero the returned reading.
			DB	Selects the DB mode.
			DBM	Selects the dBm mode.
			AVERage	Selects the average mode
			LIMit	Selects the Limit Testing mode.

Examples	CALC:FUNC DBM	Selects the dBm mode.
Query	CALC:FUNC?	Returns the selected math function.

CALCulate:STATe(?) <n>

Description Activates or deactivates the math function selected with CALC:FUNC command. This setting is stored in volatile memory.

Parameters	<n>	=	ON or 1	Activates the math function set previously by CALC:FUNC command.
			OFF or 0	Deactivates the math function.

Examples	CALC:STAT ON	Turned on the math function.
Query	CALC:STAT?	Returns the state of the math function. (0 = OFF and 1 = ON)

CALCulate:AVERage:MINimum?

Description Retrieves the minimum value measured during a statistics operation. This value is cleared whenever the Meter is powered off then back on, a statistics function is enabled, or receives a reset through the remote interface. This setting is stored in volatile memory.

Query	CALC:AVER:MIN?	Returns the minimum value of statistics operation.

CALCulate:AVERage:MAXimum?

Description Retrieves the maximum value measured during a statistics operation. This value is cleared whenever the Meter is powered off then back on, a statistics function is enabled, or receives a reset through the remote interface. This setting is stored in volatile memory.

Query	CALC:AVER:MAX?	Returns the maximum value of statistics operation.

CALCulate:AVERage:AVERage?

Description Retrieves the average value measured during a statistics operation. This value is cleared whenever the Meter is powered off then back on, a statistics function is enabled, or receives a reset through the remote interface. This setting is stored in volatile memory.

Query	CALC:AVER:AVER?	Returns the maximum value of statistics operation.

CALCulate:AVERage:COUNt?

Description Retrieves the number of measurements taken during a statistics operation. This value is cleared whenever the Meter is powered off then back on, a statistics function is enabled, or receives a reset through the remote interface. This setting is stored in volatile memory.

Query CALC:AVER:COUN? Returns the maximum value of statistics operation.

CALCulate:NULL:OFFSet(?) {<value>|MINimum|MAXimum}

Description Sets the offset value used for the zero function. Math operation must be enabled to write to the zero offset register. This setting is stored in volatile memory.

Parameters <value> = 0 to 120 % of highest range.

MINimum	Sets offset register to -120 % of highest range of selected function.
MAXimum	Sets offset register to 120 % of highest range of selected function.

Examples CALC: NULL:OFFS 100 Sets zero offset register to 100.

Query CALC:NULL:OFFS? Returns the zero offset register value.

CALCulate:DB:REFerence(?) {<value >|MINimum|MAXimum}

Description Sets the relative value used for the dB function. Math operation must be enabled to write to the zero offset register. This setting is stored in volatile memory.

Parameters <value> = 0 to ±200 dBm.

MINimum	Sets dB relative register to -200 dBm.
MAXimum	Sets dB relative register to 200 dBm.

Examples CALC:DB:REF 25 Sets dB relative register to 25 dBm.

Query

CALC:DB:REF?	Returns -200
CALC:DB:REF?	Retrieves the dB relative register value.

CALCulate:DBM:REFerence(?) {<value>|MINimum|MAXimum}

Description Sets the reference impedance for the dBm function. Math operation must be enabled to write to the zero offset register. This setting is stored in volatile memory.

Parameters <value> = 2, 4, 6, 16, *50, 75, 90, 93, 100, 110, 124, 125, 135, 150, 250, 300, 500, 600 (default), 800, 900, 1000, 1200, or 8000 Ω.*

MINimum	Sets dBm reference impedance register 50 Ω.
MAXimum	Sets dBm reference impedance register to 8000 Ω.

Examples CALC:DBM:REF 110 Sets dBm reference impedance register to 110 Ω.

Query

CALC:DBM:REF?	Retrieves the present dBm reference impedance register value.
CALC:DBM:REF? MIN	Returns 50
CALC:DBM:REF? MAX	Returns 8000

CALCulate:LIMit:LOWer(?) {<value >|MINimum|MAXimum}

Description Sets the lower limit value used for limit testing. This setting is stored in volatile memory.

Parameters <value> = 0 to 120 % of highest range.

MINimum	Sets lower limit register to -120 % of highest range of selected function.
MAXimum	Sets lower limit register to 120 % of highest range of selected function.

Examples	CALC:LIM:LOW 235	Sets lower limit register to 235.
Query	CALC: LIM:LOW?	Retrieves the lower limit register value.
	CALC:LIM:LOW? MIN	Returns -120 % of highest range of selected function.
	CALC:LIM:LOW? MAX	Returns 120 % of highest range of selected function.

CALCulate:LIMit:UPPer {<value >|MINimum|MAXimum}

Description Sets the upper limit value used for limit testing. This setting is stored in volatile memory.

Parameters <value> = 0 to 120 % of highest range.

MINimum	Sets upper limit register to -120 % of highest range of selected function.
MAXimum	Sets upper limit register to 120 % of highest range of selected function.

Examples	CALC:LIM:UPP -150	Sets upper limit register to -150.
Query	CALC:LIM:UPP?	Retrieves the upper limit register value.
	CALC:LIM:UPP? MIN	Returns -120 % of highest range of selected function.
	CALC:LIM:UPP? MAX	Returns 120 % of highest range of selected function.

DATA:FEED RDG_STORE, <n>

Description Enables (default) or disables storing measurements in the Meter's internal memory when an INITiate command is executed. When enabled, 5,000 measurements are stored in the Meter's internal memory when executing an INITiate command.

Note

The MEASure? and CONFigure commands automatically enable the storing of measurements.

Disabling the storage of readings may be beneficial when performing statistics operations. Minimum, maximum, and average values can be calculated without storing each measurement.

Note

While readings are disabled, attempting to transfer readings to the output buffer with a FETCh? command will generate an error.

Parameters	<n> =	"CALCulate" ""	Enable the storing of measurements. Disable the storage of measurements.
Example	DATA:FEED RDG_STORE, "CALC".		

DATA:FEED?

Description	Retrieves the state of the reading store setting.	
Query	DATA:FEED?	Returns CALC or "".

CALCulate:KMATh:MMFactor(?) <value>

Description	Sets the value in the "m" register for the mx+b calculation.	
Parameters	<value> = 0 to ±999.999999	
Examples	CALC:KMAT:MMF 37	Sets "m" register to 37.
Query	CALC: KMAT:MMF?	Retrieves the "m" register value.

CALCulate:KMATh:MBFactor(?) <value>

Description	Sets the value in the "b" register for the mx+b calculation.	
Parameters	<value> = 0 to ±999.999999	
Examples	CALC:KMAT:MBF 37	Sets "b" register to 37.
Query	CALC: KMAT:MBF?	Retrieves the "b" register value.

CALCulate:KMATh:MUNits(?) <name> = 3 characters using 'A' through 'Z'

Description	Sets the units for the mx+b calculation.		
Parameters	<name> =	A to ZZZ	Up to three letters
Examples	CALC:KMAT:MUN VOL		Sets units to "VOL".
Query	CALC: KMAT:MUN?		Retrieves the set units value.

CALCulate:KMATh:STATe(?) <n>

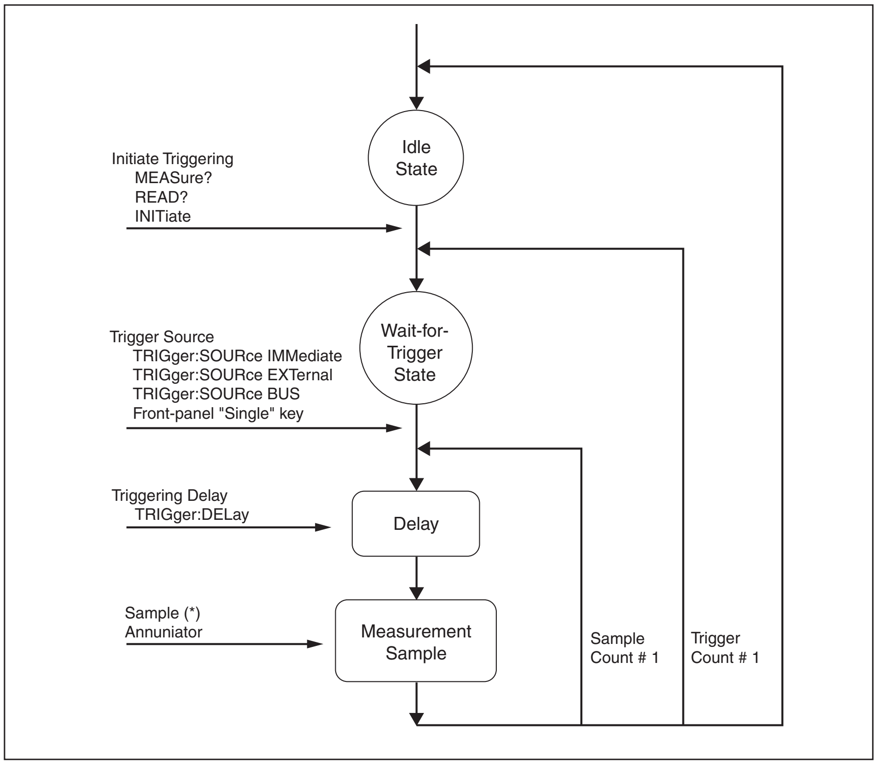
Description	Enables or disables the mx+b calculation.		
Parameters	<n> =	ON or 1 OFF or 0	Enables mx+b calculations. Disable mx+b calculations
Examples	CALC:KMAT:STAT ON		Enables mx+b calculations.
Query	CALC: KMAT:STAT?		Retrieves the state of the mx+b calculation (0 = OFF, 1 = ON).

Programming the Trigger System

The Meter is designed to provide extensive control over the triggering of a single measurement or series of measurements. One trigger can cause the Meter to take a single measurement or multiple measurements up to 50,000 per trigger.

Operating the Meter remotely requires selecting one of three trigger methods: internal, external, or bus triggering. Once a source is selected, the Meter must be in a "wait-for-trigger" state before the trigger will start a measurement cycle.

Figure 4 shows the multimeter's triggering system.



dae02.eps

Figure 4. 884XA Triggering System

The Meter can be put into a *wait-for-trigger* state remotely by sending it a **MEASure?**, **READ?**, or **INITiate** command. Once received by the Meter, it takes approximately 20 ms to setup the Meter and put it in to the *wait-for-trigger* state. Any triggers received during this set-up time are ignored.

Using the Triggering Commands

INITiate

Description Sets the Meter to the *wait-for-trigger* state in which the next trigger from the selected source triggers a measurement cycle. Up to 5,000 measurements are placed into the Meter's internal memory, where they can be retrieved with the FETCh? command.

Examples	INIT	Sets the Meter to the *wait-for-trigger* state.

READ?

Description Sets the Meter in to the *wait-for-trigger* state where the next trigger from the selected source triggers a measurement cycle. Measurements are sent directly to the output buffer.

Examples	READ?	Sets the Meter to the *wait-for-trigger* state.

TRIGger:SOURce(?) {BUS|IMMediate|EXTernal}

Description Sets the source from which the Meter will sense a measurement trigger.

Parameters	<n>	=	BUS	Sets the Meter to expect a trigger through the IEEE bus or upon execution of a *TRG command.
			IMMediate	Selects Meter’s internal triggering system.
			EXTernal	Sets Meter to sense triggers through the trigger jack on the rear panel of the Meter.

Examples	TRIG:SOUR BUS	Sets the Meter to expect a trigger through the IEEE bus or upon execution of a *TRG command.
Query	TRIG:SOUR?	Retrieves trigger source to which the Meter has been set (BUS, IMM, or EXT).

TRIGger:DELay <n>

Description Sets the delay between receiving a trigger and the beginning of measurement cycle. If the command is used without a value for *n*, the Meter automatically sets a delay time.

Parameters	<n>	=	0 to 3600	Delay specified in seconds.
			MINimum	Delay set to 0 seconds.
			MAXimum	Delay set to 3600 seconds.

Examples	TRIG:DEL 14	Sets the trigger delay to 14 seconds.
Query	TRIG:DEL?	Retrieves the amount of time set for a trigger delay.
	TRIG:DEL? MIN	Returns 0 seconds
	TRIG:DEL? MAX	Returns 3600 seconds

TRIGger:DELay:AUTO <n>

Description Enables or disables automatic trigger delay. The amount of delay is set based on selected function, integration time, and ac filter setting. When a specific trigger delay is set using TRIG:DELAY <n> command, automatic trigger delay is disabled. Setting is stored in volatile memory.

Parameters	<n>	=	ON or 1	Automatic trigger delay enabled.
			OFF or 0	Automatic trigger delay disabled.

Examples	TRIG:DEL:AUTO ON	Enables automatic trigger delay
Query	TRIG:DEL:AUTO?	Retrieves the state of the automatic trigger delay (0 = OFF, 1 = ON).

SAMPle:COUNt {<value>|MINimum|MAXimum}

Description Sets the number of measurements the Meter takes per trigger. This setting is stored in volatile memory.

Parameters	<n>	=	0 to 50,000	Number of measurements per trigger
			MINimum	Number of measurements per trigger set to 1.
			MAXimum	Number of measurements per trigger set to 50,000.

Examples	SAMP:COUN 2450	Number of measurements per trigger set to 2,450.

Query	SAMP:COUN?	Retrieves the number of samples per trigger presently set in the Meter.
	SAMP:COUN? MIN	Returns 1 to indicate the minimum number of samples the Meter will accept per trigger.
	SAMP:COUN? MAX	Returns 50,000 to indicate the maximum number of measuremens the Meter will accept per trigger.

TRIGger:COUNt <n>

Description Sets the number of triggers the Meter will take before switching to an idle state. This setting is stored in volatile memory.

Parameters	<n>	=	0 to 50,000	Number of triggers before Meter becomes idle.
			MINimum	Number of triggers is set to 1.
			MAXimum	Number of triggers is set to 50,000.
			INFinite	Continuously accepts triggers. A device clear is required to set the Meter to idle state after INFinite has been set.

Examples	TRIG:COUN 430	Number of triggers set to 430.
Query	TRIG:COUN?	Retrieves the number of triggers presently set in the Meter. Returns 9.90000000E+37 if trigger count has been set to INFinite.
	TRIG:COUN? MIN	Returns 1 to indicate the minimum number of triggers the Meter will accept per trigger.
	TRIG:COUN? MAX	Returns 50,000 to indicate the maximum number of triggers the Meter will accept per trigger.

Using System-Related Commands

FETCh[1/2]?

Description Moves measurements stored in the Meter's internal memory to the output buffer. FETCh1? or FETCh? returns measurements from the primary display. FETCh2? Returns readings from the secondary display.

Example	FETCh2?	Retrieves a single measurement from the Meter's internal memory that was taken by the secondary display. If secondary measurements are enabled.

DISPlay <n>

Description Enables or disables the Meter's display. This setting is stored in volatile memory.

Parameters	<n>	=	ON or 1	Enables display.
			OFF or 0	Disables display.

Examples	DISP ON	Enables the Meter's display.
Query	DISP?	Retrieves the state of the display (0 = OFF and 1 = ON).

DISPlay:TEXT(?) <quoted string >

Description Displays message on the Meter's display. This setting is stored in volatile memory.

Note

Meter must be remote before executing this command.

Parameters	<quoted string> =	Up to 12 characters. Additional characters are truncated.
Examples	DISP:TEXT "Hello"	Hello is displayed in the Meter's display.
Query	DISP:TEXT?	Retrieves the text sent to the Meter in a DISP:TEXT command.

DISPlay:TEXT:CLEar

Description Clears the displayed message on the Meter's display.

Examples	DISP:CLE	Meter's display message is cleared.

SYSTem:BEEPer

Description Causes the Meter to beep once.

Examples	SYST:BEEP	Meter beeps.

SYSTem:BEEPer:STATe? <n>

Description Enables or disables the Meter's beeper. This setting is stored in volatile memory. Disabling the beeper causes the Meter to not beep for the following conditions:

a new minimum or maximum is detected during statistics
a limit is exceeded during a limits test
a forward-biased diode is measured during a diode test

Parameters	<n> =	ON or 1	Enables Meter's beeper.
		OFF or 0	Disables Meter's beeper.
Examples	SYST:BEEP:STAT ON	Enables the beeper.	
Query	SYST:BEEP:STAT?	Retrieves the state of the Meter's beeper (0 = OFF and 1 = ON).	

SYSTem:ERRor?

Description Retrieves errors from the Meter's error queue. Errors are retrieved in first-in, first-out (FIFO) order. Each error may contain up to 80 characters.

Examples	SYST:ERR?	Returns error.

SYSTem:ERRor:BEEPer(?) <n>

Description Enable or disables the Meter's beeper for error messages. This setting is stored in volatile memory.

Parameters	<n> =	ON or 1	Enables beeper for error messages.
		OFF or 0	Disables beeper for error messages.
Examples	SYST:ERR:BEEP ON	Set Meter to beep when errors are detected.	
Query	SYST:ERR:BEEP?	Returns state of beeper for error messages (0 = OFF and 1 = ON).	

SYSTem:DATE(?) <date>

Description	Sets the system clock date.	
Parameters	<date> =	MM/DD/YYYY or MM-DD-YYYY. MM between 1 and 12 DD between 1 and 31 YYYY between 1970 and 2038
Examples	SYST:DATE 10/25/2007	
Query	SYST:DATE?	Returns the Meter's system clock date.

SYSTem:TIME(?) <time>

Description	Sets the system clock time in 24 format.	
Parameters	<time> =	HH:MM:SS or HH-MM-SS HH between 0 and 23 MM between 0 and 59 SS between 0 and 59
Examples	SYST:TIME 14:25:10	Sets time to 2:25:10 PM
Query	SYST:TIME?	Returns the Meter's system clock time.

SYSTem:VERSion?

Description	Retrieves the Meter's present SCPI command version.	
Examples	SYST:VERS?	Returns SCPI version.

DATA:POINts?

Description	Retrieves the number of measurements contained the Meter's internal memory.	
Examples	DATA:POIN?	Returns number of measurements in internal memory.

**RST*

Description	Resets the Meter to its power-up configuration.	
Examples	*RST	Resets the Meter.

**IDN <n>, [<quoted string>]*

Description	Enables or disables the retrieval of a user-specified IDN string or factory-set IDN string with the *IDN? command. Also sets the user defined IDN string.		
Parameters	<n> =	ON or 1	Enables user-defined string.
		OFF or 0	Disables user defined string and causes the factory IDN string to be returned for an *IDN? command.
	<quoted string> =		Up to a 35 character string.
Example	IDN ON, "My Meter"		Sets the IDN string to My Meter and enables the user defined string to be returned when the *IDN? command is received by the Meter.

*IDN?

Description Returns the IDN string. If *IDN is enabled (ON), then the Meter returns the user defined string. If *IDN is disabled (OFF), the the Meter returns the IDN string set at the factory.

Query *IDN? Returns up to 35 character string.

Using Status Reporting Commands

SYSTem:ERRor?

Description Retrieves errors from the Meter’s error queue. Errors are retrieved in first-in, first-out (FIFO) order. Each error may contain up to 80 characters.

Examples SYST:ERR? Returns the next error in the error queue. Performing a SYST:ERR? command when the error queue is empty causes +0,″No error″ to be returned.

STATus:QUEStionable:ENABle(?) <n>

Description Enables or disables bits in the Meter’s Questionable Data enable register.

Parameters <n> = 0 to 65535 Binary-weighted decimal value representing the bits to set in the register. Although a 16-bit register that will accept a number between 0 and 65535, only bits 0, 1, 9, 11, 12, and 13 are used.

Examples STAT:QUES:ENAB 4 Sets bit 2 to one and all others to zero.

Query STAT:QUES:ENAB? Retrieves a binary-weighted decimal value representing the bits set in the questionable data enable register.

STATus:QUEStionable:EVENt?

Description Enables or disables bits in the Meter’s Questionable Data event register.

Parameters <n> = 0 to 65535 Binary-weighted decimal value representing the bits to set in the register. Although a 16-bit register that will accept a number between 0 and 65535, only bits 0, 1, 9, 11, 12, and 13 are used.

Query STAT:QUES:ENAB? Retrieves a binary-weighted decimal value representing the bits set in the questionable data event register.

STATus:PRESet

Description Sets all bits to zero in the Meter’s Questionable Data enable register.

Examples STAT:PRES Sets all bits to zero.

*CLS

Description Sets all bits to zero in the Meter’s status byte register and all event registers. Also clears the error queue.

Examples *CLS Sets all bits to zero and clear error queue.

*ESE <enable value>

Description	Enables or disables bits in the Meter's Standard Event enable register.			
Parameters	<n>	=	0 to 255	Binary-weighted decimal value representing the bits to set in the register. Although this register has 8 bits and will accept a number from 0 to 255, only bits 0, 2 through 5, and 7 are used.
Examples	*ESE 160			Sets bits 5 and 7 to one and all other bits to zero.

*ESE?

Description	Retrieves the value in the Meter's Standard Event enable register.	
Examples	*ESE?	Retrieves a binary-weighted decimal value representing the bits set in the Standard Event enable register.

*ESR?

Description	Retrieves the value in the Meter's Standard Event register.	
Examples	*ESR?	Retrieves a binary-weighted decimal value representing the bits set in the Standard Event register.

*OPC

Description	Sets bit 0 (Operation complete) in the Meter's Standard Event register.	
Examples	*OPC	Sets bit 0 in Standard Event register.

*OPC?

Description	Returns a one to the Meter's output buffer.
Examples	*OPC?

*PSC <n>

Description Enables or disables the clearing of the Status Byte Enable register and Standard Event Enable register when Meter power is turned on. This setting is stored in non-volatile memory.

Parameters	<n>	=	0	Disables clearing Status Byte and Standard Event Enable register at power-up.
			1	Enables clearing Status Byte and Standard Event Enable register at power-up.

*PSC?

Description Returns the state of the clearing of the Status Byte and Standard Event Enable registers at power-up.

Examples *PSC? Returns zero if clearing is disabled. Returns one if clearing enabled.

*SRE <enable value>

Description Enables or disables bits in the Meter's Status Byte enable register.

Parameters <n> = 0 to 255 Binary-weighted decimal value representing the bits to set in the register. Although this register has 8 bits and will accept a number from 0 to 255, only bits 3 through 5 are used.

Examples *SRE 48 Sets bits 4 and 5 to one and all other bits to zero.

*SRE?

Description Retrieves the value in the Meter's Status Byte enable register.

Examples *SRE? Retrieves a binary-weighted decimal value representing the bits set in the enable register.

*STB?

Description Retrieves the value in the Meter's Status Byte summary register. Although like a serial poll, this command is processed as an instrument command. Returned results are the same a when receiving a serial poll, but the SRQ bit is not cleared if a serial poll has occurred.

Examples *STB?

Calibration Commands

CALibration? [{ON|OFF}]

Description After entering the proper code using the CAL:SEC:CODE command, this command causes the Meter to perform an adjustment using the values supplied with the CAL:VAL command. See the *8845A/8846A Service Manual* for details on using this command.

Parameters <n> = ON or 1 Execute only one calibration step.
OFF or 0 Execute a group (mode) of related calibration steps at one time.

Examples CAL? ON Execute one step of the calibration steps for the calibration group specified by the CAL:VAL command.

CAL? Returns +0 (good) or +1 (failed)

CALibration:COUNt?

Description Retrieves the number of times the Meter has been calibrated. Read this value just after receiving the Meter to have a starting value. This setting is stored in non-volatile memory.

Note

This value increments once for each calibration point. A complete calibration will increment this value many times. The maximum count is 4,294,967,295, at which point the next calibration causes this value to reset to zero.

Examples CAL:COUN?

CALibration:RECord

Description Stores the calibration values.

Example CAL:REC — Stores all of the Meter's changed calibration values.

CALibration:SECure:CODE <new code >

Description Sets a new calibration password. Before entering a new code, you must first enter the old password using the CAL:SEC:STAT command. The Meter has a password of FLUKE884X when shipped from the factory.

Parameters <new code> = Up to 12 characters of capital letters and numerials (A-Z, 0-9).

Example CAL:SEC:CODE 12B — Sets the new calibration password to 12B.

The password can not be recalled, the password can be reset to the factory default without returning the Meter for service.

⚠⚠ Warning

To avoid electric shock and or injury, do not open the Meter unless you are qualified to do so.

Follow the instructions in the *8845A/8846A Service Manual* for opening the Meter case. Located at the rear of the chassis, behind the Ethernet connector (J17), there is a jumper connector labeled W2. Short the pins of W2 together and power cycle the Meter to reset the password to FLUKE884X.

CALibration:SECure:STATe(?) <n>,<code >

Description Secure or unsecure the Meter for calibration. This setting is stored in non-volatile memory.

Parameters

<n>	=	ON or 1	Secures the Meter from calibration.
		OFF or 0	Unsecures the Meter for calibration.
<code>	=	Up to 12 character string.	

Example CAL:SEC:STAT OFF 12B — Unsecures the Meter for calibration when the password is 12B.

Query CAL:SEC:STAT? — Retrieves the state of the Meter's calibration security (0 = OFF and 1 = ON).

CALibration:STRing(?) <quoted string>

Description	Store calibration information in the Meter's memory. This setting is stored in non-volatile memory.	
Parameters	<quoted string> =	Up to a 40 character string.
Query	CAL:STR?	Retrieves the Meter's calibration string.

CALibration:DATE(?) <date>

Description	Sets the calibration date on the 8845A only.	
Parameters	<date> =	MM/DD/YYYY or MM-DD-YYYY. MM between 1 and 12 DD between 1 and 31 YYYY between 1970 and 2038
Examples	CAL:DATE 10/25/2007	
Query	CAL:DATE?	Returns the Meter's calibration date.

CALibration:VALue(?) <mode>, <value >

Description	Sets up the Meter for a calibration point. The mode parameter is the name of the functional group being calibrated. The value parameter is the Meter's range for the calibration point. Refer to the calibration procedure in the *8845A/8846A Service Manual* for mode names and values.	
Parameters	<mode> = <value> =	See *8845A/8846A Service Manual* See *8845A/8846A Service Manual*
Query	CAL:VAL?	Retrieves the Meter's calibration value.

CALibration:STEP(?) <step #> [,Reference]

Description	Specifies the calibration step number and the optional reference value of the known calibration signal used by the calibration procedure. See the *8845A/8846A Service Manual* for a list of calibration steps with values.	
Parameters	<step #>=	(See the *8845A/8846A Service Manual*)
Examples	CAL:STEP 5	Sets the calibration step to number 5.
Query	CAL:STEP?	Returns the Meter's calibration step.

Using RS-232/Ethernet Interface Commands

There are four remote commands that are specifically applicable to controlling the Meter using the RS-232 or Ethernet remote interface.

SYSTem:LOCal

Description	Places the Meter in the local mode. Front-panel keys still function.
Example	SYST:LOC

SYSTem:REMote

Description Places the Meter in the remote mode for RS-232 or Ethernet remote control. All front-panel keys, except the local key, are disabled.

Example SYST:REM

Note

To avoid unpredictable operation, send a SYS:REM command to the Meter before sending or receiving data over the RS-232 or Ethernet interface.

SYSTem:RWLock

Description Like the SYST:REM command, this command places the Meter into remote mode, but with all front-panel keys, including the local key, disabled.

Example SYST:RWL

Ctrl-C

Description Immediately stops transfers of data over the RS-232 interface and clears any output data.

Note

This the same as sending a device clear over the IEEE bus.

Command Terminators

A command string sent to the Meter must terminate with a <new line> character. The IEEE 488 EOI (end-or-identify) message is interpreted as a <new line> character and can be used to terminate a command string in place of a <new line> character. A <carriage return> followed by a <new line> is also accepted. Command string termination will always reset the current SCPI command path to the root level.

SCPI Parameter Types

The SCPI language defines several different data formats to be used in program messages and response messages.

Numeric Parameters

Commands that require numeric parameters will accept all commonly used decimal representations of numbers including optional signs, decimal points, and scientific notation. Special values for numeric parameters like MINimum, MAXimum, and DEFault are also accepted. You can also send engineering unit suffixes with numeric parameters (e.g., M, K, or u). If only specific numeric values are accepted, the Meter will automatically round the input numeric parameters. The following command uses a numeric parameter:

```
VOLTage:DC:RANGe {<range>|MINimum|MAXimum}
```

Discrete Parameters

Discrete parameters are used to program settings that have a limited number of values (like `BUS`, `IMMediate`, `EXTernal`). They have a short form and a long form just like command keywords. You can mix upper- and lower-case letters. Query responses will *always* return the short form in all upper-case letters. The following command uses discrete parameters:

```
TRIGger:SOURce {BUS|IMMediate|EXTernal}
```

Boolean Parameters

Boolean parameters represent a single binary condition that is either true or false. For a false condition, the Meter will accept **OFF** or **0**. For a true condition, the Meter will accept **ON** or **1**. When you query a boolean setting, the instrument will always return “0” or “1”. The following command uses a boolean parameter:

```
INPut:IMPedance:AUTO {OFF|ON}
```

String Parameters

String parameters can contain virtually any set of ASCII characters. A string must begin and end with matching quotes; either with a single quote or with a double quote. You can include the quote delimiter as part of the string by typing it twice without any characters in between. The following command uses a string parameter:

`DISPlay:TEXT` <*quoted string*>

Alternate Programming Language Compatibility

The Meter can be configured to accept and execute 884XA SCPI commands (HP 34401A compatible) or Fluke 45 multimeter commands. Remote operation will only allow you to access the functionality of the multimeter language selected. Full Meter capability is available through the 884XA SCPI programming language. For more information on selecting the alternate languages from the front panel menu, see *Selecting the Programming Language* earlier in this manual. From the remote interface, use the following commands to select the alternate languages:

`L1`	*selects SCPI language*
`L2`	*selects Fluke 45A language*

The Meter implements virtually all of the commands available for the Fluke 45 and HP 34401A, with the exception of the self-test and calibration commands. You must always calibrate the Meter using the SCPI language setting. The calibration commands from the other multimeters will not be executed.

Be aware that measurement timing may be different in the alternate language compatibility modes.

FLUKE 45 Command Emulation Summary

Computer Interface Command Set

RS-232 and IEEE 488 commands, grouped by related function, are listed in the tables that follow. These commands are identical, except where indicated. A parameter that must be supplied by the user or a string returned by the Meter is enclosed in angle brackets (<value>).

- IEEE 488 Common Commands (Table 20)
- Function Commands and Queries (Table 21)
- Function Modifier Commands and Queries (Table 22)
- Range and Measurement Rate Commands and Queries (Table 23)
- Measurement Queries (Table 24)
- Compare Commands and Queries (Table 25)
- Trigger Configuration Commands (Table 26)
- Miscellaneous Commands and Queries (Table 27)
- RS-232 Remote/ Local Configuration Commands (Table 28)

IEEE 488 Capabilities and Common Commands

Table 20 summarizes the IEEE 488 Commands that are common between the Fluke 884XA and the Fluke 45.

Table 20. IEEE Common Commands

Command	Name	Description
*CLS	Clear Status	Clears all event registers summarized in the status byte, except for "Message Available," which is cleared only if *CLS is the first message in the command line.
*ESE <value>	Event Status Enable	Sets Event Status Enable Register to <value>, an integer between 0 and 255, where <value> is an integer whose binary equivalent corresponds to the state (1 or 0) of bits in the register. If <value> is not between 0 and 255, an Execution Error is generated. EXAMPLE: decimal 16 converts to binary 00010000. Sets bit 4 (EXE) in ESE to 1.
*ESE?	Event Status Enable Query	Meter returns the <value> of the Event Status Enable Register set by the *ESE command, where <value> is an integer whose binary equivalent corresponds to the state (1 or 0) of bits in the register.
*ESR?	Event Status Register Query	Meter returns the <value> of the Event Status Register and then clears it. The <value> is an integer whose binary equivalent corresponds to the state (1 or 0) of bits in the register.

Table 20. IEEE Common Commands (cont.)

Command	Name	Description
*IDN?	Identification Query	Meter returns the identification code of the meter as four fields separated by commas. These fields are: manufacturer ("FLUKE"); model (“45"); seven-digit serial number; version of main software and version of display software. (example: FLUKE, 45, 9080025, 2.0, D2.0)
*OPC	Operation Complete Command	Meter sets the Operation Complete bit in the Standard Event Status Register when parsed.
*OPC?	Operation Complete Query	Meter places an ASCII "1 " in the output queue when parsed.
*RST	Reset	Meter performs power-up reset, except that the state of IEEE 488 interface is unchanged, including: instrument address, Status Byte, and Event Status Register.
*SRE <value>	Service Request Enable	Sets the "Service Request Enable Register" to <value>, an integer between 0 and 255. The value of bit six is ignored because it is not used by the Service Request Enable Register. Note that <value> is an integer whose binary equivalent corresponds to the state (1 or 0) of bits in the register. If <value> is not between 0 and 255, an Execution Error is generated.
*SRE?	Service Request Enable Query	Meter returns the <value> of the Service Request Enable Register (with bit six set to zero); <value> is an integer whose binary equivalent corresponds to the state (1 or 0) of bits in the register.
*STB?	Read Status Byte	Meter returns the <value> of the Status Byte with bit six as the Master Summary bit. <value> is an integer whose binary equivalent corresponds to the state (1 or 0) of bits in the register.
*TRG	Trigger	Causes the meter to trigger a measurement when parsed.
*WAI	Wait-to-continue	Command required by IEEE 488.2 standard. Non-operational in Fluke 45 Dual Display Multimeter. Command accepted but has no effect.

Function Commands and Queries

The commands in Table 21 lists the measurement function commands for the Fluke 45. See Tables 22A and 22B for ranges and measurement rates. Commands under Primary Display and Secondary Display cause functions to be performed on the primary display or secondary display, respectively.

Table 21. Fluke 45 Function Commands and Queries

Commands		Function
Primary Display	Secondary Display	
AAC	AAC2	AC current
ADC	ADC2	DC current
—	CLR2	Clears measurement from secondary display if one shown.
CONT	—	Continuity test. Available in the primary display only.
DIODE	DIODE2	Diode test
FREQ	FREQ2	Frequency
FUNC1 ?	—	Meter returns the function selected for the primary display as command mnemonic. EXAMPLE: If frequency is selected for the primary display, "FUNC1?" returns "FREQ".
	FUNC2?	Meter returns the function selected for the secondary display as command mnemonic. If the secondary display is not in use, an Execution Error is generated. EXAMPLE: If frequency is selected for the secondary display, FUNC2? returns "FREQ".
OHMS	OHMS2	Resistance
VAC	VAC2	AC volts
VDC	VDC2	DC volts

Function Modifier Commands and Queries

The commands in Table 22 relate to the function modifiers. A function modifier causes the Meter to modify the normal operation of a measurement function (or perform an action on a measurement) before displaying a reading.

Table 22. Function Modifier Commands and Queries

<table>
<tr><th>Command</th><th>Description</th></tr>
<tr><td>AFILT (on/off)</td><td>Activates or deactivates the 3-pole analog filter to improve noise immunity for dc functions. This filter is only available in DCV, DCI, 2-Wire and 4-Wire resistance. The default setting is OFF. If an attempt is made to enable the filter in a mode not permitted, the request is ignored.</td></tr>
<tr><td>AFILT?</td><td>Returns the state of the analog filter.</td></tr>
<tr><td>DB</td><td>Meter enters decibels modifier. Any reading shown in the primary display is in decibels.
An Execution Error is generated if the meter is not in a volts ac and/or dc function.</td></tr>
<tr><td>DBCLR</td><td>Meter exits the decibels modifier and displays readings in normal units. Also clears dB and Power modifiers.</td></tr>
<tr><td>DBPOWER</td><td>Meter enters dB Power modifier if the reference impedance is set to 2, 4, 8, or 16 ohms and a voltage function has been selected. Otherwise, an Execution Error is generated. In dB Power, readings shown in the primary display are in watts.</td></tr>
<tr><td>DBREF &lt;value&gt;</td><td>Set dB reference impedance to a <value> shown in Table 22A. This value corresponds to the reference impedance (ohms) indicated.
If <value> is not a value shown in Table 22A, an Execution Error is generated.
<b>Table 22A. Reference Impedance Values</b>
<table>
<tr><th>Value</th><th>Ref Impedance</th><th>Value</th><th>Ref Impedance</th></tr>
<tr><td>1</td><td>2</td><td>12</td><td>150</td></tr>
<tr><td>2</td><td>4</td><td>13</td><td>250</td></tr>
<tr><td>3</td><td>8</td><td>14</td><td>300</td></tr>
<tr><td>4</td><td>16</td><td>15</td><td>500</td></tr>
<tr><td>5</td><td>50</td><td>16</td><td>600</td></tr>
<tr><td>6</td><td>75</td><td>17</td><td>800</td></tr>
<tr><td>7</td><td>93</td><td>18</td><td>900</td></tr>
<tr><td>8</td><td>110</td><td>19</td><td>1000</td></tr>
<tr><td>9</td><td>124</td><td>20</td><td>1200</td></tr>
<tr><td>10</td><td>125</td><td>21</td><td>8000</td></tr>
<tr><td>11</td><td>135</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>DBREF?</td><td>Meter returns a <value> shown in Table 22A. This value corresponds to the reference impedance indicated.</td></tr>
<tr><td>DFILT (on/off)</td><td>Activates or deactivates the digital averaging filter to reduce noise for dc functions. This filter is only available in DCV, DCI, 2-Wire and 4-Wire resistance. The default setting is ON. If an attempt is made to enable the filter in a mode not permitted, the request is ignored.</td></tr>
</table>

Table 22. Function Modifier Commands and Queries (cont.)

Command	Description
DFILT?	Returns the state of the digital averaging filter.
MOD?	Meter returns a numeric value indicating modifiers in use. 8=dB, 16=dB Power, 32 = Relative, 64 = Compare.

Range and Measurement Rate Commands and Queries

The commands in Table 23 relate to ranging and measurement rates (i.e., readings/ second). In the autorange mode, the Meter automatically selects a range for each reading; in the manual range mode, the user selects a fixed range.

Table 23. Range and Measurement Rate Commands and Queries

Command	Description
AUTO	Causes the meter to enter the autoranging mode on the primary display. If the autorange mode cannot be selected (e.g., if dB or diode/continuity test is selected), an Execution Error is generated.
AUTO?	Causes meter to return "1" in autorange, or "0" if it is not.
FIXED	Causes the meter to exit autoranging on the primary display and enter manual ranging. The present range becomes the selected range.
RANGE <range>	Sets the primary display to the range designated by <range>, where <range> is a number between 1 and 7 that corresponds to a range shown in Tables 5-12A and 5-12B.

Table 23A. Ranges at Fast & Medium Measurement Rate

Range Value	Voltage Range	Ohms Range	Current Range	Frequency Range
1	300 mV	300 Ω	30 mA	1000 Hz
2	3 V	3 k Ω	100 mA	10 kHz
3	30 V	30 k Ω	10 A	100 kHz
4	300 V	300 k Ω	ERROR	1000 kHz
5	1000 V dc*	3 M Ω	ERROR	1 MHz
6	ERROR	30 M Ω	ERROR	ERROR
7	ERROR	300 M Ω	ERROR	ERROR

* 1000 V dc, 750 V ac

Table 23B. Ranges at Slow Measurement Rate

Range Value	Voltage Range	Ohms Range	Current Range	Frequency Range
1	100 mV	100 Ω	10 mA	1000 Hz
2	1000 mV	1000 Ω	100 mA	10 kHz
3	10 V	10 k Ω	10 A	100 kHz
4	100 V	100 k Ω	ERROR	1000 kHz
5	1000 V dc*	1000 k Ω	ERROR	1 MHz
6	ERROR	10 M Ω	ERROR	ERROR
7	ERROR	100 M Ω	ERROR	ERROR

* 1000 V dc, 750 V ac

Table 23. Range and Measurement Rate Commands and Queries (cont.)

Command	Description
RANGE1?	Returns the range presently selected on the primary display.
RANGE2?	Returns the range presently selected on the secondary display. If the secondary display is inactive, an Execution Error is generated.
RATE <speed>	Sets the measurement rate to <speed>. RATE <speed> is either "S" for slow (2.5 readings/second), "M" for medium (5 readings/second), or "F" for fast (20 readings/second). "S", "M", and "F" can be sent as either upper- or lower-case letters. Any other entry for <speed> generates an Execution Error.
RATE?	Returns <speed> as "S" for slow (2.5 readings/second), "M" for medium (5.0 readings/second), or "F" for fast (20 readings/second).

Measurement Queries

The commands in Table 24 cause the Meter to return readings shown on the primary and/or secondary displays.

Table 24. Measurement Queries

Command	Description
MEAS1?	Meter returns the value shown on the primary display after the *next triggered* measurement is complete.
MEAS2?	Meter returns the value shown on the secondary display after the next *triggered* measurement is complete. If the secondary display is off, an Execution Error is generated.
MEAS?	If both displays are on, the Meter returns the value shown on both displays after the next triggered measurement is complete in the format selected. These values are separated by a comma (format 1) or a space, measurement units, a comma and space (format 2). Example: +1.2345E+0,+6.7890E+3<CR><LF> If the secondary display is not on, MEAS? is equivalent to MEAS1? *Note* *If MEAS is used in external trigger (TRIGGER 2 through TRIGGER 5), unexpected results will be obtained.*
VAL1?	Meter returns the value shown on the primary display. If the primary display is blank, the next triggered measurement is returned.
VAL2?	Meter returns the value shown on the secondary display. If the secondary display is blank, the next triggered measurement is returned. If the secondary display is off, an execution error is generated.
VAL?	If both displays are on, the Meter returns the value shown on both displays. These values are separated by a comma. Example: +1.2345E+0,+6.7890E+3<CR><LF>. If the secondary display is not on, VAL is equivalent to VAL1. If a display is blank, the next triggered measurement on that display (or displays) is returned.

Compare Commands and Queries

The commands in Table 25 cause the Meter to determine whether a measurement is higher than, lower than, or within a specified range.

Table 25. Compare Commands and Queries

Command	Description
COMP	Meter enters compare (COMP) function.
COMP?	Meter returns "HI" if the last COMP measurement reading was above the compare range, "LO" if it was below it, "PASS" if within compare range, or "— " if a measurement has not completed.
COMPCLR	Meter exits compare function, and restores display tonormal operation.
COMPHI <high value>	Sets HI compare (COMP) value to <high value>, and <high value> can be a signed integer, signed real number without exponent, or signed real number with exponent.
COMPLO <low value>	Sets LO compare (COMP) value to <low value>, and <low value> can be a signed integer, signed real number without exponent, or signed real number with exponent.

Trigger Configuration Commands

The commands in Table 26 set and return the trigger configuration.

Table 26. Trigger Configuration Commands

<table>
<tr><th>Command</th><th>Description</th></tr>
<tr><td>TRIGGER <type></td><td>Sets the trigger configuration to <type>.
<type> corresponds to a number between 1 and 5 selected from Table 26A. If the <type> entered is not one of these listed numbers, an Execution Error is generated.
<b>Table 26A. Trigger Type</b>
<table>
<tr><th>Type</th><th>Trigger</th><th>Rear Trigger</th><th>Settling Delay</th></tr>
<tr><td>1</td><td>Internal</td><td>Enabled[1]</td><td>-</td></tr>
<tr><td>2</td><td>External</td><td>Enabled[1]</td><td>Off</td></tr>
<tr><td>3</td><td>External</td><td>Enabled[1]</td><td>On</td></tr>
<tr><td>4</td><td>External</td><td>Enabled</td><td>Off</td></tr>
<tr><td>5</td><td>External</td><td>Enabled</td><td>On</td></tr>
<tr><td colspan="4">[1] Although the Fluke 45 disabled the rear-panel trigger for these trigger types, the 884XA leaves the rear-panel trigger enabled.</td></tr>
</table></td></tr>
<tr><td>TRIGGER?</td><td>When the input signal is not stable, select a trigger type with the settling delay (type 3 or 5) enabled before a measurement is triggered.
Returns the trigger <type> set by the TRIGGER command.</td></tr>
</table>

Miscellaneous Commands and Queries

Miscellaneous commands and queries are summarized in Table 27.

Table 27. Miscellaneous Commands and Queries

Command	Description
^C (CNTRL C)	The RS-232 equivalent of IEEE 488 DCL. Causes <CR><LF> and =><CR><LF> to be output.
SERIAL?	Meter returns its serial number.

RS-232 Remote/Local Configurations

The commands in Table 28 are used with the RS-232 interface to set up the Remote/ Local configuration of the Meter. These commands are valid only when the RS-232 interface is enabled.

Table 28. Remote/Local Configuration Commands

Command	Description
REMS	Puts the Meter into remote state where all front-panel keys, except the local key, are disabled. LOCAL is shown above the first soft key in the display.
RWLS	Puts the Meter in the remote state, with front-panel lockout. LOCKED is shown in the display. When in RWLS, all front panel buttons are disabled.
LOCS	Puts the Meter in the local state, i.e., local operating mode without lockout. All front panel buttons are enabled.
LWLS	Puts the Meter in the IEEE 488 LWLS state, i.e., local operating mode lockout. All front panel buttons are disabled.

Triggering Output

The Meter takes measurements when it is triggered to do so. The five available trigger types are listed in Table 29. All available trigger methods fall into two basic categories:

- *Internal* triggering uses the Meter's internal trigger circuit for a continuous source of triggers.
- *External* triggering comes from a source outside the Meter controlled by the user.

Setting the Trigger Type Configuration

To select a trigger type over the computer interface, send the command:

TRIGGER <type>

where <type> is a number between 1 and 5 that identifies a trigger type. If <type> is not one of these numbers, an Execution Error is generated.

Select a trigger type that enables the settling delay (type 3 or 5) when the input signal is not stable before a measurement is triggered.

External Triggering

A measurement can be externally triggered in three ways:

- External trigger.
- GET command (IEEE Interface only)
- *TRG command

To trigger a measurement over the RS-232 or IEEE 488 computer interface, send the Meter a *TRG command over the computer interface. The GET command is only valid for the IEEE interface.

When set for external trigger, the Meter will trigger measurements when a negative-going signal is applied to the rear-panel trigger jack.

Note

The Fluke 45 provides a method of triggering through its RS-232 port. The 8845A and 8846A do not provide this method of triggering.

Table 29. Trigger Types

Type	Trigger	Rear Trigger	Settling Delay
1	Internal	Enabled[1]	-
2	External	Enabled[1]	Off
3	External	Enabled[1]	On
4	External	Enabled	Off
5	External	Enabled	On

[1] Although the Fluke 45 disabled the rear-panel trigger for these trigger types, the 884XA leaves the rear-panel trigger enabled.

Using FlukeView Forms

You can use FlukeView Forms to download and store readings from the Meter to a PC running MicroSoft's Windows operating system. FlukeView Forms Basic Documenting Software must first be installed on the PC. Refer to the *FlukeView Forms Installation Guide* to install FlukeView Forms on your Windows PC.

Note

The Meter's RS-232 port must be enabled and properly configured before FlukeView forms will communicate with the Meter. In addition, the Fluke 45 command set must be selected in the Meter.

To connect and configure the Meter to the PC with the installed *FlukeView Forms Basic Documenting Software*:

1. Connect a null-modem cable between the RS-232 port of the Meter and the PC's RS-232 port.
2. Open *FlukeView Forms Documenting Software*.
3. The current COM serial port setting is displayed at the bottom right of the *FlukeView Forms Basic* window. Double-click on it to change the COM port setting to the virtual COM port used by the null-modem cable.
4. Turn the Meter on.
5. Select the Fluke 45 Command set by following the instructions in the *Selecting the Program Language* section of Chapter 3 of the *Users Manual*.

6. Ensure the Meter's RS-232 port is set to 9600 Baud, No parity, and Echo Off using the instructions found in the *Configuring the RS-232 Port* section of Chapter 3 *Users Manual*.
7. Follow the instructions for transferring data from the Meter to the PC, found in the online *FlukeView Forms Users Manual.*

Appendix A
Error Codes

Introduction

While operating the Meter remotely, errors may be detected. Each error is stored in a buffer that is read in a first-in, first-out (FIFO) order. The error buffer will store up to 16 errors. If another error occurs before any of the first 16 are read from the buffer, the last error is replaced with -350 (Too many errors). No further errors are stored until the errors are read from the buffer.

The error buffer is cleared whenever the Meter's power is removed or a *CLS command is executed. The *RST (reset) command does NOT clear the error buffer. If no errors are in the error buffer when it is read, the Meter returns +0 (No error).

Tables 30 through 32 lists the possible error codes and their descriptions.

Table 30. Execution Error Codes and Descriptions

Error Code	Error Text	Description
-102	Syntax error	Invalid syntax was found in the command string. You may have inserted a blank space before or after a colon in the command header, or before a comma, or a character such as #, $, or % \. This error will occur when the command header is not formed properly and fails to pass header rules syntax. Example: SAMP:COUN ,1 or CONF:VOLT#DC
-115	Missing parameter	Fewer parameters were received than expected for the command. You omitted one or more parameters that are required for this command. Example: SAMP:COUN
-117	Parameter type	A parameter within the command does not match a valid type of parameter for the command specification. For example, if a command expected numeric data and received character data instead. Example: SAMP:COUNT A
-120	Numberic invalid	One or more values in a numeric/channel list parameter is invalid, e.g. floating point when not allowed.

Table 30. Execution Error Codes and Descriptions (cont.)

Error Code	Error Text	Description
-124	Numeric value overflow	The command contains a parameter of type Numeric Value that was too large to be stored internally. This occurs if the value has an exponent greater than +/-43. Example SAMP:COUNT 1e50
-125	Numeric negative	A negative numeric parameter value was entered. Example: SAMP:COUN -3
-126	Numeric real	A floating point (real) numeric parameter value was entered. Example: SAMP:COUN -13.6
-127	Channel dimension invalid	One or more entries in a channel list parameter has an invalid number of dimensions.
-130	Parameter suffix	A parameter within the Input Command had the wrong type of units for the Command Specification. Example VOLT:DC:RANGE 1A
-137	Invalid header suffix	Too many numeric suffices in the input for the specified command. As an example, valid arguments for the FETCH? Command are FETCH? FETCH1? and FETCH2? If FETCH3? is entered, error 137 will be generated.
-150	Invalid string data	The parameters in the Input Command contained an unmatched single or double quote. Example: DISP:TEXT ‘hello world”.
-154	String size	The length of the entered string exceeds 12 characters. Example CAL:SEC:CODE “this is an example of a long string”.
-157	Unmatched brackets	The parameters in the Input Command contain an unmatched bracket.
-191	Unknown parameter	One or more of the parameters contains an unspecified error.
-192	Too many dimensions	Too many dimensions in entry.
-193	No entry	There was no entry to get - the index was beyond the end of the entries.
-200	Generic execution	General Execution error has occurred.
-211	Trigger ignored	A Group Execute Trigger (GET) or *TRG was received but the trigger was ignored. Make sure the multimeter is in the *wait-for-trigger* state before issuing a trigger, and make sure the correct trigger source is selected.
-213	Init ignored	An INITiate command was received but could not be executed because a measurement was already in progress. Send a device clear to halt a measurement in progress and place the multimeter in the *idle* state.
-214	Trigger deadlock	A trigger deadlock occurs when the trigger source is BUS and a READ? command is received.
-222	Illegal data value	

Table 30. Execution Error Codes and Descriptions (cont.)

Error Code	Error Text	Description
-223	Too much data	A character string was received, but could not be executed because the string length was more than 12 characters. This error can be generated by the CALibration:STRing and DISPlay:TEXT commands.
-227	Invalid function	Decibels modifier was applied to an selected function that does not support decibels.
-230	Data stale	A FETCh? command was received but internal reading memory was empty. The reading retrieved may be invalid.
-242	Date timeout	Timed out while taking data.
-243	Second function invalid	Secondary function is not enabled.
-318	Can't save MAC	Could not save MAC address.
-319	Can't save LAN configuration	Could not save network configuration.
-320	Can't save non-volatile configuration	Could not save non-volatile configuration.
-330	Self-test failed	The Meter's complete self-test failed from the remote interface (*TST? command). In addition to this error, more specific self-test errors are also reported.
-350	Too many errors	The error queue is full because more than 16 errors have occurred. No additional errors are stored until you remove errors from the queue. The error queue is cleared when power has been off, or after a *CLS (clear status) command has been executed.
-410	Query interrupted	A command was received which sends data to the output buffer, but the output buffer contained data from a previous command (the previous data is not overwritten). The output buffer is cleared when power has been off, or after a *RST (reset) command has been executed.
-420	Query UNTERMINATED	The Meter was addressed to talk (i.e., to send data over the interface) but a command has not been received which sends data to the output buffer. For example, you may have executed a CONFigure command (which does not generate a response) and then attempted to read data from the remote interface.
-430	Query DEADLOCKED	A command was received that generated too much data to fit in the output buffer, and the input buffer is also full. Command execution continues but all data is lost.
-440	Query UNTERMINATED after indefinite response	The *IDN? command must be the last query command within a command string. Example: *IDN?;:SYST:VERS?
-501	RTC Time	Error setting the RTC/System time.
-502	RTC Data	Error setting the RTC/System date.

Table 30. Execution Error Codes and Descriptions (cont.)

Error Code	Error Text	Description
200	IG Invalid	Invalid response type from inguard.
201	IG Packet size	Incorrect packet size from inguard.
202	Trigger ignored	Trigger ignored.
203	Configuration acknowledgement	Wrong number configuration acknowledgement.
222	Parameter invalid	Invalid parameter.
223	FUNC2	Function/2nd func mismatch
224	Math mismatch	Function/math mismatch
225	Range mismatch	Function/range mismatch.
226	Load fail	Measurement configuration load failed.
300	GX Sync send	Inguard not responding (send).
301	GX Sync recv	Inguard not responding (recv),
302	GX Sync error	Lost sync with inguard.
303	GX Port fail	Could not open guard crossing port.
310	GX Ack queue full	Acknowledgement queue full.
311	GX Pack sequence	Acknowledgement queue full.
320	GX Ack	Guard crossing not acking packets.
321	GX Pack over	Guard crossing oversize packet recieved.
322	GX Ack num	Guard crossing wrong ack number.
325	GX Ack byte	Guard crossing unknown ack byte.
330	GX CRC failed	Guard crossing Bad CRC.
340	GX Info packet	Guard crossing info packet recieved; link not active.
350	GX Control byte	Guard crossing unknown control byte.
360	GX Quality low	Guard crossing quality indicator too low.
370	GX Restart	Guard crossing restarted.
421	Instrument configuration inv	Tried to set invalid state.
422	Instrument configuration parameter	Invalid parameter.
426	Instrument configuration load	Instrument configuration load failed.
510	CCO Name bad	CCO constant name is bad.
511	RS-232 framing/parity/overrun error	

Table 30. Execution Error Codes and Descriptions (cont.)

Error Code	Error Text	Description
512	RS-232 fatal error	A fatal error occured opening the serial port.
513	RS-232 Configuration error	A fatal error occured while configuring the serial port.
514	Command allowed only with RS-232	Three commands which are only allowed with the RS-232/Ethernet interface are SYSTem:LOCal, SYSTem:REMote, and SYSTem:RWLock (in Fluke 45 emulation mode – the commands are LOCS, REMS, RWLS, and LWLS..
520	Command line too long	The command line exceeded 350 characters.
521	Input buffer overflow	
522	Output buffer overflow	
531	Insufficient memory	There is not enough memory to store the requested number of readings in internal memory using the INITiate command. The product of the sample count (SAMPle:COUNt) and the trigger count (TRIGger:COUNt) must not exceed 5,000 readings.
550	Command not allowed in local	The multimeter received a READ? command while in the local mode. For RS-232 operation, you should always execute the SYSTem:REMote command before sending other commands over the interface.

Table 31. Ethernet/GPIB Configuration Errors

Error Code	Error Text	Description
560	GPIB fatal error	A fatal error occured opening the GPIB port.
570	GPIB primary address	An error occured attempting to set the GPIB primary address.
572	GPIB Read	An error occurred while attempting to read characters from the GPIB port.
580	EDVR	GPIB - DOS Error.
581	ECIC	GPIB - Specified GPIB Interface Board is Not Active Controller.
583	EADR	GPIB - Interface Board has not been addressed properly.
584	EARG	GPIB - Invalid argument.
585	ESAC	GPIB - Specified GPIB Interface Board is not System Controller.
586	EABO	GPIB - I/O operation aborted (timed out).
587	ENEB	GPIB - Non-existent GPIB board.
588	EOIP	GPIB - Routine not allowed during asynchronous I/O operation.
589	ECAP	GPIB - No capability for operation.
590	EFSO	GPIB - File System Error.
591	EBUS	GPIB - Command byte transfer error.

Table 31. Ethernet/GPIB Configuration Errors (cont.)

Error Code	Error Text	Description
592	ESTB	GPIB - Serial poll status byte lost.
593	ESRQ	GPIB - SRQ stuck in ON position.
594	ETAB	GPIB - Table problem.
801	ENET Port number	Port value is out of range (1024 to 65535).
802	ENET Server	Could not open the ethernet port.
803	ENET Timeout	Time-out occured while opening the ethernet port.
1000	Unknown function	Unknown Function Selection.
1001	Unknown range	Unknown Range Selection.
1002	Unknown CCO	Unknown Calibration Constant.
1003	Can’t set NPLC	Illegal/Unknown NPLC Selection.
1004	Can’t set trigger	Illegal/Unknown TRIGGER Selection.
1005	Can’t get DCV Gains	Cannot get 1V/10V DC linearization constants.
1006	Line Freq High	AC Line frequency too high.
1007	Line Freq Low	AC Line frequency too low.
1008	Write CCO failure	Calibration Constant write failed.
65535	Unknown	Unknown Error.

Table 32. Calibration Errors

Error Code	Error Text	Description
701	CAL Secure Code Case	Invalid characters in calibration secure code. The secure code must contain only characters 0-9 and A-Z. No lower case or other special characters are allowed.
702	CAL Secure	Cal secured.
703	CAL Secure code	Invalid secure code.
704	CAL Secure code too long	Secure code too long.
706	CAL Invalid step number	Invalid calibration step number.
707	CAL Reference	Cal reference value out of tolerance.
708	CAL Not calibrating	CAL? only works if you are calibrating.
709	CAL Abort	Calibration aborted.
710	CAL Sequence	Calibration steps out-of-sequence.
711	CAL No measurement	No measurements taken during calibration.
712	CAL Overload	Overload at input during calibration.
713	CAL Too far	Calibration measurements out-of-tolerance.

Table 32. Calibration Errors (cont.)

Error Code	Error Text	Description
714	CAL Math	Math error during calibration.
715	CAL Timeout	Timeout error during calibration.

Appendix B
Fluke 45 Emulation Limitations

Introduction

Due to differences in their design, the 8845A and 8846A (collectively the 884XA) cannot emulate all the functions and features of the Fluke 45. Some functions are compatible but are not implemented the same in the 884XA meters.

This appendix covers the differences with, a list of commands that are not compatible, and information on those functions that will respond differently by the 884XA.

Incompatible Fluke 45 Commands

Due to their design differences, there are Fluke 45 function and modifier commands that the 884XA meters will not execute. Whenever a non-compatible command is detected by the 884XA meters, they will generate a -102, syntax error. Table 33 lists Fluke 45 commands that are not compatible with the 8845A and 8846A.

Table 33. Non-compatible Fluke 45 Remote Commands

Command	Reason
AACDC	The 884XA meters do not have an ac plus dc rms current function.
HOLD	The 884XA meters do not have a Touch Hold function.
HOLDCLR	The 884XA meters do not have a Touch Hold function.
HOLDTHRESH	The 884XA meters do not have a Touch Hold function.
HOLDTHRESH?	The 884XA meters do not have a Touch Hold function.
MIN	See the section on “Math Operations” for an appropriate replacement.
MAX	See the section on "Math Operations" for an appropriate replacement.
MAXSET	See the section on "Math Operations" for an appropriate replacement.
MINSET	See the section on "Math Operations" for an appropriate replacement.
MINCLR	See the section on "Math Operations" for an appropriate replacement.
VACDC	The 884XA meters do not have an ac plus dc rms voltage function.

Dual Functions

In addition to the non-compatible functions, there are numerous dual display functions that are not part of the 884XA meter's capabilities. Table 34 is a matrix that indicates the Fluke 45 dual functions and whether or not they are compatible with the Meter.

Table 34. Fluke 45 Dual Function Compatibility Matrix

Primary Functions	Secondary Function								
	VDC	**VAC**	**IDC**	**IAC**	**FREQ**	**OHMS**	**DIODE**	**Period**	**RTD**
VDC	No	**Yes**	No	No	No	No	No	No	No
VAC	**Yes**	No	No	No	**Yes**	No	No	No	No
IDC	No	No	No	**Yes**	No	No	No	No	No
IAC	No	No	**Yes**	No	**Yes**	No	No	No	No
FREQ	No	No	No	No	No	No	No	**Yes**	No
OHMS	No	No	No	No	No	No	No	No	**Yes**
DIODE	No	No	No	No	No	No	No	No	No
Continity	No	No	No	No	**Yes**	No	No	No	No

Reading Rates

Like the 884XA meters, the Fluke 45 has multiple but different reading rates. The 884XA meters reading rates are based on the Number of Power Line Cycles (NPLC), which are explained in the Users Manual. The Fluke 45, on the other hand, has just three reading rates, selected as Fast, Medium, and Slow. To be compatible with Fluke 45 code, the 884XA meters will use a reading rate of 2.5, 5, and 20 readings per second, respectively.

Ranges

The Fluke 45 changes range at different points than the 884XA. For example, the 884XA dc voltage range changes at 100 mV, 1 V, 10 V, and 100 V. The Fluke 45 on the other hand, changes ranges at the same points when it is in Slow resolution, but for Medium and High resolution, changes occur at 300 mV, 3 V, 30 V, and 300 V.

The 884XA meters will respond to a range query with the expected Fluke 45 range whenever the range has previously been set by a range set command. However, when the 884XA meters are set to VDC, VAC or OHMS with autorange enabled and measuring with Medium or High resolution, the range returned to a range query command may return a range value that is higher or lower by one range.

For the frequency function, the 884XA meters have one range: 3 Hz. The Fluke 45 has five ranges. If the 884XA meters are set a range set command, they will respond to a range query with the set range value. If, however, the frequency function is in autorange, the 884XA meters will respond with the value of zero.

The Fluke 45 allows range selection in CONTINUITY and DIODE TEST. The 884XA meters have only one range for these functions. Therefore, whenever a RANGE command is detected in the Fluke 45 emulation mode, the 884XA meters will respond with an error.

Appendix C
Network Considerations

Introduction

This tutorial provides information on commonly used network communication technology, and describes how to get started using the Meter. It is not necessary to know the details of network communication methods in order to use the Meter effectively. The Meter and host computer software use Ethernet wiring and low level protocols and TCP/IP high level protocols, and the UNIX telnet application interface program. These are all public domain, non-proprietary standards with multiple-company support. Use of these non-proprietary protocols and hardware ensures the Meter and software will operate on most installed networks and have the lowest possible cost using off-the-shelf commercial networking products. Read “Network Primer” later in this Appendix for more information on these standards.

Your Meter and Your Network Administrator

Before you place the Meter on your company network, you need to coordinate with your Network Administrator. Specifically, before installing and setting up your Meter and host PC, you need to ask the following questions:

1. Does the network allow static addresses? If so, what values should I use for my IP addresses, and Subnet Mask? Does the Socket Port Number need to be changed from the default (3490)?
2. Does the network contain more than one subnet? If so, what is the IP address of my default gateway or router device?
3. Will all the routers route IP packets?
4. What are my domain and host names (optional)?

The minimum information you need to get is the IP Addresses for each meter. If your network contains more than one subnet and you want to place the host PC and one or more instruments in different subnets, you must also set the default gateway address and subnet mask on the Meter and the host PC.

The Meter may use DHCP to get an IP address, subnet mask, and default gateway address automatically on the network.

Your Network Administrator may also need to know the Ethernet (MAC) addresses of each Meter that you will attach to the network. You may obtain the address of the Meter by using the front panel controls.

Read “Network Primer” for more information on IP addressing and the other information needed to operate the Meter on a local area network (LAN).

Network Primer

In the early days of computer networking, vendors used many proprietary communication schemes. These forced users to purchase equipment and software from one or a few companies. As networking became more popular, users placed pressure on vendors to establish standards to allow interoperation of various types of computers, operating system software, and interface hardware.

One of these standardization efforts was started by the DARPA agency of the U.S. Defense department. Another was headed up by the DEC and Xerox companies. This effort resulted in the Ethernet wiring and low-level protocol scheme. The DARPA effort resulted in the TCP/IP high-level protocols. Ethernet became an international standard by the efforts of the IEEE-802.3 committee. TCP/IP is the protocol used on the international Internet network, and is supported by consensus of the users of that network (many thousands of hosts).

The sockets API was developed at UC Berkeley and was widely adopted by the UNIX community to support direct host-to-host communication within a TCP/IP network. WINSOCK is an MS Windows Dynamic Link Library (DLL) version of the original UNIX Sockets library, and has been standardized by a large number of PC Software and Hardware Vendors. WINSOCK has been included with Windows since the introduction of Windows 95 and Windows NT 4.0.

To reduce the complexity of network schemes and to encourage interoperation between varieties of networks, the protocols are built up of several layers that are isolated from each other by well-described interfaces. Usually, the lowest layers of the protocol are implemented in hardware logic on the interface circuits used by the computers and other devices attached to the network wiring. The Ethernet standard consists of a set of low-level addressing and data transmission protocols that run on several different wiring schemes.

Computers on a network are commonly referred to as a *host*. The Meter is a host in this context. Devices that facilitate communication between different sections of a network are called by names that indicate their function, for example, routers, bridges, and repeaters.

Physical Layer Wiring Schemes Supported by the Meter

The Meter supports the most common wiring scheme used in Ethernet networks: 10/100BaseT Unshielded Twisted Pair (or UTP).

The 10/100BaseT wiring method uses two or four pairs of twisted wires. This wiring method supports only two connections to any one run of wire. To support more than two physical connections, an active instrument called a *hub* must be used.

A hub is an active device that supports multiple 10/100BaseT connections. The network host attached to each connection of the hub may communicate with every other host attached to the hub. Hubs also may allow other types of cable connections, such as 10Base2 and 10Base5 (fat coax). This is done to allow a hub to communicate with other network hosts, such as other hubs, routers, and bridges. A hub is sometimes referred to as a network switch.

The 10/100BaseT wiring method is very popular because the wire is inexpensive to purchase and install, the use of a hub allows some protection from malfunctioning network hosts, and this type of wiring is easier for network administrators to manage and control.

Network Interconnection Devices

The following basic devices are used in networks to extend, partition, and interconnect networks:

- A repeater is a device used to physically isolate and extend the length of a network segment, but it does not divide the network into subnets.
- A hub is a device that allows communication among multiple 10/100BaseT network hosts and allows these hosts to communicate with other Ethernet wiring. Some hubs also perform Router functions.
- A *Bridge* is used on Ethernet networks to isolate two portions of the network at the Frame level (see “Basic Network Packet and Frame Contents” later in this appendix). This is done to minimize transmission collisions, but the two portions isolated by a Bridge remain on the same subnet. A Bridge also acts as a Repeater.
- A *Router* is used to isolate two portions of the network into subnets, as described in IP Addresses and Segmented Networks in this appendix. A router also acts as a bridge. Make sure your router will route IP packets if you want to place the PC and the Meter in different subnets.
- A *Gateway* is used to connect two networks with different architecture and protocols. For example, a Gateway could be used to connect an Ethernet to an X.25 net running on public telephone wiring. Gateways also perform router, bridge, and repeater functions.

The operation of the Meter and its software should be unaffected by a properly designed network using any of these network devices. However, you must use extra care when setting up host PCs and the Meter in a network containing multiple subnets (net containing one or more routers and/or gateways). The IP addresses assigned to the host PC and instruments must be carefully selected in this case. See IP Addresses and Segmented Networks for more information on IP address assignment.

When a bridge, router, or gateway is used in a network containing the Meter and hosts, be sure to reboot the host PC whenever an instrument is moved from one segment of the network to another. This is required to allow the network hardware devices to initialize bridging and routing tables.

Also, when an 8845/8846 Series instrument is used in a different subnet from the host PC, the routers and gateways used to connect the subnets must be able to route IP packets across the segments. The default gateway addresses on the the Meter and host PC must be set properly as well.

Basic Network Packet and Frame Contents

Network messages consist of short (mostly less than 1 KB) chunks of data, surrounded by header and error detection information used by the protocols. The message, together with the protocol information, is called a "packet." When physical network information (clock synchronization, error detection, etc.) is wrapped around the packet, it is called a "frame." The interface hardware adds and strips off the Frame information around the packet as it moves through a network. So, unless you’re doing low level analysis of network traffic, you never need to deal with frame information.

For any protocol, the packet consists of a destination address, a source address, some protocol type information, a message length field, and error detection information.

The TCP/IP protocol adds additional fields to the packet for message sequence determination and application port ID. The sequence number allows multi-packet messages to be assembled into the correct order. The port ID specifies which application running on a system is sending or receiving the message. Support of port IDs allow multi-tasking within a computer system, with messages being sent and received from the individual task.

In the TCP/IP protocol, error detection is supported by adding a checksum of the data in the packet to the end of each packet. Using this checksum, the receiving system can detect a bad packet and request a re-transmit (using the source address).

Each *host* (device attached to the network wiring) in an Ethernet network has a unique address that is assigned by the interface hardware vendor. Each vendor is assigned a block of addresses and it is required that each device produced have a unique Ethernet address. Users of the TCP/IP protocol very rarely need to know or deal with the Ethernet address.

When TCP/IP is used, each host is also assigned a unique IP address, but this address is assigned when the TCP/IP protocol software is initialized. In contrast to the Ethernet address, IP addresses have a structure that can be used by Network Management to facilitate breaking the network into segments (subnets) that make better use of the available data communication capacity (bandwidth). Use of IP addressing and the network segmentation scheme is described in “IP Addresses and Segmented Networks” in this appendix.

The relationship between a host’s Ethernet address and its IP address is established by the TCP/IP protocol software. No user interaction is needed to establish this relationship. However, some network management systems require that the Ethernet address of each network host be kept in a database. So, it is sometimes necessary to communicate the Ethernet addresses of all devices on the network to the Network Administrator.

IP Addresses and Segmented Networks

If all networks consisted of a few computers and other devices attached to each other locally, use of IP addressing and network segmentation schemes would not be necessary. However, networks have evolved past simple work groups into campus-wide, inter-campus, and even international interconnect schemes. This makes it necessary to divide the network into segments know as subnets.

The IP address provides two pieces of information: the *network ID* and the *host ID*. The network ID must be unique among all network subnets within a connected Internet. It identifies the network subnet to which a host is connected. The host ID must be unique among hosts within a network subnet and identifies the host within the subnet.

Network subnets connected to the public Internet must obtain an official network ID from a registrar approved by the *Internet Network Information Center* (http://www.internic.net/) to preserve the unique network IDs within the Internet. However, if you never intend to connect to the public Internet, you’re free to select your own network IDs. The IP address is a 32-bit numeric address written in four numbers separated by periods. Each of these four numbers can have a value in the range 1 to 254. An IP address is written in the form w.x.y.z. For example, "198.178.246.10" (or "C6.B2.F6.0A" in hexadecimal) is a valid IP address.

Table 35 lists the three commonly used classes of IP address assignments.

Table 35. IP Address Assignments

Class	w Value	Network ID	Host ID	Available Subnets	Available Hosts
A	1 to 126	w	x,y,z	126	16777214
B	128 to 191	w,x	y,z	16384	65534
C	192 to 223	w,x,y	z	2097151	254

The following are reserved addresses and may not be assigned to hosts:

127.0.0.0
128.0.0.0
191.255.0.0
192.0.0.0
223.255.255.0

w = 224 through 255 with x, y, and z equal to any value

Most IP subnets have Class B or C network IDs because there are quite a few of these available. You may be able to get a Class A Net ID, but there are so few of these available (only 126 world-wide) that they are rarely issued and most are already assigned.

Most companies can get one or more Class C blocks, which means that there is a limit of 254 hosts per network subnet.

The TCP/IP software separates the network ID portion of the IP address from the *host* ID portion using the user-assigned Subnet Mask. This mask looks like an IP address, but has a bit set in each bit position of the portion of the IP address that is in the network ID portion. For example, the subnet mask 255.255.255.0 sets the network ID portion to be the higher order 24 bits of the IP address (a class C address). Using the subnet mask, the TCP/IP software is able to detect if a destination address is in the local subnet or if the packet must be sent to another subnet through a Router or Gateway.

Networks are segmented by use of an active device called a *router (gateways* and *hubs* sometimes have router capabilities.) When a host on one subnet wants to send a message to a host on another subnet (the Net ID sections of the IP source and destination are different), the router is used to deliver the packet to the other network subnet.

Each Meter is shipped with a default IP address of 129.196.136.131. This is a Class C network ID assigned to the Fluke Corporation, so it is highly unlikely that it will overlap with a network ID in use at your company. However, if you want to attach a Meter to an existing network, you should check with your Network Administrator before using the default IP address or assigning a new IP address to a Meter or PC.

If your network contains more than one subnet, and you want to communicate with a Meter in another subnet, you need to set the default gateway address in both the host PC and the Meter to the address of the local router. The TCI/IP stack will detect that the destination address for a packet is in a different subnet (via the subnet mask) and send the packet to the default gateway address where the router will route it to the proper subnet.

For example, if you have three Meters, and a single PC, you could set the following IP addresses:

8845/8846 Series #1 198.178.246.1
8845/8846 Series #2 198.178.246.2
8845/8846 Series #3 198.178.246.3

Host PC 198.178.246.101

This would place all three instruments and the PC in the same subnet (net ID 198.178.246).

During initial operation of the TCP/IP software, the IP section builds a table that contains the correspondence between the IP address and Ethernet address of each host. This is done via the Address Resolution Protocol (ARP). To do this, the IP software sends out a broadcast frame that every TCP/IP host and router receives. This frame contains a request for the host with the unknown IP address to return a frame to the ARP requester. This response frame contains the Ethernet address of the sourcing host, and this information is then added to the address correspondence table. All communication with a host can then be done with information from the table.

The operation of ARP also initializes the routing tables in bridges, routers, and gateway devices on the network. These tables are used to determine the segment of the network to which a frame should be sent.

TCP/IP Protocol Stack

A protocol stack is a group of interacting programs that implement the various functions of the network communication protocol. They are usually arranged in a hierarchy of low to higher level functions, so the collection is called a *stack*.

Windows NT and later versions of Windows supply a TCP/IP protocol stack. Novell sells an optional package for NetWare that includes a TCP/IP stack. TCP/IP protocol packages with included WINSOCK DLLs can also be purchased from a variety of third-party sources.

The *Transmission Control Protocol/Internet Protocol* (TCP/IP) has evolved as a networking protocol that supports communication among diverse computers and devices (at UC Berkeley there once was a TCP/IP-connected Coke machine). The TCP/IP protocol can be used to communicate between programs running on many different computer systems, running under many different operating systems, and even running on several different physical network types (Ethernet being only one of the many types supported). The TCP/IP protocol stack is isolated from the underlying network hardware by a device driver. Applications use TCP/IP resources via one of the several Application Programming Interfaces (API) that are commonly supported by network software vendors.

You rarely need to know the details of the TCP/IP protocol. In summary, TCP/IP enables two computer systems to establish a connection that allows data to be exchanged. Data to be transmitted is assembled into manageable chunks (packets) by the TCP portion of TCP/IP. TCP also reconstructs the data at the receiving end by merging the chunks back together in the correct order. TCP also assures error free communication by use of a checksum within each packet. Finally, TCP uses the Port ID to specify the specific application within each system that is sending and receiving the data.

The IP portion of the TCP/IP protocol simply addresses, sends, and receives packets. It uses the IP address, the subnet mask, and the default gateway information. The IP address is described in “IP Addresses and Segmented Networks” in this appendix.

The subnet mask is used to separate the network ID from the host ID in an IP address. For example: if the IP address of a Meter was 198.178.246.10, and a class C network ID was active, the subnet mask would be 255.255.255.0. When this mask is applied to the address, the network ID is extracted as 198.178.246 and the host ID as 10.

The default gateway information is only used when your network contains more than one subnet, or is connected directly to the public Internet. When the network ID of the source and destination address of a packet are different (hosts on different network segments), the packet is forwarded to the default gateway for delivery. The default gateway has knowledge of the network IDs of the other network segments, so it forwards the packet to other gateways on the network until the packet is delivered to the gateway attached to the destination segment with the matching network ID. This process is generally referred to as *routing the packet,* and devices that do this are also referred to as *Routers*.

In many modern networks, the use of subnet masking and the default gateway is not necessary. These networks contain routers and gateways that support the proxy ARP protocol. In this protocol, the routing path between any two hosts is automatically established by the routers during the ARP process. As a result, the user does not need to manually enter the subnet mask and default gateway information.

When the TCP/IP protocol stack software starts operation, it communicates with an NDIS or ODI driver in a process called *binding*. During this process, the stack tells the driver which protocol it is handling. In this way, a driver can direct packets to more than one protocol stack. For example, it is quite common to have the Novell IPX/SPX protocol stack and the TCP/IP protocol stack operating over the same ODI multi-protocol driver.