User's Handbook

For

The Model 1362/S/MT
VXIbus Card DMM

For any assistance contact your nearest Wavetek Sales and Service Center. Addresses can be found at the back of this handbook.

Due to our policy of continuously updating our products, this handbook may contain minor differences in specification, components and circuit design to the instrument actually supplied. Amendment sheets precisely matched to your instrument serial number are available on request.

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April 1, 1994

Wavetek Corporation reserves the right to amend specifications without notice.
SAFETY ISSUES
READ THIS ENTIRE SECTION THOROUGHLY BEFORE ATTEMPTING TO INSTALL, OPERATE OR SERVICE THE MODEL 1362/S/MT VXIbus CARD DMM

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General Safety Summary

This instrument has been designed and tested in accordance with the British and European standard publication EN61010:1993/A2:1995, and has been supplied in a safe condition.

This manual contains information and warnings that must be observed to keep the instrument in a safe condition and ensure safe operation. Operation or service in conditions or in a manner other than specified could compromise safety. For the correct and safe use of this instrument, operating and service personnel must follow generally accepted safety procedures, in addition to the safety precautions specified.

To avoid injury or fire hazard, do not switch on the instrument if it is damaged or suspected to be faulty. Do not use the instrument in damp, wet, condensing, dusty, or explosive gas environments.

Whenever it is likely that safety protection has been impaired, make the instrument inoperative and secure it against any unintended operation. Inform qualified maintenance or repair personnel. Safety protection is likely to be impaired if, for example, the instrument shows visible damage, or fails to operate normally.

WARNING THIS INSTRUMENT CAN DELIVER A LETHAL ELECTRIC SHOCK. NEVER TOUCH ANY LEAD OR TERMINAL UNLESS YOU ARE ABSOLUTELY CERTAIN THAT NO DANGEROUS VOLTAGE IS PRESENT.

Explanation of safety-related symbols and terms

DANGER electric shock risk
The product is marked with this symbol to indicate that hazardous voltages (>30 VDC or AC peak) may be present.

CAUTION refer to documentation
The product is marked with this symbol when the user must refer to the instruction manual.

Protective Earth (Ground)

The instrument must be operated with a permanent Protective Earth/Ground connection to the VXIbus mainframe's power supply.

WARNING ANY INTERRUPTION OF THE PROTECTIVE GROUND CONDUCTOR TO THE VXI MAINFRAME IS LIKELY TO MAKE THE MAINFRAME AND ALL MODULES DANGEROUS TO USE.

To avoid electric shock hazard, make signal connections to the instrument after making the protective ground connection. Remove signal connections before removing the protective ground connection, i.e. the power cable must be connected whenever signal leads are connected.

Installation Category I:

Measurement and/or guard terminals are designed for connection at Installation (Overvoltage) Category I. To avoid electric shock or fire hazard, the instrument terminals must not be directly connected to the AC line power supply, or to any other voltage or current source that may (even temporarily) exceed the instrument's peak ratings.

WARNING TO AVOID INJURY OR DEATH, DO NOT CONNECT OR DISCONNECT SIGNAL LEADS WHILE THEY ARE CONNECTED TO A HAZARDOUS VOLTAGE OR CURRENT SOURCE.

MAKE SURE THAT SIGNAL LEADS ARE IN A SAFE CONDITION BEFORE YOU HANDLE THEM ANY WAY.

THE INSTRUMENT MUST BE POWERED WHEN ANY SIGNAL IS PRESENT AT ITS INPUT TERMINALS.

continued overleaf
Do Not Operate Without Covers

To avoid electric shock or fire hazard, do not operate the instrument with its covers removed. The covers protect users from live parts, and unless otherwise stated, must only be removed by qualified service personnel for maintenance and repair purposes.

**WARNING**

REMOVING THE COVERS MAY EXPOSE VOLTAGES IN EXCESS OF 1.5KV PEAK (MORE UNDER FAULT CONDITIONS).

Safe Operating Conditions

Only operate the instrument within the manufacturer’s specified operating conditions. Specification examples that must be considered include:

- ambient temperature
- ambient humidity
- power supply voltage & frequency
- maximum terminal voltages or currents
- altitude
- ambient pollution level (Pollution Degree 2)
- exposure to shock and vibration

To avoid electric shock or fire hazard, do not apply to or subject the instrument to any condition that is outside specified range. See Section 7 of this manual for detailed instrument specifications and operating conditions.

**CAUTION**

CONSIDER DIRECT SUNLIGHT, RADIATORS AND OTHER HEAT SOURCES WHEN ASSESSING AMBIENT TEMPERATURE.

**CAUTION**

BEFORE CONNECTING THE INSTRUMENT TO THE SUPPLY, MAKE SURE THAT THE REAR PANEL AC SUPPLY VOLTAGE CONNECTOR IS SET TO THE CORRECT VOLTAGE AND THAT THE CORRECT FUSES ARE FITTED.

Maintenance and Repair

Observe all applicable local and/or national safety regulations and rules while performing any work. First disconnect the instrument from all signal sources, then from the AC line supply before removing any cover. Any adjustment, parts replacement, maintenance or repair should be carried out only by the manufacturer’s authorized technical personnel.

**WARNING**

FOR PROTECTION AGAINST INJURY AND FIRE HAZARD, USE ONLY MANUFACTURER SUPPLIED PARTS THAT ARE RELEVANT TO SAFETY. PERFORM SAFETY TESTS AFTER REPLACING ANY PART THAT IS RELEVANT TO SAFETY.

Moving and Cleaning

First disconnect the instrument from all signal sources, then disconnect the VXI mainframe from the AC line supply before moving or cleaning. Use only a damp, lint-free cloth to clean fascia and case parts.

Observe any additional safety instructions or warnings given in this manual.
SECTION 1
INTRODUCTION
SECTION 1 THE 1362 VXibus DIGITAL MULTIMETER

Designed specifically for system operation, the 1362 is a high-performance, fully compatible VXibus card DMM. This Handbook covers 3 instruments, 1362, 1362S and 1362MT. Unless specified, it reflects all instruments.

Standard and Optional Measurement Facilities

With or without options, the 1362 native language conforms to IEEE Standard Codes, Formats, Protocols and Common Commands (ANSI/IEEE STD 488.2 - 1987) although it uses the VXI bus as the hardware message transport system.

1362 Series Basic Configuration

When purchased without options, the 1362 is a high quality DC/AC Voltmeter and Ohmmeter.

The basic configuration offers the following measurement capabilities:

- DC Voltage in five ranges from 100nV to 300V.
- AC Voltage in five ranges from 1µV to 300V.
- Resistance in six ranges from 100µΩ to 20MΩ.
- Selectable 4.5 to full 6.5 digits resolution.
- Fully IEEE-488.2 programmable, subject to the requirements of the VXI bus message transport system.
- External trigger with trigger delay.
- Autocal: covers-on programmable external calibration.

1362 Series Options

To extend its functional range, the instrument can be expanded by adding purchasable options, providing further measurement capability:

30 DC and AC Current option:
   - One range of DC Current from 1µA to 2A.
   - One range of AC Current from 10µA to 2A RMS.

40 Ratio Option:
   - Two identical front input channels, A and B.
   - Math in the form of (A - B); or (A ÷ B); or deviation: (A - B) / B

1362S Configuration

In addition to the features of the 1362, the 1362S can interpret Standard Commands for Programmable Instruments (SCPI Rev 1991). The Native language can be accessed from SCPI if necessary.

This instrument also utilizes the VXI backplane trigger bus. The Synchronous and Asynchronous protocols adhere to the VXI revision 1.3 specifications.

1362MT Configuration

This includes all the features of the 1362, but in addition the 1362MT can interpret Control Interface Intermediate Language (CIIL - Standard 2806763 - rev C), in full compatibility with ‘MATE’ applications.

In this configuration the native language (IEEE 488.2 Command Syntax) is retained as an alternative. Transfer from CIIL to Native is directly programmable as a CIIL command, and conversely from Native to CIIL as a Native command.
Safety Default State and Function Configurations

When the instrument power is switched on, all functions are forced into a safety default state. Once a function is configured to a required state it remains in that state, regardless of subsequent configurations in other functions, until either the state is changed or the instrument power is switched off.

Calibration

Autocal
The 1362 is an ‘Autocal’ instrument, providing full external calibration of all ranges and functions via the VXI bus, so that it is not necessary to remove any covers. Calibration commands can be programmed in SCPI and native language, but not in CIIL.

Periodically, the DMM should be electronically calibrated against external inputs from traceable standards. The difference between the DMM’s reading and the value of the external calibration source is used to derive calibration constants, which are stored by the instrument in non-volatile memory. The 1362 assumes that nominal values are used, unless informed of deviations from nominal by user-commands via the VXI bus.

Subsequently, when in normal use, the DMM calculates and applies a correction from the most-recently stored external calibration constants for the parameters of the measurement in progress. Thus each reading taken by the DMM receives an individual correction derived from the latest calibration.

Calibration Security
Accidental or unauthorized use of calibration facilities is prevented by a screwdriver-operated switch in a hole on the front panel. In addition, an enabling command must be used in order to enter calibration mode. For Native language this is ‘CAL ON’ (Section 5, page 5-29); and for SCPI language in the 1362S, it is ’CALibration SECure’ (Section 4, page 4-13).

Calibration Routines
The Routine Autocal procedures are given in Section 8 of this handbook.

Message Readout

Generally, the offered selections reflect the availability of facilities, incompatible combinations being excluded. Nevertheless, the 1362 outputs information to the user such as unsuitable attempts at configuration, test failures and some other conditions which would need to be reported to an authorized service center.

Programming

Data can be input via the VXI bus to set up measurements with facilities for:
- selecting a suitable range for measurement of an expected value;
- introducing user-defined trigger delays;
- setting the number of readings-per-block to be taken when in BLOCK mode;
- recalling a number of readings (sub-block) from a stored block;
- setting non-nominal targets for requested calibrations;
- performing a nominated individual test from the range of tests activated in sequence during a ‘Self Test’.

Operation within the parameters of each function or facility is programmed by selection from the available codes.

Full details are given in Sections 4, 5 and 6.

Self Test

Standard codes are used to activate the instrument’s internal Self Test sequence. These can be found in Sections 4 to 6.
SECTION 2
INSTALLATION
SECTION 2 INSTALLATION

Logical Address Switch Configuration

The Logical Address Switch is an 8-way DIL switch, accessible via a hole in the top cover (RHS).

Refer to Fig. 2.1

The switch contacts are labelled from 1 to 8, corresponding to the eight bits of the logical address value (8 = MSB; 1 = LSB). One side of the switch bank is labelled OPEN; this represents address bits at logic-1. Setting a switch to the CLOSED position sets its address bit to logic-Ø.

The address can be set to any value between 1 and 255 (address Ø is reserved for the resource manager). However, as the 1362 fully supports Dynamic Configuration as defined in Section F of the VXI specification, address 255 should be selected only if the Resource Manager also supports Dynamic Configuration.

Interrupt Acknowledge Daisy Chain

As the 1362 has VXIbus Interrupter capability, care must be taken to ensure that the Interrupt Acknowledge daisy chain is correctly configured. This is usually implemented using DIP switches or links in the subrack.

Fitting the 1362 into the Subrack

The 1362 is a standard Size C, VMEbus Functional Module, with Interrupter capability. It can be fitted to the Subrack by turning it to its vertical position with its Board to the left, and sliding it into any Slot (not Slot Ø).

Ejectors are located at top and bottom of the front panel. When removing the module, these operate levers to ease the P1 and P2 connectors out of the Backplane. When fitting, the module should be gently pressed in to engage the connectors into the backplane, and when fully home, the ejectors will be set at right angles to the surface of the front panel.

Two captive screws, outboard of the ejectors, secure the module to the subrack.

Removal from the Subrack

Two captive screws, outboard of the ejectors, are unscrewed to release the module from the subrack.

Ejectors are located at top and bottom of the front panel. These are forced gently outwards (top - up; bottom - down) to operate levers which ease the P1 and P2 connectors out of the Backplane. The module can then be pulled to slide it out of the slot.

E-M Interference:

Noisy or intense electric, magnetic or electromagnetic fields in the vicinity of the calibration set-up can disturb the measurement circuit.

Some typical sources are:
- Proximity of large electric fields
- Fluorescent lighting
- Inadequate screening, filtering or grounding of power lines
- Transients from local switching
- Induction and radiation fields of local E-M transmitters
- Excessive common mode voltages between source and load

The disturbances may be magnified by the user’s hand capacitance. Electrical interference has greatest effect in high impedance circuits. Separation of leads and creation of loops in the circuit can intensify the disturbances.
Section 2 - Installation

50Hz/60Hz/400Hz Line Frequency Configuration

Line Frequency Programming
To obtain optimum performance from the A-D converter it is necessary to adapt its configuration to the line frequency in use. The adaptation is performed by remote programming.

The 1362 has been calibrated to your local line frequency. The syntax used to reset or query the line frequency depends on the model type.

Associated SCPI Commands
The following syntax are associated with line setting and query (Refer to Section 4; page 4-32).

SENse:LFRequency <numeric_value>
Example, 50Hz, 60Hz or 400Hz
SENse:LFRequency? Queries the current line setting.
CALibration:SLFRequency?
Saves the current line frequency setting to non-volatile memory. This setting is subsequently used as the power up default.

Associated Native Commands
The following syntax are associated with line setting and query (Refer to Section 5; page 5-32).

LINE <Nrf> Selects the line frequency.
LINE? Recalls the line frequency to which the instrument is currently adapted.
STLN? Saves the current line frequency setting to non-volatile memory. This setting is subsequently used as the power up default.

Further information about the programming syntax is detailed in Sections 4 and 5.

No Associated CIIL Command
There are no implemented CIIL commands associated with line setting and query. Line frequency configuration must be set in Native Language. (Implemented CIIL commands are given in Section 6.)

Front Panel Connections
Two connectors are fitted on the front panel: a co-axial BNC external trigger input plug; above a 15-way D-type plug which carries the analog inputs.

The pin connections to these plugs are given below.

N.B. It is advisable to ensure that the trigger source applied to the EXT TRIG input is adequately debounced, to avoid multiple triggering.

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SECTION 3
1362 VXI LOW LEVEL INTERFACE
SECTION 3 1362 VXI LOW LEVEL INTERFACE

VXI Registers

This sub-section summarizes the VXI registers used by the 1362 as viewed from a VXI Slot Zero to the DMM. For further information consult the VXI Specification Issue 1.2, or VMEbus Specification revision C.

### DEVICE DEPENDENT REGISTERS

<table>
<thead>
<tr>
<th>Offset Register</th>
<th>Status/Control Register</th>
<th>Device Type</th>
<th>ID/Logical Address Register</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3F_{16}$</td>
<td>$\varnothing 6_{16}$</td>
<td>$\varnothing 4_{16}$</td>
<td>$\varnothing 2_{16}$</td>
</tr>
<tr>
<td>$\varnothing 0_{16}$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### ID/Logical Address Register (Read)

<table>
<thead>
<tr>
<th>Bit No</th>
<th>15 - 14</th>
<th>13 - 12</th>
<th>11 - $\varnothing$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Device</td>
<td>Address</td>
<td>Manufacturer ID</td>
</tr>
<tr>
<td></td>
<td>Class</td>
<td>Space</td>
<td></td>
</tr>
</tbody>
</table>

The 1362 DMM is a message-based device so the Device Class bits take the value of $10$ (binary).

The address space of the DMM is $A_{16}$ only and thus the Address Space bits take the binary value of $11$.

The Manufacture ID for Wavetek is $FFE_{16}$.

Thus the contents of this register is always $BFFE_{16}$.

### ID/Logical Address Register (Write)

This is defined by the optional Dynamic Configuration Protocol and is written into the Resource Manager.

### Device Type (Read)

<table>
<thead>
<tr>
<th>Bit No</th>
<th>15 - 12</th>
<th>11 - $\varnothing$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Required Memory</td>
<td>Model Code</td>
</tr>
</tbody>
</table>

As the DMM is $A_{16}$, there is no Required Memory, so these bits are allowed to float high.

The Model code is the identifier for the DMM this has been chosen to be $552_{16}$ ($1362$ dec).

Thus the contents of this register will always be $F552_{16}$.
Status/Control Register (Read)
(* indicates Low-Active)

<table>
<thead>
<tr>
<th>Bit No</th>
<th>15</th>
<th>14</th>
<th>13-4</th>
<th>3</th>
<th>2</th>
<th>1 - Ø</th>
</tr>
</thead>
<tbody>
<tr>
<td>A24/A32 MODID*</td>
<td>Device Dependent</td>
<td>Ready</td>
<td>Passed</td>
<td>Device Dependent</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The A24/A32 Active and the Device Dependent bits are not used by the DMM and are allowed to float high.
The MODID* is an inverted reflection of the P2 MODID line. This is used to indicate that the board has been selected.

The Ready bit indicates that the DMM is ready to accept its full set of operational commands.
The Passed bit is set to zero to indicate that the DMM is either executing or has failed its power-up / reset sequence. A one indicated the DMM has passed it’s selftest.

Status/Control Register (Write)

<table>
<thead>
<tr>
<th>Bit No</th>
<th>15</th>
<th>14 - 2</th>
<th>1</th>
<th>Ø</th>
</tr>
</thead>
<tbody>
<tr>
<td>A24/A32 Enable</td>
<td>Device Dependent</td>
<td>Sysfail Inhibit</td>
<td>Reset</td>
<td></td>
</tr>
</tbody>
</table>

As the DMM is A16 only, the A24/A32 Enable bit is always ignored.
The Device Dependent bits are ignored.

The Sysfail Inhibit is used by the controller to disable the DMM from driving the SYSFAIL line. It also forces the DMM into a ‘safe’ state when the Reset bit is also one.
A one in the Reset bit forces the DMM into the Reset state.

Offset Register (Read)

The Dynamic Configuration Protocol defines additional use of the offset register.

Device Dependent Registers

This area is further expanded by the Message Based class. See overleaf.
Message Based Specifics

The VXI specification allocates further registers for message based devices in the Device Dependent area shown above. This gives:

### DEVICE DEPENDENT REGISTERS

<table>
<thead>
<tr>
<th>Register</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3F&lt;sub&gt;16&lt;/sub&gt;</td>
<td>Reserved</td>
</tr>
<tr>
<td>1F&lt;sub&gt;16&lt;/sub&gt;</td>
<td>A32 Pointer</td>
</tr>
<tr>
<td>14&lt;sub&gt;16&lt;/sub&gt;</td>
<td>A24 Pointers</td>
</tr>
<tr>
<td>1Ø&lt;sub&gt;16&lt;/sub&gt;</td>
<td>Data Low</td>
</tr>
<tr>
<td>ØE&lt;sub&gt;16&lt;/sub&gt;</td>
<td>Data High</td>
</tr>
<tr>
<td>ØC&lt;sub&gt;16&lt;/sub&gt;</td>
<td>Response/Data Extended</td>
</tr>
<tr>
<td>ØA&lt;sub&gt;16&lt;/sub&gt;</td>
<td>Protocol/Signal Register</td>
</tr>
<tr>
<td>Ø8&lt;sub&gt;16&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>ØØ&lt;sub&gt;16&lt;/sub&gt;</td>
<td></td>
</tr>
</tbody>
</table>

### CONFIGURATION REGISTERS

The Configuration Registers are described earlier on pages 3-2 and 3-3.

#### Protocol/Signal Register (Read)

(* indicates Low-Active)

<table>
<thead>
<tr>
<th>Bit No</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>1Ø</th>
<th>9 - 4</th>
<th>3 - Ø</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMDR*</td>
<td>Signal Reg*</td>
<td>Master</td>
<td>Interrupter</td>
<td>FHS*</td>
<td>Shared Mem*</td>
<td>RESERVED</td>
<td>Device Dependent</td>
</tr>
</tbody>
</table>

In the above, the DMM is not a commander, has no signal register, is not a bus master, does not support Fast Hand Shake and does not use shared memory. Thus all of these bits float to one. The RESERVED and Device Dependent bits are not used and also float to one.

It is however an interrupter, and this is indicated by the Interrupted bit being one. Thus the entire register is always read by VXI as FFFF<sub>16</sub>.

#### Protocol/Signal Register (Write)

The signal Register in the DMM is not implemented.
Section 3 - VXI Low Level Interface

Response/Data Extended Register (Read)

<table>
<thead>
<tr>
<th>Bit No</th>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6 - Ø</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø</td>
<td>RESERVED</td>
<td>DOR</td>
<td>DIR</td>
<td>Err*</td>
<td>Read ready</td>
<td>Write ready</td>
<td>FHS</td>
<td>Locked*</td>
<td>Device dependent</td>
<td></td>
</tr>
</tbody>
</table>

In this register the RESERVED, FHS Active*, Locked* and Device Dependent bits are not used and float high.

The Err* bit is used to indicate that there is an error in the word serial protocol and is manipulated by the DMM software.

DOR (Data Out Ready) is set to Logic-1 to indicate that the DMM is ready to output data to its commander.

DIR (Data In Ready) is set to Logic-1 to indicate that the DMM is ready to receive data from its commander.

The Read Ready and Write Ready are handshakes associated with data transfer between the VXI bus and the DMM and are manipulated by the DMM software.

Response/Data Extended Register (Write)

The Data Extended Register is not implemented on the DMM.

Data High Register.

This is not implemented by the DMM.

Data Low Register (Read/Write)

This register is used for all data communication between the VXI bus and the DMM. The VXI writes data for the DMM into this location, and the DMM puts data into this location to be read by the DMM’s commander.

It is a bi-directional 16-bit register.

A24 Pointer and A32 Pointer Registers

These registers are not implemented by the DMM.
**Section 3 - VXI Low Level Interface**

## VXI to DMM Communications Cycle

This sub-section outlines the sequence of events that may take place between the DMM and its VXI commander. The main low level communication is the VXI Word Serial Protocol, which is a simple handshake system. For example: the DMM indicates with a flag that it is ready to receive, the VXI writes a word and sets a flag indicating that data is available. The DMM reads this word and clears the flag. To get data out of the DMM, the commander asks for a byte using the above sequence. It then waits for the DMM to set a flag indicating that the DMM has placed a word in the output register. When this flag goes true, the commander will read the data. This will then clear the flag indicating that the data has been read and that the cycle may repeat.

In addition to this simple system, there is an interrupt protocol which can be used to modify the above cycle.

### Word Serial Protocol

The following describes more fully the (low level) communication sequence between the DMM’s commander and the DMM. It is assumed that all power on sequences have been completed and the DMM is in a quiescent state waiting to receive a command. (Power on and Selftest will be dealt with later).

('Commander' is name given to the device which is controlling the DMM, whether it is a 'Slot Zero', a computer or another instrument.)

There are three main interactions:- data from the commander to the DMM, data from the DMM to the commander and the DMM-generated interrupt cycle.

#### Data From Commander To DMM

1. The commander waits for the DMM to set the 'Write Ready' bit true in the VXI Response register. This indicates the DMM is ready for data.
2. The commander can then write a word of data into the Data Low register of the DMM. The write action will automatically set the DMM’s Write Ready bit to false. It will also generate an internal interrupt to inform the DMM that data has arrived.
3. The DMM can then read this word of data from the Data low register. It is then up to the DMM to parse the word, in order to determine which VXI word serial command the high order byte contains. The parser acts on this command. If the lower byte of the word contains data, it is transferred to the high-level command parser.
4. When the word of data has been dealt with, then the DMM can again set the Write Ready bit true to indicate that it is ready for a further exchange.

#### Data From DMM to Commander

1. The commander can obtain a word of data from the DMM only by requesting it. This request comes in the form of the word serial protocol 'Byte Request' command. The commander must send the Byte Request command as a word of data, using the above sequence, before a response can be given.
2. On receiving the Byte Request command, the DMM takes a word of data from the output buffer and places it in the Data Low register. This action sets the 'Read Ready' bit in the DMM’s VXI Response register automatically.
3. If the DMM has been set to interrupt the commander at this stage it will do so: refer to 'The Interrupt Cycle'.
4. Either in response to the interrupt, or by polling, the commander will discover that the DMM Read Ready bit has been set true. It can then read the word of data from the DMM’s Data Low register. The commander's act of the reading this word clears the Read Ready bit automatically.
5. This completes the transfer of data from the DMM. To obtain another word of data the commander must send the Byte Request command again.
Byte Transfer Protocol

This is a mechanism for the transfer of data between a device and its commander. Data is passed using the Word Serial Protocol 'Byte Available' and 'Byte Request' commands, regulated by the DOR and DIR bits of the Response register.

1. When a device is ready to accept incoming data it sets the DIR bit to Logic-1.
2. The commander can then send a data byte via the Byte Available command.
3. When a device has data available in its internal store, and is ready to process a Byte Request command, it sets the DOR bit to Logic-1.
4. The commander can then send a Byte Request command.
5. On receipt of the Byte Request command, the device responds by placing the output data in its Data Low register. Note that incoming word serial protocol Trigger commands are also held off until the DIR bit has been set to Logic-1.

The Interrupt Cycle

The VXI specification permits two types of interrupt cycle, 'Response' or 'Event'. The two types are mutually exclusive, and must be selected by the controller before they become active.

1. The commander can use several word serial commands to select ‘when’, ‘how’, and ‘with what’ the DMM will interrupt.

‘When’ could be implemented as a result of any of the Read Ready, Write Ready or Err* bits going true.

‘How’ is selected from the VME Interrupt levels (IRQ1* to IRQ7*).

‘With What’ can be either a Response Interrupt or an Event Interrupt.

2. When the condition for the DMM to interrupt the Commander occurs, the DMM will initiate the Interrupt cycle. For example: it could be immediately after the DMM has placed a word of data in the Data Low register, for the Commander to read.

3. In the case of a Response Interrupt, the commander must respond with the VME Interrupt Acknowledge cycle. The DMM will return a vector consisting of the logical address (on the low byte) and the upper half of the Response register (on the high byte).

4. In the case of an Event Interrupt, the DMM will place the contents of the Event register in the high byte of the vector instead of the upper half of the Response register.
Word Serial Protocol Commands

The VXI specification defines a series of commands that are used to configure, and communicate with, a device. These are all low level single word commands sent, and responses received, via VXI word serial protocol. The following is the subset of commands implemented by the DMM:

(Note: The Code values and responses given apply only to the 1362 DMM and can vary for other devices)

Abort Normal Operation

The Abort Normal Operation command is used to cause the DMM to cease normal operation. On receipt of the command the DMM returns to default configuration, aborting all operations. The DMM will then be in a generally inactive state and will be ready to accept commands.

The syntax of the Abort Normal Operation command is defined in the following table.

<table>
<thead>
<tr>
<th>15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 0 0 1 0 0 0 1 1 1 1 1 1 1 1</td>
</tr>
</tbody>
</table>

When the abort operation has completed (the DMM is in the aborted state), response data is placed in the Data Low register in the following format:

<table>
<thead>
<tr>
<th>15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
</tr>
</tbody>
</table>

Assign Interrupter Line

The Assign Interrupter Line is used to assign a VMEbus IRQ line to the DMM. The syntax of this command is defined in the following table.

<table>
<thead>
<tr>
<th>15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 0 1 0 1 0 1 0 X Int_ID X Line</td>
</tr>
</tbody>
</table>

- X: Don’t care. The value written to this bit has no effect.
- Int_ID: This is a unique identifier of the particular Interrupter being assigned. It has a range of 1 to 7. As the DMM has only one interrupter, this should always take the value 1.
- Line: This is the VMEbus IRQ line number. A value of zero (0) indicates that the Interrupter is to be disconnected.

When the assignment operation has completed, response data is placed in the Data Low register in the following format:

<table>
<thead>
<tr>
<th>15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status: 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
</tr>
</tbody>
</table>

- Status: This field indicates the execution state of the command. It may have the following values:
  - 0: The command successfully completed.
  - 1: Command failed - The Interrupter referenced in the Int_ID field is unknown to this device.
Asynchronous Mode Control

The Asynchronous Mode Control command is used by a commander to direct the path of events and responses. The syntax of this command is defined in the following table.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- X: Don’t care. The value written to this bit has no effect.
- Resp. En*: A zero (0) enables generation of responses. A one (1) disables generation of responses.
- Event En*: A zero (0) enables generation of events. A one (1) disables generation of events.
- Resp. Mode: A one (1) indicates that responses should be sent as signals. A zero (0) indicates that responses should be sent as interrupts.
- Event Mode: A one (1) indicates that events should be sent as signals. A zero (0) indicates that events should be sent as interrupts.

The result data is placed in the Data Low register in the following format. The result is a confirmation/denial of the command.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Status: This field indicates the execution state of the command. It may have the following values:
  - F_{16}: The command successfully completed.
  - 7_{16}: Command failed - A requested option is not supported.
- Resp. En*: A zero (0) indicates that generation of responses is enabled. A one (1) indicates that generation of responses is disabled.
- Event En*: A zero (0) indicates that generation of events is enabled. A one (1) indicates that generation of events is disabled.
- Resp. Mode: A one (1) indicates that responses are being sent as signals. A zero (0) indicates that responses are being sent as interrupts.
- Event Mode: A one (1) indicates that events are being sent as signals. A zero (0) indicates that events are being sent as interrupts.

Since the DMM is not a VMEbus MASTER, Responses and Events can only be sent as Interrupts.
Begin Normal Operation

The Begin Normal Operation command notifies the DMM that it can begin normal operation. The Top_Level field of the Begin Normal Operation command is provided to inform a device whether or not it is a top level Commander. The syntax of this command is defined in the following table.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Top Level: A one (1) in this field indicates that the device is a top level Commander. A zero (0) indicates that it is a Servant to another device.

As the DMM is not a commander this bit should always take the value zero.

When the begin operation has completed, response data is placed in the Data Low register in the following format:

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status</td>
<td>State</td>
<td>Logical Address</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Status: This field indicates the execution state of the command. It may have the following values:
  - $F_{16}$: The Begin Normal Command has been successfully executed. The value $F_{16}$ is reported in the Logical Address field.
  - $4_{16}$: The DMM could not successfully initialize itself. The value $F_{16}$ is reported in the Logical Address field.
  - $3_{16}$: The DMM is not able to be a top level Commander. The value $F_{16}$ is reported in the Logical Address field.
  - $1_{16}$: An undefined error was caused. The value $F_{16}$ is reported in the Logical Address field.

- State: This field indicates the state of the DMM. It may have the following values:
  - $F_{16}$: The DMM is in the NORMAL OPERATION sub-state.
  - $3_{16}$: The DMM is in the CONFIGURE sub-state.

- Logical Address: This field contains the Logical Address corresponding to the status field values.

Byte Available

The Byte Available command is used by a Commander to send a byte of data to the DMM. The END field signifies that this is the last byte of the message. The syntax of this command is defined in the following table.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>END</td>
<td>Datum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Byte Request

The Byte Request command is used by a Commander to read a byte of data from the DMM. The syntax of this command is defined in the following table.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

The result data is placed in the Data Low register in the following format. The END field is used to indicate the last byte of the message.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>END</td>
<td>Datum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Clear

The *Clear* command is used by a Commander to cause the DMM to clear the VXIbus interface and any pending operations. Any initiated operations in the DMM are undisturbed. The syntax of this command is defined in the following table.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
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<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Control Event

The *Control Event* command is used by a Commander to selectively enable the generation of events by the DMM. A one (1) in the enable field enables the generation of the specific event. A zero (0) in the enable field disables the generation of the specific event. The syntax of this command is defined in the following table.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enable</td>
<td>Event</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

* Event: These bits (6-0) are the identifying bits (14-8) of the event being enabled/disabled.

The following Events are supported:

**Request True**: This event is sent by the DMM when it requires service from its Commander. The syntax of this event is defined in the following table.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Sender’s Logical Address</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Request False**: This event is sent by the DMM when it no longer requires service from its Commander. The syntax of this event is defined in the following table.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Sender’s Logical Address</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Device Response

The device returns the following data in the Data Low register:

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Status</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

* Status: This field indicates the execution state of the command. It may have the following values:
  - $F_{16}$: The command successfully completed.
  - $7_{16}$: Command failed - The event referenced is not generated by this device.
Control Response

The **Control Response** command is used to enable response interrupts on certain response register bit transitions. The syntax of this command is defined in the following table.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>X</td>
<td>B14*</td>
<td>DOR*</td>
<td>DIR*</td>
<td>Err*</td>
<td>RR*</td>
<td>WR*</td>
<td>FHS*</td>
<td></td>
</tr>
</tbody>
</table>

The bits have the following meanings:

- **X**: Don’t care. The value written to this bit has no effect.
- **B14**: A zero enables a signal/interrupt on a 0-1 transition of bit 14 of the Response register. A one disables this capability. Since bit 14 of the Response register is reserved (always one), the value of this bit will be ignored by the DMM.
- **DOR**: A zero enables an interrupt on a 0-1 transition of the **DOR** bit. A one disables this capability.
- **DIR**: A zero enables an interrupt on a 0-1 transition of the **DIR** bit. A one disables this capability.
- **Err**: A zero enables an interrupt on a 1-0 transition of the **Err** bit. A one disables this capability.
- **RR**: A zero enables an interrupt on a 0-1 transition of the **Read Ready** bit. A one disables this capability.
- **WR**: A zero enables an interrupt on a 0-1 transition of the **Write Ready** bit. A one disables this capability.
- **FHS**: A zero enables an interrupt on a 0-1 transition of the **FHS Active** bit. A one disables this capability.

The result data is placed in the Data Low register in the following format. The result is a confirmation/denial of the command.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>B14*</td>
<td>DOR*</td>
<td>DIR*</td>
<td>Err*</td>
<td>RR*</td>
<td>WR*</td>
<td>FHS*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The bits have the following meanings:

- **Status**: This field indicates the execution state of the command. It may have the following values:
  - **F**: The command successfully completed.
  - **7**: Command failed - an unsupported bit transition was requested.
- **B14**: A zero indicates that interrupt generation on transitions of bit 14 of the Response register is enabled. A one indicates that this capability is disabled. This bit will always be set to one (1).
- **DOR**: A zero indicates that interrupt generation on 0-1 transitions of the **DOR** bit is enabled. A one indicates that this capability is disabled.
- **DIR**: A zero indicates that interrupt generation on 0-1 transitions of the **DIR** bit is enabled. A one indicates that this capability is disabled.
- **Err**: A zero indicates that interrupt generation on 1-0 transitions of the **Err** bit is enabled. A one indicates that this capability is disabled.
- **RR**: A zero indicates that interrupt generation on 0-1 transitions of the **Read Ready** bit is enabled. A one indicates that this capability is disabled.
- **WR**: A zero indicates that interrupt generation on 0-1 transitions of the **Write Ready** bit is enabled. A one indicates that this capability is disabled.
- **FHS**: A zero indicates that interrupt generation on 1-0 transitions of the **FHS Active** bit is enabled. A one indicates that this capability is disabled. As the DMM does not implement FHS, a one (1) will always be returned in this position.
End Normal Operation

The *End Normal Operation* command is used to cause the DMM to cease normal operation in an orderly manner. The ‘ended’ state is defined as follows: Pending interrupts are unasserted; no new interrupts may be asserted; the DMM is in a generally inactive state and is ready to accept commands.

The syntax of the *End Normal Operation* command is defined in the following table.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When the ‘ending’ operation has completed, response data is placed in the Data Low register in the following format:

<table>
<thead>
<tr>
<th>Status</th>
<th>State</th>
<th>Logical Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Status:** This field indicates the execution state of the command. It may have the following values:
  - $F_{16}$: The End Normal Command has been successfully executed. The value $FE_{16}$ is reported in the Logical Address field.
  - $7_{16}$: The DMM was already in the CONFIGURE sub-state. The value $FE_{16}$ is reported in the Logical Address field.
  - $5_{16}$: The DMM was not able to end its operation in a consistent manner. The value $FE_{16}$ is reported in the Logical Address field.
  - $3_{16}$: An undefined error was caused. The value $FE_{16}$ is reported in the Logical Address field.

- **State:** This field indicates the state of the DMM. It may have the following values:
  - $F_{16}$: The DMM is in the CONFIGURE sub-state.
  - $3_{16}$: The DMM is in the NORMAL OPERATION sub-state.

- **Logical Address:** This field contains the Logical Address corresponding to the status field values.

Read Interrupter Line

The *Read Interrupter Line* command is used to determine which VMEbus IRQ line is connected. The syntax of this command is defined in the following table.

<table>
<thead>
<tr>
<th>15</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>X</td>
<td>Int_ID</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **X:** Don’t care. The value written to this bit has no effect.
- **Int_ID:** This is a unique identifier of the particular Interrupter being queried. It has a range of 1 to 7. As the DMM has only one interrupter, this should always take the value 1.

The VMEbus IRQ line number is placed in the Data Low register with the following format:

<table>
<thead>
<tr>
<th>Status</th>
<th>Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 1 1 1 1 1 1 1</td>
<td>Line</td>
</tr>
</tbody>
</table>

- **Status:** This field indicates the execution state of the command. It may have the following values:
  - $F_{16}$: The command successfully completed.
  - $7_{16}$: Command failed - The Interrupter referenced in the Int_ID field is unknown to this device.

- **Line:** This is the VMEbus line number currently assigned. A value of zero ($0_{16}$) indicates that the Interrupter is disconnected.
Read Interrupters

The Read Interrupters command is used to determine the number of Interrupters within the DMM. The syntax of this command is defined in the following table.

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|---|
| 11 | 10 | 00 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

The number of Interrupters is placed in the Data Low register with the following format:

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|---|

- **Int_no**: The number of Interrupters within the DMM. As the DMM has only one interrupter, this will always take the value 1.

Read Protocol

The Read Protocol command is used by a Commander to find out what protocols, in addition to the Word Serial protocol, that the DMM supports. The syntax of this command is defined in the following table.

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|---|
| 11 | 11 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

The protocol support word is placed in the Data Low register with the following format:

| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|---|
| 11 | 11 | 11 | 11 | 11 | 11 | 0 | 0 | 1 | 0 | I4* | 0 | 1 | 1 |

- **I4***: A zero (0) in this position indicates that this device supports the VXIbus 488.2 Instrument protocol. The 1362MT will report a one (1) in this position.
Read Protocol Error

The Read Protocol Error command is used by a Commander to tell the DMM to report its most-recent error code. When the error code has been reported by the DMM, the Err* bit is reset before Read Ready is asserted on the error code output. The syntax of this command is defined in the following table.

<table>
<thead>
<tr>
<th>15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 0 0 1 1 0 1 1 1 1 1 1 1 1 1 1 1</td>
</tr>
</tbody>
</table>

The error codes are placed in the Data Low register with the following format:

- No error:
<table>
<thead>
<tr>
<th>15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
</tr>
</tbody>
</table>

- Multiple Queries: The DMM was requested to overwrite previous unread response data.
<table>
<thead>
<tr>
<th>15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0</td>
</tr>
</tbody>
</table>

- Unsupported Command: The DMM has received a command that it does not implement.
<table>
<thead>
<tr>
<th>15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0</td>
</tr>
</tbody>
</table>

- DIR Violation: The DMM has received a command that violates the DIR handshake.
<table>
<thead>
<tr>
<th>15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1 1</td>
</tr>
</tbody>
</table>

- DOR Violation: The DMM has received a command that violates the DOR handshake.
<table>
<thead>
<tr>
<th>15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 0 1 0</td>
</tr>
</tbody>
</table>

Read STB

The Read STB command is used by a Commander to read the status word from the DMM. The syntax of this command is defined in the following table.

<table>
<thead>
<tr>
<th>15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
</tr>
</tbody>
</table>

The error codes are placed in the Data Low register with the following format:

<table>
<thead>
<tr>
<th>15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</th>
<th>Status Byte</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1 0</td>
<td>Status Byte</td>
</tr>
</tbody>
</table>

Trigger

The Trigger command is used by a Commander to cause the DMM to trigger. The syntax of this command is defined in the following table.

<table>
<thead>
<tr>
<th>15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1 1 0 1 1 0 1 1 1 1 1 1 1 1 1 1 1</td>
</tr>
</tbody>
</table>
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SECTION 4  1362S SCPI LANGUAGE

SCPI Programming Language

Introduction
The 1362S will power-up default in SCPI language but has the ability to switch to Native (IEEE-488.2) language. Both languages obey IEEE-488.2 command syntax.

As the instrument operates on the VXI bus, it is not in direct contact with the outside world and cannot conform fully to the IEEE 488.1 Hardware model. For example, in the IEEE 488.1 model, a separate (SRQ) line is provided for the instrument to request service from the controller.

A separate line for requesting service is not provided on the VXI bus, and to provide a similar facility, the VXI ‘request true’ syntax has to be programmed in software; thus a hardware difference imposes a departure from the standard programming model.

IEEE 488.2 defines sets of Mandatory Common Commands and Optional Common Commands along with a method of Standard Status Reporting. The 1362S implementation of SCPI language conforms with all IEEE-488.2 Mandatory Commands but not all Optional Commands. It conforms with the SCPI-approved Status Reporting method.

Note: Commands in SCPI language, prefaced by an asterisk (eg: *TRG), are IEEE-488.1 standard-defined ‘Common’ commands.

VXI WSC and Effects
The VXI Word Serial ‘clear’ Message will force the following instrument states:
- the input buffer and output queue are cleared;
- parser is reset to the beginning of a message;
- any device-dependent message interlocks are cleared.

This command will not:
- change any settings or stored data within the instrument except as listed above;
- interrupt analog input;
- interrupt or affect any functions of the device;
- change the status byte.

*RST and Effects
The effects of the *RST command are described later on page 5-39.

Reset
A complete instrument reset is accomplished by the two reset commands in sequence. In other circumstances they may be used individually:

WS clear  Message exchange initialization;
*RST  Device initialization.
Message Exchange

IEEE 488.2 Model
The IEEE 488.2 Standard document illustrates its Message Exchange Control Interface model at the detail level required by the device designer. Much of the information at this level of interpretation (such as the details of the internal signal paths etc.) is transparent to the application programmer. However, because each of the types of errors flagged in the Event Status Register are related to a particular stage in the process, a simplified 1362 interface model can provide helpful background. This is shown in Fig. 4.1, together with brief descriptions of the actions of its functional blocks.

1362S STATUS Subsystem
Input/Output Control transfers messages from the 1362 output queue to the system bus; and conversely from the bus to either the input buffer, or other predetermined destinations within the device interface. It receives the Status Byte from the status reporting system, as well as the state of the Request Service bit which it imposes on bit 6 of the Status Byte response. Bit 6 reflects the ‘Request Service state true’ condition of the interface.

Incoming Commands and Queries
The Input Buffer is a first in - first out queue, which has a maximum capacity of 128 bytes (characters). Each incoming character in the I/O Control generates an interrupt to the instrument processor which places it in the Input Buffer for examination by the Parser. The characters are removed from the buffer and translated with appropriate levels of syntax checking. If the rate of programming is too fast for the Parser or Execution Control, the buffer will progressively fill up. When the buffer is full, the VXI Commander is informed by DIR being false. Refer to Section 3.

The Parser checks each incoming character and its message context for correct Standard-defined generic syntax, and correct device-defined syntax. Offending syntax is reported as a Command Error, by setting true bit 5 (CME) of the Standard-defined Event Status register (refer to the sub-section ‘Retrieval of Device Status Information’).

Execution Control receives successfully parsed messages, and assesses whether they can be executed, given the currently-programmed state of the 1362 functions and facilities. If a message is not viable (eg the calibration trigger: CALL? when calibration is not enabled); then an Execution Error is reported, by setting true bit 4 (EXE) of the Standard-defined Event Status register. Viable messages are executed in order, altering the 1362 functions, facilities etc. Execution does not ‘overlap’ commands; instead, the 1362 Execution Control processes all commands ‘Sequentially’ (ie. waits for actions resulting from the previous command to complete before executing the next).

1362 Functions and Facilities
The 1362 Functions and Facilities block contains all the device-specific functions and features of the 1362, accepting Executable Message Elements from Execution Control and performing the associated operations. It responds to any of the elements which are valid Query Requests (both IEEE 488.2 Common Query Commands and 1362 Device-specific Commands) by sending any required Response Data to the Response Formatter (after carrying out the assigned internal operations).

Device-dependent errors are detected in this block. Bit 3 (DDE) of the Standard-defined Event Status register is set true when an internal operating fault is detected, for instance during a self test. Each reportable error has a listed number, which is appended to an associated queue as the error occurs.

Trigger Control
Two types of message are used to trigger the 1362 A-D into taking a measurement:

A Word Serial 'trigger'

*TRG (IEEE 488.2-defined)

In the 1362 either message is passed through the Input Buffer, receiving the same treatment as a program message unit, being parsed and executed as normal.

Outgoing Responses
The Response Formatter derives its information from Response Data (being supplied by the Functions and Facilities block) and valid Query Requests. From these it builds Response Message Elements, which are placed as a Response Message into the Output Queue.

The Output Queue acts as a store for outgoing messages until they are read over the system bus by the application program. For as long as the output queue holds one or more bytes, it reports the fact by setting true bit 4 (Message Available - MAV) of the Status Byte register. Bit 4 is set false when the output queue is empty (refer to the sub-section ‘Retrieval of Device Status Information’). The ‘DOR’ bit set performs the same action. Refer to Section 3.

‘Query Error’
This is an indication that the controller is following an inappropriate message exchange protocol, resulting in the Interrupted, Unterminated or Deadlocked condition:

Refer to ‘Bit 2’ on page 4-8.

The Standard document defines the 1362’s response, part of which is to set true bit 2 (QYE) of the Standard-defined Event Status register.
Section 4 - SCPI Language

Request Service (RQS)

Reasons for Requesting Service

There are two main reasons for the application program to request service from the controller:

- When the 1362 message exchange interface discovers a system programming error;
- When the 1362 is programmed to report significant events by RQS.

The significant events vary between types of devices; thus there is a class of events which are known as ‘Device-Specific’. These are determined by the device designer.

IEEE 488.2 Model

The application programmer can enable or disable the event(s) which are required to originate an RQS at particular stages of the application program. The IEEE 488.2 model incorporates a flexible extended status reporting structure in which the requirements of the device designer and application programmer are both met.

This structure is described in the next sub-section, dealing with ‘Retrieval of Device Status Information’.
Retrieval of Device Status Information

Introduction

For any remotely-operated system, the provision of up-to-date information about the performance of the system is of major importance. This is particularly so in the case of systems which operate under automatic control, as the controller requires the necessary information feedback to enable it to progress the programmed task, and any break in the continuity of the process can have serious results.

When developing an application program, the programmer needs to test and revise it, knowing its effects. Confidence that the program elements are couched in the correct grammar and syntax (and that the program commands and queries are thus being accepted and acted upon), helps to reduce the number of iterations needed to confirm and develop the viability of the whole program. So any assistance which can be given in closing the information loop must benefit both program compilation and subsequent use.

Note: The registers use binary weighting - the numbers in the boxes are bit numbers, not weighted values

Fig. 4.2 1362 Status Reporting Structure
Standard-Defined Features

Types of Status Information Available
Two main categories of information are provided for the controller:

Status Summary Information
Certain standard events are flagged in the 8-bit latched ‘Event Status Register’ (ESR), read-accessible to the controller. The user’s application program can also access its associated enabling register, to program the events which will be eligible to activate the ‘ESB’ summary bit in the Status Byte.

Status Byte Register
Contained within the ‘Status Byte Register’, the ‘Status Byte’ (STB) consists of three flag bits which direct the controller’s attention to the type of event which has occurred. One is the ESB bit mentioned above, the other two (MAV and MSS) are described in detail later.

Access via the Application Program
The application designer has access to two enable registers (one for each main register - Fig. 4.2). The application program can enable or disable any individual bit in these registers.

Each bit in the event status register remains in false condition unless its assigned event occurs, when its condition changes to true. If an event is to be reported, the application program sets its corresponding enable bit true, using the number Nrf (defined as a decimal numeric from 0 to 255 in any common format). Then when the enabled event occurs and changes the enabled bit from false to true, the ESB summary bit in the Status Byte is also set true.

If the ESB bit is also enabled, then the 1362 will generate a request true event on the VXI bus.

Thus the application programmer can decide which assigned events will generate an event, by enabling their event bits and then enabling the ESB bit in the Status Byte. The application program can read the Status Byte, and be directed to the Event Register to discover which event was responsible for originating the request.

All registers can be read by suitable commands, as an ASCII decimal numeric, which when expressed in binary, represents the bit pattern in the register. This form is also used to set the enabling registers to the required bit-patterns. The detail for each register is expanded in the following paragraphs, and in the command descriptions.
1362 Status Reporting - Detail

IEEE 488.2 Model
This incorporates the two aspects of the IEEE 488.1 model into an extended structure with more definite rules. These rules invoke the use of standard ‘Common’ messages and provide for device-dependent messages. A feature of the structure is the use of ‘Event’ registers, each with its own enabling register as shown in Fig. 4.2.

1362 Model Structure
The IEEE 488.2 Standard provides for an extensive hierarchical structure with the Status Byte at the apex, defining its bits 4, 5 and 6 and their use as summaries of a Standard-defined event structure which must be included, if the device is to claim conformance with the Standard. The 1362 employs these bits as defined in the Standard.

Bits 0, 1, 2 and 3 and 7 are made available to the device designer, but are not used in the 1362.

It must be recognized by the application programmer that whenever the controller reads the Status Byte, it can only receive summaries of types of events, and further query messages are necessary to dig deeper into the detailed information relating to the events themselves. Thus a further byte is used to expand on the summary at bit 5 of the Status Byte.

Status Byte Register
In this structure the Status Byte is held in the ‘Status Byte Register’; the bits being allocated as follows:

Bits 0 (DIO1), 1 (DIO2), 2 (DIO3) and 3 (DIO4) are not used in the 1362 status byte. They are always false.

Bit 4 (DIO5) IEEE 488.2-defined Message Available Bit (MAV)
The MAV bit helps to synchronize information exchange with the controller. It is true when the 1362 message exchange interface is ready to accept a request from the controller to startoutputing bytes from the Output Queue; or false when the Output Queue is empty.

The common command *CLS can clear the Output Queue, and the MAV bit 4 of the Status Byte Register; providing it is sent immediately following a ‘Program Message Terminator’.

Bit 5 (DIO6) IEEE 488.2-defined Standard Event Summary Bit (ESB)
Summarizes the state of the ‘Event Status byte’, held in the ‘Event Status register’ (ESR), whose bits represent IEEE 488.2-defined conditions in the device. The ESB bit is true when the byte in the ESR contains one or more enabled bits which are true; or false when all the enabled bits in the byte are false. The byte, the Event Status Register and its enabling register are defined by the IEEE 488.1 Standard; they are described later.

Bit 6 (DIO7) is the Master Status Summary Message (MSS bit), and is set true if one of the bits 0 to 4 or bit 5 is true (bits 0 to 3 and bit 7 are always false in the 1362).

Bit 7 (DIO8) is not used in the 1362 status byte. It is always false.

Reading the Status Byte Register
*STB?
Either the common query: *STB?, or the VXI word serial ‘read STB’ command (Section 3), reads the binary number in the Status Byte register. The response is in the form of a decimal number which is the sum of the binary weighted values in the enabled bits of the register. In the 1362, the binary-weighted values of bits 1, 2, 3 and 7 are always zero.
Service Request Enable Register
The SRE register is a means for the application program to select, by enabling individual Status Byte summary bits, those types of events which are to cause the 1362 to originate an RQS. It contains a user-modifiable image of the Status Byte, whereby each true bit acts to enable its corresponding bit in the Status Byte.

Bit Selector: *SRE phs Nrf
The program command: *SRE phs Nrf performs the selection, where Nrf is a decimal numeric, which when decoded into binary produces the required bit-pattern in the enabling byte.

For example:
If an RQS is required only when a Standard-defined event occurs and when a message is available in the output queue, then Nrf should be set to 48. The binary decode is 00110000 so bit 4 or bit 5, when true, will generate an RQS; but even when bit 0 or bit 6 is true, no RQS will result. The 1362 always sets the Status Byte bits 1, 2, 3 and 7 false, so they can never originate an RQS whether enabled or not.

Reading the Service Request Enable Register
The common query: *SRE? reads the binary number in the SRE register. The response is in the form of a decimal number which is the sum of the binary-weighted values in the register. The binary-weighted values of bits 1, 2, 3 and 7 are always zero.

VXIbus Implementation
An RQS is implemented as a 'request true' event on the VXIbus. Refer to Section 3.

IEEE 488.2-defined Event Status Register
The 'Event Status Register' holds the Event Status Byte, consisting of event bits, each of which directs attention to particular information. All bits are 'sticky'; i.e. once true, cannot return to false until the register is cleared. This occurs automatically when it is read by the query: *ESR?. The common command *CLS clears the Event Status Register and associated error queues, but not the Event Status Enable Register. The bits are named in mnemonic form as follows:

Bit 0 Operation Complete (OPC)
This bit is true only if *OPC has been programmed and all selected pending operations are complete. As the 1362 operates in serial mode, its usefulness is limited to registering the completion of long operations, such as self-test.

Bit 1 Request Control (RQC)
This bit would be true if the device were able to assume the role of controller, and is requesting that control be transferred to it from the current controller. This capability is not available in the 1362, so bit 1 is always false.

Bit 2 Query Error (QYE)
QYE true indicates that the controller is following an inappropriate message exchange protocol, resulting in the following situations:

- **Interrupted Condition.** When the 1362 has not finished outputting its Response Message to a Program Query, and is interrupted by a new Program Message.
- **Unterminated Condition.** When the controller attempts to read a Response Message from the 1362 without having first sent the complete Query Message (including the Program Message Terminator) to the instrument.
- **Deadlocked Condition.** When the input and output buffers are filled, with the parser and the execution control blocked.

Bit 3 Device Dependent Error (DDE)
DDE is set true when an internal operating fault is detected, for instance during a self test. Each reportable error has been given a listed number, which is appended to an associated queue as the error occurs. The queue is read destructively as a First In Last Out stack, using the query command DDQ? to obtain a code number. The DDE bit is not a summary of the contents of the queue, but is set or confirmed true concurrent with each error as it occurs; and once cleared by *ESR? will remain false until another error occurs. The query DDQ? can be used to read all the errors in the queue until it is empty, when the code number zero will be returned. The common command *CLS clears the queue.
Bit 4  Execution Error (EXE)
An execution error is generated if the received command cannot be executed, owing to the device state or the command parameter being out of bounds.

Bit 5  Command Error (CME)
CME occurs when a received bus command does not satisfy the IEEE 488.2 generic syntax or the device command syntax programmed into the instrument interface’s parser, and so is not recognized as a valid command.

Bit 6  User Request (URQ)
This bit is set true when, in block measurement mode, the number of measurements programmed for the block measurement have been completed.

Bit 7  1362 Power Supply On (PON)
This bit is not required in the VXI subsystem.

**Standard Event Status Enable Register**
The ESE register is a means for the application program to select, from the positions of the bits in the standard-defined Event Status Byte, those events which when true will set the ESB bit true in the Status Byte. It contains a user-modifiable image of the standard Event Status Byte, whereby each true bit acts to enable its corresponding bit in the standard Event Status Byte.

**Bit Selector:** *ESE phs Nrf
The program command: *ESE phs Nrf performs the selection, where Nrf is a decimal numeric, which when decoded into binary, produces the required bit-pattern in the enabling byte.

For example:
If the ESB bit is required to be set true only when an execution or device-dependent error occurs, then Nrf should be set to 24.
The binary decode is 00011000 so bit 3 or bit 4, when true, will set the ESB bit true; but when bits 0-2, or 5-7 are true, the ESB bit will remain false.

**Reading the Standard Event Enable Register**
The common query: *ESE? reads the binary number in the ESE register. The response is in the form of a decimal number which is the sum of the binary-weighted values in the register.

**SCPI Additional Status Reporting**
In addition to IEEE 488.2 status reporting the 1362S implements the Operation and Questionable Status register with associated condition, event and enable commands. The extra status deals with current operation of the instrument and the quality of any measurements taken.

The structure of these two registers are detailed in Fig. 4.3 overleaf. The registers are detailed in the STATUS subsystem on page 4-33 of this handbook.

**SCPI Syntax and Styles**
Where possible the syntax and styles used in this section follow those defined by the SCPI consortium. The commands on the following pages are broken into three columns; the KEYWORD, the PARAMETER FORM, and any NOTES.

The KEYWORD column provides the name of the command. The actual command consists of one or more keywords since SCPI commands are based on a hierarchical structure, also known as the tree system.

Square brackets ([ ]) are used to enclose a keyword that is optional when programming the command: that is, the instrument 1362 will process the command to have the same effect whether the option node is omitted by the programmer or not.

Letter case in tables is used to differentiate between the accepted shortform (upper case) and the long form (upper and lower case).

The PARAMETER FORM column indicates the number and order of parameter in a command and their legal value. Parameter types are distinguished by enclosing the type in angle brackets (< >). If parameter form is enclosed by square brackets ([ ]) these are then optional. The vertical bar ( | ) can be read as “or” and is used to separate alternative parameter options.

**Queries**
All commands unless otherwise noted have an addition query form. ( for example INPut:COUPling?)

**Native Language**
The 1362S SCPI command capabilities are an extension to the existing language now known as ‘Native’. Native and SCPI are both resident on the 1362S. Native was maintained to support those existing customers who may wish to retain their current programs. The 1362S defaults to SCPI on power on. The commands associated with switching to Native language can be found on page 4-36.
Section 4 - SCPI Language

**Fig. 4.3 1362 SCPI Status Reporting Structure**

* The use of Bit 15 is not allowed since some controllers may have difficulty reading a 16 bit unsigned integer. The value of this bit shall always be 0.
The ABORT command returns the DMM to the IDLE state. Any measurements that are in progress will be completed before the DMM goes into the IDLE state. See page 4-38, Fig. 4.4.

This command does not affect the settings of the trigger system and any subsequent INITiate will cause the DMM to return to the wait-for-trigger state as selected by the TRIGger:SOURce command. Refer to the TRIGger subsystem, page 4-38.

Syntax
ABORT
(Event, No query)

Related Commands
INITiate, TRIGger

Query Format
No Query.

Errors
No errors associated with this command.

*RST Condition
There is no associated *RST condition. However, after the *RST the DMM is put in the IDLE state.

Native Equivalents
There are no native equivalent commands.
CALibration Subsystem

This subsystem is used to calibrate the ranges and functions of the DMM. This will correct for any system errors due to drift or ageing effects.

Before any calibration can take place, two security levels must be set. First, there is a switch on the DMM itself that must be set to CAL ENABLE. Having done this, the command CALibration:SECure ON must be sent.

Syntax

CALibration
   :HIGH? [numeric_value] (manufacturer's extension)
   :LOW? [numeric_value] (manufacturer's extension)
   :SECure <Boolean> (manufacturer's extension)
   :SLFRequency? (manufacturer's extension)

Related Commands

There are no directly related commands, however commands to configure the DMM such as CONFIGure, SENSE etc. are used in conjunction with CALibration.

See also Routine Calibration Procedure; section 8 of this handbook.

CALibration:HIGH? [numeric_value]
CALibration:LOW? [numeric_value]

These commands are used to perform a calibration operation. In the case of :HIGH?, this will be at the full range value. In the case of :LOW? this will be at zero for DC and Ohms, or at 1% of range for AC. The DMM will measure the input signal as a reference. From this measurement, correction factors are calculated and stored in the non-volatile memory. These correction factors will then be applied to all subsequent readings.

If the calibration operation is a success then the command returns a 0. If the command fails for any reason, then a 1 is returned and an error message is put in the error queue.

Note that to use this command the calibration switch must be set to CAL ENABLE and the command CALibration:STATe ON must have been sent.

The optional parameter <numeric_value> gives the actual value of the reference being applied to the input terminals if this is not the nominal value.

Errors

An error - 110, 'Calibration switch disabled' will be generated if either the calibration switch is not set to enable and the CAL:SECure ON command has not been received.

Errors - 222, 'Data out of range' will be generated if the <numeric_value> is out of range or the measured value is out of range compared to the <numeric_value>.

If the input is not connected, or the instrument is in DC coupled AC, or TRIG:SOURce IMM is not selected, then the error 120, 'Calibration operation invalid' will be reported.

If the calibration fails for any other reason, then the message 122, 'Calibration operation failed' will be reported.

*RST

There is no associated *RST condition.

Notes

Both CALibration:SECure ON and the hardware calibration switch found on the front panel have to be enabled before calibration can take place. Four measurements are taken for every Calibration trigger. See Section 5-31 CVAL? command.
**CALibration:SECure** `<Boolean>`

This command is used to enable the calibration mode. Before this command can be accepted, the calibration switch on the DMM must be set to CAL ENABLE. The accepted value for `<Boolean>` is `OFF|0|1|ON`.

**Errors**
An error will be generated if `CAL:SEC ON` is received and the calibration switch is not set to CAL ENABLE.

**Query**
`CALibration:SECure?`
This queries the current setting of the secure mode. It returns either 0 for disabled, or 1 for enabled.

`*RST`
`CALibration:SECure OFF`.

**CALibration:SLFRequency?**

This query command is used to store the current setting of the ADC conversion line frequency into the non-volatile calibration stores. This value will then become the default value at power on and `*RST`.

The line frequency is set using the `SENSe:LFRequency` command (page 4-32).

Note that to use this command the calibration switch must be set to CAL ENABLE and the command `CALibration:STATE ON` must have been sent.

**Errors**
An error of 110, 'Calibration switch disabled' shall be generated if either the calibration switch is not set to enable and the `CAL:SECure ON` command has not been received.

**Query**
This command is a query only and will return 0 if the value is successfully stored, or 1 if the operation failed.

`*RST`
Last value set with an `CAL:SLFR?` command.

-----------------------------

**Native Equivalents**
- `CALibration:SECure` ≡ `CAL ON/OFF`
- `CALibration:HIGH <...>` ≡ `CALH?`
- `CALibration:LOW <...>` ≡ `CALL?`
- `CALibration:SLFRequency?` ≡ `STLN?`
CONFigure

The CONFigure command subsystem is used to configure the DMM. It prepares the DMM to take a measurement but does not cause a trigger.

Syntax

`CONFigure<function> <parameters>[,<source_list>]`

Subsystem: CONFigure

Function:

- :CURRent
  [:DC] <parameters>[,<source_list>]
  :AC <parameters>[,<source_list>]
- :FRESistance <parameters>[,<source_list>]
- :RESistance <parameters>[,<source_list>]
- :VOLTage
  [:DC] <parameters>[,<source_list>]
  :AC <parameters>[,<source_list>]

Parameters: [<expected_value>[,<resolution>]]

Source List: [,([@1])|(@2)|(@1,2)|(@1:2)]

Related Commands FETCH?, INITiate, INPut, MEASure?, READ? CONFigure?

Note

INPut:STATe <Boolean> should be ON before measurement takes place. See page 4-24 for further information on the INPut command. The <source list> will remain in the same state after a function change.

Description

As shown by the syntax, the command:

`CONFigure<function> <parameters>[,<source_list>]`

is a compound command. The <function> selects which function the DMM measures. This may be voltage, current or resistance. Each function has associated parameters that are used to select the range and resolution of subsequent measurements. There is then an optional <source_list> which selects which channel the measurement is made on.

Note

In the event of an error within the command, as much as possible of the command up to the error shall be implemented. For example, if:

`CONF:VOLT 1,1E-6,(@2)`

is received on a single channel DMM, then the 1 volt DC 6.5 digit range would be selected, but the second channel selection would generate an error.
**CONFigure:CURRent [:DC] [<expected_value>[,<resolution>]]**

**CONFigure:CURRent:AC [<expected_value>[,<resolution>]]**

Either command selects the current measuring function. The default is for DC current, AC can be selected with the additional parameter.

AC current with a DC component can be selected with the command:

```
INPut:COUPling AC|DC.
```

See the INPut Subsystem page 4-24.

The `<expected_value>` is used to select the range of the function, however the DMM has only one range: 1 Amp. Thus all values will be accepted including the commands:

- MAXimum, MINimum, AUTO, AUTO ON, AUTO OFF & DEFault

The optional `<resolution>` parameter is used to select the measurement resolution. There are three modes - 4.5, 5.5 and 6.5 digits. However, 6.5 digit resolution is not allowed in AC or DC coupled AC. The tables on the left below show the modes selected by numeric values of `<resolution>`, those on the right show the modes selected by `<resolution>` commands:

However, 6.5 digit resolution is not allowed in AC or DC coupled AC.

<table>
<thead>
<tr>
<th>DC Current</th>
<th>Numeric Values Used to Select Required Resolutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td><strong>Range</strong></td>
</tr>
<tr>
<td>CURR:DC</td>
<td>1A</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DC Current</th>
<th>Resolutions Selected by Command</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td><strong>&lt;resolution&gt;</strong></td>
</tr>
<tr>
<td>CURR:DC</td>
<td>MAXimum</td>
</tr>
<tr>
<td></td>
<td>MINimum</td>
</tr>
<tr>
<td></td>
<td>AUTO</td>
</tr>
<tr>
<td></td>
<td>AUTO ON</td>
</tr>
<tr>
<td></td>
<td>AUTO OFF</td>
</tr>
<tr>
<td></td>
<td>DEFault</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AC Current</th>
<th>Numeric Values Used to Select Required Resolutions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td><strong>Range</strong></td>
</tr>
<tr>
<td>CURR:AC</td>
<td>1A</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AC Current</th>
<th>Resolutions Selected by Command</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function</strong></td>
<td><strong>&lt;resolution&gt;</strong></td>
</tr>
<tr>
<td>CURR:AC</td>
<td>MAXimum</td>
</tr>
<tr>
<td></td>
<td>MINimum</td>
</tr>
<tr>
<td></td>
<td>AUTO</td>
</tr>
<tr>
<td></td>
<td>AUTO ON</td>
</tr>
<tr>
<td></td>
<td>AUTO OFF</td>
</tr>
<tr>
<td></td>
<td>DEFault</td>
</tr>
</tbody>
</table>

**Errors**

Current is an option and if the option is not fitted any CURRent command will generate the error -241, 'Hardware missing'.

**Query**

See CONFigure? command page 4-21.

**RST**

```
*RST CONF:CURR:DC 1, 1E-5 (Note that this function is inactive.)
```
These two commands are used to select the resistance measuring function. `RESistance` selects two wire measurements, while `FRESistance` selects four wire measurements.

The `<expected_value>` is used to select the range of the resistance measurement. The table shows that `<expected_value>` affects the range selected.

<table>
<thead>
<tr>
<th><code>&lt;expected_value&gt;</code></th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 199.9999</td>
<td>100 Ohm</td>
</tr>
<tr>
<td>200 to 1999.99</td>
<td>1 kOhm</td>
</tr>
<tr>
<td>2000 to 19999.99</td>
<td>10 kOhm</td>
</tr>
<tr>
<td>20000 to 199999.9</td>
<td>100 kOhm</td>
</tr>
<tr>
<td>200000 to 1999999</td>
<td>1 MOhm</td>
</tr>
<tr>
<td>&gt;20000000</td>
<td>10 MOhm</td>
</tr>
<tr>
<td>MINimum</td>
<td>100 Ohm</td>
</tr>
<tr>
<td>MAXimum</td>
<td>10 MOhm</td>
</tr>
<tr>
<td>DEFault, no parameter</td>
<td>Autorange</td>
</tr>
<tr>
<td>AUTO ON</td>
<td>Select Autorange</td>
</tr>
<tr>
<td>AUTO OFF</td>
<td>Deselect Autorange</td>
</tr>
</tbody>
</table>

In the table above, DEFault, AUTO and no `<expected_value>` selects autoranging. In this mode the DMM will select the most appropriate range to measure the signal on the input. Any other `<expected_value>` will de-select the autorange feature. The AUTO OFF command will leave the DMM in the last active range.
The optional <resolution> parameter is used to select the measurement resolution. There are three modes - 4.5, 5.5 and 6.5 digits. The table on the left below shows the modes selected by numeric values of <resolution>, that on the right shows the modes selected by <resolution> commands:

### Resistance (2- and 4-Wire)

**Numeric Values Used to Select Required Resolutions**

<table>
<thead>
<tr>
<th>Function</th>
<th>Range</th>
<th>6.5</th>
<th>5.5</th>
<th>4.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>RES/FRES</td>
<td>100Ω</td>
<td>&lt;1E-4&gt;</td>
<td>&lt;1E-3&gt;</td>
<td>&lt;1E-2&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100.000Ω)</td>
<td>(100.000Ω)</td>
<td>(100.00Ω)</td>
</tr>
<tr>
<td></td>
<td>1kΩ</td>
<td>&lt;1E-6&gt;</td>
<td>&lt;1E-5&gt;</td>
<td>&lt;1E-4&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.00000kΩ)</td>
<td>(1.00000kΩ)</td>
<td>(1.0000kΩ)</td>
</tr>
<tr>
<td></td>
<td>10kΩ</td>
<td>&lt;1E-5&gt;</td>
<td>&lt;1E-4&gt;</td>
<td>&lt;1E-3&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(10.00000kΩ)</td>
<td>(10.0000kΩ)</td>
<td>(10.000kΩ)</td>
</tr>
<tr>
<td></td>
<td>100kΩ</td>
<td>&lt;1E-4&gt;</td>
<td>&lt;1E-3&gt;</td>
<td>&lt;1E-2&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100.000kΩ)</td>
<td>(100.000kΩ)</td>
<td>(100.00kΩ)</td>
</tr>
<tr>
<td></td>
<td>1MΩ</td>
<td>&lt;1E-5&gt;</td>
<td>&lt;1E-4&gt;</td>
<td>&lt;1E-3&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.00000MΩ)</td>
<td>(1.00000MΩ)</td>
<td>(1.0000MΩ)</td>
</tr>
<tr>
<td></td>
<td>10MΩ</td>
<td>&lt;1E-5&gt;</td>
<td>&lt;1E-4&gt;</td>
<td>&lt;1E-3&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(10.00000MΩ)</td>
<td>(10.0000MΩ)</td>
<td>(10.000MΩ)</td>
</tr>
</tbody>
</table>

### Resistance (2- and 4-Wire)

**Resolutions Selected by Command**

<table>
<thead>
<tr>
<th>Function</th>
<th>&lt;resolution&gt;</th>
<th>selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>RES/FRES</td>
<td>MAXimum</td>
<td>6.5 digit</td>
</tr>
<tr>
<td></td>
<td>MINimum</td>
<td>4.5 digit</td>
</tr>
<tr>
<td></td>
<td>AUTO</td>
<td>6.5 digit</td>
</tr>
<tr>
<td></td>
<td>AUTO ON</td>
<td>6.5 digit</td>
</tr>
<tr>
<td></td>
<td>AUTO OFF</td>
<td>Resolution as last set</td>
</tr>
<tr>
<td></td>
<td>DEFault</td>
<td>6.5 digit</td>
</tr>
</tbody>
</table>

**Errors**

None

**Query**

See CONfigure? command page 4-21.

*RST

CONF:FRES: 1E7, 1E2 (Note that this function is inactive.)

CONF:FRES: 1E7, 1E2 (Note that this function is inactive.)
CONFigure:VOLTage[:DC] [<expected_value>[,<resolution>]]
CONFigure:VOLTage:AC [<expected_value>[,<resolution>]]

Either command selects the voltage measuring function. The default is DC voltage. AC can be selected with the additional parameter. AC voltage with a DC component can be selected with the command INPut:COUPling AC|DC. See INPut Subsystem page 4-24.

The <expected_value> is used to select the range of the voltage measurement. The table shows how <expected_value> affects the range selected.

<table>
<thead>
<tr>
<th>&lt;expected_value&gt;</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to .1999999</td>
<td>100 mV</td>
</tr>
<tr>
<td>0.2 to 1.999999</td>
<td>1 V</td>
</tr>
<tr>
<td>2.0 to 19.99999</td>
<td>10 V</td>
</tr>
<tr>
<td>20.0 to 199.9999</td>
<td>100 V</td>
</tr>
<tr>
<td>&gt;200</td>
<td>300 V</td>
</tr>
<tr>
<td>MINimum</td>
<td>100 mV</td>
</tr>
<tr>
<td>MAXimum</td>
<td>300 V</td>
</tr>
<tr>
<td>DEFault</td>
<td>Autorange</td>
</tr>
<tr>
<td>no parameter</td>
<td>Autorange</td>
</tr>
<tr>
<td>AUTO ON</td>
<td>Select Autorange</td>
</tr>
<tr>
<td>AUTO OFF</td>
<td>Deselect Autorange</td>
</tr>
</tbody>
</table>

In the above table, DEFault, AUTO and no <expected_value> selects autoranging. In this mode the DMM will select the most appropriate range to measure the signal on the input. Any other <expected_value> will de-select the autorange feature. The AUTO OFF command will leave the DMM in the last active range.
The optional <resolution> parameter is used to select the measurement resolution. There are three modes - 4.5, 5.5 and 6.5 digit. However, 6.5 digit resolution is not allowed in AC or DC coupled AC. The tables on the left below show the modes selected by numeric values of <resolution>, those on the right show the modes selected by <resolution> commands:

### DC Voltage
#### Numeric Values Used to Select Required Resolutions

<table>
<thead>
<tr>
<th>Function</th>
<th>Range</th>
<th>Required Digits</th>
<th>6.5</th>
<th>5.5</th>
<th>4.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLT:[DC]</td>
<td>100mV</td>
<td>&lt;1E-4&gt;</td>
<td>&lt;1E-3&gt;</td>
<td>&lt;1E-2&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100.0000mV)</td>
<td>(100.000mV)</td>
<td>(100.00mV)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1V</td>
<td>&lt;1E-6&gt;</td>
<td>&lt;1E-5&gt;</td>
<td>&lt;1E-4&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.000000V)</td>
<td>(1.0000V)</td>
<td>(1.000V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10V</td>
<td>&lt;1E-5&gt;</td>
<td>&lt;1E-4&gt;</td>
<td>&lt;1E-3&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(10.000000V)</td>
<td>(10.0000V)</td>
<td>(10.000V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100V</td>
<td>&lt;1E-4&gt;</td>
<td>&lt;1E-3&gt;</td>
<td>&lt;1E-2&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100.000000V)</td>
<td>(100.000V)</td>
<td>(100.00V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300V</td>
<td>&lt;1E-3&gt;</td>
<td>&lt;1E-2&gt;</td>
<td>&lt;1E-1&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(300.000000V)</td>
<td>(300.000V)</td>
<td>(300.00V)</td>
<td></td>
</tr>
</tbody>
</table>

### DC Voltage
#### Numeric Values Used to Select Required Resolutions

<table>
<thead>
<tr>
<th>Function</th>
<th>Range</th>
<th>Required Digits</th>
<th>5.5</th>
<th>4.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLT:AC</td>
<td>100mV</td>
<td>&lt;1E-3&gt;</td>
<td>&lt;1E-2&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100.0000mV)</td>
<td>(100.000mV)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1V</td>
<td>&lt;1E-5&gt;</td>
<td>&lt;1E-4&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.000000V)</td>
<td>(1.0000V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10V</td>
<td>&lt;1E-4&gt;</td>
<td>&lt;1E-3&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(10.000000V)</td>
<td>(10.0000V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100V</td>
<td>&lt;1E-3&gt;</td>
<td>&lt;1E-2&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100.000000V)</td>
<td>(100.000V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300V</td>
<td>&lt;1E-2&gt;</td>
<td>&lt;1E-1&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(300.000000V)</td>
<td>(300.000V)</td>
<td></td>
</tr>
</tbody>
</table>

### Errors
An error of -241, ‘Data questionable’ will be generated if greater than 6.5 digit resolution is selected. (or >5.5 for AC).

### Query
See CONFigure? command page 4-21.

### *RST
CONF:VOLT:DC 300,1E-3. This function is active.
<source_list>  

All the above commands (VOLT, CURR, RES and FRES) may have an additional parameter specifying which of the input channels to measure. If the DMM has option 40 (Ratio) fitted then this parameter may be used to select the different inputs.

In the above list, '1' selects the main channel and is the default, '2' selects the additional ratio channel. The parameters (@1,2) and (@1:2) will cause both channels to be measured sequentially when a trigger occurs. Note because of user configuration there is no guarantee of timing between the two measurements.

**Query**

Note that when a measurement is taken in the (@1,2) or (@1:2) mode, then the RATIO between the two channels is returned. It is not possible to access the partial measurements. Channels are not changed by a function change.

**Errors**

An execution error of -241, 'Hardware missing' is generated if @2 is selected when the option is not fitted.

**RST**

The reset condition is channel 1, (see INPut command).

---

**Native Equivalents**

DCV, DCI, ACV, ACI,

**Note**

Measurement inputs are isolated from the front connector on power up. INPut:STATe<Boolean> should be ON before valid measurement can take place.

See page 4-24 for further information on the INPut command.
**CONFigure?**

This queries the current configuration of the DMM. Note that it returns the present setting of the DMM - not what was last set with a CONFG command.

Syntax

```
CONFigure? (Query Only)
```

Related Commands

```
CONFigure, MEASure?, SENSE
```

**CONFigure?** This single command is used to query the current settings of the DMM. It returns a string in the form of:

```
"<function> <range>, <resolution>,<source_list>"
```

The possible combinations of the string are:

<table>
<thead>
<tr>
<th>&lt;function&gt;</th>
<th>&lt;range&gt;</th>
<th>&lt;resolution&gt;</th>
<th>&lt;source_list&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>CURR</td>
<td>1</td>
<td>1E-6,1E-5,1E-4</td>
<td>(01)</td>
</tr>
<tr>
<td>CURR:AC</td>
<td>1E2</td>
<td>&lt;range&gt;/1E-6</td>
<td>(01)</td>
</tr>
<tr>
<td>RES</td>
<td>1E3</td>
<td>&lt;range&gt;/1E-5</td>
<td>(02)</td>
</tr>
<tr>
<td>FRES</td>
<td>1E5</td>
<td>&lt;range&gt;/1E-4</td>
<td>(01,2)</td>
</tr>
<tr>
<td>VOLT</td>
<td>1E-1</td>
<td>&lt;range&gt;/1E-6</td>
<td>(01)</td>
</tr>
<tr>
<td>VOLT:AC</td>
<td>1E0</td>
<td>&lt;range&gt;/1E-5</td>
<td>(02)</td>
</tr>
<tr>
<td></td>
<td>1E1</td>
<td>&lt;range&gt;/1E-4</td>
<td>(01,2)</td>
</tr>
<tr>
<td></td>
<td>1E2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3E2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If **AUTO, DEF, MIN or MAX** was selected for `<range>` or `<resolution>` then the CONFG? string will contain the current setting that the DMM has selected.

Note that in the above the `<resolution>` depends on the range currently selected. Thus if the current active selection is 10 volt, 5.5 digits, then the returned string would be:

```
VOLT:DC 1E1,1E-4,(01)
```

In the case of the 300V range, then the resolution is returned as 1E-1, 1E-2 or 1E-3.

**RST**

Query only, no associated RST condition.

Native Equivalents

```
*LRN
```
FETCh?

This query command retrieves the last set of measurements taken and places them in the output queue. The returned data will be either a single reading if 'block' mode is not selected, or the several readings if 'block' mode is selected.

Syntax

FETCh? (Query only)

Related Commands

CONFigure, INITiate, READ?

Qualifiers

Note that the SCPI definition allows <function> and <parameter> qualifiers, but as the DMM only stores the readings for the current setting, these commands are not implemented.

Query

The returned data is formatted in the following character positions:

4.5 digit 1 2 3 4 5 6 7 8 9 10 11 12
s n x x x n n E s n n t

5.5 digit 1 2 3 4 5 6 7 8 9 10 11 12 13
s n x x x n n n E s n n t

6.5 digit 1 2 3 4 5 6 7 8 9 10 11 12 13 14
s n x x x n n n n E s n n t

Where

s = the sign + or -
n = ASCII digit 0 to 9
x = either an n or a decimal point
E = ASCII character identifying the exponent
t = a terminator or separator- either ; or , or <lf> (linefeed character)

The measurement overload condition is reported as 200.000E+33t

Multiple readings are returned with each value separated by a comma and the last reading terminated with the linefeed character.

Errors

If no measurement has been taken or the instrument has been reconfigured, then no result is returned and the error -230,'Data corrupt or stale' is stored in the error queue. This will be as a result of *RST, a CONF, SENSE etc command or after an INIT command has been sent.

*RST Condition

As this is a query command then there is no associated *RST condition. However note that *RST puts the DMM into the idle state and thus a FETCh? command would cause an error if no INIT had been received.

Native Equivalents

RDG? BRCL?
**INITiate**

This command removes the DMM from the idle state and into the wait for trigger state. When the trigger occurs the subsequent readings are stored within the DMM. These can then be accessed by the FETCh? command. Any readings already in memory will be overwritten.

**Syntax**

```
INITiate[:IMMediate] (Event, No query)
```

**Related Commands**

ABORt, CONFigure, FETCh?, READ?, TRIGger

**INITiate[:IMMediate]**

This puts the DMM into the wait for trigger state. The DMM will then wait for the appropriate trigger to occur before taking a measurement. If the trigger state is set to `TRIG:SOUR IMM` then the DMM will take a reading immediately, without waiting for any other event.

Any other trigger state set by the `TRIG:SOUR` command will cause the DMM to wait until that event occurred before taking a reading.

The `ABORt` command can be used to remove the DMM from the wait for trigger state.

Once the pending trigger conditions have been met, and all the readings have been taken, then the DMM will return to the idle state and another INIT command is required before further triggers are executed. The FETCh? command can be used to access these readings.

The READ? command executes an INITiate command implicitly and the MEASure? command executes a READ? command implicitly. Thus both commands will put the DMM into the wait for trigger state. Note that if TRIGger:SOURce IMMEDIATE is in operation then these two commands will implicitly cause a trigger. Once the trigger has occurred, then the measurement will be placed in the output queue. Note that for external triggers, it will not be possible to communicate with the DMM until the trigger has occurred. See Appendix A to this section for further details.

**Query Format**

INIT is an event and cannot be queried.

**Errors**

An error of `-213,'Init ignored'` will be generated if the DMM is not in the idle state when this command is received.

**∗RST Condition**

There is no associated ∗RST condition, but note that the ∗RST places the DMM in the idle state.

```
--------------------------------------
Native Equivalents
```

No direct equivalent, but is related to X?, ∗TRG
INPut

Controls the connection of the input terminals to the signal to be measured. The command is also used to configure the remote guard and the state of the input filter.

Syntax:

Subsystem INPut

Alternatives/Parameters :
  :COUPling AC|DC
  :FILTer [:LPASs] [:STATe] <Boolean>
  :GUARD LOW|FLOAT [:STATe] <Boolean>
  :ZERO? (Manufacturer's extension)

Related commands CONFIGure, MEASure?, SENSE

INPut:COUPling AC|DC

This command is used to cause the DMM to measure the DC component of an AC voltage signal. It is valid only when in AC voltage measurement, thus a CONFIG or SENSE command must have already selected the AC function.

If the command is received with the AC parameter, then the DMM will only measure the AC component. However, sending the DC parameter will enable the DMM to measure the DC and the AC components of the signal.

Errors If the DMM is not in AC, then the error -221, 'Settings conflict' is generated.

Query INPut:COUPling?

This will return either the string "AC" or "DC". If the DMM is in the Ohms function, then this query will return "DC".

*RST INPut:COUPling AC - but inactive (See CONFIG:VOLT AC)

INPut:FILTer[:LPASs][:STATe] <Boolean>

This sub-system configures the state of the input filter of the DMM. As the DMM has effectively only a low pass filter, the other SCPI defined parameters are not implemented.

Note that both :LPASs and :STATe are optional. If the value of <Boolean> is 0 or OFF, then the filter is deselected. If <Boolean> is 1 or ON then the filter is selected.

Errors No associated errors.

Query INPut:FILTer[:LPASs][:STATe]?

This will return the string '0' if the filter is inactive or '1' if the filter is active.

*RST INPut:FILTer:LPASs:STATe 0 (Low-pass Input Filter in OFF state)
INPut:GUARd LOW|FLOat

This command sets the connection of the internal guard shield:

<table>
<thead>
<tr>
<th>Option</th>
<th>Guard Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>Internally connected to signal common</td>
</tr>
<tr>
<td>FLOat</td>
<td>connected to front panel guard terminal</td>
</tr>
</tbody>
</table>

Errors
No associated errors

Query
INPut:GUARd?
This queries the setting of the guard shield. Will return either "LOW" for internally connected, or "FLO" for connected to guard terminal.

*RST INPut:GUARd LOW

INPut[:STATe] <Boolean>

This command controls whether the input terminals are connected to the measurement signal. If <Boolean> is 0 or OFF then the DMM is isolated from the external signal source. If <Boolean> is 1 or ON, then the DMM input is connected to the external signal source.

Errors
No directly associated errors; however, it is not possible to take measurements if the input is not connected to the signal. Thus a command such as MEAS? and INIT:IMM can generate errors as a result of the setting of INPut[:STATe]

Query
INPut[:STATe]?
Returns either '0' if the input is disconnected or '1' if the input is connected.

*RST INPut[:STATe] 0
Note that this is different to that mandated by SCPI, but it is our policy to disconnect all instruments from the signal lines. This isolation will improve safety and prevent internal damage due to inadvertently large inputs at power-on.

INPut:ZERO?

This command will cause the DMM to measure the current input value and subtract this from all subsequent readings for the setting (i.e. function and range etc.)

Errors
An execution error is generated if the measured value is outside the range of the input zero correction range. The error 100,'Input not connected' is reported if this command is received and the input is disconnected

Query
INPut:ZERO?
This command returns 1 for a fail, 0 for a successful input zero.

*RST
All input zero corrections are unaffected by *RST.

-----------------------------

Native Equivalents
INPut:COUPling AC|DC  =  ACV ACCP DCCP
INPut:FILTER            =  FILT0/FILT1 in DCV etc.
INPut[:STATe]           =  INPUT OFF, CH_A etc.
INPut:ZERO              =  ZERO?
MEASure?

This command configures the DMM, takes a measurement and then outputs the reading to the output queue. This is equivalent to sending a CONF command followed by a READ? command.

**Syntax**

```
MEASure <function>?<parameters>[,<source_list>]
```

**Subsystem**

MEASure

**Function:**

- :CURRent[:DC]? <parameters>[,<source_list>]
- :CURRent:AC? <parameters>[,<source_list>]
- :FRESistance? <parameters>[,<source_list>]
- :RESistance? <parameters>[,<source_list>]
- :VOLTage[:DC]? <parameters>[,<source_list>]
- :VOLTage:AC? <parameters>[,<source_list>]

**Parameters:**

```
[<expected_value>[,<resolution>]]
```

**Source List:**

```
[,(@1)|(@2)|(01,2)|(01:2)]
```

**Related Commands**

READ?, INPut, CONFigure

**Note**

INPut:STATe <Boolean> should be ON before measurement takes place. See page 4-24 for further information on the INPut command.

As the MEASure? and CONFigure commands have the same structure — please refer to this for a full description of CURRent, RESistance etc. For the format of the data returned see the FETCh? command.

For the operation of MEAS? with the various trigger modes see Appendix A to this section.

The MEASure command also allows for a <presentation layer>. This has not been implemented on the 1362.

**Errors**

If the input is not connected, then error 100, 'Input not connected' is reported.

If the DMM is in TRIGger:SOURce BUS, then the error -214, Trigger deadlock is reported.
OUTPut

This command is used to select the response mode of the DMM to a TTL trigger.

Syntax  
OUTPut:TTLTrg<n>:PROTocol SYNChronous|ASYNchronous  
Where \( n = 0 \) through \( 7 \), referring to the eight backplane lines.

Related Commands  
TRIGger:SOURce:TTLTrg

OUTPut:TTLTrg<n>:PROTocol SYNChronous|ASYNchronous

This command is used to select the trigger protocol for the backplane TTL lines. The SYNChronous mode configures the eight TTL lines as individual trigger inputs. That is, a measurement can be triggered from any one of the lines if the line is selected and INITiated.

In the ASYNchronous mode, the eight lines are treated as four input/output pairs - 0/1, 2/3, 4/5, 6/7.

In this configuration the trigger is received on the lower number (i.e. TTL0/2/4/6) and the measurement complete signal is output on the higher number (i.e. TTL1/3/5/7).

The ASYN command will select the pair of the currently active TTL line.
E.g. if TTLT5 is selected ASYN would select pair 4/5.

Refer to VXI Specifications revision 1.3 for further information on triggering protocols.

Query Format  
OUTPut:TTLTrg<n>:PROTocol?

This query will return 'SYNC' or 'ASYN' depending on which is currently selected.

Errors  
No associated errors with this command.

*RST Condition  
SYNChronous mode all TTLTrg lines deselected.

Native Equivalents  
None.
**READ?**

This command places the DMM in a 'wait for trigger' state and then returns the measurement after the trigger. In effect this executes an **INITiate** and **FETCH?** command.

**Syntax**

READ?  (Query only)

**Related Commands**

CONFigure, FETCH? INITiate

**Query**

See the **FETCH?** command for a description of the data format returned.

**Errors**

An execution error - 100, 'Input not connected' will be generated if the DMM input has not been selected with the **INPUT** command.

If the DMM is in TRIGger:SOURce BUS, then the error - 214, 'Trigger deadlock' is reported.

For the operation of **READ?** with the various trigger modes see Appendix A.

**RST Condition**

Query command, no associated **RST** state.

**Native Equivalents**

X?
This command is used to configure the DMM to a more detailed level that the \texttt{CONFigure} command. Note that :SENSe is a root level command and can be omitted. Thus only the \texttt{VOLTage}, \texttt{FILTER} etc. part of the command need be sent. This command also selects the line frequency that the measurements are taken over.

\textbf{Syntax} \\
\texttt{[:SENSe]} \\
\textbf{Function} \\
\texttt{:CURRent} \\
\hspace*{1em}[:DC] \\
\hspace*{2em} :RANGE <\texttt{numeric\_value}> \\
\hspace*{2em} :AUTO <\texttt{Boolean}> \\
\hspace*{2em} :RESolution <\texttt{numeric\_value}> \\
\hspace*{1em} :AC \\
\hspace*{2em} :RANGE <\texttt{numeric\_value}> \\
\hspace*{2em} :AUTO <\texttt{Boolean}> \\
\hspace*{2em} :RESolution <\texttt{numeric\_value}> \\
\texttt{:FRESistance} \\
\hspace*{2em} :RANGE <\texttt{numeric\_value}> \\
\hspace*{2em} :AUTO <\texttt{Boolean}> \\
\hspace*{2em} :RESolution <\texttt{numeric\_value}> \\
\texttt{:RESistance} \\
\hspace*{2em} :RANGE <\texttt{numeric\_value}> \\
\hspace*{2em} :AUTO <\texttt{Boolean}> \\
\hspace*{2em} :RESolution <\texttt{numeric\_value}> \\
\texttt{:VOLTage} \\
\hspace*{1em}[:DC] \\
\hspace*{2em} :RANGE <\texttt{numeric\_value}> \\
\hspace*{2em} :AUTO <\texttt{Boolean}> \\
\hspace*{2em} :RESolution <\texttt{numeric\_value}> \\
\hspace*{1em} :AC \\
\hspace*{2em} :RANGE <\texttt{numeric\_value}> \\
\hspace*{2em} :AUTO <\texttt{Boolean}> \\
\hspace*{2em} :RESolution <\texttt{numeric\_value}> \\
\texttt{:FILTER} \\
\hspace*{1em}[[:LPASs]] \\
\hspace*{2em}[[:STATe]] <\texttt{Boolean}> \\
\hspace*{1em}[:LFRequency] <\texttt{numeric\_value}> \hspace*{2em} (manufacturer's extension)

\textbf{Related Commands} \hspace*{1em} \texttt{CONFigure, MEASure? INPut}

As the six \texttt{<function>} defining sub-systems (see the list below) all have similar sub-levels, they will all be described together:

\texttt{[:SENSe]} \\
\hspace*{1em} \texttt{CURRent[:DC]} \\
\hspace*{1em} \texttt{CURRent:AC} \\
\hspace*{1em} \texttt{FRESistance} \\
\hspace*{1em} \texttt{RESistance} \\
\hspace*{1em} \texttt{VOLTage[:DC]} \\
\hspace*{1em} \texttt{VOLTage:AC}

\textit{Continued overleaf}
These commands select the range of the specified function. The range selected for any value of <expected_value> can be found in the tables in the CONfigure command under the relevant <function>.

Note that these commands do not accept the special operators MAXimum, MINimum and DEFault.

The :AUTO parameter selects the autorange mode. In this setting, the DMM will select the most appropriate range to measure the signal. Selecting a valid RANGE will deselect autorange.

Query

[:SENSe:]<function>:RANGe? [MAXimum|MINimum]
[:SENSe:]<function>:RANGe:AUTO?

The query versions of these commands return the currently selected range. The table below gives the returned string depending on the <function>:

<table>
<thead>
<tr>
<th>parameter</th>
<th>CURRent</th>
<th>RESistance</th>
<th>VOLTage</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINimum</td>
<td>1E2</td>
<td>1E-1</td>
<td></td>
</tr>
<tr>
<td>MAXimum</td>
<td>1E7</td>
<td>3E2</td>
<td></td>
</tr>
</tbody>
</table>

If the qualifier MINimum or MAXimum is present then the following is returned:

<table>
<thead>
<tr>
<th>parameter</th>
<th>CURRent</th>
<th>RESistance</th>
<th>VOLTage</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINimum</td>
<td>1E2</td>
<td>1E-1</td>
<td></td>
</tr>
<tr>
<td>MAXimum</td>
<td>1E7</td>
<td>3E2</td>
<td></td>
</tr>
</tbody>
</table>

The query for the AUTO parameter will return either ’0’ if autorange is deselected, or ’1’ if autorange is selected.

Errors

See the CONfigure command (page 4-14) for the errors associated with selecting combinations that are not available.

*RST

[:SENSe:]CURRent:DC:RANGe 1 - inactive
[:SENSe:]RESistance:RANGe 1E7 - inactive
[:SENSe:]FRESistance:RANGe 1E7 - inactive
[:SENSe:]VOLTage:DC:RANGe 300 - active
[:SENSe]:<function>:RESolution <numeric_value>

As with the RESolution sub-command in the CONFigure command, this selects the resolution of the measurements. Please refer to the settings as defined under the CONFigure command (page 4-14).

Errors

See the CONFigure command for the errors associated with selecting combinations that are not available.

Query

[SENSe:]<function>:RESolution? [MINimum|MAXimum]

The query form will return one of the following strings as appropriate:

<table>
<thead>
<tr>
<th>&lt;function&gt;</th>
<th>&lt;resolution&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>CURR</td>
<td>CURR:AC</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>RES</td>
<td>FRES</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>VOLT</td>
<td>VOLT:AC</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If the qualifier MINimum or MAXimum is present then the following will be returned for each of the above functions:

<table>
<thead>
<tr>
<th>&lt;parameter&gt;</th>
<th>&lt;resolution&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>MINimum</td>
<td>&lt;range&gt; / 1E-4</td>
</tr>
<tr>
<td>MAXimum</td>
<td>&lt;range&gt; / 1E-6</td>
</tr>
</tbody>
</table>

*RST

[SENSe:]CURRent:DC:RESolution 1E-6 - inactive
[SENSe:]RESistance:RESolution 1E1 - inactive
[SENSe:]FRESistance:RESolution 1E1 - inactive
[SENSe:]VOLTage:DC:RESolution 1E-3 - active

[SENSe:]FILTer[:LPAs]:[STATe] <Boolean>

This sub-system configures the state of the input filter of the DMM. As the DMM effectively only has a low pass filter, the other SCPI defined parameters are not implemented.

Note that both :LPAs and :STATe are optional. For a <Boolean> value of 0 or OFF, the filter is deselected. For a <Boolean> value of 1 or ON the filter is selected.

Errors

No associated errors

Query

[SENSe:]<function>:FILTer[:LPAs]:[STATe]?

This will return the string '0' or '1' corresponding to filter inactive or filter active.

*RST

[SENSe:]<function>:FILTer:LPAs:STATe: OFF
[:SENSe]LFRequency <numeric_value>

This command is a manufacturer-defined extension to the SCPI-confirmed [:SENSe] subsystem. It is used to set the line frequency at which the ADC converts. The table below shows the accepted numeric values (nv) and the resulting line frequency selection. Any other <numeric_value> will generate an error. The units are Hertz.

<table>
<thead>
<tr>
<th>&lt;numeric_value&gt; selected</th>
<th>Line Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 &lt; nv ≤ 55</td>
<td>50 Hz</td>
</tr>
<tr>
<td>55 &lt; nv ≤ 100</td>
<td>60 Hz</td>
</tr>
<tr>
<td>100 &lt; nv</td>
<td>400 Hz</td>
</tr>
<tr>
<td>MINimum</td>
<td>50 Hz</td>
</tr>
<tr>
<td>MAXimum</td>
<td>400 Hz</td>
</tr>
<tr>
<td>DEFault</td>
<td>60 Hz</td>
</tr>
</tbody>
</table>

N.B.  Partial Calibration of the 1362
When carrying out a partial calibration, ensure that the programmed frequency is the same as that for the most-recent full calibration. Otherwise, small offsets may be introduced which can only be removed by a full calibration.

Errors
If the parameter is less than zero an execution error will be generated.

Query
[:SENSe:]LFRequency?
The query form of the command returns the current setting of the line frequency, and the current setting in the calibration stores. These will be either 50, 60 or 400 and the two values will be comma separated e.g. 50, 60 <lf>

This would indicate that the temporary line frequency is 50 Hz, but the default power on setting is 60 Hz.

Note that the parameters MAX, MIN etc are not applicable in this command.

*RST
The line frequency remains unchanged as it is stored in the non-volatile store.

Native Equivalents
DCV, DCI, ACV, ACI, OHMS, FILT, LINE
STATus

This command controls the SCPI defined status reporting structures. The commands that are listed in this section are the mandatory commands that must be implemented by any SCPI instrument.

The status reporting is additional to that defined by the IEEE488.2 specification. The extra status deals with the current operation of the instrument and quality of any measurements taken.

For a diagram of the status register system please refer to the SCPI specification, section 9.2, Figure 9.1.

Syntax

```plaintext
STATus

:OPERation
[:EVENT]?            (Query Only)
:CONDITION?          (Query Only)
:ENABLE <NR>         (Query Only)
:ENABLE?             (Query Only)
:QUESTionate
[:EVENT]?            (Query Only)
:CONDITION?          (Query Only)
:ENABLE <NR>         (Query Only)
:ENABLE?             (Query Only)
:PRESet              (Event, No Query)
```

Related Commands  No directly-related SCPI commands.

STATus:OPERation[:EVENT]?

This query command will return the latched settings from the operational status register. The value that is returned is a binary weighted number. Thus converting this number into a binary value will indicate which bits are set true.

The list below shows which bits of the operational register are used:

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>DMM is performing a calibration</td>
</tr>
<tr>
<td>2</td>
<td>DMM is currently range changing</td>
</tr>
<tr>
<td>4</td>
<td>DMM is currently measuring</td>
</tr>
<tr>
<td>5</td>
<td>DMM in wait for trigger state</td>
</tr>
</tbody>
</table>

Note that no other bits are used by the DMM and are returned as having the value zero.

Note that this command clears any bits that are currently set. Also sending the *CLS command will clear any set bits.

Errors  There are no associated errors with this command.

*RST  As this is a query command then there is no associated *RST condition. However, SCPI defines that the *RST will not effect the SCPI Event registers. The operational register is cleared by one of the following:

:OPER:EVENt?  *CLS  power on
STATus:OPERation:CONDition?

This query command returns the current binary-weighted contents of the operational status register. It is similar to the :EVENt? query, except the condition register is non-latched or buffered and as such returns what is currently happening within the DMM.

Note that this command does not clear any of the set bits in the register. Also note that because the DMM goes 'busy' during range change and calibration, these bits will never be read true by this command.

Errors

There are no associated errors with this command.

*RST

As this is a query command then there is no associated *RST condition. However, SCPI defines that *RST will not effect the SCPI Event registers. The operational register is cleared by one of the following:

:OPER:EVENt?

*CLS

power on

STATus:OPERation:ENABLE <NRf>

This command is used to enable the summary and reporting of operational status bits. <NRf> is converted into a weighted binary number and used as the mask for the operational enable status register. If any of the enabled bits in the operational status register are true, or subsequently go true, then bit 7 of the Status Byte will be set true.

Note that the DMM only uses bits 0, 2 4 and 5 of the operational status register.

Errors

An error of -222, 'Data out of range' will be reported if the enable value is greater that 65535.

Query

STATus:OPERation:ENABLE?

This returns an <NRf1> that is the binary weighted representation of enable bits that are set.

*RST

SCPI defines that the *RST will not effect the SCPI Enable registers. The operational register is cleared by one of the following:

:OPER:EVENt?

*CLS

power on

STATus:QUEStionable[:EVENt]?

This command will return the latched settings from the questionable status register, reporting information about the quality of the measurement. The value that is returned is a binary-weighted decimal number. Converting this number into a binary value will indicate which bits are set true.

The table below shows which bits of the questionable status register are used, and the meaning of the response:

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Voltage Overrange</td>
</tr>
<tr>
<td>1</td>
<td>Current Overrange</td>
</tr>
<tr>
<td>8</td>
<td>Invalid Calibration</td>
</tr>
<tr>
<td>9</td>
<td>Resistance Overrange</td>
</tr>
</tbody>
</table>

Note that no other bits are used by the DMM and these are returned as having the value zero. This command clears any bits that are currently set. Also sending the *CLS command will clear any set bits.

Errors

There are no associated errors with this command.

*RST

As this is a query command then there is no associated *RST condition. However, SCPI defines that *RST will not effect the SCPI Event registers. The only way to clear the questionable register is with a *CLS, STATus:QUEStionable[:EVENt]? command, or at power on.
STATus:QUEStionable:CONDition?

This query command returns the current binary weighted contents of the questionable status register. It is similar to the :EVENt? query, except the condition register is non-latched or buffered and as such returns what is currently happening within the DMM.

Note that this command does not clear any of the set bits in the register.

Errors
There are no associated errors

*RST
As this is a query command, there is no associated *RST condition. However, SCPI defines that the *RST will not effect the SCPI Event registers. The only way to clear the questionable register is with a *CLS command or at power on.

STATus:QUEStionable:ENABle <NRf>

This command is used to enable the summary and reporting of questionable status bits summarized by bit 3 of the IEEE 488.2 Status Byte. The value of <NRf> is converted into a weighted binary number and used as the mask for the operational enable status register. If any of the enabled bits in the operational status register are true, or subsequently go true, then bit 3 of the Status Byte will be set.

Note that the DMM only uses bits and 0, 1, 8 and 9 of the questionable status register.

Errors
An error of -222, 'Data out of range' will be reported if the enable value is greater that 65535.

Query
STATus:QUEStionable:ENABle?
This returns an <NRf1> that is the binary weighted representation of enable bits that are set.

*RST
SCPI defines that the *RST will not effect the SCPI Enable registers. The only way to clear the questionable register is with a *CLS command or at power on.

STATus:PRESet

This command sets the SCPI defined Event and Enable registers into a known state. See SCPI specification, Section II, 18.7 for details. The STATus:PRESet condition is all bits set to zero (disabled) Positive Transition true.

Errors
No associated errors with this command.

*RST
No associated *RST condition.
**SYSTem**

The SYSTem command is used to query the current contents of the error queue. It can also be used to switch the DMM into a different command language interpreter, and it also reports the version of SCPI that the instrument conforms to.

**Syntax**

```
:SYSTem:
:ERRor?  (Query only)
:LANGuage NATive  (manufacturer's extension)
:VERSion?  (Query only)
```

**Related Commands** None.

**SYSTem:ERRor?**

This query command returns the error currently at the top of the error queue. The format of the response is:

```
<NRf1>,<description>
```

<NRf1> represents the error number and <description> is a short ASCII description of the error.

If there are no errors currently in the queue then the DMM will return `0,'No error'`. If the queue overflows then the last error message added to the queue will be replaced with the message `-350,'Queue overflow'`. The queue can store 10 errors before the overflow occurs.

The error queue is a First In, First Out system, thus the oldest error is reported first.

See the section entitled 'Error Codes' for a full list of the DMM errors. All error numbers will be in the range: -32768 to +32767.

**Errors** There are no errors associated with this command.

**SYSTem:LANGuage NATive**

This command causes the DMM to switch to the native command parser. This will allow the control of the DMM with an IEEE488.2 compatible language. Refer to the 1362 VXIbus Card DMM Users Handbook for language use. Once in native mode, control can be returned to the SCPI parser by the native command 'SCPI'.

**Errors** There are no errors associated with this command.

**Query** There are no associated errors.

*RST A *RST will not change the current parser mode, thus once this command has been issued, the only way back is by using the native command 'SCPI'.

**SYSTem:VERSion?**

This query command will report the version of SCPI that the instrument conforms to. The returned <NRf2> is:

```
1991.0
```

**Errors** There are no associated errors.

*RST No associated *RST
TEST

This command performs an instrument selftest. It may be either one specific test or a complete run of all tests.

Syntax

<table>
<thead>
<tr>
<th>TEST [:ALL] ?</th>
<th>&lt;numeric_value&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Query only)</td>
<td>(Query only)</td>
</tr>
</tbody>
</table>

Related Commands

* TST?

TEST [:ALL] ?

This query command performs the full selftest, returning a number '0' if all tests pass, or a non-zero number if a test failed. Also, in the case of a test failure, an error code number is placed in the error queue to indicate the test which failed. Code numbers in the queue can be retrieved using the query SYSTem ERRor? (the same error code numbers are used as for the 1362 native selftest). During the selftest, once a test fails the DMM does not proceed with the testing.

Errors

As described above.

*RST

There is no associated *RST condition. Selftest is not active.

TEST: TYPE? <numeric_value>

This query command performs the specified number test. It then returns the same data as the native 1362 TEST? command.

Errors

None

Native Equivalent

TEST?, *TST?. Note that this will use the current 1362 selftest structure.
TRIGger

This command controls the behaviour of the trigger system. It is used to specify where the trigger is to originate, any delays between the trigger and the measurement and how many measurements to take.

The basic principle of the SCPI trigger system is that an instrument is normally in an IDLE state, see Fig. 4.4. This is the state after a RST, ABORT or power on. The instrument may then be initiated from the idle state by placing it into the ARM state. This is an Event Detection Layer at which the instrument will wait until the specified event has occurred.

Once the ARM event(s) have occurred then the instrument will move into the TRIGGER state. This is again an Event Detection Layer and the instrument will wait for the specified event to occur before commencing with the measurement. Once this specified number of ARM and TRIGGER states have been satisfied, then the DMM will return to the IDLE state.

The 1362 DMM does not implement the ARM layer of the trigger subsystem. Thus the DMM will proceed from the IDLE state directly to the trigger state. Other than the more drastic methods of reset or interrupting line power, there are two routes out of this state - either a Word Serial Clear command followed by the ABORT (or equivalent) command to return the DMM to IDLE state, or the specified trigger Event. In this latter case, the DMM will take a measurement before returning to the IDLE state.

If the TRIGger:COUNt command has been set to more that the default of 1, then the DMM will wait for COUNT triggers, taking a measurement for each one, before returning to the IDLE state.

Syntax

TRIGger
[:IMMediate] (Event, No Query)
:COUNT <numeric_value>
:DELAY <numeric_value>
:AUTO <Boolean>
:SOURce BUS|EXternal|HOLD|IMMediate|TTLTrg<n>

Where \( n = 0 \) to 7

Notes

See appendix A for further information on the trigger subsystem

Related Commands

ABORt, MEASure?, CONFigure, READ?, INITiate, FETCH?
If the DMM is in the Wait-for-trigger state set by the \texttt{INIT}iate command, then the DMM will take a measurement. The measurements can then be recalled using the \texttt{FETCh}\? command. Note that the DMM must be in either \texttt{TRIG:SOUR BUS} or \texttt{TRIG:SOUR HOLD} state for this command to trigger the DMM and not generate an error.

**Errors**

An error of -211, 'Trigger ignored' will be generated if the DMM has not been initiated with an \texttt{INIT} command. (Thus from this command the error will be generated if \texttt{TRIG:SOURce IMM} is selected).

**Query**

This is an event and thus cannot be queried.

*RST*

On *RST* the DMM is placed into the Idle state.

**TRIGger:COUNt <numeric_value>**

This command configures the DMM to expect <numeric_value> triggers and to take a measurement for each trigger and store them internally. The DMM must be placed in the wait-for-trigger mode. This can be done using the \texttt{INIT} command. The subsequent readings taken can be recalled with the \texttt{FETCh}\? command. Alternatively, the DMM can be placed into the wait-for-trigger state using the \texttt{READ}\? command. This will then return the subsequent measurements to the output queue when they are taken.

The <numeric_value> must be in the range 1 to 1000. If \texttt{MAXimum} is sent then the DMM will expect 1000 triggers. If \texttt{MINimum} is sent then the DMM will expect 1 trigger.

**Errors**

An error of -222, 'Data out of range' is generated if <numeric_value> is outside the range 1–1000.

**Query**

TRIGger:COUNt? [\texttt{MINimum}|\texttt{MAXimum}]

This query command returns the current setting of the number of triggers expected. If \texttt{MINimum} is present '1' is returned, if \texttt{MAXimum} is present, then '1000' is returned.

*RST*

TRIGger:COUNt 1

**TRIGger:DELay:AUTO <Boolean>**

This command enables or disables the use of default trigger delays. If the value of <Boolean> is 'OFF' or '0' then the default delays are not used, if <Boolean> is 'ON' or '1' then the defaults are used. If the default delays are deselected the delay between trigger and measurement is given by the TRIGger:DELay command.

The default delays are dependent on the current function, range and resolution as set in the 1362 handbook. The default value will change every time a new function or range or resolution is selected.

If a TRIGger:DELay <numeric_value> command is received then TRIGger:DELay:AUTO will be turned OFF.

**Errors**

There are no associated errors.

**Query**

TRIGger:DELay:AUTO?

This returns either '0' or '1' depending if delays are respectively disabled or enabled.

*RST*

TRIGger:DELay:AUTO ON
TRIGger:DELay <numeric_value>

This command defines the time delay between a trigger event and the measurement conversion starting. The range of <numeric_value> must be in the range 0 sec to 10 sec. (See 1362 handbook for resolutions). If a value of greater that 10 is received, the DMM will default to 10. MINimum will select a value of 0 sec, MAXimum will select 10 sec.

Once a delay is selected, then this will apply to all subsequent measurements.

Errors

An error of -222 'Data out of range' will be reported if the <numeric_value> is less than 0 or greater than 10 seconds.

Query

TRIGger:DELay? [MINimum|MAXimum]

This will return the current setting of the trigger delay. If a default delay is currently active, then this value will be returned. If MINimum is present, then '0' will be returned, if MAXimum is present then '10' will be returned.

*RST

As TRIGger:DELay:AUTO ON is selected, then the DMM default delays will be selected.

TRIGger:SOURce BUS|EXTernal|HOLD|IMMediate|TTLTrg<n> (n = 0 to 7)

This command defines the source of the measurement trigger. The following lists the possible parameter options:

Alternative Parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUS</td>
<td>This will accept Group Execute Trigger (GET). *TRG.</td>
</tr>
<tr>
<td>EXTernal</td>
<td>This selects the DMM front panel 'EXT TRIG' connector.</td>
</tr>
<tr>
<td>HOLD</td>
<td>This deselects all triggers, however the TRIGger:IMMediate command will override this 'HOLD' state and cause a measurement to be taken.</td>
</tr>
<tr>
<td>IMMEDIATE</td>
<td>In this mode, an INIT, READ? or MEAS? command will cause a measurement to be taken.</td>
</tr>
<tr>
<td>TTLTrg&lt;n&gt;</td>
<td>This selects the backplane TTL VXI trigger system. Note that only one of these TTLTrg lines can be selected at any one time. If the OUTPut:TTLTrg&lt;n&gt;:PROTocol ASYNchronous mode is selected, then TTLTrg1</td>
</tr>
</tbody>
</table>

Errors

The DMM must be in the idle mode for a TRIGger:SOURce command to be accepted. An execution error of -221, 'Settings conflict' will be generated if a TRIGger:SOURce command is received when the DMM is already in the trigger mode.

If the DMM is in the idle state then any GET or *TRG commands will cause an execution error of -211, 'Trigger ignored'. However any triggers on the external or TTL lines will be ignored with no error.

MEAS? and READ? will generate an error of -214, 'Trigger deadlock' If received while in the TRIGger:SOURce BUS mode.

Query

TRIGger:SOURce?

This queries the current setting of the trigger mode. it will return one of the following:

'BUS' 'EXT' 'HOLD' 'IMM' 'TTLTn'

*RST

The DMM is initially placed in the idle state with TRIG:SOUR IMM.

--------------------------------------

Native Equivalent BLOCK

Related Commands OUTPut, INITiate.
APPENDIX A to SECTION 4

1362S SCPI -
   Command Summary
   Error Codes and Messages
   *RST (Reset) Conditions
   Trigger Combinations
   Trigger Timing Information
## SCPI Command Summary

The following is a table of Command and Query Command codes that have been implemented in the 1362S.

<table>
<thead>
<tr>
<th>COMMAND FORMAT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABORT</td>
<td>Abort current trigger state and return to idle state.</td>
</tr>
<tr>
<td>CALibration</td>
<td>Perform full scale calibration using the <code>&lt;numeric_value&gt;</code>.</td>
</tr>
<tr>
<td>LOW?</td>
<td>Performs zero scale calibration using the <code>&lt;numeric&gt;</code>.</td>
</tr>
<tr>
<td>:SECure?</td>
<td>Enable the calibration security.</td>
</tr>
<tr>
<td>:SECure?</td>
<td>Query the current setting of the security.</td>
</tr>
<tr>
<td>:SLFRequency?</td>
<td>Store current line frequency in non-volatile stores.</td>
</tr>
<tr>
<td>CONFIGure&lt;function&gt;[,.&lt;parameter&gt;][,.&lt;source_list&gt;]</td>
<td>General configuration command.</td>
</tr>
<tr>
<td>&lt;function&gt;</td>
<td>Selects Current; respectively DC or AC</td>
</tr>
<tr>
<td>:FRESistance</td>
<td>Selects four wire Ohms.</td>
</tr>
<tr>
<td>:RESistance</td>
<td>Selects two wire Ohms.</td>
</tr>
<tr>
<td>:VOLTage[.DC]</td>
<td>:AC</td>
</tr>
<tr>
<td>&lt;parameter&gt;</td>
<td>Parameters for the <code>&lt;function&gt;</code>.</td>
</tr>
<tr>
<td>&lt;source_list&gt;</td>
<td>This selects channel (if option fitted) to be measured.</td>
</tr>
<tr>
<td>CONFIGure?</td>
<td>This returns the current selected function, range and resolution of the DMM.</td>
</tr>
<tr>
<td>FETCh?</td>
<td>Returns the last set of measurements taken.</td>
</tr>
<tr>
<td>INITiate</td>
<td>Places DMM in the wait for trigger state.</td>
</tr>
<tr>
<td>INPut</td>
<td>Selects input coupling source.</td>
</tr>
<tr>
<td>:COUPling AC</td>
<td>DC</td>
</tr>
<tr>
<td>:FILTer[:LPAS]:STATe&lt;Boolean&gt;</td>
<td>Selects or Deselects the input filter.</td>
</tr>
<tr>
<td>:GUARD LOW</td>
<td>FLOat</td>
</tr>
<tr>
<td>:GUARDd?</td>
<td>Query the status of the guard connection.</td>
</tr>
<tr>
<td>:GUARD?</td>
<td>Selects input connection or isolation.</td>
</tr>
<tr>
<td>:STATe&lt;Boolean&gt;</td>
<td>Queries the state of the input connection.</td>
</tr>
<tr>
<td>ZERO?</td>
<td>Performs an input zero offset correction.</td>
</tr>
<tr>
<td>MEASure&lt;function&gt;[,.&lt;parameters&gt;][,.&lt;source_list&gt;]</td>
<td>Configure the DMM and take a measurement and INITiates that measurement.</td>
</tr>
<tr>
<td>&lt;function&gt;</td>
<td>Selects Current, either DC or AC</td>
</tr>
<tr>
<td>:FRESistance</td>
<td>Selects four wire Ohms.</td>
</tr>
<tr>
<td>:RESistance</td>
<td>Selects two wire Ohms.</td>
</tr>
<tr>
<td>:VOLTage[.DC]</td>
<td>:AC</td>
</tr>
<tr>
<td>&lt;parameter&gt;</td>
<td>Parameters for the <code>&lt;function&gt;</code>.</td>
</tr>
<tr>
<td>&lt;source_list&gt;</td>
<td>This selects channel (if option fitted) to be measured.</td>
</tr>
<tr>
<td>OUTPut</td>
<td>Set the VXI trigger line protocol mode.</td>
</tr>
<tr>
<td>:TTLTrg0[1</td>
<td>2</td>
</tr>
<tr>
<td>READ?</td>
<td>Places the DMM in a wait for trigger state and then returns the measurement after the trigger.</td>
</tr>
<tr>
<td>[SENSe:]</td>
<td>Selects either DC or AC current.</td>
</tr>
<tr>
<td>CURRent[.DC]</td>
<td>:AC</td>
</tr>
<tr>
<td>CURRent[.DC]</td>
<td>:AC</td>
</tr>
<tr>
<td>:RESistance</td>
<td>Query the setting resistance setting.</td>
</tr>
<tr>
<td>:VOLTage[.DC]</td>
<td>:AC</td>
</tr>
<tr>
<td>:VOLTage[.DC]</td>
<td>:AC</td>
</tr>
<tr>
<td>:RANGe&lt;numeric_value&gt;</td>
<td>Selects the value expected to be measured.</td>
</tr>
<tr>
<td>:AUTO&lt;Boolean&gt;</td>
<td>Selects Autorange.</td>
</tr>
<tr>
<td>:RESolution&lt;numeric_value&gt;</td>
<td>Selects the resolution for the function selected.</td>
</tr>
<tr>
<td>MAXimum</td>
<td>Selects the maximum resolution for the function selected.</td>
</tr>
<tr>
<td>:MINimum&lt;numeric_value&gt;</td>
<td>Selects the minimum resolution for the function selected.</td>
</tr>
<tr>
<td>:AUTO ON</td>
<td>Explicitly setting a value for RESolution will turn Auto:Off.</td>
</tr>
<tr>
<td>FILTer[:LPAS]:STATe&lt;Boolean&gt;</td>
<td>Selects or Deselects the input filter.</td>
</tr>
<tr>
<td>:LFRequency&lt;numeric_value&gt;</td>
<td>Query the state of the input filter.</td>
</tr>
<tr>
<td>:LFRequency</td>
<td>Set the integration time related to line frequency setting.</td>
</tr>
<tr>
<td>:LFRequency?</td>
<td>Query the line frequency setting.</td>
</tr>
</tbody>
</table>
Appendix A to Section 4 - SCPI Language

SCPI Command Summary (Contd.)

<table>
<thead>
<tr>
<th>COMMAND FORMAT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATus</td>
<td>Queries the operational condition register.</td>
</tr>
<tr>
<td>:OPERation:CONDition?</td>
<td></td>
</tr>
<tr>
<td>:OPERation:[EVEN]?</td>
<td>Queries the operation event register.</td>
</tr>
<tr>
<td>:OPERation:ENABle&lt;Nrf&gt;</td>
<td>Sets conditions in the operation status register.</td>
</tr>
<tr>
<td>:OPERation:ENABle?</td>
<td>Queries set conditions in operation status register.</td>
</tr>
<tr>
<td>:QUEStionable:CONDition?</td>
<td>Queries the questionable condition register.</td>
</tr>
<tr>
<td>:QUEStionable:[EVEN]?</td>
<td>Queries the questionable event register.</td>
</tr>
<tr>
<td>:QUEStionable:ENABle&lt;Nrf&gt;</td>
<td>Sets conditions in questionable status enable register.</td>
</tr>
<tr>
<td>:QUEStionable:ENABle?</td>
<td>Queries set conditions in questionable status register.</td>
</tr>
<tr>
<td>:PRESet</td>
<td>Resets the state of the STATus register.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYSTem</th>
<th>Query the next error in the error queue.</th>
</tr>
</thead>
<tbody>
<tr>
<td>:ERROR?</td>
<td>Causes DMM to switch to another command interpreter.</td>
</tr>
<tr>
<td>LANGUAGE NATive</td>
<td>Returns the version of SCPI to which the instrument conforms.</td>
</tr>
</tbody>
</table>

| TEST | Performs complete selftest. |
|:ALL]? | Performs a specific numbered test. |
| :VERSion? | |

| TRIGger | Trigger the DMM immediately |
|:IMMediate] | Sets the number of triggers. |
| :COUNT <numeric_value> | Query the count setting. |
| :COUNT? | |
| :DElay<numeric_value> | Sets the time delay between the trigger and the measure. |
| :AUTO<Boolean> | Selects default delay settings. |
| :DElay? | Queries the current trigger delay. |
| :SOURce BUS | Specify the trigger source. |
| :EXTernal | Query the trigger source setting. |
| :HOLD | |
| :IMMediate] | |
| TTLTrg<n> | |
| (n = 0 to 7) | |

Error Codes and Messages

The following is a table of error codes that have been implemented in the 1362S. The system errors all have negative values, the DMM specific errors have positive values.

<table>
<thead>
<tr>
<th>ERROR NUMBER &amp; MESSAGE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No error This message is reported when there are no more errors to report.</td>
</tr>
<tr>
<td>-100</td>
<td>Command error This is generated when the DMM parser detects an error in the command string, but which cannot be specified.</td>
</tr>
<tr>
<td>-101</td>
<td>Invalid Character A syntactic element contains a character which is invalid for that type.</td>
</tr>
<tr>
<td>-105</td>
<td>GET not allowed A Group Execute Trigger was received within a program message.</td>
</tr>
<tr>
<td>-120</td>
<td>Numeric data error An error has been detected in the numeric data string.</td>
</tr>
<tr>
<td>-200</td>
<td>Execution Error This is reported when the dmm has been asked to perform a task that it cannot do, but cannot report a more specific error.</td>
</tr>
<tr>
<td>-211</td>
<td>Trigger ignored Indicates that a GET or TRG signal was received but ignored for either editing or dmm setting reasons.</td>
</tr>
<tr>
<td>-213</td>
<td>Init Ignored An INIT was received when the dmm was already in the wait for trigger state.</td>
</tr>
<tr>
<td>-221</td>
<td>Settings Conflict The dmm has received a request for an operation and cannot perform this operation as the dmm is incorrectly configured. e.g. taking a measurement.</td>
</tr>
<tr>
<td>-222</td>
<td>Data out of range Indicates that the numeric value is outside the limit for the command it was sent, e.g. a negative time delay.</td>
</tr>
<tr>
<td>-230</td>
<td>Data corrupt or stale Invalid data, e.g. a FETCH? after a RST.</td>
</tr>
<tr>
<td>-241</td>
<td>Hardware missing An operation was requested that could not be performed because the option (e.g. Current) is not fitted.</td>
</tr>
<tr>
<td>-350</td>
<td>Queue Overflow This indicates that there is no more room available in the error queue.</td>
</tr>
<tr>
<td>100</td>
<td>Input not connected A measurement has been attempted without connecting to the signal input.</td>
</tr>
<tr>
<td>110</td>
<td>Calibration switch disabled. A calibration operation has been attempted without fully enabling the calibration security mechanism.</td>
</tr>
<tr>
<td>120</td>
<td>Calibration operation invalid An invalid calibration has been attempted.</td>
</tr>
<tr>
<td>122</td>
<td>Calibration operation failed This message is reported if the calibration operation was started but not completed.</td>
</tr>
</tbody>
</table>
### RST Condition

The following list indicates the state in which the instrument defaults following a reset (*RST*).

<table>
<thead>
<tr>
<th>SUBSYSTEM</th>
<th>KEYWORD</th>
<th>DEFAULT CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABORt</td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>CALibration</td>
<td>:HIGH?</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>:LOW?</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>:SECure</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>:SLFRequency?</td>
<td>Last Stored Value</td>
</tr>
<tr>
<td>CONFigure</td>
<td>:CURRent</td>
<td>CONF:CURR:DC 1, 1E-6, (@1)</td>
</tr>
<tr>
<td></td>
<td>:FRESistance</td>
<td>CONF:FRES 1E7, 1E2, (@1)</td>
</tr>
<tr>
<td></td>
<td>:RESistance</td>
<td>CONF:RES 1E7, 1E2, (@1)</td>
</tr>
<tr>
<td></td>
<td>:VOLTage</td>
<td>CONF:VOLT:DC 300, 1E-3, (@1)</td>
</tr>
<tr>
<td>CONFigure?</td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>FETCH?</td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>INITiate</td>
<td>[:IMMediate]</td>
<td>None</td>
</tr>
<tr>
<td>INPut</td>
<td>:COUPling</td>
<td>INP:COUP:AC</td>
</tr>
<tr>
<td></td>
<td>:FILTer[:LPASs][:STATe]</td>
<td>INP:FILT:LPAS:STAT OFF</td>
</tr>
<tr>
<td></td>
<td>:GUARD</td>
<td>INP:GUAR:LOW</td>
</tr>
<tr>
<td></td>
<td>[:STAT]</td>
<td>INP:STAT:OFF</td>
</tr>
<tr>
<td></td>
<td>ZERO</td>
<td>Unaffected.</td>
</tr>
<tr>
<td>MEASure</td>
<td>:CURRent</td>
<td>MEAS:CURR:DC 1,1E-6, (@1)</td>
</tr>
<tr>
<td></td>
<td>:FRESistance</td>
<td>MEAS:FRES 1E7, 1E2, (@1)</td>
</tr>
<tr>
<td></td>
<td>:RESistance</td>
<td>MEAS:RES 1E7, 1E2, (@1)</td>
</tr>
<tr>
<td></td>
<td>:VOLTage</td>
<td>MEAS:VOLT:DC 300, 1E-3, (@1)</td>
</tr>
<tr>
<td>OUTput</td>
<td>TTLTrg0</td>
<td>OUTP TTLTrg0[1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[:IMMediate]</td>
</tr>
<tr>
<td></td>
<td>:COUPling</td>
<td>SENS:CURR:DC 1, 1E-6, (@1)</td>
</tr>
<tr>
<td></td>
<td>:FRESistance</td>
<td>SENS:FRES 1E7, 1E2, (@1)</td>
</tr>
<tr>
<td></td>
<td>:RESistance</td>
<td>SENS:RES 1E7, 1E2, (@1)</td>
</tr>
<tr>
<td></td>
<td>:VOLTage</td>
<td>SENS:VOLT:DC 300, 1E-3, (@1)</td>
</tr>
<tr>
<td></td>
<td>:RANGe</td>
<td>SENS:&lt;function&gt;:RANG:AUTO OFF</td>
</tr>
<tr>
<td></td>
<td>:AUTO</td>
<td>SENS:FILTPAS:STAT OFF</td>
</tr>
<tr>
<td>STATus</td>
<td>:OPERation:CONDition?</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>:OPERation[:EVENt]?</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>:OPERation:ENABLE</td>
<td>Unaffected</td>
</tr>
<tr>
<td></td>
<td>:QUEStionable:CONDition?</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>:QUEStionable[:EVENt]?</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>:QUEStionable:ENABLE</td>
<td>Unaffected</td>
</tr>
<tr>
<td></td>
<td>:PRESet</td>
<td>See SCPI Specification.</td>
</tr>
<tr>
<td>SYSTEM</td>
<td>:ERROR?</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>:LANGE : NATive</td>
<td>SCPI Parser</td>
</tr>
<tr>
<td></td>
<td>:VERSion?</td>
<td>None</td>
</tr>
<tr>
<td>TEST</td>
<td>[:ALL]?</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>:TYPE?</td>
<td>None</td>
</tr>
<tr>
<td>TRIGger</td>
<td>[:IMMediate]</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>:COUNt</td>
<td>TRIG:COUN 1</td>
</tr>
<tr>
<td></td>
<td>:DELay</td>
<td>Default values (see Section 5; p5-21)</td>
</tr>
<tr>
<td></td>
<td>:AUTO</td>
<td>TRIG:DEL:AUTO ON</td>
</tr>
<tr>
<td></td>
<td>:SOURce</td>
<td>TRIG:SOUR IMM</td>
</tr>
</tbody>
</table>
Trigger Combinations

The table below outlines how the various triggers and trigger sources interrelate.

<table>
<thead>
<tr>
<th>Type/Mode</th>
<th>IMM</th>
<th>BUS</th>
<th>HOLD</th>
<th>EXT</th>
<th>TTL</th>
</tr>
</thead>
<tbody>
<tr>
<td>READ?[3]</td>
<td>1 reading taken and returned</td>
<td>-214, 'Trigger deadlock'</td>
<td>-213, 'Init ignored'</td>
<td>Holds bus until trigger occurs, then returns result.</td>
<td>Holds bus until trigger occurs, then returns result.</td>
</tr>
<tr>
<td>MEAS?[3]</td>
<td>1 reading taken and returned</td>
<td>-214, 'Trigger deadlock'</td>
<td>-213, 'Init ignored'</td>
<td>Holds bus until trigger occurs, then returns result.</td>
<td>Holds bus until trigger occurs, then returns result.</td>
</tr>
<tr>
<td>TRIG:IMM[2]</td>
<td>-211, 'Trigger ignored.'</td>
<td>1 reading taken and stored.</td>
<td>1 reading taken and stored.</td>
<td>1 reading taken and stored.</td>
<td>1 reading taken and stored.</td>
</tr>
<tr>
<td>TTL</td>
<td>No error, trigger ignored.</td>
<td>No error, trigger ignored.</td>
<td>No error, trigger ignored.</td>
<td>No error, trigger ignored.</td>
<td>1 reading taken and stored.</td>
</tr>
<tr>
<td>EXT</td>
<td>No error, trigger ignored.</td>
<td>No error, trigger ignored.</td>
<td>No error, trigger ignored.</td>
<td>1 reading taken and stored.</td>
<td>No error trigger ignored.</td>
</tr>
<tr>
<td>GET</td>
<td>-211, 'Trigger ignored.'</td>
<td>1 reading taken and stored.</td>
<td>-211, 'Trigger ignored.'</td>
<td>-211, 'Trigger ignored.'</td>
<td>-211, 'Trigger ignored.'</td>
</tr>
<tr>
<td>*TRG</td>
<td>-211, 'Trigger ignored.'</td>
<td>1 reading taken and stored.</td>
<td>-211, 'Trigger ignored.'</td>
<td>-211, 'Trigger ignored.'</td>
<td>-211, 'Trigger ignored.'</td>
</tr>
<tr>
<td>INIT[1]</td>
<td>1 reading taken and stored.</td>
<td>Enables this mode</td>
<td>Enables this mode</td>
<td>Enables this mode</td>
<td>Enables this mode</td>
</tr>
</tbody>
</table>

Notes:
1. TRIG:IMM will give an error or -211, 'Trigger ignored' if an INIT has not been received first.
2. If source is IMM, then an INIT will cause a measurement to be taken, putting the dmm back to IDLE state. Thus the TRIG:IMM command will always generate the -211, 'Trigger ignored' error.
3. If the DMM is in block mode, eg. TRIG:COUNt 5, then READ?/MEAS? will take 5 measurements in the TRIG:SOURce IMM mode. However, if TRIG:SOURce EXT|TTL is selected then 5 individual trigger pulses must be supplied before an answer is returned.

Also note that if in the TRIG:SOURce EXT|TTLn mode with a READ?/MEAS? command, it is not possible to send any further commands to the dmm as it is waiting for the triggers to arrive so it can respond with the data to the query. The only way out of this is by all of the triggers arriving or a Word Serial Clear command followed by ABORT or equivalent command to return the DMM to IDLE state.

Certain trigger modes will hold the Bus as defined under SCPI version 1991.0.

Trigger Timing Information.

The following information, along with associated diagrams, detail trigger characteristics. The 1362S will respond to external trigger pulses from either front panel BNC socket or VXI backplane trigger bus. Measurement complete triggers can only be generated on the VXI backplane.
IEEE 488.2 Programming Language

Introduction
As the instrument has to operate on the VXI bus, it is not in direct contact with the outside world and cannot conform fully to the IEEE 488.1 Hardware model. For example, in the IEEE 488.1 model, a separate (SRQ) line is provided for the instrument to request service from the controller.

A separate line for requesting service is not provided on the VXI bus, and to provide a similar facility, the VXI ‘request true’ syntax has to be programmed in software; thus a hardware difference imposes a departure from the standard programming model. Apart from such external constraints, the 1362 ‘Native Language’ conforms to the syntax rules of the IEEE 488.2 Standard programming model.

IEEE 488.2 defines sets of Mandatory Common Commands and Optional Common Commands along with a method of Standard Status Reporting. The 1362 conforms with all Mandatory Commands but not all Optional Commands, and conforms with the defined Status Reporting method.

Note: Commands prefaced by asterisk, (eg: *TRG) are standard-defined ‘Common’ commands.

VXI WSC and Effects
The VXI Word Serial ‘clear’ Message will force the following instrument states:

- the input buffer and output queue are cleared;
- parser is reset to the beginning of a message;
- any device-dependent message interlocks are cleared.

This command will not:

- change any settings or stored data within the instrument except as listed above;
- interrupt analog input;
- interrupt or affect any functions of the device;
- change the status byte.

*RST and Effects
The effects of the *RST command are described later on page 5-39.

Reset
A complete instrument reset is accomplished by the two reset commands in sequence. In other circumstances they may be used individually:

WS clear Message exchange initialization;
*RST Device initialization.

IEEE 488.2 Syntax Diagrams in this Section
The following notations describe the syntax diagrams used in this handbook.

Notation
- 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 and above them, which can also contain a separator such as a comma.
- When it is possible to bypass elements, a left-to-right path is shown around and below them.
- When there is a choice of elements, the path branches to the choices.

Hierarchy of Syntactic Elements
Messages are characterized by the presence of terminators, each of which seals the set of syntactic elements sent since the previous terminator to form a ‘Program Message’.
The Program Message
Each Program Message can 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 block named ‘Program Message Unit’ therefore represents either repeats of the same unit, or a set of different units, or a mixture of both. The starting circle is a device used only for the diagram; there is no requirement to use a special character to start a message, providing the previous message was correctly terminated. It is possible to send only the terminator as a complete Program Message (as shown by the forward bypass path), but this feature has little use when programming the 1362.

Character Usage
Notice that the names of some elements are shown here in italics. This agrees with the convention used on the syntax diagrams in this handbook, which sets ‘non-literal’ text (names given to particular elements) in italics, whereas ‘literal’ text (the actual characters to be sent, such as the semi-colon in the diagram) is shown in plain-text capitals.

Upper/Lower Case Equivalence
The plain-text capitals are not demanded by the standard, and the 1362 will not differentiate between upper and lower case characters in literal program text. Either or both can be used, mixed upper and lower case if this conveys an advantage.

Numeric Representation
Several commands and queries used for the 1362 require transmission and reception of numbers. Decimal formats are generally used.

For program data it insists that a device must accept the decimal ‘Flexible Numeric Representation (Nr/f)’, which is a flexible version of three numeric representations (Nr1, Nr2 and Nr3) defined by ANSI X3.42-1975 [2]. The 1362 complies.

Decimal numeric response data from the 1362 employs either Nr1 or Nr3 format, usage depending on the particular response. In this handbook, all syntax diagrams for query messages are accompanied by a paragraph which spells out the response format. Users are left in no doubt as to the construction of the response.
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

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

Use of phs

The Command Program Header

Several versions are defined by the IEEE 488.2 Standard document. The ‘Simple’, ‘Common’ and ‘Query’ headers are designed into the 1362, but not ‘Compound’ headers.

The asterisk (Common) and question mark (Query) are defined separately by the standard document, but as they are inseparable from the command, they are shown on the 1362 syntax diagrams in the same block as the program mnemonic. For example: the command for Full Selftest (*TST?) is shown in abbreviated format, not in full format.

Separators

Program header separator (phs)  
white space.

Program data separator (pds)  
a comma;  
or a comma preceded by, followed by, or both preceded and followed by white space.

Program message unit separator (pmus)  
a semi-colon;  
or a semi-colon preceded by white space.

'White Space'  
is any number of white space characters, which are:  
  hex  
    00-09, 0B-20  
  decimal  
    0-9, 11-32
**Program Data Elements**

Four versions of the defined program data elements are employed. They are emphasized in the following syntax diagrams, which are examples from the list of commands available for the 1362:

**Character**

![Character Diagram]

**Decimal Numeric**

![Decimal Numeric Diagram]

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

**Arbitrary Block**

![Arbitrary Block Diagram]

Both the ‘Definite’ and ‘Indefinite’ forms of arbitrary block may be used as specified in the Standard document, and described by the Syntax diagram above. The *user message* is limited to a maximum of 63 bytes. When the indefinite form of arbitrary block program data element is used, there is no exit to further message units. The program message must be terminated to inform the instrument that the block is complete.
Message Exchange

IEEE 488.2 Model
The IEEE 488.2 Standard document illustrates its Message Exchange Control Interface model at the detail level required by the device designer. Much of the information at this level of interpretation (such as the details of the internal signal paths etc.) is transparent to the application programmer. However, because each of the types of errors flagged in the Event Status Register are related to a particular stage in the process, a simplified 1362 interface model can provide helpful background. This is illustrated in Fig. 5.1, together with brief descriptions of the actions of its functional blocks.

1362 Message Exchange Model
Input/Output Control transfers messages from the 1362 output queue to the system bus; and conversely from the bus to either the input buffer, or other predetermined destinations within the device interface. It receives the Status Byte from the status reporting system, as well as the state of the Request Service bit which it imposes on bit 6 of the Status Byte response. Bit 6 reflects the ‘Request Service state true’ condition of the interface.

Incoming Commands and Queries
The Input Buffer is a first in - first out queue, which has a maximum capacity of 128 bytes (characters). Each incoming character in the I/O Control generates an interrupt to the instrument processor which places it in the Input Buffer for examination by the Parser. The characters are removed from the buffer and translated with appropriate levels of syntax checking. If the rate of programming is too fast for the Parser or Execution Control, the buffer will progressively fill up. When the buffer is full, the VXI Commander is informed by DIR being false. Refer to Section 3.

The Parser checks each incoming character and its message context for correct Standard-defined generic syntax, and correct device-defined syntax. Offending syntax is reported as a Command Error, by setting true bit 5 (CME) of the Standard-defined Event Status register (refer to the sub-section ‘Retrieval of Device Status Information’).

Execution Control receives successfully parsed messages, and assesses whether they can be executed, given the currently-programmed state of the 1362 functions and facilities. If a message is not viable (eg the calibration trigger: CALL? when calibration is not enabled); then an Execution Error is reported, by setting true bit 4 (EXE) of the Standard-defined Event Status register. Viable messages are executed in order, altering the 1362 functions, facilities etc. Execution does not ‘overlap’ commands; instead, the 1362 Execution Control processes all commands ‘sequentially’ (ie. waits for actions resulting from the previous command to complete before executing the next).

1362 Functions and Facilities
The 1362 Functions and Facilities block contains all the device-specific functions and features of the 1362, accepting Executable Message Elements from Execution Control and performing the associated operations. It responds to any of the elements which are valid Query Requests (both IEEE 488.2 Common Query Commands and 1362 Device-specific Commands) by sending any required Response Data to the Response Formatter (after carrying out the assigned internal operations).

Device-dependent errors are detected in this block. Bit 3 (DDE) of the Standard-defined Event Status register is set true when an internal operating fault is detected, for instance during a self test. Each reportable error has a listed number, which is appended to an associated queue as the error occurs.

Trigger Control
Two types of message are used to trigger the 1362 A-D into taking a measurement:

- A Word Serial 'trigger' *TRG (IEEE 488.2-defined)

In the 1362 either message is passed through the Input Buffer, receiving the same treatment as a program message unit, being parsed and executed as normal.

Outgoing Responses
The Response Formatter derives its information from Response Data (being supplied by the Functions and Facilities block) and valid Query Requests. From these it builds Response Message Elements, which are placed as a Response Message into the Output Queue.

The Output Queue acts as a store for outgoing messages until they are read over the system bus by the application program. For as long as the output queue holds one or more bytes, it reports the fact by setting true bit 4 (Message Available - MAV) of the Status Byte register. Bit 4 is set false when the output queue is empty (refer to the sub-section ‘Retrieval of Device Status Information’). The 'DOR' bit set performs the same action. Refer to Section 3.

‘Query Error’
This is an indication that the controller is following an inappropriate message exchange protocol, resulting in the Interrupted, Unterminated or Deadlocked condition:

Refer to ‘Bit 2’ on page 5-12.

The Standard document defines the 1362’s response, part of which is to set true bit 2 (QYE) of the Standard-defined Event Status register.
Request Service (RQS)

Reasons for Requesting Service
There are two main reasons for the application program to request service from the controller:

- When the 1362 message exchange interface discovers a system programming error;
- When the 1362 is programmed to report significant events by RQS.

The significant events vary between types of devices; thus there is a class of events which are known as ‘Device-Specific’. These are determined by the device designer.

IEEE 488.2 Model
The application programmer can enable or disable the event(s) which are required to originate an RQS at particular stages of the application program. The IEEE 488.2 model incorporates a flexible extended status reporting structure in which the requirements of the device designer and application programmer are both met.

This structure is described in the next sub-section, dealing with ‘Retrieval of Device Status Information’.

Fig. 5.1 1362 Message Exchange Model
Retrieval of Device Status Information

Introduction

For any remotely-operated system, the provision of up-to-date information about the performance of the system is of major importance. This is particularly so in the case of systems which operate under automatic control, as the controller requires the necessary information feedback to enable it to progress the programmed task, and any break in the continuity of the process can have serious results.

When developing an application program, the programmer needs to test and revise it, knowing its effects. Confidence that the program elements are couched in the correct grammar and syntax (and that the program commands and queries are thus being accepted and acted upon), helps to reduce the number of iterations needed to confirm and develop the viability of the whole program. So any assistance which can be given in closing the information loop must benefit both program compilation and subsequent use.

**Note:** The registers use binary weighting - the numbers in the boxes are bit numbers, not weighted values.

![Fig. 5.2 1362 Status Reporting Structure](image)
Standard-Defined Features

Types of Status Information Available
Two main categories of information are provided for the controller:

Status Summary Information
Certain standard events are flagged in the 8-bit latched ‘Event Status Register’ (ESR), read-accessible to the controller. The user’s application program can also access its associated enabling register, to program the events which will be eligible to activate the ‘ESB’ summary bit in the Status Byte.

Status Byte Register
Contained within the ‘Status Byte Register’, the ‘Status Byte’ (STB) consists of three flag bits which direct the controller’s attention to the type of event which has occurred. One is the ESB bit mentioned above, the other two (MAV and MSS) are described in detail later.

Access via the Application Program
The application designer has access to two enable registers (one for each main register - Fig. 5-2). The application program can enable or disable any individual bit in these registers.

Each bit in the event status register remains in false condition unless its assigned event occurs, when its condition changes to true. If an event is to be reported, the application program sets its corresponding enable bit true, using the number Nrf (defined as a decimal numeric from 0 to 255 in any common format). Then when the enabled event occurs and changes the enabled bit from false to true, the ESB summary bit in the Status Byte is also set true. If the ESB bit is also enabled, then the 1362 will generate a request true event on the VXI bus.

Thus the application programmer can decide which assigned events will generate an event, by enabling their event bits and then enabling the ESB bit in the Status Byte. The application program can read the Status Byte, and be directed to the Event Register to discover which event was responsible for originating the request.

All registers can be read by suitable commands, as an ASCII decimal numeric, which when expressed in binary, represents the bit pattern in the register. This form is also used to set the enabling registers to the required bit-patterns. The detail for each register is expanded in the following paragraphs, and in the command descriptions.
1362 Status Reporting - Detail

IEEE 488.2 Model
This incorporates the two aspects of the IEEE 488.1 model into an extended structure with more definite rules. These rules invoke the use of standard ‘Common’ messages and provide for device-dependent messages. A feature of the structure is the use of ‘Event’ registers, each with its own enabling register as illustrated in Fig. 5.2.

1362 Model Structure
The IEEE 488.2 Standard provides for an extensive hierarchical structure with the Status Byte at the apex, defining its bits 4, 5 and 6 and their use as summaries of a Standard-defined event structure which must be included, if the device is to claim conformance with the Standard. The 1362 employs these bits as defined in the Standard.

Bits 0, 1, 2 and 3 and 7 are made available to the device designer, but are not used in the 1362.

It must be recognized by the application programmer that whenever the controller reads the Status Byte, it can only receive summaries of types of events, and further query messages are necessary to dig deeper into the detailed information relating to the events themselves. Thus a further byte is used to expand on the summary at bit 5 of the Status Byte.

Status Byte Register
In this structure the Status Byte is held in the ‘Status Byte Register’; the bits being allocated as follows:

- **Bit 4 (DIO5)** IEEE 488.2-defined Message Available Bit (MAV)
The MAV bit helps to synchronize information exchange with the controller. It is true when the 1362 message exchange interface is ready to accept a request from the controller to start outputting bytes from the Output Queue; or false when the Output Queue is empty.

The common command *CLS can clear the Output Queue, and the MAV bit 4 of the Status Byte Register; providing it is sent immediately following a ‘Program Message Terminator’.

- **Bit 5 (DIO6)** IEEE 488.2-defined Standard Event Summary Bit (ESB)
Summarizes the state of the ‘Event Status byte’, held in the ‘Event Status register’ (ESR), whose bits represent IEEE 488.2-defined conditions in the device. The ESB bit is true when the byte in the ESR contains one or more enabled bits which are true; or false when all the enabled bits in the byte are false. The byte, the Event Status Register and its enabling register are defined by the IEEE 488.1 Standard; they are described later.

- **Bit 6 (DIO7)** is the Master Status Summary Message (MSS bit), and is set true if one of the bits 0 to 4 or bit 5 is true (bits 0 to 3 and bit 7 are always false in the 1362).

- **Bit 7 (DIO8)** is not used in the 1362 status byte. It is always false.

Reading the Status Byte Register

- **STB?**
Either the common query: *STB?, or the VXI word serial 'read STB' command (Section 3), reads the binary number in the Status Byte register. The response is in the form of a decimal number which is the sum of the binary weighted values in the enabled bits of the register. In the 1362, the binary-weighted values of bits 1, 2, 3 and 7 are always zero.
Service Request Enable Register
The SRE register is a means for the application program to select, by enabling individual Status Byte summary bits, those types of events which are to cause the 1362 to originate an RQS. It contains a user-modifiable image of the Status Byte, whereby each true bit acts to enable its corresponding bit in the Status Byte.

Bit Selector: *SRE phs Nrf
The program command: *SRE phs Nrf performs the selection, where Nrf is a decimal numeric, which when decoded into binary produces the required bit-pattern in the enabling byte.

For example:
If an RQS is required only when a Standard-defined event occurs and when a message is available in the output queue, then Nrf should be set to 48. The binary decode is 00110000 so bit 4 or bit 5, when true, will generate an RQS; but even when bit 0 or bit 6 is true, no RQS will result. The 1362 always sets the Status Byte bits 1, 2, 3 and 7 false, so they can never originate an RQS whether enabled or not.

Reading the Service Request Enable Register
The common query: *SRE? reads the binary number in the SRE register. The response is in the form of a decimal number which is the sum of the binary-weighted values in the register. The binary-weighted values of bits 1, 2, 3 and 7 are always zero.

VXIbus Implementation
An RQS is implemented as a 'request true' event on the VXIbus. Refer to Section 3.
IEEE 488.2-defined Event Status Register

The ‘Event Status Register’ holds the Event Status Byte, consisting of event bits, each of which directs attention to particular information. All bits are ‘sticky’; i.e. once true, cannot return to false until the register is cleared. This occurs automatically when it is read by the query: *ESR?. The common command *CLS clears the Event Status Register and associated error queues, but not the Event Status Enable Register. The bits are named in mnemonic form as follows:

Bit 0 Operation Complete (OPC)
This bit is true only if *OPC has been programmed and all selected pending operations are complete. As the 1362 operates in serial mode, its usefulness is limited to registering the completion of long operations, such as self-test.

Bit 1 Request Control (RQC)
This bit would be true if the device were able to assume the role of controller, and is requesting that control be transferred to it from the current controller. This capability is not available in the 1362, so bit 1 is always false.

Bit 2 Query Error (QYE)
QYE true indicates that the controller is following an inappropriate message exchange protocol, resulting in the following situations:

- **Interrupted Condition.** When the 1362 has not finished outputting its Response Message to a Program Query, and is interrupted by a new Program Message.

- **Unterminated Condition.** When the controller attempts to read a Response Message from the 1362 without having first sent the complete Query Message (including the Program Message Terminator) to the instrument.

- **Deadlocked Condition.** When the input and output buffers are filled, with the parser and the execution control blocked.

Bit 3 Device Dependent Error (DDE)
DDE is set true when an internal operating fault is detected, for instance during a self test. Each reportable error has been given a listed number, which is appended to an associated queue as the error occurs. The queue is read destructively as a First In Last Out stack, using the query command DDQ? to obtain a code number. The DDE bit is not a summary of the contents of the queue, but is set or confirmed true concurrent with each error as it occurs; and once cleared by *ESR? will remain false until another error occurs. The query DDQ? can be used to read all the errors in the queue until it is empty, when the code number zero will be returned. The common command *CLS clears the queue.

Bit 4 Execution Error (EXE)
An execution error is generated if the received command cannot be executed, owing to the device state or the command parameter being out of bounds.

Bit 5 Command Error (CME)
CME occurs when a received bus command does not satisfy the IEEE 488.2 generic syntax or the device command syntax programmed into the instrument interface’s parser, and so is not recognized as a valid command.

Bit 6 User Request (URQ)
This bit is set true when, in block measurement mode, the number of measurements programmed for the block measurement have been completed.

Bit 7 1362 Power Supply On (PON)
This bit is not required in the VXI subsystem.
Standard Event Status Enable Register
The ESE register is a means for the application program to select, from the positions of the bits in the standard-defined Event Status Byte, those events which when true will set the ESB bit true in the Status Byte. It contains a user-modifiable image of the standard Event Status Byte, whereby each true bit acts to enable its corresponding bit in the standard Event Status Byte.

Bit Selector: *ESE phs Nrf
The program command: *ESE phs Nrf performs the selection, where Nrf is a decimal numeric, which when decoded into binary, produces the required bit-pattern in the enabling byte.

For example:
If the ESB bit is required to be set true only when an execution or device-dependent error occurs, then Nrf should be set to 24. The binary decode is 00011000 so bit 3 or bit 4, when true, will set the ESB bit true; but when bits 0-2, or 5-7 are true, the ESB bit will remain false.

Reading the Standard Event Enable Register
The common query: *ESE? reads the binary number in the ESE register. The response is in the form of a decimal number which is the sum of the binary-weighted values in the register.
1362 Native Language - IEEE 488.2 Command Syntax Diagrams

Select DC Voltage measurement mode, range, filter and accuracy

Nrf is a decimal numeric value used to select the range. Thus for a modulus value of Nrf:

- Ø to Ø.1999999 selects the 100mV range.
- Ø.2 to 1.999999 selects the 1V range.
- 2Ø to 19.99999 selects the 10V range.
- 2Ø to 199.9999 selects the 100V range.
- >2ØØ selects the 300V range.

Excessive digits in Nrf are rounded to 6.5 digits.

AUTO selects the autorange facility. When in AUTO, the DMM attempts to select the most appropriate range, moving up-range on overload and down-range on less than 18% of range. If there is still an overload on the 300V range, then a measurement error will be generated.

A valid Nrf deselects the AUTO mode.

Note: On exit from this function the states of the range, filter and resolution are stored.

On return to this function, these settings are recalled and used as default unless explicitly specified.

FILT0 inserts the analog filter.

The NMR is 74dB @ 50Hz/60Hz ±0.1%.

FILT1 removes the analog filter.

The NMR is 54dB @ 50Hz/60Hz ±0.1%.

RESL4 sets resolution and A-D performance to 4.5 digits.

RESL5 sets resolution and A-D performance to 5.5 digits.

RESL6 sets resolution and A-D performance to 6.5 digits.

At Power On or Reset, the default: DCV (300V) RESL6 FILT0 is selected and active.
Select DC Current measurement mode, range, filter and accuracy

The 1A range is the only range available.

**FILT1** inserts the analog filter.
- The NMRR is 74dB @ 50Hz/60Hz ±0.1%.

**FILT0** removes the analog filter.
- The NMRR is 54dB @ 50Hz/60Hz ±0.1%.

**RESL4** sets resolution and A-D performance to 4.5 digits.

**RESL5** sets resolution and A-D performance to 5.5 digits.

**RESL6** sets resolution and A-D performance to 6.5 digits.

At **Power On** or **Reset**, the default:

**DCI RESL5 FILT0**

is selected but not active.

An **Execution Error** is generated if the instrument is not fitted with Option 30.

Note: On exit from this function the states of the filter and resolution are stored.
- On return to this function, these settings are recalled and used as default unless explicitly specified.
Select AC Voltage measurement mode, range, filter and accuracy

**Nrf** is a decimal numeric value used to select the range. Thus for a modulus value of Nrf:

- Ø to Ø.199999 selects the 100mV range.
- Ø.2 to 1.99999 selects the 1V range.
- 2Ø to 19.9999 selects the 10V range.
- 2Ø to 199.999 selects the 100V range.
- >2ØØ selects the 300V range.

Excessive digits in Nrf are rounded to 5.5 digits.

**AUTO** selects the autorange facility. When in AUTO, the DMM attempts to select the most appropriate range, moving up-range on overload and down-range on less than 18% of range. If there is still an overload on the 300V range, then a measurement error will be generated.

A valid Nrf deselects the AUTO mode.

**FILT1** inserts the analog filter.

**FILTØ** removes the analog filter.

**RESL4** sets resolution and A-D performance to 4.5 digits.

**RESL5** sets resolution and A-D performance to 5.5 digits.

**DCCP** DC-coupled.

**ACCP** AC-coupled.

**Filter Combinations:**

- FILTØ and ACCP: >360Hz; AC-coupled.
- FILTØ and DCCP: >360Hz; DC-coupled.
- FILT1 and ACCP: >40Hz; AC-coupled.
- FILT1 and DCCP: >10Hz; DC-coupled.

At **Power On** or **Reset**, the default:

ACV (300V) RESL5 FILTØ ACCP

is selected but not active.

**Note:** On exit from this function the states of the range, filter, resolution and coupling are stored.

On return to this function, these settings are recalled and used as default unless explicitly specified.
Select AC Current measurement mode, range, filter and accuracy

The 1A range is the only range available.

**FILT1** inserts the analog filter.
**FILTØ** removes the analog filter.
**RESL4** sets resolution and A-D performance to 4.5 digits.
**RESL5** sets resolution and A-D performance to 5.5 digits.
**DCCP** DC-coupled.
**ACCP** AC-coupled.

**Filter Combinations:**
- **FILTØ** and **ACCP**: >360Hz; AC-coupled.
- **FILTØ** and **DCCP**: >360Hz; DC-coupled.
- **FILT1** and **ACCP**: >40Hz; AC-coupled.
- **FILT1** and **DCCP**: >10Hz; DC-coupled.

At **Power On** or **Reset**; the default:

```
ACI RESL5 FILTØ ACCP
```

is selected but not active.

An **Execution Error** is generated if the instrument is not fitted with Option 30.

Note: On exit from this function the states of the filter, resolution and coupling are stored.
On return to this function, these settings are recalled and used as default unless explicitly specified.
Select Ohms measurement mode, range, filter and accuracy

**Nrf** is a decimal numeric value used to select the range. Thus for a modulus value of Nrf:

- Ø to 199.999 selects the 100Ω range.
- 20Ø to 1999.99 selects the 1kΩ range.
- 200Ø to 19999.9 selects the 10kΩ range.
- 2000Ø to 1999999 selects the 100kΩ range.
- 2ØØØØØ selects the 1MΩ range.
- >2ØØØØØØ selects the 10MΩ range.

Excessive digits in Nrf are rounded to 6.5 digits.

**AUTO** selects the autorange facility. When in AUTO, the DMM attempts to select the most appropriate range, moving up-range on overload and down-range on less than 18% of range. If there is still an overload on the 10MΩ range, then a measurement error will be generated.

A valid Nrf deselects the AUTO mode.

**FILT1** inserts the analog filter.
- The NMRR is 74dB @ 50Hz/60Hz ±0.1%.

**FILT0** removes the analog filter.
- The NMRR is 54dB @ 50Hz/60Hz ±0.1%.

**RESL4** sets resolution and A-D performance to 4.5 digits.

**RESL5** sets resolution and A-D performance to 5.5 digits.

**RESL6** sets resolution and A-D performance to 6.5 digits.

**WIRE2** - Two-wire input connection.

**WIRE4** - Four-wire input connection.

At **Power On** or **Reset**, the default: `OHMS (10MΩ) RESL6 FILT0 WIRE4` is selected but not active.

Note: On exit from this function the states of the range, filter resolution and 2/4 wire connection are stored.

On return to this function, these settings are recalled and used as default unless explicitly specified.

### 2-Wire Measurements

For the majority of applications the simple 2-wire arrangement will be adequate. However, the value displayed will include the resistance of the connecting leads.

Use a twisted pair cable to reduce induced voltages, particularly where Rx is high.

### 4-wire Measurements

With a 4-wire connection the lead resistances have negligible effect and only the value of Rx is displayed.
Select an input port and the ratio mode

All of the above selections are mutually exclusive.

**OFF** disconnects all inputs.

**CH_A** selects Channel A inputs (See Sect. 2 p2-3).

Option 40 Selections:

**CH_B** selects Channel B inputs (See Sect. 2 p2-3).

**ADIVB** takes readings from Channel A and Channel B input alternately, then divides the Channel A reading by the Channel B reading to produce the result.

**ASUBB** takes readings from Channel A and Channel B input alternately, then subtracts the Channel B reading from the Channel A reading to produce the result.

**DEVTN** takes readings from both channels A and B. The resulting deviation data obtained from this mode is of the form:

\[
\frac{A - B}{B}
\]

At Power On or Reset; the default: **INPUT OFF** is selected and active.

An **Execution Error** is generated if the instrument is not fitted with Option 40, together with an attempt being made to select **CH_B, ADIVB, ASUBB** or **DEVTN**.

Select Local or Remote Guard

The above selections are mutually exclusive.

**LCL** Internal guard tracks and shields are internally connected to Signal Common. The Guard pins of the front panel Input plug are open circuit.

**REM** Internal guard tracks and shields are disconnected from Signal Common, and connected to the selected channel's Guard pin on the front panel Analog Input plug (Ch A - pin 7; Ch B - pin 9).

At Power On or Reset; the default: **GUARD LCL** is selected and active.
Perform Input Zero
This command is used to remove the offsets at zero input. To ensure true zero input, the front panel input plug Hi and Lo pins must be shorted together. Channels A (Hi - pin 1; Low - pin 5) and B (option 40 only - Hi - pin 15; Low - pin 11) are zeroed separately, and only the selected channel is zeroed.
The corrections are held in volatile memory, but are cleared only on power down.

Response:
Ø t No errors present.
1 t Errors present.

Where: \( t = ; \) or \(<\text{If}>\)

If any errors are present, the relevant error codes are placed in a queue which is accessible using the request DDQ?.
(See *TST? on page 5-28.)

Note: ZERO? is not accepted in Autorange, or in any AC function. In these cases an Execution Error is generated.

Select Trigger Source
This command selects either the 'System' or an external trigger to initiate a measurement.

If SYS is selected, then measurements can be taken using *TRG; X?; or the VXI word serial trigger command.

If EXT is selected, then measurements will be taken on receipt of suitable hardware triggers from the front panel BNC connector.

At Power On or Reset; the default:

**TSRCE SYS**

is selected and active.
Section 5 - Native Language

Select a Trigger Delay

This command sets the time delay between the trigger being received and the start of the analog-to-digital conversion.

DFLT
Each measurement mode and function has its own default delay setting (fixed in firmware) which will be used if DFLT is selected.

Nrf
This is a decimal numeric value used to set the delay time. Its basic units are seconds.

The span of the Nrf delay counter is from 0 to 10s. An Nrf of greater than 10s results in a delay of 10s. For shorter delays, the resolution of the intervals between delay-time settings is dependent on the size of the memory used to store the delay-time data. This is as follows:

<table>
<thead>
<tr>
<th>Delay Selection</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤10ms</td>
<td>10µs</td>
</tr>
<tr>
<td>≤100ms</td>
<td>100µs</td>
</tr>
<tr>
<td>≤1s</td>
<td>1ms</td>
</tr>
<tr>
<td>≤10s</td>
<td>10ms</td>
</tr>
</tbody>
</table>

If a fast read-rate is required, then Nrf must be used and set to zero.

Once a non-default delay is set, it remains set until either a new Nrf is set or DFLT is selected, even if there is a range or function change. However, the default delay will be forced when there is an update during a measurement cycle, such as when autoranging or switching channels in Ratio mode.

At Power On or Reset: the default:

<table>
<thead>
<tr>
<th>DELAY DFLT</th>
</tr>
</thead>
</table>

is selected and active.

1362 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 until either the DELAY DFLT command is received, or the instrument is returned to local control. Delays then return to their default values.

<table>
<thead>
<tr>
<th>DCV, DCI, ACV &amp; ACI</th>
<th>Defaut Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCV &amp; DCI</td>
<td></td>
</tr>
<tr>
<td>Out</td>
<td>5ms</td>
</tr>
<tr>
<td>In</td>
<td>300ms</td>
</tr>
<tr>
<td>ACV &amp; ACI</td>
<td></td>
</tr>
<tr>
<td>Out</td>
<td>200ms</td>
</tr>
<tr>
<td>In</td>
<td>500ms</td>
</tr>
<tr>
<td></td>
<td>(2.5 secs if dccp selected)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ohms</th>
<th>Range</th>
<th>Filt.</th>
<th>Default Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100Ω - 100kΩ</td>
<td>Out</td>
<td>5ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In</td>
<td>750ms</td>
</tr>
<tr>
<td></td>
<td>1MΩ</td>
<td>Out</td>
<td>300ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In</td>
<td>1s</td>
</tr>
<tr>
<td></td>
<td>10MΩ</td>
<td>Out</td>
<td>300ms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In</td>
<td>10s</td>
</tr>
</tbody>
</table>
Perform a System Trigger

An Execution Error is generated if an input channel is not connected.

Fetch the Last Reading

Response for 4.5 digit resolution is an Nrf:
$$1 2 3 4 5 6 7 8 9 10 11 12 \quad s \ n \ x \ x \ x \ n \ n \ E \ s \ n \ n \ t$$

Response for 5.5 digit resolution is an Nrf:
$$1 2 3 4 5 6 7 8 9 10 11 12 13 \quad s \ n \ x \ x \ x \ n \ n \ n \ E \ s \ n \ n \ t$$

Response for 6.5 digit resolution is an Nrf:
$$1 2 3 4 5 6 7 8 9 10 11 12 13 14 \quad s \ n \ x \ x \ x \ n \ n \ n \ n \ E \ s \ n \ n \ t$$

Where:
- $s$ = the sign: + or -.
- $n$ = ASCII digit $0$ to $9$.
- $x$ = either $n$ or an ASCII decimal point.
- $E$ = ASCII character identifying the exponent.
- $t$ = ; or $<lf>$ (= line feed).

Response for Overload: 200.0000E+33 t

The normal response is the most-recent measurement, which is read but not destroyed.

If a request is received while the DMM analog-to-digital conversion is still in progress; then that conversion is allowed to complete, and its result is given as the response.

If RDG? is sent when no trigger has been received since Power On or Reset, the following response is generated:

-20.0000E+36 t

Where: $t$ = ; or $<lf>$
Perform a System Trigger and output the result

Response: \( \text{Response: } 200\,000\,000\times 33 \text{ t } \) Overload.
Where: \( t = ; \text{ or } <\text{If}> \) if this is a single query command or the last message in a multiple query command.

This command terminates any BLOCK measurement in progress.

An **Execution Error** is generated if an input channel is not connected.
A response is also generated:

**Response with Execution Error:** \( 20,000\,000\times 36 \text{ t } \)
Where: \( t = ; \text{ or } <\text{If}> \)
Status Reporting

Status Byte and Event Status Registers

**Read Event Status Register**

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

**ESR?**

recalls the standard defined events.

**Response Format:**

- **Character position:** 1 2 3 4
- **n n n nl**

**Where:**

- n = 0 to 9
- nl = newline

**Response Decode:**

The value returned, when converted to base 2 (binary), identifies the bits as described on page 5-12, and defined in the IEEE 488.2 standard.

**Execution Errors:**

None

**Power On and Reset Conditions**

The register is cleared.
Event Status Enable
This event status data structure conforms to the IEEE 488.2 standard requirements for this structure.

∗ESE enables the standard defined event bits which will generate a summary message in the status byte.

Nrf is a Decimal Numeric Data Element representing an integer decimal value equivalent to the Hex value required to enable the appropriate bits in this 8-bit register. Note that numbers will be rounded to an integer.

Execution Errors:
None.

Power On and Reset Conditions
Not applicable.

Recall Event Status Enable
This event status data structure conforms to the IEEE 488.2 standard requirements for this structure.

∗ESE? recalls the enable mask for the standard defined events.

Response Format:
Character position
1 2 3 4
n n n nl

Where:
n = 0 to 9
nl = newline

Response Decode:
The value returned, when converted to base 2 (binary), identifies the enabled bits which will generate a summary message in the service request byte, for this data structure.

Execution Errors:
None

Power On and Reset Conditions
The register is cleared.
Service Request Enable
This measurement event status data structure conforms to the IEEE 488.2 standard requirements for this structure.

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

Nrf is a Decimal Numeric Data Element representing an integer decimal value equivalent to the Hex value required to enable the appropriate bits in this 8-bit register. Note that numbers will be rounded to an integer.

Execution Errors:
None.

Power On and Reset Conditions
Not applicable.

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

*SRE? recalls the enable mask for the standard defined events.

Response Format:
Character position
1 2 3 4
n n n nl

Where:
n = 0 to 9
nl = newline

Response Decode:
The value returned, when converted to base 2 (binary), identifies the enabled bits which will generate a service request.

Execution Errors:
None.

Power On and Reset Conditions
None.
Read Service Request Register
This measurement event status data structure conforms to the IEEE 488.2 standard requirements for this structure.

*STB?
recalls the service request register for summary bits.

**Response Format:**

<table>
<thead>
<tr>
<th>Character position</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  2  3  4</td>
</tr>
<tr>
<td>n  n  n  nl</td>
</tr>
</tbody>
</table>

**Where:**

- n = 0 to 9
- nl = newline

**Response Decode:**
The value returned, when converted to base 2 (binary), identifies the summary bits for the current status of the data structures involved. There is no method of clearing this byte directly. Its condition relies on the clearing of the overlying status data structure.

**Execution Errors:**
None.

**Power On and Reset Conditions**
Not applicable.

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

*CLS
clears all the event registers and queues except the output queue.

**Power On and Reset Conditions**
The output queue and MAV bit will be cleared if *CLS immediately follows a Program Message Terminator.

**Execution Errors:**
None.
Perform Selftest

![TST? Button]

Response code:
- Ø t  Indicates test complete with no errors.
- 1 t  Indicates test complete with errors detected.

Where:
- t = ; or <lf> (= line feed).

In the event of an error, the DDE bit in the Event Status Register will be set. An identifying number will be placed in the associated error queue. The error number can be read using the DDQ? query.

Recall Device Errors

![DDQ? Button]

Recalls the last error from the queue of device-dependent errors.

Response:
- n n n t

Where:
- n = ASCII digit Ø to 9.
- t = ; or <lf> (= line feed).

Errors relating to the numbers returned:

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø</td>
<td>queue empty</td>
</tr>
<tr>
<td>1ØØ</td>
<td>A/D transfer; bad data</td>
</tr>
<tr>
<td>1Ø1</td>
<td>Internal calculation error</td>
</tr>
<tr>
<td>1Ø2</td>
<td>System queue overflow</td>
</tr>
<tr>
<td>15Ø</td>
<td>Calibration measurement overflow</td>
</tr>
<tr>
<td>151</td>
<td>Calibration constants corrupt</td>
</tr>
<tr>
<td>152</td>
<td>Illegal cal store access</td>
</tr>
<tr>
<td>153</td>
<td>Invalid non-nominal calibration value</td>
</tr>
<tr>
<td>16Ø</td>
<td>Illegal test number</td>
</tr>
<tr>
<td>17Ø</td>
<td>Corrupt Default Line Frequency</td>
</tr>
<tr>
<td>50Ø</td>
<td>Selftest: +10V DC</td>
</tr>
<tr>
<td>501</td>
<td>Selftest: -10V DC</td>
</tr>
<tr>
<td>505</td>
<td>Selftest: -10V DC filter</td>
</tr>
<tr>
<td>506</td>
<td>Selftest: +10V DC filter</td>
</tr>
<tr>
<td>507</td>
<td>Selftest: +10V DC filter</td>
</tr>
<tr>
<td>51Ø</td>
<td>Selftest: +1V DC</td>
</tr>
<tr>
<td>515</td>
<td>Selftest: +100mV DC</td>
</tr>
<tr>
<td>52Ø</td>
<td>Selftest: divider check</td>
</tr>
<tr>
<td>53Ø</td>
<td>Selftest: +10V AC</td>
</tr>
<tr>
<td>531</td>
<td>Selftest: -10V AC</td>
</tr>
<tr>
<td>532</td>
<td>Selftest: +1V AC</td>
</tr>
<tr>
<td>533</td>
<td>Selftest: +100mV AC</td>
</tr>
<tr>
<td>535</td>
<td>Selftest: 10V zero filter</td>
</tr>
<tr>
<td>536</td>
<td>Selftest: +10V filter</td>
</tr>
<tr>
<td>537</td>
<td>Selftest: +10V filter</td>
</tr>
<tr>
<td>54Ø</td>
<td>Selftest: 1kΩ</td>
</tr>
<tr>
<td>541</td>
<td>Selftest: 10kΩ</td>
</tr>
<tr>
<td>542</td>
<td>Selftest: 100kΩ</td>
</tr>
<tr>
<td>543</td>
<td>Selftest: 1MΩ</td>
</tr>
<tr>
<td>55Ø</td>
<td>Selftest: Current fuse</td>
</tr>
<tr>
<td>551</td>
<td>Selftest: AC preamp offset</td>
</tr>
<tr>
<td>552</td>
<td>Selftest: AC/DC Relay</td>
</tr>
</tbody>
</table>
Enable calibration mode

An Execution Error is generated if the external cal switch is not in the enabled position (Up) when this command is received.

Perform an Autocalibration

If CALL? is selected, then the operation will correct the zero point (generally the 1% point for AC) in the two-point calibration.

If CALH? is selected, then the operation will correct the Full Range point in the two-point calibration.

If Nrf is present, then the operation will use its value as the non-nominal target in the requested calibration.

Response:

<table>
<thead>
<tr>
<th>Ø t</th>
<th>Calibration complete with no errors.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 t</td>
<td>Calibration complete but with errors present.</td>
</tr>
</tbody>
</table>

Where: \( t = \); or <lf>

Execution Errors:
Calibration can only be executed if the following conditions are met:

1. The external cal switch must be in the enable position (Up), and the calibration mode must have been turned on by sending the CAL ON command; before this command is received.

If either of these conditions is not fulfilled, then an execution error will be generated.

2. When an Nrf is used, it must be compatible with the setting to be calibrated.

If an Nrf is present, but it is not compatible with the setting; then an execution error will be generated.
Recall Calibration Constants

Response Code:

\[\begin{array}{c}
1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 13 & 14 \\
\text{s} & \text{n} & \text{x} & \text{x} & \text{x} & \text{n} & \text{n} & \text{n} & \text{n} & \text{E} & \text{s} & \text{n} & \text{n} \\
\text{s} & \text{n} & \text{x} & \text{x} & \text{x} & \text{n} & \text{n} & \text{n} & \text{n} & \text{E} & \text{s} & \text{n} & \text{n} \\
29 & 30 & 31 & 32 & 33 & 34 & 35 & 36 & 37 & 38 & 39 & 40 & 41 & 42 \\
\text{s} & \text{n} & \text{x} & \text{x} & \text{x} & \text{n} & \text{n} & \text{n} & \text{n} & \text{E} & \text{s} & \text{n} & \text{n} & \text{t}
\end{array}\]

Where:
- \(s\) = the sign: + or -.
- \(n\) = ASCII digit 0 to 9.
- \(x\) = either \(n\) or an ASCII decimal point.
- \(E\) = ASCII character identifying the exponent.
- \(t\) = ; or <lf> (= line feed).

The numbers returned relate only to the currently-selected function and range. The first number is the positive gain factor, the second is the negative gain factor, and the third is the zero offset. For AC and Ohms functions, the negative gain factor returned is always unity.

Recall A/D Calibration Constants

Response Code:

\[\begin{array}{c}
1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 & 13 & 14 \\
\text{s} & \text{n} & \text{x} & \text{x} & \text{x} & \text{n} & \text{n} & \text{n} & \text{n} & \text{E} & \text{s} & \text{n} & \text{n} \\
\text{s} & \text{n} & \text{x} & \text{x} & \text{x} & \text{n} & \text{n} & \text{n} & \text{n} & \text{E} & \text{s} & \text{n} & \text{n} \\
29 & 30 & 31 & 32 & 33 & 34 & 35 & 36 & 37 & 38 & 39 & 40 & 41 & 42 \\
\text{s} & \text{n} & \text{x} & \text{x} & \text{x} & \text{n} & \text{n} & \text{n} & \text{n} & \text{E} & \text{s} & \text{n} & \text{n} & \text{t}
\end{array}\]

Where:
- \(s\) = the sign: + or -.
- \(n\) = ASCII digit 0 to 9.
- \(x\) = either \(n\) or an ASCII decimal point.
- \(E\) = ASCII character identifying the exponent.
- \(t\) = ; or <lf> (= line feed).

The numbers returned relate only to the currently-selected line frequency and resolution. The first number is the positive gain factor, the second is the negative gain factor, and the third is the zero offset.
Recall Calibration Values Stored during Calibration Sequence

Response Format

Response Detail

A calibration trigger (see \texttt{CALH?} and \texttt{CALL?} earlier) can initiate several ‘Calibration Operations’, depending on the type of calibration being performed.

Each Calibration Operation takes four readings. It then computes their mean, which ultimately results in a correction constant (sometimes directly, and sometimes by computation with the means of other operations).

Thus a group of five values (four readings and their mean) results from every operation. Each group is placed into the calibration buffer and all five values can be recalled by a single \texttt{CVAL?} query.

They are returned as five pairs of numbers, the first four pairs representing the reading values and the fifth pair representing their mean; all from a single calibration operation. In each pair, the first number is the value itself (\texttt{Nr3 format}) and the second is its index number (\texttt{Nr1 format}) in the calibration buffer.

The calibration buffer has sufficient capacity for the greatest number of operations to result from a single calibration trigger. \texttt{CVAL?} returns the values from the calibration buffer, starting at the highest occupied buffer location, decrementing the index number as it reads each value. When the index reaches 0, all the values have been read. Any subsequent \texttt{CVAL?} continues to return both the value at index 0 and the index No 0, until another calibration trigger is commanded.

The next calibration trigger will place new values in the buffer as the calibration operations proceed, starting again at register 0.
Section 5 - Native Language

Line Frequency Selection

This command selects the line frequency and thus the optimum A/D configuration for this frequency. It should always be selected with care before using STLN, as it is stored as the default power up and reset configuration by that command.

The only numbers accepted by this command are: 50, 60, or 400.

**N.B. Partial Calibration of the 1362**
When carrying out a partial calibration, ensure that the programmed frequency is the same as that for the most-recent full calibration. Otherwise, small offsets may be introduced which can only be removed by a full calibration.

Read the Line Frequency Switch Setting

Two numbers are returned: the **first** indicates the currently-selected line frequency; the **second** is the default which is set at power on or reset, or at calibration trigger.

**Response:**
- \(50 \ t \) 50Hz.
- \(60 \ t \) 60Hz.
- \(400 \ t \) 400Hz.

Where: \( t = ; \) or \(<lf>\)

Save Default Line Frequency

This command saves the currently-selected line frequency for use as the default frequency under Power On and Reset conditions.

**Response:**
- \(Ø \ t \) Save successful, no errors present.
- \(1 \ t \) Errors present.

Where: \( t = ; \) or \(<lf>\)

**Execution Errors:**
Errors are generated if calibration is not enabled with both the CAL switch and the CAL ON command.

If this value is corrupt, then the default becomes 60Hz.
Set the Number of Readings to be Taken in a Block

This command arms the DMM to take the next Nrf triggers and put the results into the block reading buffer. These may then be accessed by the BRCL? query.

After Nrf triggers have been received, the DMM generates a URQ in the Standard Event Status Register, then resumes placing single measurements in the output queue.

The Span of Nrf is 1 to 1000.

Execution Errors:
An error is generated if Nrf is less than 1 or greater than 1000.

Note:
Receipt of the X? query terminates the BLOCK operation.

Read the Number of Readings Present in the Block Store

Response:
Nr1

This request also terminates the operation of the BLOCK command if sufficient triggers have not been received.
Recall the readings from the block store

The first Nrf is the start point for readings from the buffer; the second Nrf is for the finish point.

The readings are returned in the format described for the RDG? query, successive readings being separated by a comma.

**Execution Errors:**
An error is generated if the start value is greater than the end value, or if the end value is greater than the number of readings in the buffer.

**Note:**
This query terminates the operation of the BLOCK command if sufficient triggers have not been received.

Return to CIIL

This directs the DMM to interpret CIIL commands instead of IEEE 488.2 commands. It is the complement of the CIIL command GAL.

**Command Errors:**
A command error is generated if the instrument is not a Model 1362MT.

Return to SCPI

This directs the DMM to interpret SCPI commands instead of IEEE 488.2 commands. It is the complement of the SCPI command SYSTEM LANGUAGE NATIVE.

**Command Errors:**
A command error is generated if the instrument is not a Model 1362S.
Perform an Individual Test from the Selftest List

The Nrf for this command gives the test number to be performed. The test will leave the DMM in the hardware configuration required for the test.

Note that the individual test numbers used in this command are the same as the numbers of the failed test that are reported by the DDQ? query. For group test add 100 to the test number.

Response Code

The Nr1 in this response is either Ø for test pass or 1 for test fail

The first Nr3 is the value measured by the DMM during the test. The second Nr3 is the absolute high limit of the test. The third Nr3 is the absolute low limit of the test.
Recall Test Measurements

This command fetches the result of a test from the test buffer and reports it only in a normalized format: 0 - 1.9999.

The buffer is organized to increment on each read until it hits the 'empty' marker when it will reset to the start. The 'empty' indicator is a large negative number -19.00000E+33. A new test will overwrite the previous values.

Response Code:

```
1 2 3 4 5 6 7 8 9 10 11 12 13 14
s n x x x n n n n E s n n t
```

Where:

- **s** = the sign: + or -.
- **n** = ASCII digit 0 to 9.
- **x** = either n or an ASCII decimal point.
- **E** = ASCII character identifying the exponent.
- **t** = ; or <lf> (= line feed).

Clear the Calibration Store (EEPROM)

**IMPORTANT!**

This operation clears all calibration memories (except serial number, default frequency and those items stored using the *PUD code).

Response:

```
Ø t  Operation successful, no errors present.
1 t  Errors present.
```

Where: **t** = ; or <lf>

If any errors are present, the relevant error codes are placed in a queue which is accessible using the request DDQ?.

**Execution Errors:**

The calibration store can be cleared only if the following conditions are met:

- The external cal switch must be in the enable position (Up), and the calibration mode must have been turned on by sending the **CAL ON** command; before this command is received.

If either of these conditions is not fulfilled, then an execution error will be generated.
Mandatory IEEE 488.2 Commands
All of the commands under this heading are common commands or queries defined in the IEEE-488.2 standard.

I/D (Identification)
This command conforms to the IEEE 488.2 standard requirements.

*IDN?
will recall the instrument’s manufacturer, model number, serial number and firmware level.

Examples of Response Format:

Character Positions:

```
1 2 3 4 5 6 7 8 9 10 11 12 13
W A V E T E K , 1 3 6 2 ,
14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
2 3 4 5 6 7 , Ø 1 . Ø 2 <lf>
```

```
1 2 3 4 5 6 7 8 9 10 11 12 13 14
W A V E T E K , 1 3 6 2 S ,
15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33
3 4 5 6 7 8 , Ø 1 . Ø 2 <lf>
```

```
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
W A V E T E K , 1 3 6 2 M T ,
16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
4 5 6 7 8 9 , Ø 1 . Ø 2 <lf>
```

Where:
The data contained in the response consists of four comma-separated fields, the last two of which are instrument-dependent.

```
<lf> = Linefeed
```

The data element type is defined in the IEEE 488.2 standard specification.

Response Decode:
The data contained in the four fields is organized as follows:
- First field - manufacturer
- Second field - model
- Third field - serial number
- Fourth field - firmware level (will possibly vary from one instrument to another).

Execution Errors:
None.

Power On and Reset Conditions
Not applicable.
Mandatory IEEE 488.2 Commands (Contd.)

Operation Complete
This command conforms to the IEEE 488.2 standard requirements.

*OPC
is a synchronization command which will generate an operation complete message in the standard Event Status Register when all pending operations are complete.

Execution Errors:
None.

Power On and Reset Conditions
Not applicable.

Operation Complete?
This command conforms to the IEEE 488.2 standard requirements.

Response Format:
Character position
  1  2
  n  nl

Where:
  n = 1
  nl = newline

Response Decode:
The value returned is always 1, which is placed in the output queue when all pending operations are complete.
Section 5 - Native Language

Reset
This command conforms to the IEEE 488.2 standard requirements.

*RST
will reset the instrument to a defined condition, detailed in Appendix B to this section.

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;
• the state of the IEEE 488 interface;
• stored math constants.

Wait
This command conforms to the IEEE 488.2 standard requirements.

*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.

Execution Errors:
None.

Power On and Reset Conditions
Not applicable.
Optional IEEE 488.2 Commands

From a choice of many commands, the following are included because of their relevance to the 1362.

Recall Current Instrument Settings

This command conforms to the IEEE 488.2 standard requirements.

*Lrn?

returns data about the current settings of the instrument. The response given below must be regarded as only typical, as there are many combinations of possible responses. The maximum number of characters that can be expected is 90.

Response Format:

Character Positions:

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
O H M S 1 E + 7 , W I R E 4 , F I L T
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Ø , R E S L 5 ; I N P U T C H - A ; G
41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
U A R D L C L ; T S R C E S Y S ; D
61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
E L A Y D F L T ; C A L O F F t

Where:

r = test result: Ø or 1.
s = the sign: + or -.
n = ASCII digit Ø to 9.
x = either n or an ASCII decimal point.
E = ASCII character identifying the exponent.
t = ; or <lf> (= line feed).
Return the option numbers of the instrument options that are fitted.

Response Code

The first Nr1 indicates the presence or absence of the Current Option: Option 30. The value of this Nr1 can be:

- $\emptyset$ - No option
- $3\emptyset$ - Current option

The second Nr1 indicates the presence or absence of the Ratio Option: Option 40. The value of this Nr1 can be:

- $\emptyset$ - No option
- $4\emptyset$ - Ratio option
Protected User Data

Entry of User Data
This command conforms to the IEEE 488.2 standard requirements.

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 DMM. 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 external calibration mode for this command to execute.

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

Power On and Reset Conditions
Data area remains unchanged.
Recall of User Data
This command conforms to the IEEE 488.2 standard requirements.

```
*PUD?
```

recalls previously entered user data:

**Response Syntax:**

```
# 2 digit digit user message
```

*Where:*

- \(digit\) = one of the ASCII-coded numerals
- \(user\ message\) = the saved user message

**Response Decode:**

The previously-saved message is recalled. If no message is available, the value of the two digits is 00. The data area contains 63 bytes of data.

**Execution Errors:**

None.

**Power On and Reset Conditions**

Data area remains unchanged.

**Note:** Some controllers may need programming to accept strings of this length. Refer to appropriate manuals.
APPENDIX A to SECTION 5
1362 Device Settings at Power On
Appendix A to Section 5 - Native Language

1362 Device Settings at Power On

Active Function:

<table>
<thead>
<tr>
<th>Func.</th>
<th>Range</th>
<th>Filter</th>
<th>Resol.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCV</td>
<td>300V</td>
<td>FILTØ</td>
<td>RESL6</td>
</tr>
</tbody>
</table>

Inactive Functions:

<table>
<thead>
<tr>
<th>Func.</th>
<th>Range</th>
<th>Filter</th>
<th>Resol.</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCI</td>
<td>1A</td>
<td>FILTØ</td>
<td>RESL5</td>
<td></td>
</tr>
<tr>
<td>ACV</td>
<td>300V</td>
<td>FILTØ</td>
<td>RESL5</td>
<td>ACCP</td>
</tr>
<tr>
<td>ACI</td>
<td>1A</td>
<td>FILTØ</td>
<td>RESL5</td>
<td>ACCP</td>
</tr>
<tr>
<td>Ohms</td>
<td>10MΩ</td>
<td>FILTØ</td>
<td>RESL6</td>
<td>WIRE4</td>
</tr>
</tbody>
</table>

Analog Connections

Input: INPUT OFF
Guard: GUARD LCL

Analog Processes and Conditioning

Trigger Source: TSRCE SYS
Delay: DELAY DFLT
Input Zero: Setting retained in non-volatile memory

Calibration Processes

Calibration: Disabled
External Calibration Corrections: Applied
Line Frequency 50/60 Hz: Setting retained in non-volatile memory (or if corrupted, 60Hz)

Device Monitoring

Last Reading Value Recall: Invalid until after first trigger
Device I/D (Serial Number): Setting retained in non-volatile memory
Options Fitted Data: As fitted
Protected User Data: Setting retained in non-volatile memory

Status Reporting Conditions

Status Byte Register: Clear
Event Status Register: Clear
Output Queue: Empty until after first query
SECTION 6  Guide to CIIL Command Language

‘Power On’ Default Settings

After the power has been applied, the DMM will perform its power-on configuration routine. This routine will set the DMM analogue circuits into their initial states:

- DC
- 300V Range
- Input Disconnected
- No Filter
- Local Guard
- No Autorange
- 6.5 Digit

If it is not possible to set the DMM into its initial state (due to a hardware fault, for example) then the DMM will generate a Fatal Error and attempt to report the failure at the first opportunity. The DMM will not respond to any further commands once the fatal error has been reported.

When the DMM has finished its initialization, it is then ready to accept commands.

Control Interface Intermediate Language (CIIL)

The instrument will communicate in accordance with the MATE Specification Document Standard 2806763 Revision C, 21 Jun 1988. All references to CIIL in this Section are with respect to 2806763 Rev C, 21 Jun 1988.

Command Code Summary

The minimum op-code requirements for a sensor unit (the DMM) are:

- FNC  SET  SRX  INX  FTH  CLS  OPN  RST  CNF  IST  STA
- and the optional GAL

The only accepted <noun>s for this instrument are:

- DCS  ACS  IMP

The only valid <mode-des> for this instrument are:

- ACCP  VOLT  VRMS  RESI  CURR

The only used <noun-mod>s are:

- ACCF  ACCP  ACPL  CURR  DCPL  FORW  FREQ  GARD
- GAWD  MAXT  RESI  TWOW  TSRC  VOLT  VRMS
FNC <noun> <mchar> <port>

This op-code is used to set the measurement configuration of the DMM. The FNC op-mode must always be at the start of a command string and may or may not be followed by the SET, SRN or SRX op-code(s).

The <noun> is used to select a specific measurement quantity, i.e. DCS for DC signals, IMP for resistance (impedance) and ACS for AC signals.

The <mchar>s that may be applied to the <noun>s are shown in the syntax diagram below.

**Syntax Diagram**

N.B. All fields within a terminated string must be separated by an ASCII space.

![Syntax Diagram](image)

**Note 1:** The CURR <mchar> is only valid if the DMM has current fitted.

**Note 2:** The channel :CH1 is only valid if the DMM has ratio fitted.

**Note 3:** In the case of DCS, ACCP causes the AC measurement mode to be selected, enabling the DMM to measure the AC component of a DC signal.

**Note 4:** All DCS measurements will be in **6.5 digit** resolution.
All ACS measurements will be in **5.5 digit** resolution.
All IMP measurements will be in **6.5 digit** resolution.
All DCS CURR measurements will be in **6.5 digit** resolution.
All ACS CURR measurements will be in **5.5 digit** resolution.
SET, SRN and SRX Associated with DCS

Syntax Diagram
N.B. All fields within a terminated string must be separated by an ASCII space.

Note 1: The <mchar> must match the <mchar> in the FNC command, i.e. either VOLT, ACCP or CURR.

Note 2: If the DMM can measure current, then the ACCP <mchar> is modified to include an optional <unit> field, e.g. in the syntax diagram below:

The <unit>:A allows the measurement of the AC component of a current signal.
**Note 3:** If **SET GARD** is present, then the DMM selects **REMOTE GUARD**.
If **SET GARD** is not present the default of **LOCAL GUARD** is selected.

**Note 4:** **SET TSRC EXT** allows measurement triggers to come from the BNC connector on the front panel.

**Note 5:** The `<value>` following the `<mchar>` selects the range of the DMM according to the table:

<table>
<thead>
<tr>
<th>Absolute <code>&lt;value&gt;</code></th>
<th>DMM Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;value&gt;</code> &lt; 0.2</td>
<td>100mV</td>
</tr>
<tr>
<td>0.2 ≤ <code>&lt;value&gt;</code> &lt; 2.0</td>
<td>1V</td>
</tr>
<tr>
<td>2.0 ≤ <code>&lt;value&gt;</code> &lt; 20.0</td>
<td>10V</td>
</tr>
<tr>
<td>20.0 ≤ <code>&lt;value&gt;</code> &lt; 200.0</td>
<td>100V</td>
</tr>
<tr>
<td>200.0 ≤ <code>&lt;value&gt;</code></td>
<td>300V</td>
</tr>
</tbody>
</table>

**Note 6:** If **AUTO** follows the `<mchar>` instead of a `<value>`, then the DMM goes into the autorange mode and will select the most appropriate measurement range within its capabilities.

**Note 7:** The `<noun-mod>` `<ACCF, FREQ and GAWD` are all used to select the **analogue filter** in the DMM.

  In the case of **ACCF** and **FREQ**:
  - If `<value>` > 40 (Hz) then the filter is **de-selected**.
  - If `<value>` ≤ 40 (Hz) or less then the filter is **selected**.

  In the case of **GAWD**:
  - If `<value>` > 0.025 the filter is **selected**
  - If `<value>` ≤ 0.025 then the filter is **de-selected**.

  Note that only positive `<value>`s are allowed. Negative `<values>`s will give an error.

**Note 8:** **MAXT** is used to select an external trigger window.

  The `<value>` that follows the **MAXT** `<noun-mod>` must be **greater than zero** and less than 10 Seconds.

  This `<value>` will then be used in checking the time between the trigger command and the external trigger actually arriving. If the external trigger does not arrive within the specified time, a timeout condition will occur and will be reported at the first opportunity.

**Note 9:** **SET**, **SRN** and **SRX** commands may only follow on from a **FNC** command. They may not be used as an independent command string.
**Control Interface Intermediate Language (CIIL) (Contd.)**

**SET, SRN and SRX Associated with IMP**

**Syntax Diagram**

N.B. All fields within a terminated string must be separated by an ASCII space.

Note 1: The `<value>` following RESI selects the range of the DMM according to the table:

<table>
<thead>
<tr>
<th>Absolute <code>&lt;value&gt;</code></th>
<th>DMM Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;value&gt;</code> &lt; 200 Ω</td>
<td>0.1 kΩ</td>
</tr>
<tr>
<td>200 Ω ≤ <code>&lt;value&gt;</code> &lt; 2E3</td>
<td>1 kΩ</td>
</tr>
<tr>
<td>2E3 ≤ <code>&lt;value&gt;</code> &lt; 2E4</td>
<td>10 kΩ</td>
</tr>
<tr>
<td>2E4 ≤ <code>&lt;value&gt;</code> &lt; 2E5</td>
<td>100 kΩ</td>
</tr>
<tr>
<td>2E5 ≤ <code>&lt;value&gt;</code> &lt; 2E6</td>
<td>1 MΩ</td>
</tr>
<tr>
<td>2E6 ≤ <code>&lt;value&gt;</code></td>
<td>10 MΩ</td>
</tr>
</tbody>
</table>

Note 2: If AUTO follows the `<mchar>` instead of a `<value>`, then the DMM goes into the autorange mode and will select the most appropriate measurement range within its capabilities.

Note 3: If SET GARD is present, then the DMM selects REMOTE GUARD.
If SET GARD is not present then the default of LOCAL GUARD is selected.

Note 4: SET TSRC EXT allows measurement triggers to come from the BNC connector on the front panel.
Note 5: SET TWOW selects the two wire method for measuring Ohms.
SET FORW selects the four wire method for measuring Ohms.
The default is SET TWOW if neither is specified.

Note 6: The <noun-mod> GAWD is used to select the analogue filter in the DMM.
If the <value> > 0.025 the filter is selected
If the <value> ≤ 0.025 then the filter is de-selected.
Note that only positive <value>s are allowed. Negative <values>s will give an error.

Note 7: MAXT is used to select an external trigger window.
The <value> that follows the MAXT <noun-mod> must be greater than zero and less than 10 Seconds.
This <value> will then be used in checking the time between the trigger command and the external trigger actually arriving. If the external trigger does not arrive within the specified time, a timeout condition will occur and will be reported at the first opportunity.

Note 8: SET, SRN and SRX commands may only follow on from an FNC command. They may not be used as an independent command string.
Control Interface Intermediate Language (CIIL) (Contd.)

SET, SRN and SRX Associated with ACS.

**Syntax Diagram**

N.B. All fields within a terminated string must be separated by an ASCII space.

<table>
<thead>
<tr>
<th>Absolute &lt;value&gt;</th>
<th>DMM Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;value&gt; &lt; Ø.2</td>
<td>100mV</td>
</tr>
<tr>
<td>Ø.2 ≤ &lt;value&gt; &lt; 2.Ø</td>
<td>1V</td>
</tr>
<tr>
<td>2.Ø ≤ &lt;value&gt; &lt; 2Ø.Ø</td>
<td>10V</td>
</tr>
<tr>
<td>2Ø.Ø ≤ &lt;value&gt; &lt; 2ØØ.Ø</td>
<td>100V</td>
</tr>
<tr>
<td>2ØØ.Ø ≤ &lt;value&gt;</td>
<td>300V</td>
</tr>
</tbody>
</table>

**Note 1:** The <mchar> above must match the <mchar> in the FNC command, i.e. VOLT, VRMS or CURR

**Note 2:** If SET GARD is present, then the DMM selects REMOTE GUARD.
If SET GARD is not present then the default of LOCAL GUARD is selected.

**Note 3:** SET TSRC EXT allows measurement triggers to come from the BNC connector on the front panel.

**Note 4:** The <value> following the <mchar> selects the range of the DMM according to the table:
Note 5: If `AUTO` follows the `<mchar>` instead of a `<value>`, then the DMM goes into the autorange mode and will select the most appropriate measurement range within its capabilities.

Note 6: `SET ACPL` selects measurement of the AC component of the signal
`SET DCPL` selects measurement of the sum of the AC and DC components of the signal.

Note 7: The `<noun-mod>`s `ACCF`, `FREQ` and `GAWD` are all used to select the analogue filter in the DMM.

In the case of `ACCF` and `FREQ`:
- If `<value> > 40 (Hz)` then the filter is de-selected.
- If `<value> ≤ 40 (Hz)` or less then the filter is selected.

In the case of `GAWD`:
- If `<value> > 0.025` the filter is selected
- If `<value> ≤ 0.025` then the filter is de-selected.

Note that only positive `<value>`s are allowed. Negative `<value>`s will give an error.

Note 8: `MAXT` is used to select an external trigger window.

The `<value>` that follows the `MAXT` `<noun-mod>` must be greater than zero and less than 10 Seconds.
This `<value>` will then be used in checking the time between the trigger command and the external trigger actually arriving. If the external trigger does not arrive within the specified time, a timeout condition will occur and will be reported at the first opportunity.

Note 9: `SET`, `SRN` and `SRX` commands may only follow on from an `FNC` command. They may not be used as an independent command string.
Control Interface Intermediate Language (CIIL) (Contd.)

**INX <mchar><crlf>**

This op-code is used to trigger the DMM in **TSRC INT** mode, or arm the DMM for an external trigger if in **TSRC EXT** mode. Note that the <mchar> must match the one sent in the **FNC** command.

This command replies in accordance with **Section 5.3.2.1.1**. e.g: `<sp><ascii-int><crlf>

Where the ascii-int is a value representing the timeout required before the next **FTH** is sent to the DMM.

**FTH <mchar><crlf>**

This op-code is used to retrieve data from the DMM. Its main use is in connection with a previous trigger command **INX**.

The <mchar> in the **FTH** op-code must match the <mchar> received in the last **FNC** op-code. Under normal conditions, where the measurement has successfully been taken, this command will cause the DMM to return:

`<space><value><crlf>`

In the event of a previous (unreported) error the DMM will return a suitable error string of the form described in **Rev C; Section 5.3.4** onwards.

**CLS :CH0 <crlf>; OPN :CH0 <crlf>;**

**CLS :CH1 <crlf>; OPN :CH1 <crlf>;**

(These two only valid if **Ratio** fitted)

These op-codes are used to connect and disconnect the DMM to the measurement bus.

In the disconnected mode (**OPN**), there is total isolation between all measurement terminals (**Hi, Lo, I+, I- and Guard**) of the DMM and the measurement bus.

Note that it is **invalid** to attempt to trigger a measurement (using **INX**) when the DMM is disconnected (**OPN**). If this is attempted then an error will be reported at the first opportunity.
RST <noun> <mchar> <port> <crlf>

This op-code is used to reset the DMM module back into its **Power On** state. Note that the <noun>, <mchar> and <port> must match the <noun>, <mchar> and <port> that were sent in the last **FNC** command. If these do not match, then there will be no reset and an error will be reported at the first opportunity.

**Syntax Diagram**

N.B. All fields within a terminated string must be separated by an ASCII space.

Note that **CURR** is only valid if **Current** is fitted.

Note that **:CH1** is only valid if **Ratio** is fitted.
Control Interface Intermediate Language (CIIL) (Contd.)

**CNF\n\n\n\nIST\n\n\n**

These two op-codes both cause the DMM to perform the Internal Selftest routine. Note that neither command has any modifiers.

In the case of a selftest **PASS**, the message that is returned on receipt of the next **STA** command is:

\n\n\n
In the case of a selftest **FAIL** the message is:

\n\n\nF07DMM01 (DEV): <ascii string>\n\n
Where the <ascii string> is explained in the section under selftest (in the native mode section).

**STA**

This op-code is used to find out the DMM’s current operating status.

The data returned is in the format covered in Rev C, Section 5.3.4.

**GAL**

This op-code causes the DMM to cease interpreting CIIL command codes and accept native mode commands instead. The op-code has no modifiers.
SECTION 7
1362 SPECIFICATIONS
and
SPECIFICATION VERIFICATION
### Section 7 - 1362 Specifications

#### FUNCTION RANGE

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>RANGE [1]</th>
<th>FREQUENCY (Hz)</th>
<th>ACCURACY [2][4]</th>
<th>TEMP. COEFF. (ppm/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Voltage</td>
<td>100.000 0mV</td>
<td>8+6</td>
<td>0.3%+0.1%</td>
<td>100°C-40°C</td>
</tr>
<tr>
<td></td>
<td>1.000 000V</td>
<td>5+3</td>
<td>0.4%+0.1%</td>
<td>50°C-35°C</td>
</tr>
<tr>
<td></td>
<td>10.000 00V</td>
<td>5+2</td>
<td>0.02%+0.01%</td>
<td>40°C-15°C</td>
</tr>
<tr>
<td></td>
<td>100.000 0V</td>
<td>8+3</td>
<td>0.07%+0.02%</td>
<td>25°C±1°C</td>
</tr>
<tr>
<td></td>
<td>300.000V</td>
<td>8+3</td>
<td>0.1%+0.03%</td>
<td>1 year</td>
</tr>
<tr>
<td>AC Voltage [4]</td>
<td>All Ranges (as DCV)</td>
<td>10-40</td>
<td>0.1%+0.03%</td>
<td>Tcal±5°C [6]</td>
</tr>
<tr>
<td></td>
<td>40-20k</td>
<td>20-3</td>
<td>0.35%+0.01%</td>
<td>23°C±1°C</td>
</tr>
<tr>
<td></td>
<td>20k-50k</td>
<td>20+2</td>
<td>0.1%+0.02%</td>
<td>23°C±1°C</td>
</tr>
<tr>
<td></td>
<td>50k-100k</td>
<td>30+3</td>
<td>0.1%+0.02%</td>
<td>23°C±1°C</td>
</tr>
<tr>
<td>Resistance</td>
<td>100.000 0Ω</td>
<td>15+6</td>
<td>0.3%+0.1%</td>
<td>23°C±1°C</td>
</tr>
<tr>
<td></td>
<td>1.000 000kΩ</td>
<td>10+3</td>
<td>0.4%+0.1%</td>
<td>23°C±1°C</td>
</tr>
<tr>
<td></td>
<td>10.000 00kΩ</td>
<td>10+3</td>
<td>0.05%+0.03%</td>
<td>23°C±1°C</td>
</tr>
<tr>
<td></td>
<td>100.000 0kΩ</td>
<td>15+3</td>
<td>0.08%+0.03%</td>
<td>23°C±1°C</td>
</tr>
<tr>
<td></td>
<td>1.000 000MΩ</td>
<td>40+3</td>
<td>0.1%+0.03%</td>
<td>23°C±1°C</td>
</tr>
<tr>
<td></td>
<td>10.000 00MΩ</td>
<td>100+4</td>
<td>0.0%+0.03%</td>
<td>23°C±1°C</td>
</tr>
<tr>
<td>DC Current</td>
<td>1000.00mA</td>
<td>100+10</td>
<td>0.3%+0.1%</td>
<td>23°C±1°C</td>
</tr>
<tr>
<td>AC Current</td>
<td>1000.00mA</td>
<td>40-3k</td>
<td>0.4%+0.1%</td>
<td>23°C±1°C</td>
</tr>
</tbody>
</table>

#### NOTES:

[1] 100% overrange on all ranges except 300V.
[4] Valid for signals >1%FS, < 3 x 10^7 V.Hz product.
[6] Tcal. is calibration temperature in range 15°C to 35°C.

#### FUNCTION DIGITS READ RATE ADDITIONAL ERRORS

<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>DIGITS</th>
<th>READ RATE (readings/s)</th>
<th>ADDITIONAL ERRORS (ppmR+ppmFS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCV, DCI &amp; RESISTANCE</td>
<td>6 1/2</td>
<td>5</td>
<td>0+0</td>
</tr>
<tr>
<td></td>
<td>5 1/2</td>
<td>50</td>
<td>0+5</td>
</tr>
<tr>
<td></td>
<td>4 1/2</td>
<td>1000</td>
<td>0+150</td>
</tr>
<tr>
<td>ACV &amp; ACI</td>
<td>5 1/2</td>
<td>10Hz</td>
<td>0+0</td>
</tr>
<tr>
<td></td>
<td>4 1/2</td>
<td>40Hz</td>
<td>0+0</td>
</tr>
<tr>
<td></td>
<td>1/3</td>
<td>360Hz</td>
<td>0+0</td>
</tr>
</tbody>
</table>

7-2
## OTHER SPECIFICATIONS

<table>
<thead>
<tr>
<th><strong>DCV</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Impedance:</td>
<td>10GΩ (0.1V to 10V ranges), 10MΩ (100V &amp; 300V ranges)</td>
</tr>
<tr>
<td>CMRR (1kΩ unbalance):</td>
<td>&gt;140dB at DC</td>
</tr>
<tr>
<td>NMRR: filter out</td>
<td>&gt;80dB + NMRR at 1-60Hz</td>
</tr>
<tr>
<td>filter in</td>
<td>&gt;54dB at 50/60Hz±0.1%</td>
</tr>
<tr>
<td>Protection all ranges:</td>
<td>add 20dB to above</td>
</tr>
<tr>
<td>Max. Input Current:</td>
<td>300V RMS</td>
</tr>
<tr>
<td>(to 10ppm of step)</td>
<td>50pA</td>
</tr>
<tr>
<td>Settling Time:</td>
<td>5ms filter out</td>
</tr>
<tr>
<td>&amp; 350ms filter in</td>
<td></td>
</tr>
</tbody>
</table>

| **CMRR (1kΩ unbalance):** | >140dB at DC |
| **NMRR: filter out** | >80dB + NMRR at 1-60Hz |
| **filter in** | >54dB at 50/60Hz±0.1% |
| **Protection all ranges:** | add 20dB to above |
| **Max. Input Current:** | 300V RMS |
| **Settling Time:** | 50pA |
| **(to 10ppm of step)** | 5ms filter out |
| **& 350ms filter in** | | |

<table>
<thead>
<tr>
<th><strong>ACV</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Impedance:</td>
<td>1MΩ/100pF</td>
</tr>
<tr>
<td>CMRR (1kΩ unbalance):</td>
<td>&gt;80dB at DC to 60Hz</td>
</tr>
<tr>
<td>Crest Factor:</td>
<td>5:1 at full range</td>
</tr>
<tr>
<td>Protection all ranges:</td>
<td>300V RMS</td>
</tr>
<tr>
<td>(to 0.1% of step)</td>
<td>2.5s</td>
</tr>
<tr>
<td>10Hz(DC coupled)</td>
<td>500ms</td>
</tr>
<tr>
<td>40Hz</td>
<td>200ms</td>
</tr>
<tr>
<td>360Hz</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>RESISTANCE</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection all ranges:</td>
<td>250V RMS</td>
</tr>
<tr>
<td>Settling Time:</td>
<td>as DCV up to 10kΩ</td>
</tr>
<tr>
<td>Max. Lead Resistance:</td>
<td>10kΩ in any or all leads</td>
</tr>
<tr>
<td>Open circuit voltage:</td>
<td>15V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>DC CURRENT</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection all ranges:</td>
<td>2A internal fuse</td>
</tr>
<tr>
<td>Settling Time:</td>
<td>as DCV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>AC CURRENT</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Crest Factor:</td>
<td>5:1 at full range</td>
</tr>
<tr>
<td>Protection all ranges:</td>
<td>2A internal fuse</td>
</tr>
<tr>
<td>Settling Time:</td>
<td>as ACV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>RATIO</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability:</td>
<td>All functions</td>
</tr>
<tr>
<td>Protection:</td>
<td>As main functions</td>
</tr>
<tr>
<td>Accuracy:</td>
<td>±(net channel A accuracy + net channel B accuracy)</td>
</tr>
</tbody>
</table>

## GENERAL

| **PEAK MODULE CURRENT:** | 1.4A (5V), 0.5A (±12V) |
| **DYNAMIC MODULE CURRENT:** | 0.06A (5V), 0.15A (±12V) |
| **MAINS SUPPLY FLUCTUATION:** | not to exceed ±10% |
| **MINIMUM AIRFLOW (10°C rise):** | 1 Liter/sec. |
| **PRESSURE DROP:** | 0.05mm H₂O |
| **OPERATING TEMPERATURE:** | 5°C to 40°C |
| **STORAGE TEMPERATURE:** | -40°C to +70°C |
| **RELATIVE HUMIDITY:** | up to 31°C, max RH 80%, decreasing linearly to 50% RH at 40°C |
| **ALTITUDE:** | up to 2000m |
| **INDOOR USE:** | Pollution Degree 2 |
| **DIMENSIONS: (C size)** | 234mm(9.2")x340mm(13.4")x30mm(1.2") |
| **WEIGHT:** | 1.6kg (3.5lbs) |
| **SAFETY:** | Designed to UL1244, IEC 348, BS EN61010-1 |
| **WARRANTY:** | 1 year |
| **WARM-UP:** | 15 minutes to full accuracy |

## VXIbus SPECIFICATIONS

| **MODULE:** | C size, single slot width |
| **DEVICE TYPE:** | Message based instrument; Word serial protocol; A16 slave only |
| **LOGICAL ADDRESS:** | Manual selection 1 to 255 (Address 255 supports dynamic configuration) |
| **INTERRUPT LEVEL:** | User programmable 1 to 7 |
1362 Specification Verification

Introduction
The factory calibration of the 1362/S/MT ensures traceable accuracy to national standards. Its performance is quoted in the specifications at the beginning of this section, related to time since calibration.

On receipt, it is recommended that the instrument is thoroughly checked. This section deals with user verification of the 1362 performance to its 90-day specification, this being the most likely period to apply on receipt. Tables and calculations are provided enabling the user to verify each of the parameters listed below.

Equipment Requirements

Basic Configuration (including Option 40):
DC and AC Voltage and Resistance Calibrator of suitable accuracy.
e.g. Model 4800 or 4808
(Options 10, 20, 30 & 50)

Full Analog Configuration (including Option 30):
DC and AC Voltage, DC and AC Current, and Resistance Calibrator of suitable accuracy.
e.g. Model 4800 or 4808
(Options 10, 20, 30, 40 & 50)

User's Uncertainty Calculations
The accuracy and traceability of a user’s standards affects the manner in which the performance of any new equipment can be verified. Users will need to evaluate the effects of the uncertainties associated with their own equipment, in conjunction with those of the instrument, therefore calculations for total tolerance limits (Validity Tolerance) are required.

The ‘Validity Tolerance’
It is impossible to verify the specification of an instrument with absolute certainty, even using the original calibration equipment to make the measurements. All measurements carry a degree of uncertainty, this being quantified by the ’Traceability’ of the measuring equipment to National Standards.

The measurements which follow are intended to establish that the instrument performs within its specifications, meaning it operates within the tolerance of its accumulated uncertainties. As the measurements to be taken have their own accumulated uncertainties, these must be added to those of the instrument in order to set a ’Validity Tolerance’.

The Validity Tolerance is obtained by adding together all the intervening uncertainties at the time the measurement is made. The specification sets out the worst-case allowances (relative tolerances) for the instrument’s performance. For the standards equipment used, worst-case tolerances must also be assumed. Complete the Verification Report Sheet and calculate the validity tolerance limits using the formulae provided. If any range fails to verify and the instrument is to be returned, please be certain to include copies of the verification report sheets and give as much detail as possible.

Abbreviations Used

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hr</td>
<td>1362 upper relative accuracy tolerance limit</td>
</tr>
<tr>
<td>Lr</td>
<td>1362 lower relative accuracy tolerance limit</td>
</tr>
<tr>
<td>Uf</td>
<td>Manufacturer’s factory calibration standard uncertainty relative to National Standards</td>
</tr>
<tr>
<td>Um</td>
<td>Sum of uncertainties from 1362 terminals through the user’s measurement system to National Standards</td>
</tr>
</tbody>
</table>
Verification Report Sheet

Model 1362/S/MT  Serial Number..........................  Calibration Interval..........................

Date..........................  Checked by..........................  Company/Dept..........................

Note: It is advisable to make duplicate copies of the report sheets for future use. Check at the values shown in the tables. Contact your authorized Service Centre if the instrument fails to verify and please include copies of the completed verification report sheets if the instrument is returned.

Implementation

On Receipt of Instrument

The tables in this report document provide columns to enter both the user’s calculations of tolerance limits and the results of measurements made.

The relative accuracy tolerance limits (90 day Specification) are already entered in the columns. These figures include the manufacturer’s factory calibration standards’ uncertainties.

A relevant formula, for calculating the validity tolerances on receipt, is given on each page of tables.

After User-calibration

Once the instrument has been re-calibrated against the user’s standards, the manufacturer’s factory calibration uncertainties are no longer valid.

Validity tolerance limits should then be recalculated to include the user’s uncertainties in place of the manufacturer’s, which for convenience are entered in a separate column.

A relevant formula, for calculating the validity tolerances after user-calibration, is given on each page of tables.

Preparation

The purpose of this Verification is to check the instrument against its 90-day specification.

N.B. For 1362MT version

This Preparation must be programmed in the Native Language of the instrument (IEEE 488.2 syntax described in Section 5) as the Input Zero operation, required to ensure measurement accuracy, is not programmable in CIIL.

The verification procedures (overleaf) may be performed in the CIIL language of the instrument, noting that the DCV, DCI and Ohms functions default to 6.5-digit resolution in CIIL.

1. Ensure that the instrument is correctly mounted and operative in its subrack.
2. Turn on the instrument to be checked and allow to warm up for at least 15 minutes in the specified environment.
3. Ensure that the calibration switch is in the disable position (Down).
4. Consult the appropriate manufacturers’ handbooks before connecting and operating any of their equipment.
5. Program and execute a 'Selftest' (Code *TST? for 1362 and TEST:ALL? or *TST? for 1362S). Should the instrument fail, contact your local authorized Service Center. If the instrument is to be returned, complete a Failure Report form, which can be found at the back of this handbook. Detach and return it with the instrument to your local service centre.
7. Use Channel A. Short together the four Inputs Hi, Lo, I+ and I-. Set to 4-wire Ohms. Execute an 'Input Zero' on each of the Ohms ranges.
8. Use Channel A. With all Channel A inputs open circuit, execute an 'Input Zero' on the 1A DC Current Range.
Procedures

WARNING  THIS INSTRUMENT CAN DELIVER A LETHAL ELECTRIC SHOCK. NEVER TOUCH ANY LEAD OR TERMINAL UNLESS YOU ARE ABSOLUTELY CERTAIN THAT NO DANGEROUS VOLTAGE IS PRESENT.

Input Connections
With its output turned off, connect the calibrator output to the relevant input pins of Channel 'A' on the Front Panel INPUT connector.

Channel 'A' Input Pins
(Front Panel Input Connector)

<table>
<thead>
<tr>
<th>Input</th>
<th>Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi</td>
<td>1</td>
</tr>
<tr>
<td>I+</td>
<td>2</td>
</tr>
<tr>
<td>Lo</td>
<td>5</td>
</tr>
<tr>
<td>I-</td>
<td>6</td>
</tr>
<tr>
<td>Gu</td>
<td>7</td>
</tr>
</tbody>
</table>

DC Voltage
1. Program the 1362 and Calibrator to DC Voltage, 6½ digits.
2. Set the 1362 to its 100mV DC range and the calibrator to 100mV AC output at 1kHz. Note the 1362 measured value.
3. Enter the measured value in the top line of Table 1 on page 7-8, under '1362 READING'.
4. Repeat (2) and (3) for the remainder of the 1362 ranges and calibrator outputs of Table 1.
5. Calculate the 'Validity Tolerance Limits' using the appropriate formula beneath Table 1 on page 7-8.
6. Check that the values in the 1362 READING column are at or within the corresponding lower and higher validity tolerance limits.

AC Voltage
1. Program the 1362 and Calibrator to AC Voltage, 5½ digits.
2. Set the 1362 to its 100mV AC range and the calibrator to 100mV AC output at 1kHz. Note the 1362 measured value.
3. Enter the measured value in the top line of Table 2 on page 7-9, under '1362 READING'.
4. Set the 1362 to its 100mV AC range and the calibrator to 100mV AC output at 30kHz. Note the 1362 measured value.
5. Enter the measured value in the second line of Table 2 under '1362 READING'.
6. Repeat (2) to (5) for the remainder of the 1362 ranges and calibrator outputs of Table 2.
7. Calculate the 'Validity Tolerance Limits' using the appropriate formula beneath Table 3 on page 7-9.
8. Check that the values in the 1362 READING column are at or within the corresponding lower and higher validity tolerance limits.

AC Voltage Linearity Checks
1. Program the 1362 and Calibrator to AC Voltage, 5½ digits.
2. Set the 1362 to its 10V AC range and the calibrator to 1V AC output at 1kHz. Note the 1362 measured value.
3. Enter the measured value in the top line of Table 3 on page 7-9, under '1362 READING'.
4. Increase the calibrator output to 10V AC output at 1kHz. Note the 1362 measured value.
5. Enter the measured value in the second line of Table 3 under '1362 READING'.
4. Increase the calibrator output to 19V AC output at 1kHz. Note the 1362 measured value.
5. Enter the measured value in the third line of Table 3 under '1362 READING'.
6. Calculate the 'Validity Tolerance Limits' using the appropriate formula beneath Table 3 on page 7-9.
7. Check that the values in the 1362 READING column are at or within the corresponding lower and higher validity tolerance limits.
**Resistance**

1. Program the 1362 and Calibrator to Ohms, 6½ digits, 4-wire connection.
2. Set the 1362 to its 100Ω range and the calibrator to 100Ω nominal output.
3. Enter the calibrator resistance value in the top line of Table 4 on page 7-10, under ‘Calibrator Resistance Value’. Calculate and enter δR in its column.
4. Note the 1362 measured value. Enter the value in the top line of Table 4 under ‘1362 READING’.
5. Repeat (2) to (4) for the remainder of the 1362 ranges and calibrator resistances of Table 4.
6. Calculate the ‘Validity Tolerance Limits’ using the appropriate formula beneath Table 4 on page 7-10.
7. Check that the values in the 1362 READINGS column are at or within the corresponding lower and higher validity tolerance limits.

**DC Current**

1. Program the 1362 and Calibrator to DC Current, 6½ digits.
2. Set the 1362 to its 1000mA DC range and the calibrator to +1000mA output. Note the 1362 measured value.
3. Enter the measured value in the top line of Table 5 on page 7-11, under ‘1362 READING’.
4. Set the 1362 to its 1000mA DC range and the calibrator to -1000mA output. Note the 1362 measured value.
5. Enter the measured value in the second line of Table 5 under ‘1362 READING’.
6. Calculate the ‘Validity Tolerance Limits’ using the appropriate formula beneath Table 6 on page 7-11.
7. Check that the value in the 1362 READING column is at or within the lower and higher validity tolerance limits.

**AC Current**

1. Program the 1362 and Calibrator to AC Current, 5½ digits.
2. Set the 1362 to its 1000mA AC range and the calibrator to 1000mA AC output at 10kHz. Note the 1362 measured value.
3. Enter the measured value in the top line of Table 6 on page 7-11, under ‘1362 READING’.
4. Calculate the ‘Validity Tolerance Limits’ using the appropriate formula beneath Table 6.
5. Check that the value in the 1362 READING column is at or within the corresponding lower and higher validity tolerance limits.
### Table 1. DC VOLTAGE Full Range Checks

<table>
<thead>
<tr>
<th>1362 Range &amp; Calibrator Output</th>
<th>Relative Accuracy Tolerance Limits (Lr)</th>
<th>Higher (Hr)</th>
<th>Factory Cal. Std. ±Uf</th>
<th>User's Measurement Tolerance ±Um</th>
<th>Validity Tolerance Limits Lower</th>
<th>Higher</th>
<th>1362 Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ 100mV</td>
<td>+99.9958</td>
<td>+100.0042</td>
<td>0.00045mV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 100mV</td>
<td>-100.0042</td>
<td>-99.9958</td>
<td>0.00045mV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ 1V</td>
<td>+0.999974</td>
<td>1.000026</td>
<td>0.0000035V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 1V</td>
<td>-1.000026</td>
<td>-0.999974</td>
<td>.0000035V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ 10V</td>
<td>+9.99976</td>
<td>+10.00024</td>
<td>0.000025V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- 10V</td>
<td>-10.00024</td>
<td>-9.99976</td>
<td>0.000025V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+100V</td>
<td>+99.9964</td>
<td>+100.0036</td>
<td>0.00045V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-100V</td>
<td>-100.0036</td>
<td>-99.9964</td>
<td>0.00045V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+199V</td>
<td>+198.9932</td>
<td>+199.0068</td>
<td>0.0009V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-199V</td>
<td>-199.0068</td>
<td>-198.9932</td>
<td>0.0009V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

On Receipt from the manufacturer, Validity Tolerance Calculations:

Higher Limit = Hr + Um  
Lower Limit = Lr - Um

Following User Calibration, Validity Tolerance Calculations:

Higher Limit = Hr - Uf + Um  
Lower Limit = Lr + Uf - Um
### Table 2. AC VOLTAGE Full Range Checks

<table>
<thead>
<tr>
<th>1362 RANGE</th>
<th>Calib. FREQ</th>
<th>Wideband Relative Accuracy</th>
<th>Factory Cal. Std. Uncertainty</th>
<th>User’s Measurement Uncertainty</th>
<th>Validity Tolerance Limits</th>
<th>1362 READING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Tolerance Limits</td>
<td>±Uf</td>
<td>±Um</td>
<td>Lower</td>
<td>Higher</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower (Lr)</td>
<td>Higher (Hr)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100mV</td>
<td>1kHz</td>
<td>99.945</td>
<td>100.055</td>
<td>0.004mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100mV</td>
<td>30kHz</td>
<td>99.860</td>
<td>100.140</td>
<td>0.017mV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1V</td>
<td>1kHz</td>
<td>.99945</td>
<td>1.00055</td>
<td>0.00003V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1V</td>
<td>30kHz</td>
<td>.99860</td>
<td>1.00140</td>
<td>0.00007V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10V</td>
<td>1kHz</td>
<td>9.9945</td>
<td>10.0055</td>
<td>0.003V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10V</td>
<td>30kHz</td>
<td>9.9860</td>
<td>10.0140</td>
<td>0.007V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100V</td>
<td>1kHz</td>
<td>99.945</td>
<td>100.055</td>
<td>0.003V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100V</td>
<td>30kHz</td>
<td>99.860</td>
<td>100.140</td>
<td>0.007V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>199V</td>
<td>1kHz</td>
<td>198.901</td>
<td>199.099</td>
<td>0.006V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>199V</td>
<td>30kHz</td>
<td>198.741</td>
<td>199.259</td>
<td>0.014V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 3. AC VOLTAGE Linearity Checks (Performed on 10V Range)

<table>
<thead>
<tr>
<th>1V</th>
<th>1kHz</th>
<th>0.9977</th>
<th>1.0023</th>
<th>0.0001V</th>
</tr>
</thead>
<tbody>
<tr>
<td>10V</td>
<td>1kHz</td>
<td>9.9945</td>
<td>10.0055</td>
<td>0.0003V</td>
</tr>
<tr>
<td>19V</td>
<td>1kHz</td>
<td>18.9934</td>
<td>19.0066</td>
<td>0.0006V</td>
</tr>
</tbody>
</table>

On Receipt from the manufacturer, Validity Tolerance Calculations:

Higher Limit = Hr + Um  
Lower Limit = Lr - Um

Following User Calibration, Validity Tolerance Calculations:

Higher Limit = Hr - Uf + Um  
Lower Limit = Lr + Uf - Um
### Section 7 - Specifications and Verification

#### Table 3. RESISTANCE Full Range Checks

<table>
<thead>
<tr>
<th>1362 RANGE (Calibrator Nom. val.)</th>
<th>Calibrator Resistance Value (Vr)</th>
<th>δR (Vr - Nom.)</th>
<th>Relative Accuracy Tolerance Limits</th>
<th>Factory Cal. Std. Uncert'y ±Uf</th>
<th>User's Measurement Tolerance ±Um</th>
<th>Validity Tolerance Limits</th>
<th>1362 READING</th>
</tr>
</thead>
<tbody>
<tr>
<td>100Ω</td>
<td></td>
<td>99.9953</td>
<td>100.0047</td>
<td>0.00045</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1kΩ</td>
<td></td>
<td>0.999964</td>
<td>1.000036</td>
<td>0.0000045</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10kΩ</td>
<td></td>
<td>9.99964</td>
<td>10.00036</td>
<td>0.000045</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100kΩ</td>
<td></td>
<td>99.9954</td>
<td>100.0046</td>
<td>0.0008</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1MΩ</td>
<td></td>
<td>0.999912</td>
<td>1.000088</td>
<td>0.000012</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10MΩ</td>
<td></td>
<td>9.99792</td>
<td>10.00208</td>
<td>0.00015</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4-wire connection

On Receipt from the manufacturer, Validity Tolerance Calculations:

Higher Limit = \( H_r + \delta R + U_m \)
Lower Limit = \( L_r + \delta R - U_m \)

Following User recalibration, Validity Tolerance Calculations:

Higher Limit = \( H_r + \delta R - U_f + U_m \)
Lower Limit = \( L_r + \delta R + U_f - U_m \)
## Table 5. DC CURRENT Full Range Checks

<table>
<thead>
<tr>
<th>1362 Range &amp; Calibrator output</th>
<th>Calibrator FREQ</th>
<th>Relative Accuracy Tolerance Limits</th>
<th>Factory Cal. Std Uncert’y ±Uf</th>
<th>User’s Measurement Tolerance ±Um</th>
<th>Validity Tolerance Limits</th>
<th>1362 READING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower(Lr)</td>
<td>Higher(Hr)</td>
<td>Lower</td>
<td>Higher</td>
<td></td>
</tr>
<tr>
<td>+1A</td>
<td>1kHz</td>
<td>0.99860</td>
<td>1.00140</td>
<td>0.00013A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-1A</td>
<td></td>
<td>-0.999780</td>
<td>-1.000220</td>
<td>0.000050A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

On Receipt from the manufacturer, Validity Tolerance Calculations:

Higher Limit = Hr + Um  
Lower Limit = Lr - Um

Following User recalibration, Validity Tolerance Calculations:

Higher Limit = Hr - Uf + Um  
Lower Limit = Lr + Uf - Um

## Table 6. AC CURRENT Full Range Checks

<table>
<thead>
<tr>
<th>1362 Range &amp; Calibrator output</th>
<th>Calibrator FREQ</th>
<th>Relative Accuracy Tolerance Limits</th>
<th>Factory Cal. Std Uncert’y ±Uf</th>
<th>User’s Measurement Tolerance ±Um</th>
<th>Validity Tolerance Limits</th>
<th>1362 READING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower(Lr)</td>
<td>Higher(Hr)</td>
<td>Lower</td>
<td>Higher</td>
<td></td>
</tr>
<tr>
<td>1A</td>
<td>1kHz</td>
<td>0.99860</td>
<td>1.00140</td>
<td>0.00013A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

On Receipt from the manufacturer, Validity Tolerance Calculations:

Higher Limit = Hr + Um  
Lower Limit = Lr - Um

Following User recalibration, Validity Tolerance Calculations:

Higher Limit = Hr - Uf + Um  
Lower Limit = Lr + Uf - Um
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SECTION 8
1362 ROUTINE CALIBRATION
SECTION 8 1362 ROUTINE CALIBRATION

NB. This calibration routine was developed for a 1362 using Native language. To calibrate using SCPI, follow this procedure but transpose the calibration commands for those detailed in Section 4; pages 4-12 & 4-13. Calibration is not programmable in CIIL.

Introduction

Read This First
To verify the instrument specification without affecting the calibration memory, please refer to Section 7 of this handbook.

For information on other forms of calibration, such as the types of repairs which must be followed by calibration, refer to your authorized service center. The instrument must be thoroughly checked before attempting calibration.

WARNING THIS INSTRUMENT CAN DELIVER A LETHAL ELECTRIC SHOCK. NEVER TOUCH ANY LEAD OR TERMINAL UNLESS YOU ARE ABSOLUTELY CERTAIN THAT NO DANGEROUS VOLTAGE IS PRESENT.

Equipment Requirements

Basic Configuration (including Option 40):
DC and AC Voltage and Resistance Calibrator of suitable accuracy.
e.g. Model 4800 or 4808 (Options 10, 20, 30 & 50)

Full Analog Configuration (including Option 30):
DC and AC Voltage, DC and AC Current, and Resistance Calibrator of suitable accuracy.
e.g. Model 4800 or 4808 (Options 10, 20, 30, 40 & 50)

Non-Nominal Calibration

The levels at which calibration is performed, given in the following procedures, are the 'nominal' points for the functions/ranges. Nominal points need not be programmed; they are assumed by the 1362 when the commands CALL? and CALH? are sent without Nrf.

For users who wish to calibrate at non-nominal values, CALL? and CALH? allow the non-nominal value to be entered in 'Nrf' form. This causes the 1362 to assume that the value represented by the Nrf is that which will be input.

There is a high probability that nominal resistance values will not be available; this is reflected in the 4-wire procedure at operation 7 on page 8-4.

An Nrf in the following ranges of values is valid:

- With CALL? - any value up to +25% of full range, except for the DCV or ACV 300V range: 75V.
- With CALH? - any value between 75% of full range and full scale.

Refer to Section 5, page 5-29.)

Preparation

1. Ensure that the instrument is correctly mounted and operative in its subrack.
2. Turn on the instrument and allow to warm up for at least 15 minutes in the specified environment.
3. Ensure that the front panel calibration switch is in the disable position (Down).
4. Program and execute a 'Selftest' (Query ∗TST?). Should the instrument fail, contact your local authorized Service Center. If the instrument is to be returned, complete a Failure Report form, which can be found at the back of this handbook. Detach and return it with the instrument to your local service centre.
5. Set the calibration switch to the enable position (Up).
6. Use the LINE Nrf code to select the appropriate Line Frequency and Integration mode (page 5-32).

Note: If a partial calibration is being attempted, use the same line frequency as for the most-recent main calibration. If the local line frequency differs from the cal frequency, ensure that common mode noise on the input signal is minimized.

7. Use the CAL ON code to enable calibration mode (page 5-29).
8. If required, use the STLN? query to store the currently-selected line frequency as the Power On Default setting (the current default can be read using the LINE? query) (page 5-32).

To disable calibration mode at any time, either send CAL OFF or set the front panel calibration switch to the disable position (Down) (page 5-29).

After Routine Calibration

Once the instrument has been re-calibrated against the user's standards, its performance can be verified against the calibration standards as detailed in Section 7.

Note: The manufacturer's factory calibration uncertainties are no longer valid after user-recalibration, so when performing the calculations in Section 7, the validity tolerance limits should be calculated to include the user's calibration uncertainties in place of the manufacturer’s.
Section 8 - Routine Calibration

Procedures

Warning

⚠️ In the following sequences, when changing connections or switching ranges, ensure that the calibrator output is switched or programmed off.

DC Voltage

Input Connections

CAUTION

⚠️ Consult the appropriate manufacturers’ handbooks before connecting and operating any of their equipment.

With its output turned OFF, connect the calibrator output to the relevant input pins of Channel 'A' on the Front Panel INPUT connector.

Channel 'A' Input Pins

(Front Panel Input Connector)

<table>
<thead>
<tr>
<th>Input</th>
<th>Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi</td>
<td>1</td>
</tr>
<tr>
<td>I+</td>
<td>2</td>
</tr>
<tr>
<td>Lo</td>
<td>5</td>
</tr>
<tr>
<td>I-</td>
<td>6</td>
</tr>
<tr>
<td>Gu</td>
<td>7</td>
</tr>
</tbody>
</table>

DCV Zero and Full Range

1. Set the Calibrator to:
   - Output OFF, DC 10V range, Zero output, Local Guard.
2. Program the 1362 to:
   - **DCV 1Ø,FILTO,RESL6;GUARD LCL**
     (DC Voltage, 10V range, Filter Off, 6½ digit resolution, Local Guard) (page 5-14).
3. Set the Calibrator Output ON.
4. Send **CALL?** to the 1362 (page 5-29).
5. Set the Calibrator output to +10.00000V.
6. Send **CALH?** to the 1362 (page 5-29).
7. Set the Calibrator output to -10.00000V.
8. Send **CALH?** to the 1362 (page 5-29).
9. Set the Calibrator Output OFF.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Calibrator</th>
<th>1362</th>
</tr>
</thead>
<tbody>
<tr>
<td>100mV Range</td>
<td>100mV Range, Zero</td>
<td>DCV Ø</td>
</tr>
<tr>
<td>(1)</td>
<td></td>
<td>CALL?</td>
</tr>
<tr>
<td>(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>+100.0000mV</td>
<td>CALH?</td>
</tr>
<tr>
<td>(6)</td>
<td>-100.0000mV</td>
<td>CALH?</td>
</tr>
<tr>
<td>(7)</td>
<td>-100.0000mV</td>
<td>CALH?</td>
</tr>
<tr>
<td>(8)</td>
<td>-100.0000mV</td>
<td></td>
</tr>
</tbody>
</table>

1V Range

<table>
<thead>
<tr>
<th>Operation</th>
<th>Calibrator</th>
<th>1362</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>1V Range, Zero</td>
<td>DCV 1</td>
</tr>
<tr>
<td>(2)</td>
<td></td>
<td>CALL?</td>
</tr>
<tr>
<td>(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>+1.000000V</td>
<td>CALH?</td>
</tr>
<tr>
<td>(6)</td>
<td>-1.000000V</td>
<td>CALH?</td>
</tr>
<tr>
<td>(7)</td>
<td>-1.0000000V</td>
<td>CALH?</td>
</tr>
<tr>
<td>(8)</td>
<td>-1.0000000V</td>
<td></td>
</tr>
<tr>
<td>100V Range</td>
<td>100V Range, Zero</td>
<td>DCV 10Ø</td>
</tr>
<tr>
<td>(1)</td>
<td></td>
<td>CALL?</td>
</tr>
<tr>
<td>(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>+100.0000V</td>
<td>CALH?</td>
</tr>
<tr>
<td>(6)</td>
<td>-100.0000V</td>
<td>CALH?</td>
</tr>
<tr>
<td>(7)</td>
<td>-100.0000V</td>
<td>CALH?</td>
</tr>
<tr>
<td>(8)</td>
<td>-100.0000V</td>
<td></td>
</tr>
<tr>
<td>300V Range</td>
<td>100V Range, Zero</td>
<td>DCV 30Ø</td>
</tr>
<tr>
<td>(1)</td>
<td></td>
<td>CALL?</td>
</tr>
<tr>
<td>(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>+199.0000V</td>
<td>CALH? 199</td>
</tr>
<tr>
<td>(6)</td>
<td>-199.0000V</td>
<td>CALH? 199</td>
</tr>
<tr>
<td>(7)</td>
<td>-199.0000V</td>
<td>CALH? 199</td>
</tr>
<tr>
<td>(8)</td>
<td>-199.0000V</td>
<td></td>
</tr>
</tbody>
</table>
Section 8 - Routine Calibration

Resistance
Input Connections

CAUTION

Consult the appropriate manufacturers' handbooks before connecting and operating any of their equipment.

With its output turned OFF, connect the calibrator output to the relevant input pins of Channel 'A' on the Front Panel INPUT connector.

Channel 'A' Input Pins
(Front Panel Input Connector)

<table>
<thead>
<tr>
<th>Input</th>
<th>Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi</td>
<td>1</td>
</tr>
<tr>
<td>I+</td>
<td>2</td>
</tr>
<tr>
<td>Lo</td>
<td>5</td>
</tr>
<tr>
<td>I-</td>
<td>6</td>
</tr>
<tr>
<td>Gu</td>
<td>7</td>
</tr>
</tbody>
</table>

4-Wire Zero and Full Range

1. Set the Calibrator to:
   Output OFF, ZeroΩ, Remote Guard.

2. Program the 1362 to:
   **OHMS 100Ω, FILT0, RESL6, WIRE4; GUARD LCL**
   (Ohms, 100Ω range, Filter Off, 6½ digit resolution, 4-wire connection, Local Guard) *(page 5-18)*.

3. Set the Calibrator Output to 100Ω. (If nominal value is not available on the calibrator, disconnect the calibrator and connect a short-circuit between pins 1, 2, 5, and 6 of the 1362 input connector instead, using the shortest possible wire.)

4. Send **CALL?** to the 1362 *(page 5-29)*.

5. If a short-circuit was connected at operation (3), disconnect it and reconnect the calibrator leads.

6. Set the Calibrator output to 100Ω. (If nominal value is not available, see operation (7) regarding the use of **CALH? Nrf**.

7. Send **CALH?** to the 1362 for calibration at nominal value *(page 5-29)*.

8. Set the Calibrator Output OFF.

9. Repeat operations 1 to 8, to calibrate zero and full range on the 1kΩ, 10kΩ, 100kΩ, 1MΩ and 10MΩ ranges, resetting the calibrator and 1362 at operations (1), (2), (4), (6) and (7) as shown in the table in the next column (table shows settings for nominal values).

### Operation 1kΩ Range

<table>
<thead>
<tr>
<th>Operation</th>
<th>Calibrator</th>
<th>1362</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>ZeroΩ</td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td>OHMS 100Ω</td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td>CALL?</td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>1000.000Ω</td>
<td>CALH?</td>
</tr>
<tr>
<td>(7)</td>
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### Operation 10kΩ Range

<table>
<thead>
<tr>
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<th>1362</th>
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</thead>
<tbody>
<tr>
<td>(1)</td>
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</tr>
<tr>
<td>(2)</td>
<td>OHMS 100Ω</td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td>CALL?</td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>10,000.00Ω</td>
<td>CALH?</td>
</tr>
<tr>
<td>(7)</td>
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</table>

### Operation 100kΩ Range

<table>
<thead>
<tr>
<th>Operation</th>
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<th>1362</th>
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</thead>
<tbody>
<tr>
<td>(1)</td>
<td>ZeroΩ</td>
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</tr>
<tr>
<td>(2)</td>
<td>OHMS 100Ω</td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td>CALL?</td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>100,000.0Ω</td>
<td>CALH?</td>
</tr>
<tr>
<td>(7)</td>
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</table>

### Operation 1MΩ Range

<table>
<thead>
<tr>
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<th>1362</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>ZeroΩ</td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td>OHMS 100Ω</td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td>CALL?</td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>1,000,000Ω</td>
<td>CALH?</td>
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### Operation 10MΩ Range

<table>
<thead>
<tr>
<th>Operation</th>
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<th>1362</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
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</tr>
<tr>
<td>(2)</td>
<td>OHMS 100Ω</td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td>CALL?</td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>10,000.00kΩ</td>
<td>CALH?</td>
</tr>
<tr>
<td>(7)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2-Wire Zero

1. Disconnect the Calibrator. Connect a short-circuit between Channel A Hi and Lo on the front panel input connector (pins 1 and 5). Use the shortest length of wire possible.

2. Program the 1362 to:
   **OHMS 100Ω, FILT0, RESL6, WIRE2; GUARD LCL**
   (Ohms, 100Ω range, Filter Off, 6½ digit resolution, 2-wire connection, Local Guard) *(page 5-18)*.

3. Set the Calibrator Output to 100Ω. (If nominal value is not available, see operation (4) regarding the use of **CALH? Nrf**.

4. Repeat operations (2) and (3) for the 1kΩ range *(OHMS 100Ω, WIRE2)* only at operation (2)).

5. Repeat operations (2) and (3) for the 10kΩ range *(OHMS 100Ω, WIRE2)* only at operation (2)).

6. Repeat operations (2) and (3) for the 100kΩ range *(OHMS 100Ω, WIRE2)* only at operation (2)).

7. Repeat operations (2) and (3) for the 1MΩ range *(OHMS 100Ω, WIRE2)* only at operation (2)).

8. Repeat operations (2) and (3) for the 10MΩ range *(OHMS 100Ω, WIRE2)* only at operation (2)).
AC Voltage

Input Connections

CAUTION

Consult the appropriate manufacturers’ handbooks before connecting and operating any of their equipment.

With its output turned OFF, connect the calibrator output to the relevant input pins of Channel ‘A’ on the Front Panel INPUT connector.

Channel ‘A’ Input Pins

(Front Panel Input Connector)

<table>
<thead>
<tr>
<th>Input</th>
<th>Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi</td>
<td>1</td>
</tr>
<tr>
<td>I+</td>
<td>2</td>
</tr>
<tr>
<td>Lo</td>
<td>5</td>
</tr>
<tr>
<td>I-</td>
<td>6</td>
</tr>
<tr>
<td>Gu</td>
<td>7</td>
</tr>
</tbody>
</table>

ACV Low, and ACV Full Range

1. Set the Calibrator to:
   Output OFF, AC 100mV range, 10mV RMS output at 1kHz, Local Guard.

2. Program the 1362 to:
   ACV 0,FILTO,RESLS5;GUARD LCL
   (AC Voltage, 100mV range, Filter Off, 5½ digit resolution, Local Guard) *(page 5-16)*.

3. Set the Calibrator Output ON.

4. Send CALL? to the 1362 *(page 5-29)*.

5. Set the Calibrator output to 1kHz, 100.000mV RMS.

6. Send CALH? to the 1362 *(page 5-29)*.

7. Set the Calibrator Output OFF.

8. Repeat operations 1 to 7, to calibrate zero and full range on the 1362 100mV, 1V and 100V ranges, and at zero and 199V on the 300V range, resetting the calibrator and 1362 at operations (1), (2), (4), (5) and (6) as shown in the table in the next column.
**DC Current (Option 30)**

**Input Connections**

**CAUTION**

Consult the appropriate manufacturers' handbooks before connecting and operating any of their equipment.

With its output turned **OFF**, connect the calibrator output to the relevant input pins of Channel 'A' on the Front Panel **INPUT** connector.

**Channel 'A' Input Pins**

(Front Panel Input Connector)

<table>
<thead>
<tr>
<th>Input</th>
<th>Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>I+</td>
<td>2</td>
</tr>
<tr>
<td>I-</td>
<td>6</td>
</tr>
</tbody>
</table>

**DCI Zero and Full Range**

1. Set the Calibrator to:
   - Output OFF, DC 1A range, Open Circuit output, Local Guard.
2. Program the 1362 to:
   - \texttt{DCI FILT0,RESL6;GUARD LCL}
   (DC Current, 1A range, Filter Off, 6½ digit resolution, Local Guard) \textit{(page 5-15)}.
3. Set the Calibrator Output ON.
4. Send \texttt{CALL?} to the 1362 \textit{(page 5-29)}.
5. Set the Calibrator output to +1.000000A.
6. Send \texttt{CALH?} to the 1362 \textit{(page 5-29)}.
7. Set the Calibrator output to -1.000000A.
8. Send \texttt{CALH?} to the 1362 \textit{(page 5-29)}.
9. Set the Calibrator Output OFF.

**AC Current (Option 30)**

**Input Connections**

**CAUTION**

Consult the appropriate manufacturers' handbooks before connecting and operating any of their equipment.

With its output turned **OFF**, connect the calibrator output to the relevant input pins of Channel 'A' on the Front Panel **INPUT** connector.

**Channel 'A' Input Pins**

(Front Panel Input Connector)

<table>
<thead>
<tr>
<th>Input</th>
<th>Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>I+</td>
<td>2</td>
</tr>
<tr>
<td>I-</td>
<td>6</td>
</tr>
</tbody>
</table>

**ACI Low, and Full Range**

1. Set the Calibrator to:
   - Output OFF, AC 1A range, 1kHz, 100.000mA RMS output, Local Guard.
2. Program the 1362 to:
   - \texttt{ACI FILT0,RESL6,ACCP;GUARD LCL}
   (AC Current, 1A range, Filter Off, 5½ digit resolution, Local Guard) \textit{(page 5-17)}.
3. Set the Calibrator Output ON.
4. Send \texttt{CALL?} to the 1362 \textit{(page 5-29)}.
5. Set the Calibrator output to 1kHz, 1.00000A RMS.
6. Send \texttt{CALH?} to the 1362 \textit{(page 5-29)}.
7. Set the Calibrator Output OFF.
# SECTION 11 1362 Servicing Diagrams

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2. The pages in this section are not numbered, but the Diagrams are placed in the following order.

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<th>Circuit Diagrams</th>
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</thead>
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<td>---</td>
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<tr>
<td>1362S Finished Assembly</td>
<td>DA401080 Shts 1 &amp; 2</td>
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<tr>
<td>1362MT Finished Assembly</td>
<td>DA400952 Shts 1 &amp; 2</td>
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</tr>
<tr>
<td>Card DMM Assembly</td>
<td>Layout Drawing DA400911</td>
<td>Circuit Diagram DC400911</td>
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<tr>
<td></td>
<td>Sht  Detail</td>
<td>Sht  Detail</td>
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<td>No.</td>
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<td>1 Full Board Layout</td>
<td>1 Processor and Memory</td>
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<tr>
<td>2 Rear Section Detail</td>
<td>2 Serial Interface</td>
<td></td>
</tr>
<tr>
<td>3 Mid Section Detail</td>
<td>3 Digital Connections</td>
<td></td>
</tr>
<tr>
<td>4 Front Section Detail</td>
<td>4 Digital Subsystem &amp; VME Interface</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 RMS Converter</td>
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</tr>
<tr>
<td></td>
<td>6 AC Preamp</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7 A to D Converter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 DC Preamp</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9 Power Supplies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 Self-Test Subsystem</td>
<td></td>
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<tr>
<td></td>
<td>11 Floating Ohms</td>
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</tr>
<tr>
<td></td>
<td>12 Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 Input and A-D Optos</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14 VXI I/F Chip</td>
<td></td>
</tr>
</tbody>
</table>
### Assembly Description

<table>
<thead>
<tr>
<th>Assembly Description</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1362 Finished Instrument Parts List</td>
<td>LP400910</td>
</tr>
<tr>
<td>1362S Finished Instrument Parts List</td>
<td>LP401080</td>
</tr>
<tr>
<td>1362MT Finished Instrument Parts List</td>
<td>LP400952</td>
</tr>
<tr>
<td>Card DMM Assembly Parts List</td>
<td>LP400911</td>
</tr>
</tbody>
</table>
U01 2U80280 IC DIG PROCESSOR 16 BIT 16MHz MULLER M875405F166 EA 1
U02 401082-5 ASSY EWRM 13625 FLUKE SEE DRG S2 1
U03 401082-5 ASSY EWRM 13625 FLUKE SEE DRG S2 -
U07 401197-1 ASSY PCIe BI Dir Dec/Dec PCIe 4237 FLUKE SEE DRG EA 1
U452 400914-4 ASSY FPGA VXI INT 1362 FLUKE SEE DRG EA 1
#1 400911-6 ASSY PCB VXI CARD DMM 1362 BI ELECTRONICS SEE DRG EA 1
#1 400912-1 ASSY CABLE SINGLE 1/F 1505 FLUKE SEE DRG EA 0
#1 400953-1 ASSY CABLE RATIO 1/F 1506 FLUKE SEE DRG EA 0
#1 400954-2 ASSY DISK VXI 44P DRIVER 1362 FLUKE SEE DRG EA 1
#1 41044-1 PCB TOP SCREEN 1362 INLYNE SEE DRG EA 1
#1 41044-1 PCB BOTTOM SCREEN 1362 INLYNE SEE DRG EA 1
#1 420114 LABEL SSD WARNING DESTRUCTABLE JM 7102 A EA 1
#1 420119-1 LABEL CAL STICKER CJM LABELS SEE DRG EA 2
#1 420120 LABEL SSD WARNING DESTRUCTABLE STATIC SAFE ENVIROM SWL 1939 EA 2
#1 420163-2 LABEL CABLE 148.5 X 50 CROME SEE DRG EA 1
#1 420146 LABEL 63.5 X 25.4 SILVER/VE BRADY LAT-21-773-1 EA 1
#1 440164-1 KIT CURRENT OPTION 1362 FLUKE SEE DRG EA 0
#1 440165-1 KIT RATIO OPTION 1362 FLUKE SEE DRG EA 0
#1 450787-1 TOP COVER 1361 FARNELL TECH SEE DRG EA 1
#1 450797-2 BOTTOM COVER 1362 FARNELL TECH SEE DRG EA 1
#1 450785-3 PANEL FRONT 1362 FARNELL TECH SEE DRG EA 1
#1 450787-2 PACKING BOX 1362 A.E.SUTTON SEE DRG EA 1
#1 450788-1 INSULATION SHEET 1362 KENSILAT SEE DRG EA 1
#1 450789-3 EARTHING SHIELD PSU 1362 FARNELL TECH SEE DRG EA 1
#1 450790-3 GUARD SHIELD PSU 1362 FARNELL TECH SEE DRG EA 1
#1 450791-3 GUARD SHIELD AC 1361 FARNELL TECH SEE DRG EA 1
#1 450819-1 COVER INSULATION 1362 HUGHES & WYNNE SEE DRG EA 1
#1 450965-1 OVERLAY 1362 TKNCRAFT SEE DRG EA 1
#1 450971-1 NAMEPLATE ‘KAVETEK’ 1362 SCREENCRAFT SEE DRG EA 1
#1 450972-1 NAMEPLATE ‘VXI’ 1362 SCREENCRAFT SEE DRG EA 1
#1 451395-1 INSULATOR A-D FPOA 1362 HUGHES & WYNNE SEE DRG EA 1
#1 460977-1 SLEEVE H 0.125 DIA CLEAR NAYCOR KX931.1.8X1.2M CLEAR EA 1
#1 604110 PLUG 15-WAY D TYPE CARBON DAM-15P A EA 1
#1 605206 SOCKET 15-WAY D TYPE CARBON DAM-15S A EA 1
#1 60603 WASHER 1/2" M4Y PVC CONNECTORS M4Y EA 1
#1 606028 SCREW LOCK D TYPE CARBON D20418-2 EA 2
#1 606036 CABLE MOUNT MET JUNCT SHELL NARRE 3107-9210 EA 1
#1 611033 SCREW M2.5 X 10 POSIFAN SFP GKN SEE DRG DP611000 EA 2
#1 611114 SCREW M2.5 X 11 COLLAR SCHROFF 2110-379 EA 2
#1 611117 SCREW M2.5 X 8 POSICOK SFP GKN SEE DRG DP611000 EA 2
#1 611220 SCREW M3 X 6 POSICEK SS GKN SEE DRG DP611000 EA 6
#1 611221 SCREW M3 X 6 POSICOK SS GKN SEE DRG DP611000 EA 4
#1 612056-2 STANDOFF M3 X 2.5 SWIFT ENGINEERING SEE DRG EA 6
#1 612057 SPACER M3 X 14 M/F HEX HAIRPIN R30-3001402 EA 6
#1 613029 WASHER M3 CRINKE SS GKN SEE DRG DP611000 EA 10
#1 613047 WASHER M2.5 CRINKE SS GKN SEE DRG DP611000 P EA 2
#1 613077 WEDGE SPECIAL HHC 1/2" X 15-28 HEX APG 1-129631-2 EA 1
#1 617019 SLEEVE SCREW RETAINING GREY SCHROFF 2110-464 EA 2
#1 618016 PAN INSEL NIL TO220 SELF ADH WARTX 817-AC-819 EA 2
#1 630255 TAPE SELF ADH DSH SLDE JD Y9669 X 1/2" WIDE AR 1
#1 630355 CLIP CABLE SUPPORT LEWIS SPRING L.S.109/65 EA 2
#1 630359 EXTERNAL HANDLE TOP SCHROFF 20817-328 EA 1
#1 630363 EXTERNAL HANDLE BOTTOM SCHROFF 20817-327 EA 1
#1 630373-1 SILICA GEL SELF-IND 50G EUGEL CHEMICALS SEE DRG EA 1
#1 630476 BAG ANTI STATIC CUSHIONED 40 X JM 2120X16 X 11 EA 1
#1 850255-4 HANDHEE USERS 1362 CROME SEE DRG EA 1
#1 900009 LOCKING COMPOUND LECTRITE 222 AR 1
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<thead>
<tr>
<th>DESIGN NUMBER</th>
<th>DESCRIPTION</th>
<th>PRINCIPAL MANUF</th>
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<td>R13 050076</td>
<td>RES MF 1k8 1.12.2W</td>
<td>MEC</td>
<td>HR 3080 0.1% 500PF</td>
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<td>R15 050077</td>
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<tr>
<td>R19 290026-J</td>
<td>KIT SMD SELECTED</td>
<td>FLOX</td>
<td>SEE DRG</td>
<td>S3 1</td>
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<td>R20 080442-7</td>
<td>RES Fl 1k 0.1% 3PPM</td>
<td>VISHAY</td>
<td>S102C 200000 0.01% A</td>
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<td>R21 080442-7</td>
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<td>VISHAY</td>
<td>S102C TO DRG</td>
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<td>R23 050130</td>
<td>RES MF 33k 1% 12W 100PPM</td>
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<td>R24 050135</td>
<td>RES MF 1k8 1% 12W 100PPM</td>
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<td>RES MF 1k5 1% 12W 100PPM</td>
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<td>NECOM</td>
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<td>NECOM</td>
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<tr>
<td>R30 050097</td>
<td>RES MF 560k 1% 12W 100PPM</td>
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<td>LG3024 560K 1% A</td>
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<tr>
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<td>LG3024 68K 1% A</td>
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<tr>
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<td>RES MF 1k8 1% 12W 100PPM</td>
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</tr>
<tr>
<td>R35 050129</td>
<td>RES MF 0.1% 12W 100PPM</td>
<td>NECOM</td>
<td>LG3024 0.1% 1% 100PPM</td>
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<td>R36 290026-J</td>
<td>KIT SMD SELECTED</td>
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<td>SEE DRG</td>
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**Notes:**
- **RES** stands for Resistor.
- **MF** indicates a metal film resistor.
- **Fl** refers to a ceramic film resistor.
- **NEOHM** indicates a non-inductive resistor.
- **RMS** stands for resistors with a power rating of 0.12W.
- **1%** indicates a tolerance of ±1%.
- **12W** indicates a power rating of 12W.
- **100PPM** indicates a tolerance of ±100ppm.
- **QUANTITY** indicates the quantity of each component.
- **A** indicates an available stock, while **HA** indicates a hard-to-find component.
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