

## ***Chapter 4***

### ***Remote Operations Using the IEEE 488 Interface***

<b>Title</b>	<b>Page</b>
Introduction.....	4-3
Interface Capability: IEEE Standards 488.1 and 488.2 .....	4-3
The Multimeter in IEEE 488.2 Terminology .....	4-3
Programming Options .....	4-3
Capability Codes .....	4-3
Interconnections.....	4-4
Using the 8508A Reference Multimeter in a System .....	4-5
Setting the Multimeter Address.....	4-5
Remote Operation General Considerations .....	4-5
Syntax Diagrams in this Manual .....	4-5
The 8508A Status Reporting Structure.....	4-8
Types of Status Information Available.....	4-9
Syntax Diagrams of Major 8508A Functions .....	4-10
DC Voltage.....	4-10
AC Voltage.....	4-11
Resistance: Normal OHMS .....	4-13
Resistance: High Voltage OHMS.....	4-14
Resistance: True OHMS.....	4-15
DC Current .....	4-16
AC Current .....	4-17
Using Platinum Resistance Thermometers to obtain Temperature. ....	4-18
Determine the PRT identity.....	4-18
Entering or Editing the Characteristics of a PRT to Non-volatile Store.....	4-19
Recalling the Characteristics of a Known PRT .....	4-20
Deleting a Known PRT from the Non-volatile Store .....	4-20
Input.....	4-21
Guard .....	4-21
Measurement Gate Width.....	4-22
Maximum, Minimum and Peak-Peak .....	4-22
Limits.....	4-24
Recall Limits .....	4-24
Enable Limits.....	4-24
Standard Deviation .....	4-25
Syntax Diagrams of Math Functions .....	4-25
Averaging .....	4-25
Multiplication .....	4-27

Subtraction.....	4-28
Division .....	4-29
Decibel Calculations.....	4-30
Syntax Diagram of Test .....	4-31
Selftest .....	4-31
Device Errors and Syntax Diagrams.....	4-31
Error Detection .....	4-31
Recall Device Errors.....	4-32
Triggering and Reading Operations.....	4-33
Trigger Source Selector.....	4-33
Execute Trigger .....	4-34
Execute Trigger and Take a Reading .....	4-34
Settling Delay .....	4-34
Input Zero .....	4-36
Wait .....	4-36
Reading Recall.....	4-36
Access to the Internal Buffer Memory .....	4-37
Internal Operations Commands .....	4-39
Reset .....	4-39
Complete Operations .....	4-40
Status Reporting.....	4-40
Instrument I/D and Setup.....	4-44
Calibration Commands and Messages.....	4-46
Calibration Sequences .....	4-46
Protected User Data.....	4-48
Special Calibrations.....	4-49

## Introduction

Chapter 4 provides the information necessary to operate the 8508A Reference Multimeter remotely via the IEEE 488 Interface. (Hereafter, the 8508A is also referred to as "the Multimeter" or, in the context of IEEE 488.2 terminology, "the device")

For users unfamiliar with the IEEE 488 Interface, refer to the standard specification, which appears in the publications ANSI/IEEE Std. 488.1-1987 and IEEE Std. 488.2-1988.

A complete description of all commands and queries, along with syntax diagrams, is provided under "Command, Queries, and Syntax Diagrams" later in this chapter.

The material in this chapter is organized in the following categories:

- **Interface Capability**  
Introduction to the IEEE 488.1 subsets that are implemented in the Fluke 8508A, satisfying IEEE 488.2.
- **Interconnections**  
Description of the rear panel IEEE 488 connector and its pin designations.
- **Using the Multimeter in a System**  
Addressing, remote operation, programming guidance.
- **Syntax Diagrams in this Manual**  
An introduction to syntax diagrams
- **The 8508A Status Reporting Structure**
- **Programming Commands and Queries**  
Detailed descriptions of both common and device-specific commands and queries, including syntax diagrams.

## Interface Capability: IEEE Standards 488.1 and 488.2

The Fluke 8508A Reference Multimeter conforms to the Standard Specification IEEE 488.1-1987: *IEEE Standard Digital Interface for Programmable Instrumentation*, and to IEEE 488.2-1988: *Codes, Formats, Protocols and Common Commands*.

## The Multimeter in IEEE 488.2 Terminology

In IEEE 488.2 terminology, the Multimeter is a **device** containing a **system interface**.

As such, it can be connected to a **system** via its **system bus** and put into programmed communication with other bus-connected **devices** under the direction of a **system controller**.

## Programming Options

The Multimeter can be programmed via the IEEE Interface to do the following:

- Change its operating state (e.g., function, range etc).
- Transmit measurements and its own status data over the bus.
- Request service from the system controller.

## Capability Codes

The codes that apply to the 8508A Reference Multimeter and a short description of each are given in Table 4-1. They also appear on the rear of the instrument next to the interface connector. These codes conform to the capabilities required by IEEE 488.2. Appendix C of the IEEE 488.1 standard contains a complete description of each code.

Table 4-1. IEEE Interface Capability

IEEE 488.1 Subset	Interface Function
SH1	Source Handshake Capability
AH1	Acceptor Handshake Capability
T6	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 (including Local Lockout)
PP0	No Parallel Poll Capability
DC1	Device Clear Capability
DT1	Device Trigger Capability
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 interface socket is fitted on the rear panel. It accommodates the specified connector, whose pin designations are also standardized as shown in Figure 4-1.

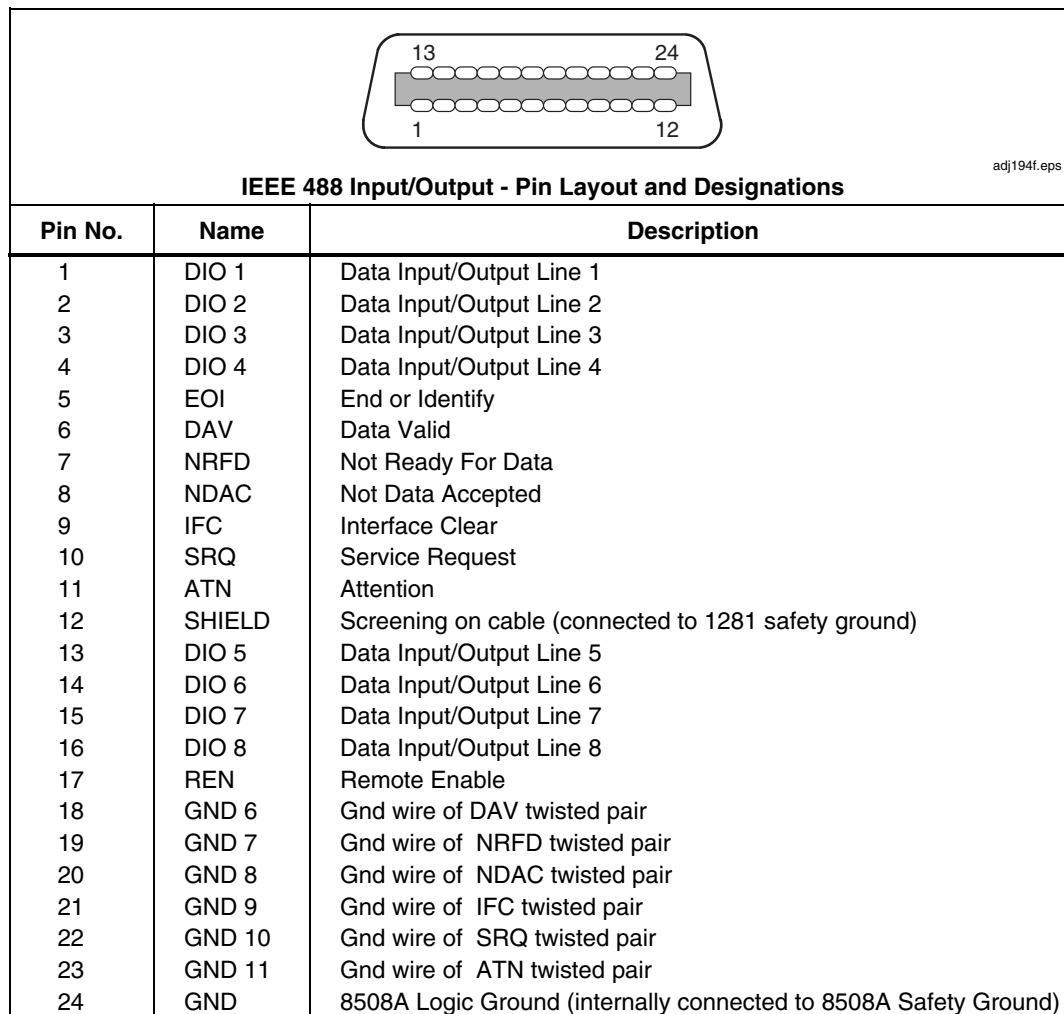


Figure 4-1. IEEE 488 Input/Output Connector

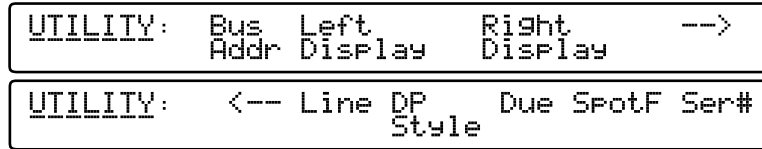
## Using the 8508A Reference Multimeter in a System

### Setting the Multimeter Address

The Multimeter will only respond to Talk or Listen commands from the controller at a specified address. The Multimeter address can only be set manually; using the ADDRESS menu that is accessed via the Utility menu.

To change the address, proceed as follows:

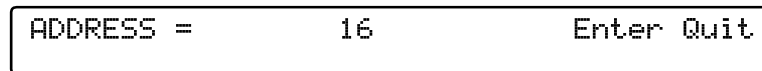
1. Press the UTILITY key to see the menu:



adj119f.eps

#### UTILITY menu

2. Press Bus Addr to display the ADDRESS menu from which you can enter or change the Multimeter's IEEE-488 bus address.



adj120f.eps

#### ADDRESS menu

The menu displays the present address and the numeric-keyboard keys are activated.

3. Enter any valid numeric value between 0 and 30. If you enter an invalid address, 1007: data entry error is displayed.
4. Press Enter to store the new address OR press Quit to leave the old address unchanged.

### Remote Operation General Considerations

When the 8508A Reference Multimeter is operating under the direction of the controller, the right hand display indicates Remote Operation together with the function and range settings. The front panel controls are disabled with the exception of LOCAL (provided *Local Lockout* has not been programmed).

### Syntax Diagrams in this Manual

The following paragraphs describe the syntax diagrams used in this manual.

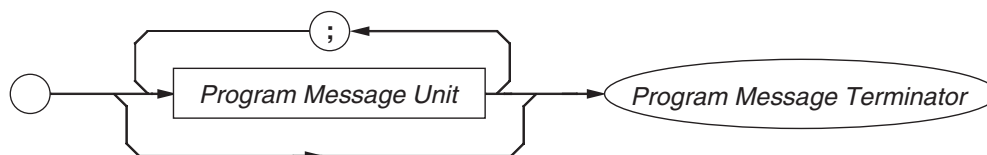
- Syntactic elements are connected by lines with directional symbols to indicate the flow, which generally proceeds from left to right.
- Repeatable elements have a right-to-left reverse path shown around them, which will also contain a separator such as a comma.
- When it is possible to bypass elements, a left-to-right path is shown around them.
- When there is a choice of elements, the path branches to the choices.

### The Program Message

Each Program Message may consist of only one syntactic element plus its terminator, or may be subdivided into many "Program Message Units", separated by semi-colons (;)

which are known as "Program Message Unit Separators". Thus the semi-colon cannot be used for any other purpose.

As you can see from the diagram, multiple Program Message Units can be sent if they are separated using semi-colons (shown in the repeat path). The starting circle is used only for the diagram to indicate the start of a complete Program Message.



**Syntax Diagram of a Simple Program Message**

adj199f.eps

### *Use of Italics*

Notice that the names of some elements are shown here in italics which indicate "non-literal" text (i.e., names given to particular elements). The actual characters to be sent, are shown in plain-text capitals.

### *Upper/Lower Case Equivalence*

The Multimeter will not differentiate between upper and lower case characters in literal program text.

### *Numeric Representation*

The Multimeter accepts a "Flexible Numeric Representation" (*Nrf*), when receiving numbers.

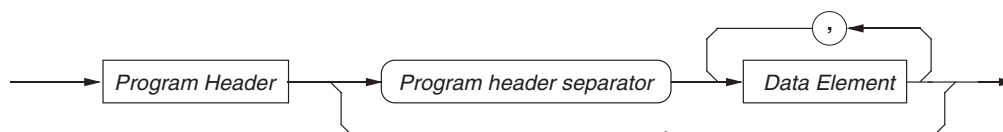
Decimal numeric responses from the Multimeter are in either Nr1 or Nr3 format. In this manual, all syntax diagrams for query contain the response format.

### *The Program Message Terminator*

The message terminator for the 8508A Reference Multimeter is the hexadecimal number 0A, characterized in IEEE 488.2 as **NL**. Alternatively, the **EOI** (end or identify) line can be set true with the last byte to be sent. This is represented on the syntax diagram by /<sup>^</sup>END/.

### *The Program Message Unit*

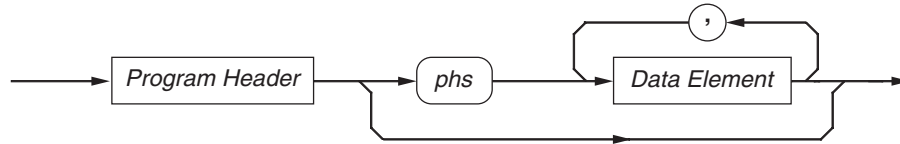
Program Message Units (PMUs) can be "Terminal" or "Non-terminal". The final PMU in any Program Message is always Terminal (includes the terminator), whereas all preceding PMUs within the Program Message are obviously Non-terminal. Most of the commands in this handbook are described in the form of non-terminal message units:



**Non-Terminal Program Message Unit**

adj352f.eps

To save space, the name 'program header separator' is abbreviated to 'phs'.



adj201f.eps

Program Header Separator - phs

### The Program Header

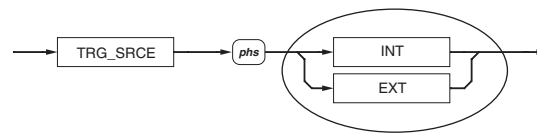
The 'Program Header' provides the main command identification. This may be followed by 'Program Data Elements' and these must be separated from the 'Program Header' by a 'Program Header Separator'.

### The Program Header Separator

The 'Program Header Separator' is one or more 'white space' characters excluding the message terminator (NL).

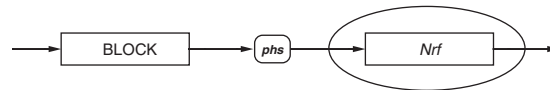
### Program Data Elements

Four versions of the defined program data elements are employed. They are emphasized in the following syntax diagrams, taken from the commands available for the Multimeter:



adj203f.eps

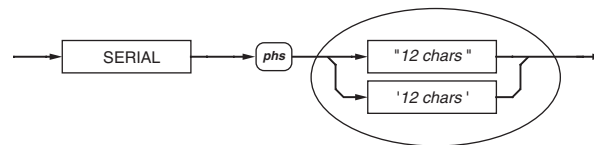
Character



adj204f.eps

Decimal Numeric

(*Nrf* can be expressed in any of the ways defined by the Standard document.)



adj205f.eps

String

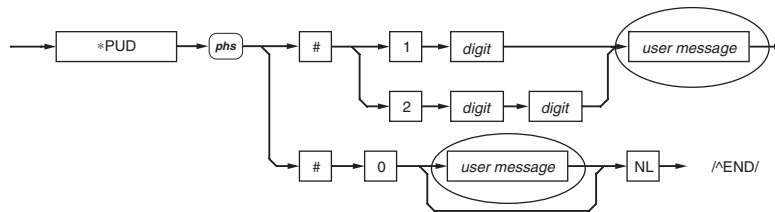
(The maximum size of the string is specified in the command detail.)

### Arbitrary Block Data Elements

Both the "Definite" and "Indefinite" forms specified in the Standard document are used, as shown in the Syntax diagram below. The *user message* must be limited to a maximum of 63 bytes.

The Definite form can be fitted into an assembly of message units, but the Indefinite form (lower path) has no exit to further message units. In this case the program message must be terminated to inform the instrument that the block is complete.

Note that the slash-delimited **/^END/** box is not outlined. This is to draw attention to the fact that it is not a data element, but represents the **EOI** line being set true with the last byte **NL** to terminate the program message.

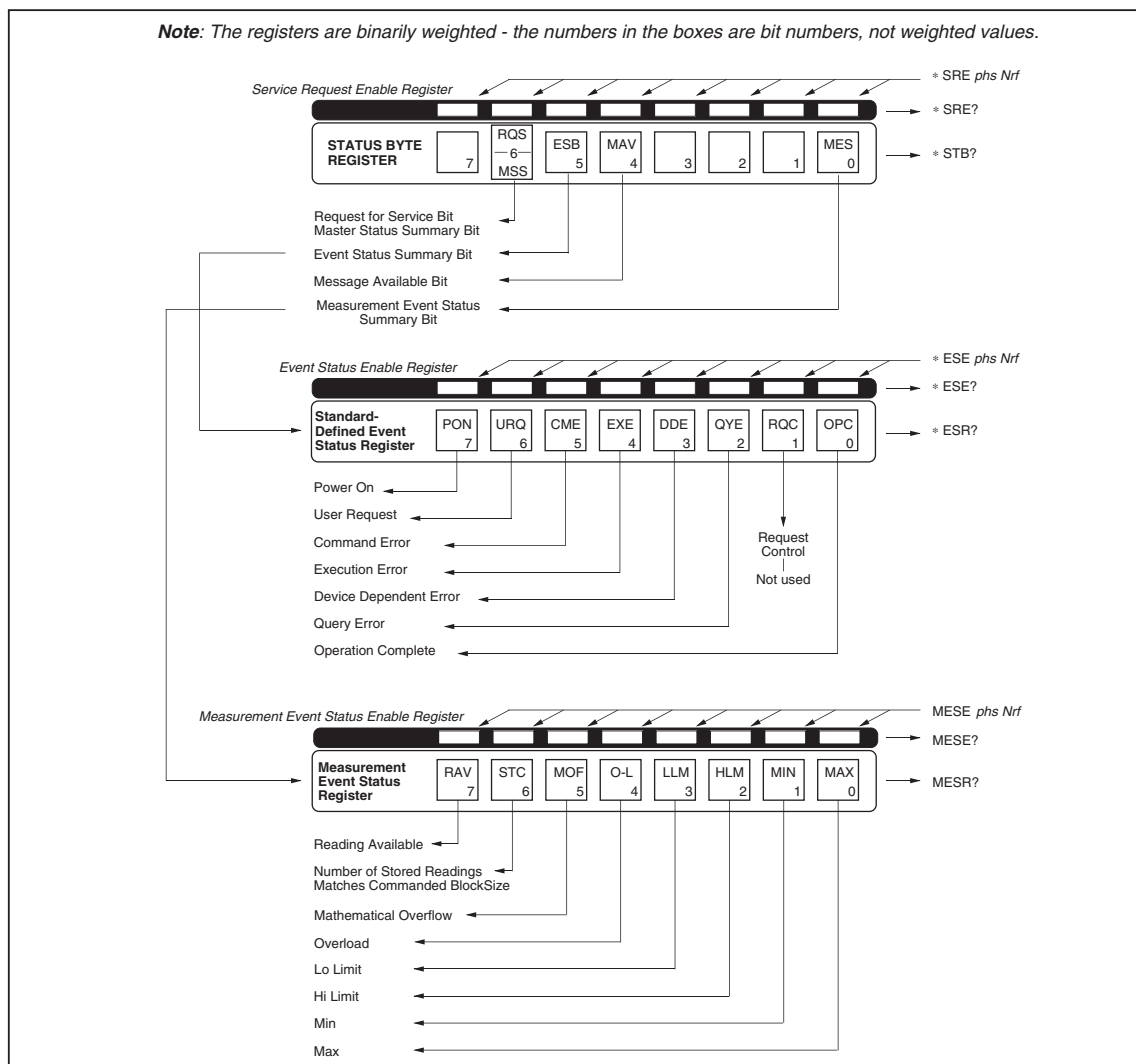


Arbitrary Block Data Element

adj206f.eps

### The 8508A Status Reporting Structure

The IEEE 488.2 status reporting structure provides the application programmer with a mechanism to choose the status information required at each stage in the application program.



adj208f.eps

Figure 4-2. 8508A Status Report Structure

### Standard-Defined and Device-Specific Features

In the 8508A, the structure has three main registers, as follows:

- **The Status Byte Register**, and its associated enable register, control the generation of the **Status Byte**, which summarizes the remainder of the status structure.
- **The Event Status Register**, and its associated enable register, control the generation of the **Event Status Byte**, whose component bits report Standard-defined types of events. This register is summarized by the **ESB** bit 5 in the **Status Byte**.
- **The Measurement Event Status Register**, and its associated enable register, control the generation of the **Measurement Event Status Byte**, whose component bits relate to measurement events in the 8508A. It is summarized by the **MES** bit 0 in the **Status Byte**.

In the **Event Status Byte** the **EXE** bit is associated with a queue of execution errors related to the 8508A programmed condition, and the **DDE** bit is associated with a queue of device-dependent errors related to 8508A internal faults.

*A Note about Queues. These are 'historical' (Last-in - Last Out) stacks, and when the queue stack is full the eldest entries are discarded. It is recommended that the application read the queue as soon as its summary bit is set true, particularly the error bits, otherwise the original cause of the error can be discarded as subsequent dependent errors fill up the stack. However any message indicated by the MAV bit should be read before attempting to obtain the ESR status byte.*

### Access via the Application Program

The application designer has access to three enable registers to enable or disable any individual bit in these registers.

Thus the application programmer can decide which assigned events will generate an **SRQ**, by enabling their event bits and then enabling the appropriate summary bit(s) in the **Status Byte**. The Controller can be programmed to read the **Status Byte** during a resulting serial poll, and be directed to the appropriate **Event Register** to discover which event was responsible for originating the **SRQ**.

### Types of Status Information Available

#### Status Summary Information

The **Status Byte (STB)** consists of flag bits which direct the Controller's attention to the type of event which has occurred.

#### Standard-defined events

The following events are flagged in the 8-bit latched **Event Status Register (ESR)**, read-accessible to the controller.

- Power On - the instrument's power supply has been switched on.
- User Request - This capability is not available in the 8508A.
- Command Error - a received bus command does not satisfy the syntax rules programmed into the instrument interface's parser, and so is not recognized as a valid command.
- Execution Error - a received command has been successfully parsed, but it cannot be executed owing to the current programmed condition of the instrument.

- Device-Dependent Error - a reportable internal operating fault has been detected.
- Query Error - the controller is following an inappropriate message exchange protocol, in attempting to read data from the output queue.
- Request Control - provided for devices which are able to assume the role of controller. This capability is not available in the 8508A.
- Operation Complete - initiated by a message from the controller, indicates that the 8508A has completed all selected pending operations.

### **Measurement events**

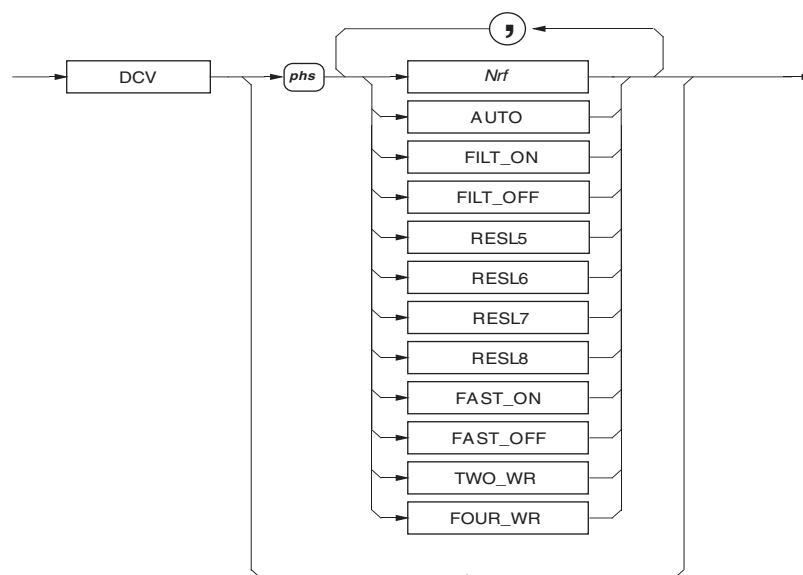
The following events are flagged in another 8-bit latched register, called the **Measurement Event Status Register (MESR)**, read-accessible to the controller.

- A measurement has been completed from an initiating trigger.
- When the instrument has been commanded to store a number of measurements in a block, and the specified number of measurements in the block has been stored.
- Mathematical Overflow
- Overload
- Low Limit Reached
- High Limit Reached
- New Minimum Value Established
- New Maximum Value Established

## **Syntax Diagrams of Major 8508A Functions**

### **DC Voltage**

The following commands are used to select the DCV function and set its configuration.



adj209f.eps

### Nrf

A numeric value that selects the range for the expected signal. For example, an **Nrf** of 2, 10, or even 15.6789, selects the 20 V range. Any valid numeric value cancels autorange.

### AUTO

Selects the autorange mode where the multimeter will determine the appropriate range for the measured signal.

If the signal exceeds the maximum capability then RANGE OVERLOAD appears on the front panel, and the appropriate bit is set in the device status registers.

### FILT\_ON / FILT\_OFF

FILT\_ON inserts a hardware analog filter into the signal path.

### RESL5 / RESL6 / RESL7 / RESL8

Sets the resolution of the measurement to 5.5, 6.5, 7.5 or 8.5 digits.

### FAST\_ON / FAST\_OFF

FAST\_ON Reduces the A-D integration time, for faster conversions.

### TWO\_WR

Requires only a connection to the input terminals.

### FOUR\_WR

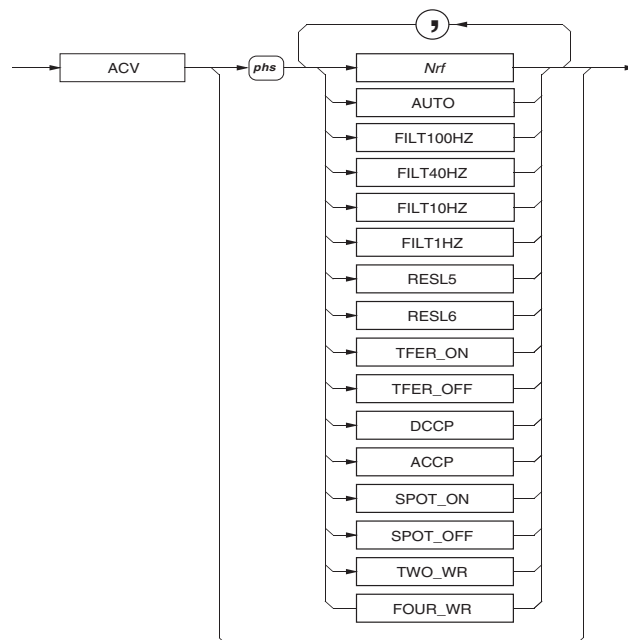
Requires a connection to the input terminals and to the sense terminals.

### Power On and Reset Conditions

1kV, FILT\_OFF, RESL7, FAST\_ON, TWO\_WR

### AC Voltage

The following commands are used to select the ACV function and set its configuration.



adj210f.eps

## AC Voltage

### **Nrf**

A numeric value that selects the range for the expected signal. For example, an **Nrf** of 2, 10, or even 15.6789, selects the 20 V range. Any valid numeric value cancels autorange.

### **AUTO**

Selects the autorange mode where the multimeter will determine the appropriate range for the measured signal. If the signal exceeds the maximum capability then **RANGE OVERLOAD** appears on the front panel and the appropriate bit is set in the device status registers.

### **FILT100HZ / FILT40HZ / FILT10HZ / FILT1HZ**

Selects the chosen analog filter for the RMS converter, thus allowing measurement to be made at frequencies down to the chosen filter frequency. One of the four available filters is always in circuit.

### **TFER\_ON**

This selects an internal electronic AC-DC transfer mode for AC measurement which improves linearity and temperature performance.

### **TFER\_OFF**

The instrument can take faster readings at some reduction in accuracy.

### **DCCP**

Selects DC-coupled measurements. *Note - DC-coupled should be selected for signal frequencies less than 40 Hz.*

### **ACCP**

Selects AC-coupled measurements.

### **RESL5 / RESL6**

Sets the resolution of the measurement to 5.5 or 6.5 digits.

### **SPOT\_ON / SPOT\_OFF**

Applies spot frequency corrections (previously calibrated) when the signal frequency is within 10 % of the spot frequencies.

### **TWO\_WR**

Requires only a connection to the INPUT terminals.

### **FOUR\_WR**

Requires a connection to the INPUT terminals and to the SENSE terminals.

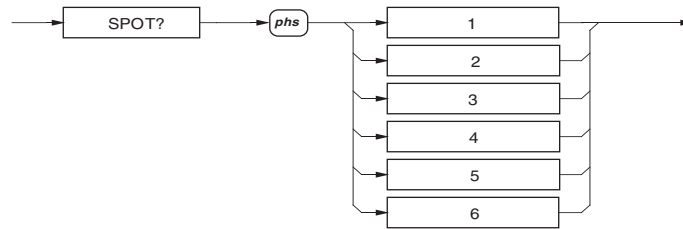
### **Measurements of RMS Value and Frequency**

For each RMS measurement trigger, a parallel measurement of signal frequency is also triggered (4.5 or 6.5 digit frequency resolution depending on gate width selection).

### **Power On and Reset Conditions**

1kV, FILT40HZ, RESL6, TFER\_ON, ACCP, SPOT\_OFF, TWO\_WR

### Recall of Spot Frequency Value



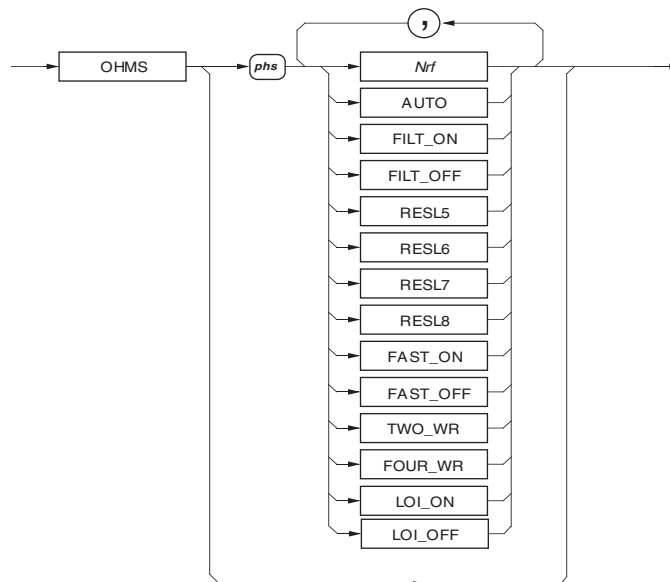
adj211f.eps

#### Recall of Spot Frequency

(Nr3) Recalls the frequency value for the specified calibrated spot on the active ACV range.

### Resistance: Normal OHMS

The following commands are used to select the Normal OHMS function and set its configuration.



adj212f.eps

#### Normal OHMS

##### **Nrf**

A numeric value that selects the range for the expected signal. Any valid numeric value cancels autorange.

##### **AUTO**

Selects the autorange mode where the multimeter will determine the appropriate range for the measured signal. If the signal exceeds the maximum capability then RANGE OVERLOAD appears on the front panel and the appropriate bit is set in the device status registers.

##### **FILT\_ON / FILT\_OFF**

FILT\_ON inserts a hardware analog filter into the measurement signal path.

### **RESL5 / RESL6 / RESL7 / RESL8**

Sets the resolution of the measurement to 5.5, 6.5, 7.5, or 8.5, digits.

### **FAST\_ON / FAST\_OFF**

FAST\_ON Reduces the A-D integration time, for faster conversions.

### **TWO\_WR**

Selects 2-wire Ohms (Use Hi and Lo terminals). (For backwards compatibility TWR can also be used.)

### **FOUR\_WR**

Selects 4-wire Ohms. (For backwards compatibility FWR can also be used.)

### **LOI\_ON / LOI\_OFF**

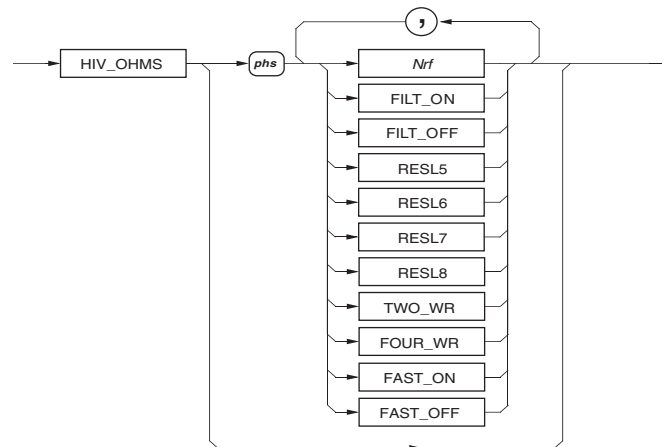
Selects low current mode.

### **Power On and Reset Conditions**

20k $\Omega$ , FILT\_OFF, RESL7, FAST\_ON, TWO\_WR, LOI\_OFF

### **Resistance: High Voltage OHMS**

The following commands are used to select the High Voltage OHMS function and set its configuration.



adj213f.eps

### **High Voltage OHMS**

#### **Nrf**

A numeric value that selects the range for the expected signal. Any valid numeric value cancels autorange.

### **FILT\_ON / FILT\_OFF**

FILT\_ON inserts a hardware analog filter into the measurement signal path.

### **RESL5 / RESL6 / RESL7 / RESL8**

Sets the resolution of the measurement to 5.5, 6.5, 7.5, or 8.5, digits.

### **FAST\_ON / FAST\_OFF**

FAST\_ON Reduces the A-D integration time, for faster conversions.

### TWO\_WR

Selects 2-wire Ohms (Use Hi and Lo terminals). (For backwards compatibility TWR can also be used.)

### FOUR\_WR

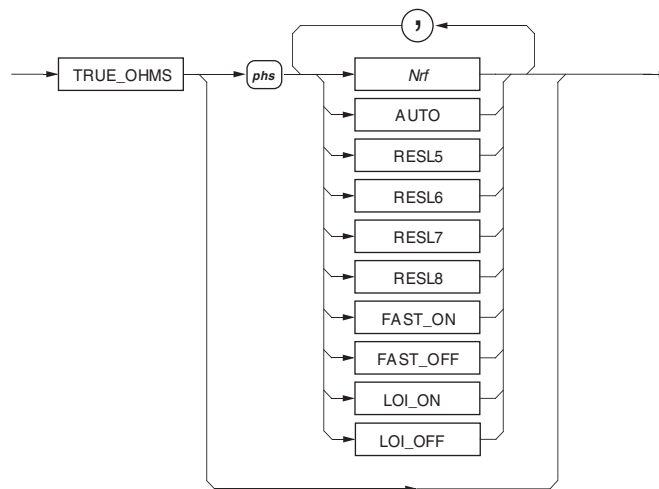
Selects 4-wire Ohms. (For backwards compatibility FWR can also be used.)

### Power On and Reset Conditions

20MΩ, FILT\_OFF, RESL6, FAST\_OFF, TWO\_WR

### Resistance: True OHMS

The following commands are used to select the True OHMS function and set its configuration.



True OHMS

adj214f.eps

### Nrf

A numeric value that selects the range for the expected signal. Any valid numeric value cancels autorange.

### AUTO

Selects the autorange mode where the multimeter will determine the appropriate range for the measured signal. If the signal exceeds the maximum capability then RANGE OVERLOAD appears on the front panel and the appropriate bit is set in the device status registers.

### RESL5 / RESL6 / RESL7 / RESL8

Sets the resolution of the measurement to 5.5, 6.5, 7.5, or 8.5 digits.

### FAST\_ON / FAST\_OFF

FAST\_ON Reduces the A-D integration time, for faster conversions.

### LOI\_ON / LOI\_OFF

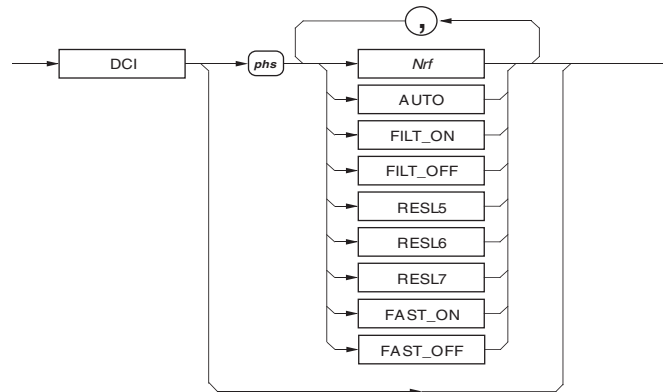
Selects low current mode.

### Power On and Reset Conditions

20kΩ, RESL7, FAST\_ON, LOI\_OFF

## **DC Current**

The following commands are used to select the DCI function and set its configuration.



**DC Current**

adj215f.eps

### **Nrf**

A numeric value that selects the range for the expected signal. Any valid numeric value cancels autorange.

### **AUTO**

Selects the autorange mode where the multimeter will determine the appropriate range for the measured signal. If the signal exceeds the maximum capability then **RANGE OVERLOAD** appears on the front panel and the appropriate bit is set in the device status registers.

### **FILT\_ON / FILT\_OFF**

**FILT\_ON** inserts a hardware analog filter into the measurement signal path.

### **RESL5 / RESL6 / RESL7**

Sets the resolution of the measurement to 5.5, 6.5, or 7.5 digits.

### **FAST\_ON / FAST\_OFF**

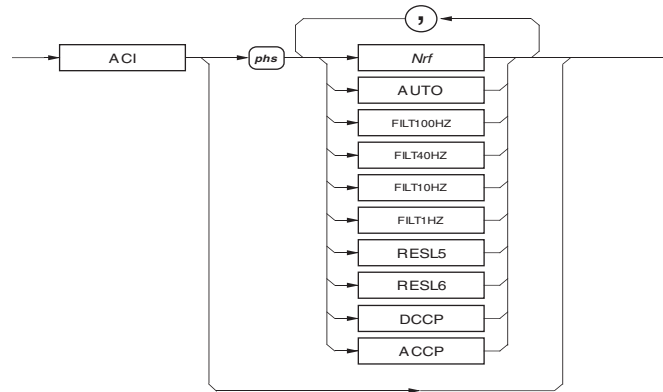
**FAST\_ON** Reduces the A-D integration time, for faster conversions.

### **Power On and Reset Conditions**

2A, **FILT\_OFF**, **RESL7**, **FAST\_ON**

## AC Current

The following commands are used to select the ACI function and set its configuration.



adj216f.eps

### AC Current

#### Nrf

A numeric value that selects the range for the expected signal. Any valid numeric value cancels autorange.

#### AUTO

Selects the autorange mode where the multimeter will determine the appropriate range for the measured signal. If the signal exceeds the maximum capability then **RANGE OVERLOAD** appears on the front panel and the appropriate bit is set in the device status registers.

#### FILT100HZ / FILT40HZ / FILT10HZ / FILT1HZ

Selects the chosen analog filter for the RMS converter, thus allowing measurement to be made at frequencies down to the chosen filter frequency. One of the four available filters is always in circuit.

#### RESL5 / RESL6

Sets the resolution of the measurement to 5.5 or 6.5 digits.

#### DCCP

Selects DC-coupled measurements. *Note - DC-coupled should be selected for signal frequencies less than 40 Hz.*

#### ACCP

Selects AC-coupled measurements.

#### Measurements of RMS Value and Frequency

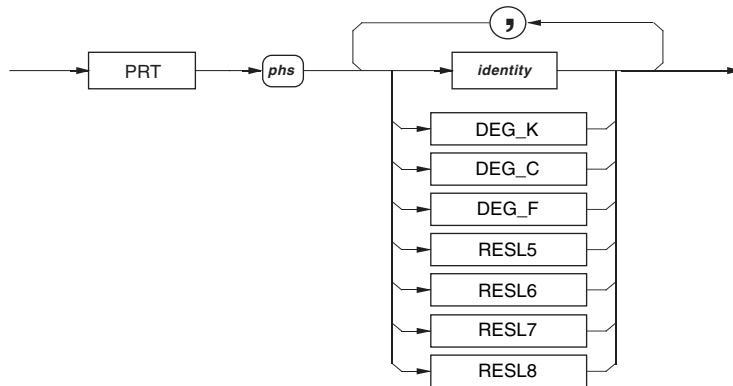
For each RMS measurement trigger, a parallel measurement of signal frequency is also triggered (4.5 or 6.5 digit frequency resolution depending on gate width selection).

#### Power On and Reset Conditions

2A, FILT40HZ, RESL6, ACCP

## Using Platinum Resistance Thermometers to obtain Temperature.

The following commands are used to select the PRT function and set its configuration.



adj356f.eps

### Platinum Resistance Thermometers

#### Identity

This is a string value and thus must be enclosed in *double quotes* and must be identical in all respects with the identity of an already entered PRT. This command will set the selected PRT as the active measurement probe.

#### DEG\_K / DEG\_C / DEG\_F

This selects the format for presentation of the temperature.

#### RESL5 / RESL6 / RESL7 / RESL8

Sets the resolution of the measurement and the temperature display to 5.5, 6.5, 7.5 or 8.5 digits.

#### Execution Errors

If the identity does not match one of the stored PRT identities the error 1026 is generated.

#### Power On and Reset Conditions

The active probe identity if available, DEG\_C, RESL6

## Determine the PRT identity.



### PRT Identity

adj353f.eps

#### Response:

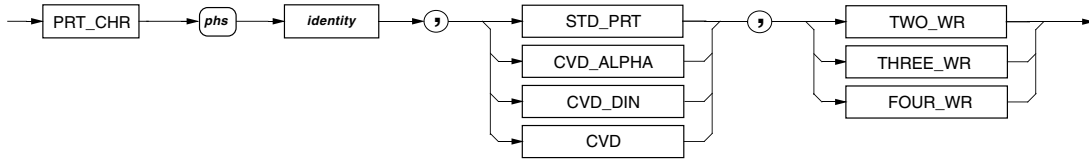
(string) Active Probe, (string) next inactive probe

There is always the one identity returned as a string, but the second identity is obtained from an incremental search of the available identities. If no other identities exist then the second string with the separating comma is not appended.

This command can be used to increment through the list of PRT's stored. The user should check for a second appearance of the inactive identity to determine when all possible identities have been viewed.

### Entering or Editing the Characteristics of a PRT to Non-volatile Store

The following commands are used to construct a **PRT** identity and set associated parameters and coefficients.



adj357f.eps

#### Entering or editing PRT characteristics

This command with its associated parameter can be used to enter characteristics of a new PRT identity to the non-volatile store.

#### Identity

This is a string value and thus must be enclosed in *double* , *limited to 17 characters*.

#### STD\_PRT

This selects the conversion algorithm to be used. The ITS90 conversion is used for a standard PRT.

#### CVD\_ALPHA

This selects the conversion algorithm (Callender Van Deusen) to be used and the method for expressing the conversion coefficients ( $R_{zero} \alpha \beta \delta$ ).

#### CVD\_DIN

This selects the conversion algorithm to be used and the method for expressing the conversion coefficients ( $R_{zero} A B C$ ).

#### CVD

This selects the conversion algorithm to be used and requires only the  $R_{zero}$  value. The other parameters are set to a default value.

#### TWO\_WR / THREE\_WR / FOUR\_WR

This specifies the type of connection and thus the measurement method.



adj358f.eps

#### Entering or Editing PRT Coefficients

This command with its associated parameter is used to enter the coefficients, or to edit the existing coefficients of a PRT with a known identity. *NOTE that when editing all the parameters MUST be given in the correct order.* The numbers entered are associated in the following manner:

- For CVD only one number is required for the  $R_{zero}$  value.
- For CVD\_DIN the first number is the  $R_{zero}$  value, the second is the A coefficient, the third the B coefficient and the fourth is the C coefficient.
- For CVD\_ALPHA the first number is the  $R_{zero}$  value, the second is the  $\alpha$  coefficient, the third the  $\beta$  coefficient and the fourth is the  $\delta$  coefficient.
- For STD\_PRT the first number is the resistance of the probe at the triple point of water. The second is the  $a^+$  value ( $a_7$ ). The third is the  $b^+$  value ( $b_7$ ). The fourth is the  $c^+$  value ( $c_7$ ). The fifth is the  $a^-$  value ( $a_4$ ). The sixth is the  $b^-$  value ( $b_4$ ).

## Execution Errors

If the identity is unknown an error is generated for the coefficient entry.

An error is generated if any of the coefficients exceed the limits for correct algorithm operation.

## Recalling the Characteristics of a Known PRT

### PRT\_DATA?



adj355f.eps

### Recalling PRT data

Recalls the characterization data and associated coefficients for the probe identity given.

### Response Format:

This is a variable length response consisting of comma separated elements :

(string) Identity , algorithm , connection , (Nr3)  $R_{tp}$  or  $R_{zero}$  , (Nr3) coefficient1 , (Nr3) coefficient2 , (Nr3) coefficient3 , (Nr3) coefficient4 , (Nr3) coefficient5

The 'Identity' consists of 17 ASCII characters enclosed with quotes.

The 'algorithm' will be one of the following: **STD\_PRT** or **CVD\_ALPHA** or **CVD\_DIN** or **CVD**.

The 'connection' will be one of the following: **TWO\_WR** or **THREE\_WR** or **FOUR\_WR**.

The first numeric value will be the resistance of the PRT at either the triple point of water (STD\_PRT) or zero degrees C (all CVD).

The number of coefficients appended to this response detailed above is dependant on the algorithm used:

- For CVD there will be no further coefficients.
- For CVD\_DIN and CVD\_ALPHA there are three comma separated numbers.
- For STD\_PRT there are five comma separated numbers.

## Deleting a Known PRT from the Non-volatile Store

### PRT\_DEL



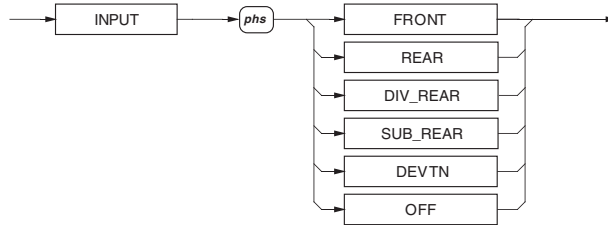
adj354f.eps

### Deleting a known PRT

Removes the probe from the store of probe data for the identity given.

### Input

The following commands are used to select an input; or combined usage of the two inputs to calculate the Ratio, Difference and Deviation measurement modes. The selections are mutually exclusive.



adj217f.eps

Input and Ratio Configurations

#### FRONT

This selects the front terminals.

#### REAR

This selects the rear terminals. *NOTE – the DCI/ACI signals that can be applied to the rear terminals are restricted to 2A max. and scan operations for these function are not available. Also 4 wire sense for voltage is not available.*

#### OFF

This isolates all the terminals and deselects the scanning measurements.

#### DIV\_REAR

This selects the measurement at the front terminals followed by a measurement at the rear terminals and computes the ratio of the signals (Front / Rear).

#### SUB\_REAR

This selects the measurement at the front terminals followed by a measurement at the rear terminals and computes the difference of the signals (Front - Rear).

#### DEVTN

This selects the measurement at the front terminals followed by a measurement at the rear terminals and computes the deviation of the signals (Front – Rear / Rear).

### Power On and Reset Conditions

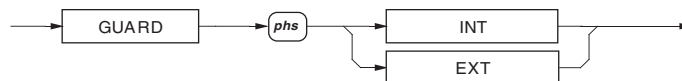
FRONT

### Exit from a Scanning Mode

Achieved by selecting one of the two inputs or OFF.

### Guard

Selection of guarding for all functions.



adj218f.eps

Remote Guard

## INT / EXT

This selects the connection of the multimeter's guarding. (For backwards compatibility LCL & REM can also be used.)

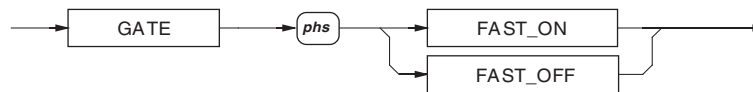
For scan operations, the guard selection is applied to the channel currently being applied to the A-D converter.

## Power On and Reset Conditions

INT (internal)

## Measurement Gate Width

This command selects the gate width for frequency readings during AC measurements.



adj220f.eps

**Measurement Gate Width**

## FAST\_ON

Selects a gate width of 50ms, and a frequency resolution of 4.5 digits.

## FAST\_OFF

Selects a gate width of 1s, and a frequency resolution of 6.5 digits.

Both selections are mutually exclusive.

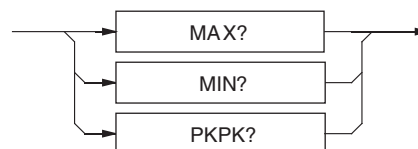
The use of the longer gate width results in a 6.5 digit frequency measurement. The frequency gate is triggered at the same point as the A-D conversion which could be significantly shorter than 1 second. This may reduce the read-rate, as the measurement processing cannot begin until both the frequency gate and the A-D conversion are complete.

## Power On and Reset Conditions

FAST\_ON.

## Maximum, Minimum and Peak-Peak

## Recall Stored Values



adj221f.eps

**Recall Stored values**

## MAX?

Recalls the stored value of the maximum signal value to be measured since the most-recent general reset, store reset or function change.

## MIN?

Recalls the stored value representing the minimum signal value to be measured since the most-recent general reset, store reset or function change.

### PKPK?

Obtains the stored value representing the difference between the maximum and minimum signal values to be measured since the most-recent general reset, store reset or function change.

### Response Format

(Nr3) Max or Min:

The returned value represents the signal with two exceptions:

- When an overload has occurred, and thus the maximum is not measurable, the response is +200.000000E+33.
- When no measurement has been made since a reset, the response is -20.0000000E+36.

(Nr3) PkPk:

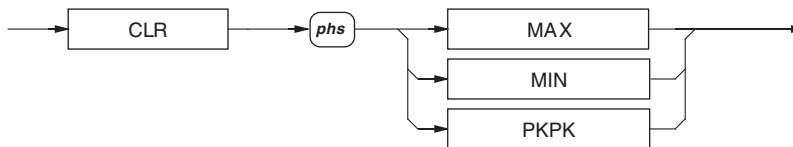
The returned value represents the difference between the max and min signals with two exceptions:

- When an overload occurs in one or both stores, the computation is still performed and thus the response indicates a numeric difference which has an obviously overlarge exponent.
- When no measurement has been made since a reset, the response is -40.00000000E+36.

### Function Change, Power On and Reset:

These automatically clear Max, Min, and thus PkPk values.

### Reset Max and Min Memories



**Reset Max and Min Memories**

adj222f.eps

### MAX / MIN

Resets the specified store only.

### PKPK

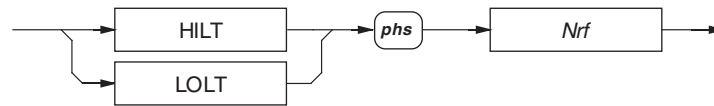
Resets both the MAX and MIN stores.

### Function Change, Power On and Reset:

These automatically clear Max, Min, and thus PkPk values.

## Limits

Each command sets its corresponding limit, for comparison with each measurement when enabled.



adj223f.eps

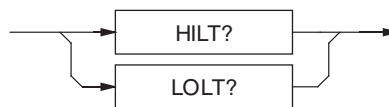
### Setting Hi/Lo Limits

## Nrf

A Decimal Numeric Data element that represents the mathematical value to be used for limit-checking. Its resolution is 8.5 significant digits; numbers in excess of this resolution will be rounded to it. The limits are stored in non volatile memory.

## Recall Limits

Each of these queries recalls its corresponding limit value.



adj224f.eps

### Recall Limits

## HILT?

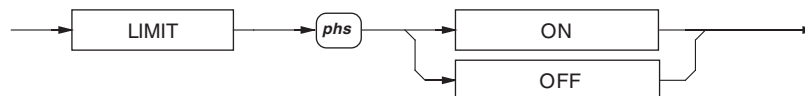
(Nr3) Recalls the set Hi Limit value.

## LOLT?

(Nr3) Recalls the set Low limit value.

## Enable Limits

These commands enable and disable the checking of measurements against preset limits.



adj225f.eps

### Enable Limits

## Note

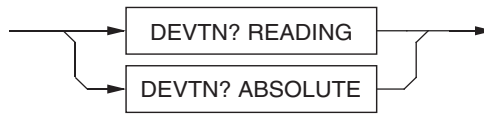
*Limit calculations are performed after all math operations are complete. Thus the choice of limit values should be relevant to the result of the math operation on the measured signal.*

## Power On and Reset Conditions

OFF

## Standard Deviation

Each of these queries recalls the stored standard deviations for a block of readings.



Recall Standard Deviation

adj363f.eps

### DEVTN? READING

(Nr3) Recalls the standard deviation of the block relative to the mean of the block.

### DEVTN? ABSOLUTE

(Nr3) Recalls the standard deviation of the block as an absolute quantity.

#### Note

*To obtain a valid standard deviation value the AvR or BlocN average mode must be configured and enabled.*

## Syntax Diagrams of Math Functions

#### Note

*Combinations of math operations are allowed, but they must be performed in the following order:*

1. Averaging (AVG)
2. Multiplication (MUL\_M)
3. Subtraction (SUB\_C)
4. Division (DIV\_Z)
5. Decibels (DB).

## Averaging

Two forms of averaging are available:

- **Rolling Average**

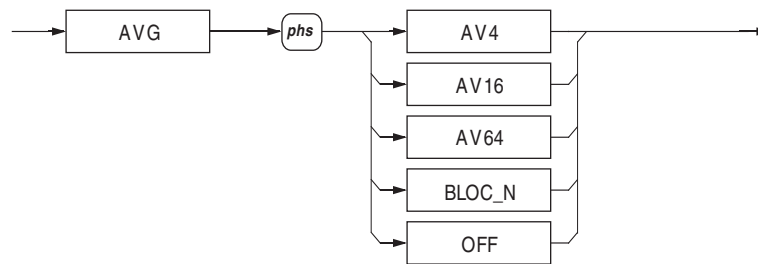
Processes successive readings to provide a measurement which is the arithmetic mean of the most-recent "R" (4, 8, 16, 32 or 64) readings. When the window has filled with the selected number of readings, the earliest reading is discarded as each new reading is added. The mean is updated with every new reading.

- **Block Average**

Continuously calculates the arithmetic mean of successive readings until a block of "N" readings is complete, then presents the mean of the whole block. A new block of N readings is started, but the old block's mean remains on the display until the new block is completed, when the new mean is presented.

## Enable Averaging

All selections are mutually exclusive.



adj226f.eps

### Enable Averaging

#### AVG AV...

Averages the number of readings requested (4, 16, or 64) as a rolling average.

#### Note

*From a cleared average memory, the average is the mean of the number of readings to date, until the selection window number is reached. The average memories are cleared on each command update.*

#### AVG BLOC\_N

Selects N readings for a block average.

#### Note

*The parameter BLOC\_N selects the average of N readings, where only one result is obtained after the required number of readings (internally triggered) have been obtained.*

#### AVG OFF

Turn averaging OFF; the number N is not destroyed.

### Power On and Reset Conditions

OFF

## Set Block Size

Sets the integer constant N for use with the averaging math function.



adj227f.eps

### Set Block Size

#### Nrf

An integer value to be used as the number of readings to be taken and averaged in each block.. This value is saved in non volatile memory.

Example:

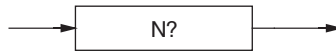
N 15 sets the number of readings to be averaged to 15.

### Execution Errors

Execution errors will be generated when  $N > 10,000$ .

Power On and Reset Conditions: No Change. The number N is saved at Power Off.

### Recall Block Size



adj228f.eps

Recall block Size

#### N?

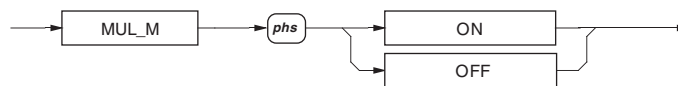
(Nr1) Recalls the active value of "N".

### Multiplication

Each signal value is multiplied by a user-defined factor "M".

#### Enable Multiplication

Selects the multiplication operation to be performed on the measurement.



adj229f.eps

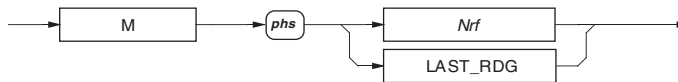
Enable Multiplication

#### Power On and Reset Conditions

OFF

### Set Multiplication Constant

This command allows the definition of the factor M, to be used as the multiplication factor.



adj230f.eps

Set multiplication constant

#### Nrf

A numeric value required for use in the **MUL\_M** command. The decimal data resolution is 8.5 digits; numbers exceeding this resolution will be rounded to 8.5 digits. This value is saved in non volatile memory.

Example:

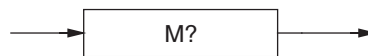
M -3E+2 Sets M at -300.

#### LAST\_RDG

Place the most recent reading into the numeric memory.

The mathematical processing capability is limited in the range of numbers which it can successfully handle. The maximum resolution of the mantissa is 8.5 digits, and the exponent is limited to  $\pm 15$ . Calculations which result in values outside this range will produce a mathematical overflow error.

### Recall Multiplication Constant



**Recall Multiplication Constant**

adj231f.eps

#### **M?**

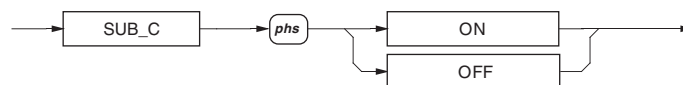
( Nr3) Recalls the defined value of M.

### Subtraction

A user-defined constant "C" is subtracted from each signal value.

#### Enable Subtraction

Selects the subtraction operation to be performed on the measurement.



**Enable Subtraction**

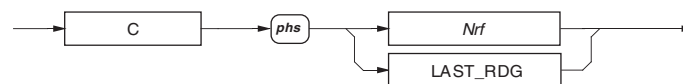
adj232f.eps

#### Power On and Reset Conditions

OFF.

### Set Subtraction Constant

This command allows the definition of the constant C.



**Set Subtraction Constant**

adj233f.eps

#### **Nrf**

A numeric value required for use in the SUB\_C processing. The decimal data resolution is 8.5 digits; numbers exceeding this resolution will be rounded to 8.5 digits. This value is saved in non volatile memory.

Example:

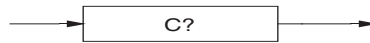
C 10E2 sets the C constant to 1000.

#### **LAST\_RDG**

Places the most recent reading into the numeric store.

The mathematical processing capability is limited in the range of numbers which it can successfully handle. The maximum resolution of the mantissa is 8.5 digits, and the exponent is limited to  $\pm 15$ . Calculations which result in values outside this range will produce an error indicated by the invalid response when accessed by a query command.

### Recall Subtraction Constant



Recall Subtraction Constant

adj234f.eps

#### C?

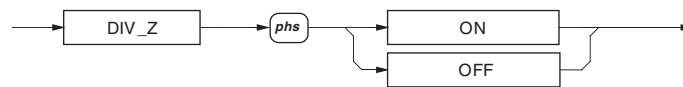
(Nr3) Recalls the defined value of C.

### Division

Each signal value is divided by a user-defined factor "Z".

#### Enable Division

Selects the division operation to be performed on the measurement.



Enable Division

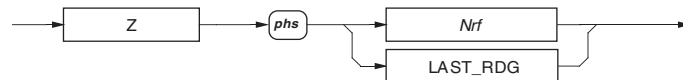
adj235f.eps

#### Power On and Reset Conditions

OFF

#### Set Division Constant

This command allows the definition of the factor Z.



Set Division Constant

adj236f.eps

#### Nrf

A numeric value required for use in the DIV\_Z processing. The decimal data resolution is 8.5 digits; numbers exceeding this resolution will be rounded to 8.5 digits. Divide by zero will set bit 5 (MOF) of the Measurement Event Status Byte. This value is saved in non volatile memory.

Example:

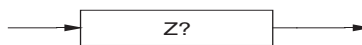
Z -56.999 sets Z to -56.999.

#### LAST\_RDG

Places the most recent reading into the numeric memory.

The mathematical processing capability is limited in the range of numbers which it can successfully handle. The maximum resolution of the mantissa is 8.5 digits, and the exponent is limited to  $\pm 15$ . Calculations which result in values outside this range will produce an error indicated by the invalid response when accessed by a query command.

### Recall Division Constant



adj237f.eps

#### Recall Division Constant

### Z?

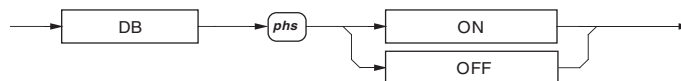
(Nr3) Recalls the defined value of z.

### Decibel Calculations

Decibel operations calculate, and express in decibels, the ratio of the reading to one of four standard references: unity, and 1 mW in either 50  $\Omega$ , 75  $\Omega$  or 600  $\Omega$ . As the dB calculation is set as the final part of any calculation, it is also possible to use the other Math operations to alter the effective reference value.

### Enable dB Calculation

Selects the decibel operation to be performed on the measurement. This operation computes the dB ratio of a corrected A-D result and a stored reference value "R".



adj238f.eps

#### Enable dB Calculation

### ON / OFF

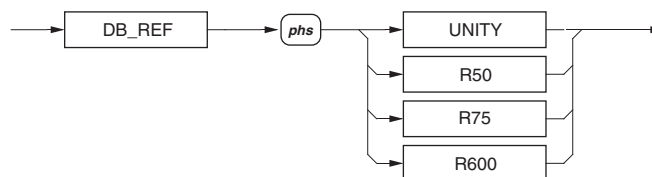
Displays the result of the calculation  $20\log[(\text{Reading})/\text{dB Ref}]$ .

### Power On and Reset Conditions

OFF.

### Set dB Reference Value

The user defines the value of the reference R, to be used in dB calculation. All selections are mutually exclusive.



adj239f.eps

#### Set dB Reference

### UNITY

Selects a dB reference of unity, in whole units of the active function.

Each of the following commands selects the dB reference voltage (as shown in parenthesis), which corresponds to 1 mW in the given impedance. These are only available for use in voltage functions

R50	50 $\Omega$	(i.e., 0.223606800V)
R75	75 $\Omega$	(i.e., 0.273861280V)
R600	600 $\Omega$	(i.e., 0.774596670V)

### Power On and Reset Conditions

UNITY.

### Recall dB Reference Value



adj240f.eps

#### Recall dB Reference Value

##### DB\_REF?

(Nr3) Recalls the current value of the DB\_REF voltage.

The value returned is the voltage value assigned to the program data elements:

The element UNITY: +1.00000000E+00.

The element R50: +223.606800E-03.

The element R75: +273.861280E-03.

The element R600: +774.596670E-03.

## Syntax Diagram of Test

### Selftest

This command conforms to the IEEE 488.2 standard requirements.



adj241f.eps

#### Selftest

##### \*TST?

Executes a selftest.

The success of Selftest can be inhibited by:

- Temperature not in the range: 5 °C to 40 °C.
- Presence of excessive RFI or Line noise.

##### Response

(Nr1) The value returned identifies pass (0) or failure (1) of self test. The errors numbers can be found in the device dependent error queue.

##### Execution Errors:

Selftest is not permitted when calibration is enabled.

## Device Errors and Syntax Diagrams

### Error Detection

All errors which cannot be recovered transparently result in some system action to inform the user via a message, and where possible restore the system to an operational condition. Errors are classified by the method with which they are handled.

- Recoverable errors report the error and continue.
- System errors which cannot be recovered cause the system to halt with a message displayed. Restarting the system from power on may clear the error, but generally such messages are caused by hardware or software faults.

A device-dependent error (DDE) is generated if the device detects an internal operating fault (e.g., during self-test). The **DDE** bit (3) is set *true* in the Standard-defined **Event Status Byte**, and the error code number is appended to the **Device-Dependent Error** queue.

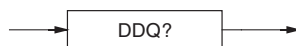
In remote operations, the error is reported by the mechanisms described in the section which deals with status reporting, and the queue entries can be read destructively as LIFO by the query command **DDQ?**. The remote user can ignore the queue, but it is good practice to read the errors as they occur.

In local (front panel) operations, the DDE status is checked at the end of the operation (e.g., Cal, Zero, Test). If *true*, an error has occurred, and the content of the last entry in the queue is displayed on the front panel. The local user cannot continue until the queue has been read.

If both bus and front panel users attempt to read the queue concurrently, the error data is read out destructively on a first-come, first-served basis. Thus one of the users cannot read the data on one interface as it has already been destroyed by reading on the other. This difficulty should be solved by suitable application programming to avoid the possibility of a double readout. Ideally the IEEE 488 interface should set the instrument into REMS or RWLS to prevent confusion.

The code numbers for device dependent errors, with their associated descriptions, are given in Appendix A.

## Recall Device Errors



Recall Device Errors

adj243f.eps

### DDQ?

Recalls the last error from the queue of device-dependent errors (e.g., errors recorded during a failed selftest). The queue is organized as a last-in - first-out stack, its individual entries being destructively read. If there are no entries in the queue, then use of this command generates a result of 0.

#### Note

*Read the queue until empty. To prevent unrelated history of errors being retained, read the queue until empty on each occurrence of a device-dependent error.*

### Response

(Nr1) The value returned is a specified integer value indicating the fault.

## Recall Execution Errors



Recall Execution Error

adj268f.eps

### EXQ?

Recalls the last error from the queue of execution errors. An execution error occurs when a command cannot be complied with.

**Read the Queue until Empty.** It is good practice to read the queue until empty on each occurrence of execution error, to prevent unrelated history of errors being retained.

### Response

(Nr1) The value returned is a integer value indicating the fault.

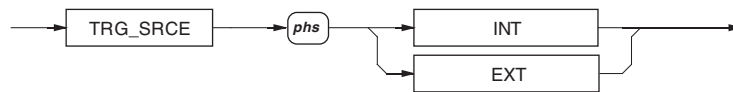
The execution error queue operates as a Last In - First Out stack, and individual entries are read destructively. If there are no entries in the queue, then use of this command produces a result of zero. For details of the number/fault relationship refer to Appendix A.

### Power On and Reset Conditions

The queue is cleared.

## Triggering and Reading Operations

### Trigger Source Selector



adj244f.eps

Trigger Source Selector

### INT

Selects the internal interval counter as the source, and disables external trigger sources.

### EXT

Disables internal triggers and enables three external trigger sources:

- Rear panel trigger socket.
- Controller-generated **GET** or **\*TRG** commands.
- Front panel Sample key. This will have been disabled when the instrument was transferred from Local to Remote Control.

Selections are mutually exclusive.

### Note

*Internal triggers or uncontrolled rear panel triggers can produce unexpected results, due to the time required for the A-D conversion, and the A-D triggers being unsynchronized with the IEEE 488 bus operations. Such triggers should be avoided unless they form an essential ingredient of the required measurement.*

### Power On and Reset Conditions

INT.

Execute Trigger

This command conforms to the IEEE 488.2 standard requirements.



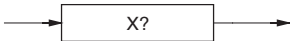
Execute Trigger

adj245f.eps

\*TRG

Equivalent to a Group Execute Trigger (GET). Causes a single reading to be taken.

Execute Trigger and Take a Reading



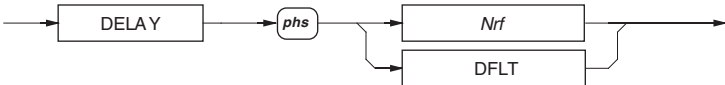
Execute Trigger and Take Reading

adj246f.eps

X?

Equivalent to performing an Execute Trigger (\*TRG ; RDG?) followed by a reading query. X? is intended for high speed use.

Settling Delay



Setting Delay

adj247f.eps

Nrf

A numeric value for the required settle delay. The minimum period allowed is 0, and the maximum is 65,000 seconds.

Examples:

DELAY 0.001 sets a settle delay after trigger of 1ms before the reading begins

DELAY DFLT sets the default delay for the selected function, range, filter etc.

The programmed delay is active with TRG\_SRCE EXT selected, although delays may be programmed whilst unit is in Remote with default (internal) triggers selected. They will then become active upon the selection of the external trigger.

Delay Selection Resolution

<0.01 s	10 µs
0.01 s to 0.1 s	100 µs
0.1 s to 1 s	1 ms
1 s to 10 s	10 ms
>10 s	100 ms

Execution Errors:

Execution errors are generated if an attempt is made to program the delays when the instrument is not in remote control.

An execution error is generated if the selected value of Nrf exceeds the limiting value.

Power On and Reset Conditions

DFLT

### Delay Default Tables

The delays listed in the following tables are active unless a specific delay is programmed.

Once programmed, a specific delay will be applied to all subsequent readings providing External Trigger mode is selected until either the DELAY DFLT command is received, or the instrument is returned to local control. Delays then return to their default values.

**Table 4-2. Delay Defaults for DCV, DCI, ACV, and ACI**

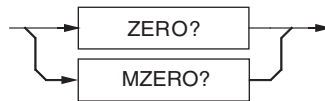
Function	Filter.	Resolution			
		5	6	7	8
<b>DCV</b>	Out	0.08 s	0.1 s	1 s	5 s
	In	0.8 s	1 s	5 s	10 s
<b>DCI</b>	Out	0.08 s	0.1 s	0.1 s	---
	In	0.8 s	1 s	1 s	---
<b>ACV</b> <b>Norm</b> <b>(Scan)</b>	100 Hz	0.25 (0.5) s	0.3 (1.25) s	---	---
	40 Hz	0.6 (1.25) s	0.75 (3.25) s		
	10 Hz	2 (5) s	2.5 (12.5) s		
	1 Hz	20 (50) s	25 (125) s		
<b>ACI</b>	100 Hz	0.25 s	---	---	---
	40 Hz	0.6 s			
	10 Hz	2 s			
	1 Hz	20 s			

**Table 4-3. Delay Defaults for Ohms, Tru Ohms, and Hi Ohms**

Function	Filter	Resolution			
		5	6	7	8
<b>1 <math>\Omega</math>-100 k<math>\Omega</math></b>	Out	0.8 s	1 s	5 s	10 s
	In	0.8 s	1 s	5 s	10 s
<b>1 M<math>\Omega</math></b>	Out	0.8 s	1 s	5 s	10 s
	In	2.5 s	3 s	5 s	10 s
<b>10 M<math>\Omega</math></b>	Out	2.5 s	3 s	5 s	10 s
	In	8 s	10 s	30 s	30 s
<b>100 M<math>\Omega</math></b>	Out	2.5 s	3 s	5 s	10 s
	In	8 s	10 s	30 s	30 s
<b>1 G<math>\Omega</math></b>	Out	2.5 s	3 s	5 s	10 s
	In	8 s	10 s	30 s	30 s
<b>1 <math>\Omega</math>-10 k<math>\Omega</math></b> <b>Tru Ohm</b>	Out	0.08 s	0.1 s	1 s	5 s
	In	0.8 s	1 s	5 s	10 s
<b>10/100 M<math>\Omega</math></b> <b>HV Ohm</b>	Out	8 s	10 s	20 s	50 s
	In	25 s	30 s	50 s	50 s
<b>1/10 G<math>\Omega</math></b> <b>HV Ohm</b>	Out	10 s	10 s	20 s	50 s
	In	30 s	30 s	50 s	50 s

## Input Zero

Determines and corrects for the input zero and stores the result in volatile memory. An Input Zero is stored only for the input channel selected. Each input has its own set of Input Zero stores, for all of the applicable range/function combinations. For OHMS function an independent Input Zero should be executed for the two/four wire connection and for the low/normal current selection. The PRT function utilizes input zero's obtained in the relevant OHMS/TRU\_OHMS ranges.



Input Zero

adj248f.eps

### ZERO?

Causes an Input Zero operation to be executed for the selected range and function, if the instrument is not in a calibration mode.

### MZERO?

Multiple ranges are zeroed for the selected function, starting at the highest range. If an error is detected further zeroing ceases.

### Responses

The value returned (Nr1) identifies pass (0) or failure (1) of input zero. The error can be found in the device dependent error queue.

### Execution Errors

Execution errors are generated if calibration is **enabled**, PRT function is selected or a scan operation is selected.

## Wait

This command conforms to the IEEE 488.2 standard requirements.



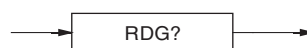
Wait

adj249f.eps

### \*WAI

Prevents the instrument from executing any further commands or queries until the No Pending Operations Flag is set *true*. This is a mandatory command for IEEE-488.2 but has no relevance to this instrument as there are no parallel processes requiring Pending Operation Flags.

## Reading Recall



Reading Recall - Voltage, Current and Resistance Readings

adj250f.eps

## Voltage, Current and Resistance Readings

### RDG?

(Nr3) Recalls the most recently triggered reading taken by the instrument.

If no trigger has been received to generate a conversion of the input signal, then the response to this command will represent the most-recent measurement. If a trigger has already been received, this query will wait for the completion of the measurement before placing the result in the output queue.

The value represents the applied signal together with any mathematical modifications selected with the Math facility. Overload is represented by a value of  $\pm 200.0000\text{E}+33$  and the O-L bit set in the measurement event status register.

### Power On and Reset Conditions

All previous results are cleared at power ON and Reset.

## Frequency Readings



**Reading Recall - Frequency Readings**

adj251f.eps

### FREQ?

(Nr3) Recalls the frequency associated with the most-recently triggered measurement.

A value of  $200.0000\text{E}+33$  is returned if the measurement circuits cannot produce a result.

If no trigger has been received to generate a conversion of the input signal, then the response to this command will be the frequency of the most-recent measurement. If a trigger has already been received, this query will wait for the completion of the measurement before placing the result in the output queue.

## Access to the Internal Buffer Memory

### Set and Arm Block Measurement Mode



**Set and Arm Block Measurement Mode**

adj293f.eps

### BLOCK

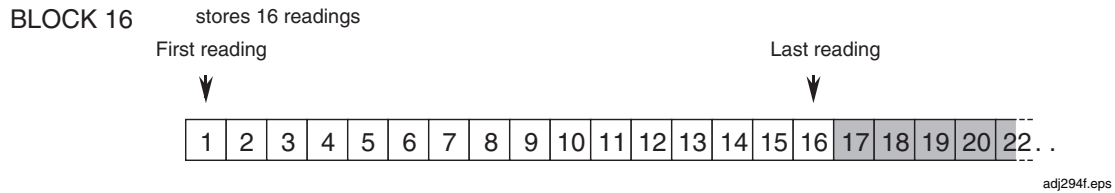
Arms the measurement system diversion of measurements to the internal buffer store, and enters the required number of diverted results.

### Nrf

A numeric value for the number of measurements to be stored. This value must lie between 1 and 6000 measurements inclusive. Note that numbers will be rounded to an integer.

### Putting Readings into Memory

Readings are placed into consecutive stores numbered from 1 to 6000. An example for a block of 16 readings is given below:



#### Block of 16 readings

At the completion of the block of measurements, bit 0 of the 8508A **Status Byte** is set, providing the appropriate bits of the **Service Request Enable** register (bit 0) and **Measurement Event Status Enable** register (bit 6) are set. Use of commands associated with this internal store prior to the completion of the specified number of readings, will abort the diversion of results.

#### Execution Errors

Occur when the numeric value exceeds the specified limits.

#### Power On and Reset Conditions

Diversion to the internal store is inoperative.

#### Note

*If **BLOCK phs Nrf** is selected in external trigger mode, **Nrf** triggers will be required to complete this sequence.*

#### Recall the Number of Results



#### Recall Number of Results

##### COUNT?

(Nr1) Recalls the number of measurements contained in the internal store.

If this command is used before a commanded block is complete, the diversion of measurements to store is aborted.

This number is set to zero when **BLOCK** command is executed.

#### Recall Measurements from Internal Memory



#### Recall Measurements from Internal Memory

##### BLOCK?

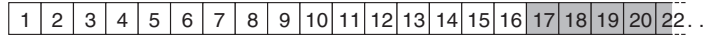
(Nr3) Recalls a series of readings between two store locations in the reading buffer. If this command is used before a commanded block is complete, the diversion of measurements to store is aborted.

#### Memory Locations

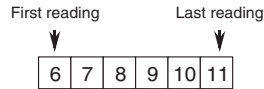
The first **Nrf** represents the location of the first reading of the series in the buffer, and the second **Nrf** represents the last reading of the series. All readings between these locations (inclusive) are recalled.

Example:

Locations of readings stored by BLOCK 16



BLOCK? 6,11 recalls selected readings consecutively from the stored block:



**Block of 16 Readings**

adj297f.eps

### Execution Errors

Occur when the start point number is greater than the finish point number, or when the finish point number is greater than the number of readings actually saved. An execution error will also result from either of the numbers being zero.

### Power On and Reset Conditions

No stored readings are available.

## Internal Operations Commands

All of the commands under this heading are common commands defined in the IEEE-488.2 standard.

### Reset



**Reset**

adj252f.eps

### \*RST

Resets the instrument to a defined condition.

The reset condition is independent of past-use history of the instrument except as noted below:

\*RST does not affect the following:

- The selected address of the instrument
- Calibration data that affect specifications
- SRQ mask conditions
- Contents of the Status Byte Register and Event Status Register
- The state of the IEEE 488 interface
- Stored math constants.

The action of the front panel Reset key is not equivalent to \*RST, but is a subset of it.

## **Complete Operations**

### **\*OPC**

A synchronization command that generates an operation complete message in the standard **Event Status Register** when all pending operations have been processed by the parser.



adj253f.eps

**Complete**

### **OPC?**

A synchronization command that places the ASCII character '1' in the output queue when all pending operations have been processed by the parser.

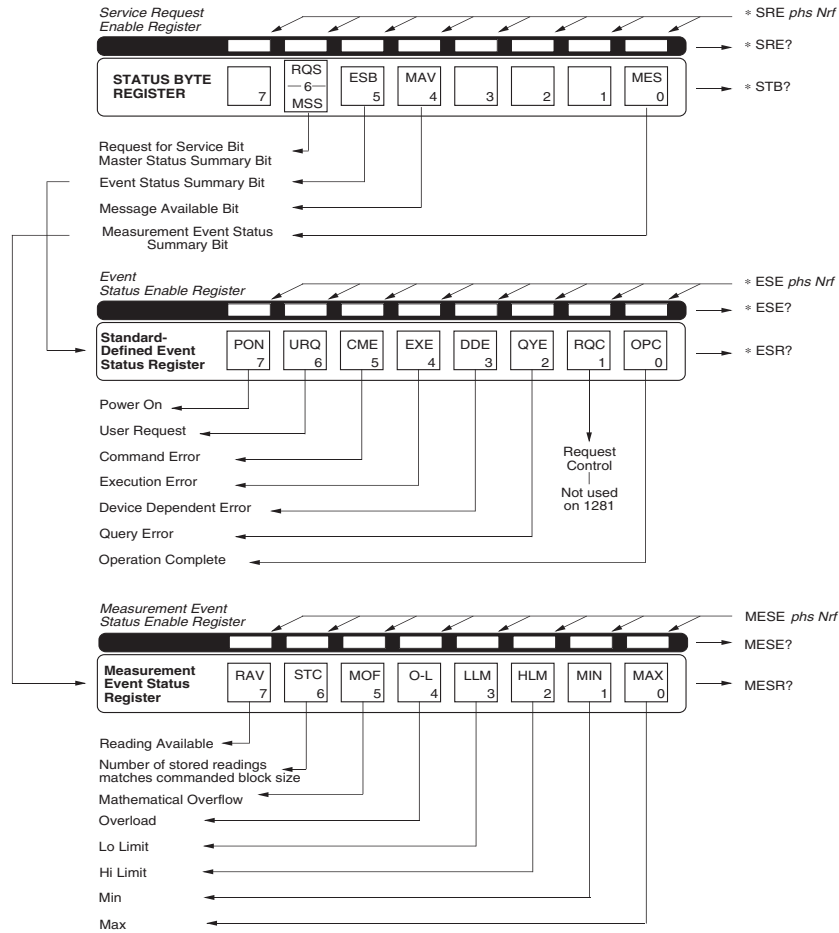


adj254f.eps

**Complete?**

## **Status Reporting**

Most of the commands in this sub-section are standard reporting commands defined in the IEEE-488.2 standard.



adj255f.eps

**Status Data Structure**

### Read Service Request Register



adj266f.eps

**Read Service Request Register**

#### **\*STB?**

(Nr1) Recalls the service request register for summary bits. The returned value, when converted to base 2 (binary), identifies the summary bits as detailed in the status data structure diagram. There is no method of clearing this byte directly. Its condition relies on the clearing of the overlying status data structure.

### Service Request Enable



adj262f.eps

**Service Request Enable**

#### **\*SRE**

Enables the standard and user-defined summary bits in the service request byte, which will generate a service request.

## Nrf

A number which, when rounded to an integer and expressed in base 2 (binary), enables the appropriate bits in this register. The detail definition is contained in the IEEE 488.2 document and in the status data structure diagram.

### Recall Service Request Enable



adj263f.eps

#### Recall Service Request Enable

## \*SRE?

(Nr1) Recalls the enable mask for the standard defined event register. The returned value, when converted to base 2 (binary), identifies the enabled bits which will generate a service request. The detail is contained in the IEEE 488.2 document and in the status data structure diagram.

### Read Event Status Register



adj259f.eps

#### Read Event Status Register

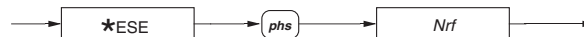
## \*ESR?

(Nr1) The value returned, when converted to base 2 (binary), identifies the bits as defined in the IEEE 488.2 standard and detailed in the status data structure diagram.

### Power On and Reset Conditions

The Power On condition depends on the condition stored by the common \*PSC command - if 0 then it is not cleared; if 1 then the register is cleared. Reset has no effect.

### Event Status Enable



adj260f.eps

#### Event Status Enable

## \*ESE

Enables the standard defined event bits which will generate a summary message in the status byte.

## Nrf

A number which, when rounded to an integer and expressed in base 2 (binary), enables the appropriate bits in this event register. The detail definition is contained in the IEEE 488.2 document, and in the status data structure diagram.

### Recall Event Status Enable



adj261f.eps

#### Recall Event Status Enable

### **\*ESE?**

(Nr1) Recalls the enable mask for the standard defined event register. The returned value, when converted to base 2 (binary), identifies the bits as defined in the IEEE 488.2 standard and detailed in the status data structure diagram.

### **Power On and Reset Conditions**

The Power ON condition depends on the condition stored by the common **\*PSC** command - if 0 then it is not cleared; if 1 then the register is cleared. Reset has no effect.

### *Read Measurement Event Register*



adj258f.eps

### **Read Measurement Event Register**

### **MESR?**

(Nr1) Destructively reads the measurement event register which, when converted to base 2 (binary), identifies the events that have occurred since the most-recent read or general clear of this register. The detail is contained in the status data structure diagram. The register is also cleared by the common command **\*CLS**.

### **Power On and Reset Conditions**

The register is cleared.

### *Measurement Event Enable*



adj257f.eps

### **Measurement Event Enable**

### **MESE**

Enables the measurement event bits which will generate a summary message in the service request byte. See the device status reporting model for detail.

### **Nrf**

A number which, when rounded to an integer and expressed in base 2 (binary), enables the appropriate bits in this event enable register.

### *Recall Measurement Event Enable*

This measurement event status data structure conforms to the IEEE 488.2 standard requirements for this structure.



adj256f.eps

### **Recall Measurement Event Enable**

### **MESE?**

(Nr1) Recalls the measurement status register enable mask which, when converted to base 2 (binary), identifies the enabled bits which will generate a summary message in the service request byte.

## Power On and Reset Conditions

Cleared (i.e., nothing enabled).

### Clear Status



Clear Status

adj265f.eps

#### \*CLS

Clears all the event registers and queues except the output queue. The output queue and **MAV** bit will be cleared if **\*CLS** immediately follows a "Program Message Terminator".

### Power On Status Clear



Power On Status Clear

adj264f.eps

#### \*PSC

Sets the flag controlling the clearing of defined registers at Power On.

#### Nrf

A number which, when rounded to an integer value of zero, sets the *power on clear flag* false. This allows the instrument to assert **SRQ** at power on.

When the value rounds to an integer value other than zero it sets the *power on clear flag* true, which clears the standard *event status enable* and *service request enable* registers so that the instrument will not assert an SRQ on power up. This data is saved in non volatile memory for use at Power On.

### Recall Status Clear Flag



Recall Power On Status Clear)

adj267f.eps

#### \*PSC?

(Nr1) Recalls the saved Power On status condition: false (0) and true (1).

## Instrument I/D and Setup

### I/D (Identification)



I/D

adj269f.eps

#### \*IDN?

Recalls the instrument's manufacturer, model number, serial number and firmware level.

## Response

The data contained in the four comma separated fields is organized as follows:

- First field - Manufacturer
- Second field - Model
- Third field - Serial number
- Fourth field - Firmware level (issue.revision).

## Options



adj270f.eps

## Options

### \*OPT?

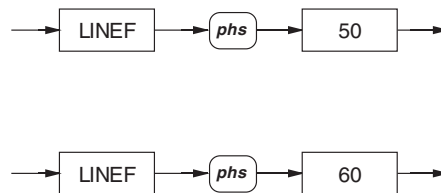
(String) Recalls the instrument's option configuration which matches the options provided in the sales literature.

Example:

"8508A/01" -- for instrument fitted with rear terminals.

## Setting Line Frequency

Selection of line frequency setting adjusts the integration time of the A-D converter for improved line frequency noise rejection.



adj281f.eps

## Setting Line Frequency 50 Hz or 60 Hz

### LINEF 50

Selects a line frequency operation of 50Hz.

### LINEF 60

Selects a line frequency operation of 60Hz.

The selection is saved in non volatile memory. *Note The only allowed values of **Nrf** are **50** for 50Hz, and **60** for 60Hz. Numbers exceeding the defined data element resolution will be rounded to that resolution.*

## Power On and Reset Conditions

Reactivated at Power On

## Recall of Line Frequency Setting



adj282f.eps

## Recall Line Frequency Setting

## LINEF?

(Nr1) Recalls the active setting for line frequency.

## Calibration Commands and Messages

### ⚠⚠ Caution

The descriptions in the following pages are intended only as a guide to the messages available to calibrate the instrument. They contain neither examples nor calibration routines, and should NOT be used directly as a basis for calibrating any part of the instrument. Some of the commands, if used unwisely, will obliterate an expensive calibration or re-calibration.

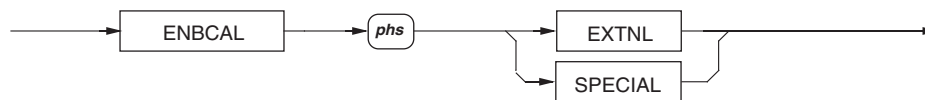
### Calibration Sequences

Remote calibration via the IEEE 488 system bus generally follows similar sequences (and is subject to similar constraints) as for local calibration. But because the remote method does not require a human operator to gain access to a sequence of commands via a single menu screen, it is possible to group commands together within bus message units.

For this reason the user should not always expect to find a one-to-one correspondence between the local and remote calibration commands.

Refer to Chapter 6 for details of the required calibration points and procedure.

### Enable Calibration



adj271f.eps

### Enable Calibration

#### ENBCAL

Allows access to the calibration operations, provided the calibration key switch on the instrument rear panel is set to "ENABLE".

#### EXTNL

Selects the external calibration facility where the user supplies the calibration source signals and the calibration trigger commands.

#### SPECIAL

Allows access to a mode for 'special' calibrations and entry of protected data.

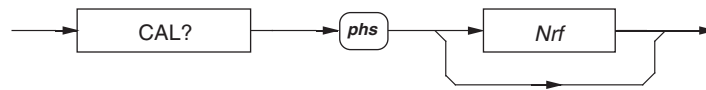
### Execution Errors

An execution error is generated if the rear panel switch is not in the ENABLE position.

### Power On and Reset Conditions

Calibration disabled.

### Trigger "External Calibration"



adj272f.eps

#### Trigger External Calibration

##### CAL?

Triggers an external calibration event, including the "SET" feature used for local calibration.

##### Nrf

A numeric value representing the "SET" calibration value. This is used as the target for the actual measured value. The difference between these two values is used to determine the calibration factors. The *Nrf* value is rounded to 8.5 digits resolution.

If the *Nrf* data element is included then *phs* is required. The number must conform to the limits required for the function being calibrated.

If the program header separator (*phs*) and *Nrf* are omitted, the instrument assumes that the nominal calibration point value is the target for the actual measured value.

##### Response

(Nr1) The value returned identifies the success (0) or failure (1) of the calibration exercise:

##### Execution Errors

If calibration is not enabled, or if the number used is incompatible with the setting being calibrated.

### Select Spot Frequency

Selects the spot frequency store to be used by the calibration trigger (ACV only).



adj273f.eps

#### Spot Frequency

##### SELSPOT

Allows the user to select a spot frequency on the active ACV range by entering the spot number. The user then enters the target value that calibrates the selected spot.

##### 1st Nrf

A decimal numeric data element representing the selected spot frequency store, from 1 to 6.

##### 2nd Nrf

A decimal numeric element that represents the **SET** value to be applied. This value is preceded by the "SET" element. This is used as the target for the actual measured value.

The frequency that will be assigned to the spot number, is allocated by the Multimeter's frequency detector. To complete the calibration a calibration trigger is required (CAL?).

Numbers that exceed the required resolution will be rounded.

##### Execution Errors

If calibration is not enabled, or if the 1st *Nrf* is out of range.

## Calibration Due Date



adj275f.eps

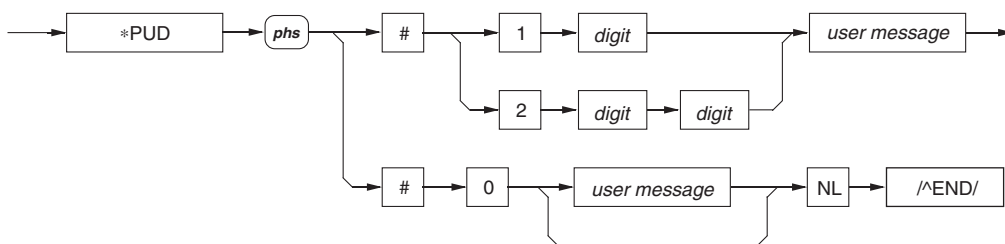
### Calibration Due Date

#### EXT\_DUE?

(String) Returns the user-entered recommended date for the re-calibration of the instrument. The date is that most-recently entered either as a parameter of **EXITCAL**, or when an exit was made from the front panel calibration mode.

## Protected User Data

### Entry of User Data



adj277f.eps

### Protected User Data

where:

*phs* = Program Header Separator

*digit* = one of the ASCII-coded numerals

*user message* = any message up to 63 bytes maximum

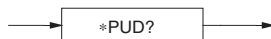
#### \*PUD

Allows a user to enter up to 63 bytes of data into a protected area to identify or characterize the instrument. The two representations above are allowed depending on the message length and the number of 'digits' required to identify this. The instrument must be in the calibration mode for this command to execute.

### Execution Errors

Execution errors are generated if the instrument is not in calibration mode.

## Recall of User Data



adj278f.eps

### Recall User Data

#### \*PUD?

Recalls previously entered user data: If no message is available, the value of the two digits is 00.

The data area contains 63 bytes of data.

### Response Syntax



adj279f.eps

### Response Syntax

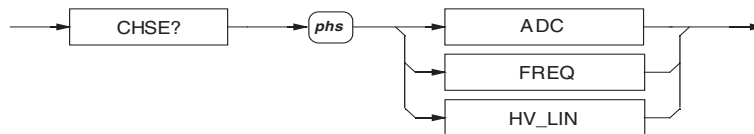
where:

*digit* = one of the ASCII-coded numerals

*user message* = the saved user message

### Special Calibrations

#### Perform a "Special" Calibration



adj280f.eps

### Special Calibration

#### CHSE?

Triggers special calibration

#### ADC

Aligns the different resolutions available from the analog to digital converter, so that there are no significant differences in readings when changing resolutions with a constant input value.

#### FREQ

Calibrates the frequency counter against an external frequency standard, by correcting an internal frequency 'gain' factor.

#### HV\_LIN

ONLY used after the five linearity measurements have been taken using the command HV\_LIN? <parameter>, to calculate the DC high voltage linearity correction from these measurements.

### Response

(Nr1) The value returned identifies the success (0) or failure (1) of the calibration step.

### Execution Errors

If special calibration is not enabled.