User Manual

Tektronix

VX4237
Digital Multimeter Module

070-9075-02

This document supports firmware version 1.00

Warning
The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to the Safety Summary prior to performing service.

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Tektronix, Inc., P.O. Box 1000, Wilsonville, OR 97070–1000

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To write us	Tektronix, Inc. P.O. Box 1000 Wilsonville, OR 97070-1000

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of the system. Read the *General Safety Summary* in other system manuals for warnings and cautions related to operating the system.

To Avoid Fire or Personal Injury

Connect and Disconnect Properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Ground the Product. This product is indirectly grounded through the grounding conductor of the mainframe power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Observe All Terminal Ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Do Not Operate Without Covers. Do not operate this product with covers or panels removed.

Use Proper Fuse. Use only the fuse type and rating specified for this product.

Avoid Exposed Circuitry. Do not touch exposed connections and components when power is present.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Provide Proper Ventilation. Refer to the manual’s installation instructions for details on installing the product so it has proper ventilation.

Symbols and Terms

Terms in this Manual. These terms may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

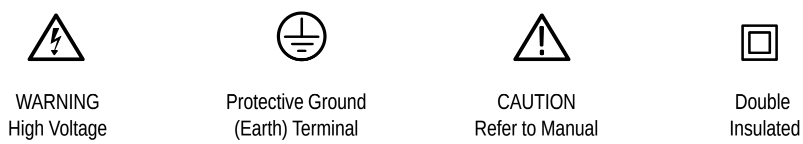
Terms on the Product. These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product. The following symbols may appear on the product:



Service Safety Summary

Only qualified personnel should perform service procedures. Read this *Service Safety Summary* and the *General Safety Summary* before performing any service procedures.

Do Not Service Alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect Power. To avoid electric shock, disconnect the mains power by means of the power cord or, if provided, the power switch.

Use Care When Servicing With Power On. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

To avoid electric shock, do not touch exposed connections.

Preface

This is the user manual for the VX4237 Digital Multimeter Module.

Please read and follow all instructions for installation and configuration. Use the Installation Checklist to insure proper installation, and as a record of initial settings.

This manual assumes you are familiar with VXIbus instruments and operation, and with the purpose and function of this instrument. The *Operating Basics* section gives a summary of VXIbus operation, and presents an overview of this instrument's operation.

The *Syntax and Commands* section has a summary of all the commands, and detailed descriptions of each command.

Conventions

The names of all switches, controls, and indicators appear in this manual exactly as they appear on the instrument.

Specific conventions for programming are given in the section *Syntax and Commands*.

This manual uses the following notational conventions:

- An asterisk (*) following a signal mnemonic denotes that the signal is active when in the low state (typically, 0 V).
- A signal mnemonic without a following asterisk (*) denotes that the signal is active when in the high state (typically, 2.8 – 5 V).

Regarding the base of a number:

- Unless otherwise noted, all numbers are assumed to be decimal (base 10).

Related Publications

The following documents on related subjects may be useful in making efficient use of the module:

VXIbus System Specification, Version 1.4

ANSI/IEEE Std. 1014–1987, IEEE Standard for a Versatile Backplane Bus: VME Bus

Getting Started

Getting Started

Product Description

The VX4237 Digital Multimeter Module is a printed circuit board assembly for use in a mainframe conforming to the VXIbus Specification. The VX4237 is a fully compatible VXIbus C-size Digital Multimeter (DMM) that has the following measurement capabilities and features:

- Five DC voltage ranges from 200 mV – 300 V with 100 nV resolution
- Five AC voltage ranges from 200 mV – 300 V with 1 μV resolution
- Six resistance ranges from 200 Ω – 20 MΩ with 100 μΩ resolution
- AC and DC current 1000 mA range
- Selectable 4.5 – 6.5 digit resolution
- External trigger with delay
- Programmable external calibration

The VX4237 is a message-based device using A16 addressing.

BITE (Built-In Test Equipment)

Built In Test Equipment is provided by extensive self tests that are automatically invoked on power-up, and may also be invoked on command. Circuitry tested includes the CPU and all memory, and the DMM circuitry. The front panel LEDs provide visual BITE for module operation.

Accessories

Standard

Standard accessories to the VX4237 are the *VX4237 Digital Multimeter User Manual and Reference Manual*.

Optional

An optional input lead (for the 15-pin front panel connector) is available from Tektronix by ordering part number 012-1391-00.

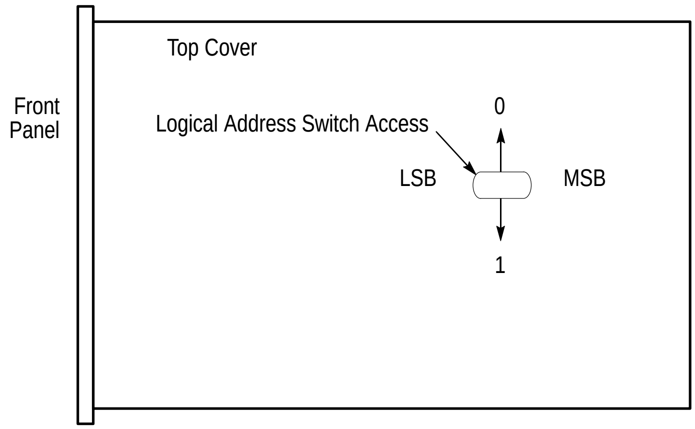


Figure 1–1: VX4237 Controls and Indicators

Controls And Indicators

The following controls and indicators are provided to select and display the functions of the VX4237 Module's operating environment. See Figures 1 and 2 for their physical locations.

Switches

The Local Address switch must be correctly set to insure proper operation. See *Configuration* for details of how to set the switches.

LEDs

The following LEDs are visible at the top of the VX4237 Module's front panel to indicate the status of the module's operation. See *Operating Basics* for a description of each LED's meaning.

Fail LED
Ready LED
Trig LED

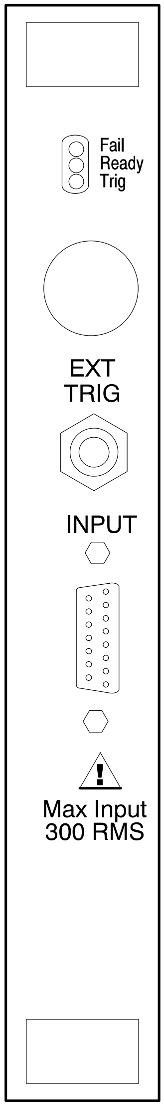


Figure 1–2: VX4237 Front Panel

Configuration

Logical Address Switch

The Logical Address Switch must be correctly set to insure proper operation. Refer to Figure 1–1 for the physical location.

Each function module in a VXIbus System must be assigned a unique logical address, from 1 to 255 decimal. The base VMEbus address of the VX4237 is set to a value between 1 and 255 by an 8-way DIL switch, accessible through a hole in the top cover.

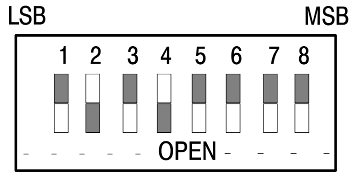


Figure 1–3: Logical Address Switch Set To Logical Address 6

The switch contacts are labelled 1 through 8, corresponding to the eight bits of the logical address value (8 $\equiv$ MSB; 1$\equiv$ 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 0.

The address can be set to any value between 1 and 255 (address 0 is reserved for the Resource Manager).

The VX4237 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.

IEEE-488 Address. Using the VX4237 Module in an IEEE-488 environment requires knowing the module's IEEE-488 address in order to program it. Different manufacturers of IEEE-488 interface devices may have different algorithms for equating a logical address with an IEEE-488 address. Consult the operating manual of the IEEE-488 Interface Module being used.

Line Frequency

Using the LINE command, you can set the VX4237 for best accuracy by matching it to the specific line frequency used in your application. Refer to the *Native Command Language* sub-section for further information.

Backplane Jumpers

NOTE*. The following instructions pertain to Tektronix Mainframes. If you are installing the DMM in a different mainframe, refer to the Instruction Manual for that mainframe for the correct jumper strap numbers.*

VXIbus mainframes contain daisy-chain jumper straps for the Bus Grant (BG0 – BG3) and Interrupt Acknowledge (IACK) signals. Tektronix Mainframes are shipped with all jumpers installed. All jumper straps must be removed for slots that have cards installed.

NOTE. *If you are using a Tektronix Mainframe, the names of the jumper straps (BG0 through BG3 IACK) are printed on the circuit board facing the front of the mainframe. These jumpers are accessed from the front of the mainframe.*

Remove all jumper straps to the immediate left of the slot in which the DMM will be installed. Retain the straps for possible future reconfiguration.

Bus Grant Jumper Straps

Slot	BG0	BG1	BG2	BG3
1	J1011	J1012	J1013	J1014
2	J1021	J1022	J1023	J1024
3	J1026	J1027	J1028	J1029
4	J1031	J1032	J1033	J1034
5	J1036	J1037	J1038	J1039
6	J1041	J1042	J1043	J1044
7	J1046	J1047	J1048	J1049
8	J1051	J1052	J1053	J1054
9	J1056	J1057	J1058	J1059
10	J1061	J1062	J1063	J1064
11	J1066	J1067	J1068	J1069
12	J1071	J1072	J1073	J1074

Interrupt Acknowledge Jumper Straps

Slot	IACK Connector	Slot	IACK Connector
0	J2010	6	J2040
1	J2015	7	J2045
2	J2020	8	J2050
9	J2055	10	J2060
3	J2025	11	J2065
4	J2030	12	J2070
5	J2035		

Front Panel Connectors

There are two front panel connectors: a coaxial BNC external trigger input, and a D-type 15-pin analog input. The pinout for the analog input is shown in Figure 1–4.

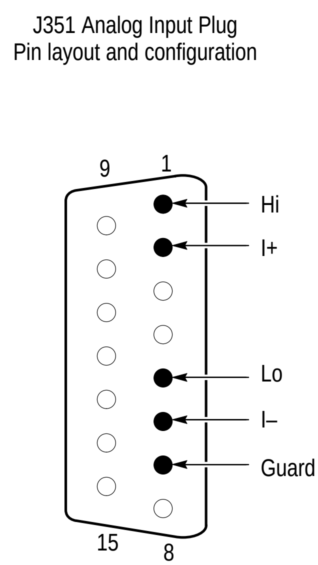


Figure 1–4: Analog Input Connector

Installation

Requirements and Cautions

The VX4237 Module is a C size VXIbus instrument module and therefore may be installed in any C or D size VXIbus mainframe slot other than slot 0. If the module is being installed in a D size mainframe, consult the operating manual for the mainframe to determine how to install the module in that particular mainframe. Setting the module's Logical Address switch defines the module's programming address. Refer to *Configuration* for information on selecting and setting the module's logical address. To avoid confusion, it is recommended that the slot number and the logical address be the same.

A slotted screwdriver is required for proper installation.

WARNING. To avoid electric shock, tighten the module mounting screws after installing the module into the mainframe to ensure that the front panel is properly grounded.

***NOTE**. There are two printed ejector handles on the card. To avoid installing the card incorrectly, make sure the ejector marked "VX4237" is at the top.*

In order to maintain proper mainframe cooling, unused mainframe slots must be covered with the blank front panels supplied with the mainframe.

Based on the number of instrument modules ordered with a Tektronix mainframe, blank front panels are supplied to cover all unused slots. Additional VXIbus C size single-slot and C size double-slot blank front panels can be ordered from your Tektronix supplier.

***NOTE**. Verify that the mainframe is able to provide adequate cooling and power with this module installed. Refer to the mainframe Operating Manual for instructions.*

If the VX4237 is used in a Tektronix Mainframe, all VX4237 cooling requirements will be met.

***NOTE**. If the VX4237 Module is inserted in a slot with any empty slots to the left of the module, the VME daisy-chain jumpers must be installed on the backplane in order for the VXI Module to operate properly. Check the manual of the mainframe being used for jumpering instructions.*

Installation Procedure

***CAUTION.** The VX4237 Module is a piece of electronic equipment and therefore has some susceptibility to electrostatic damage (ESD). ESD precautions must be taken whenever the module is handled.*

1. Record the revision level, serial number (located on the label on the top shield of the VX4237), and switch settings on the Installation Checklist.
2. Verify that the switches are switched to the correct values.
3. Make sure power is off in the mainframe.
4. The module can now be inserted into one of the instrument slots of the mainframe.
5. Cable Installation: Use the correct cable to interface between the module I/O connector and the Unit Under Test (UUT). The recommended cable is listed in *Specifications.*

Installation Checklist

Installation parameters will vary depending on the mainframe being used. Be sure to consult the mainframe Operating Manual before installing and operating the module.

Revision Level:

Serial No.: ________________

Mainframe Slot Number: _________

Switch Settings:

VXIbus Logical Address Switch: ______________
(FFh enables dynamic configuration.)

Interrupt Level Select Switch: Dynamically programmed by the Resource Manager.

Cables Installed: (if any)

Performed by: ______________________ Date: ____________

Functional Check

The VX4237 Module will execute a self test at power-on, or on direction of a VXIbus hard or soft reset condition, or on command. The power-on self test consists of an interface self test and an instrument self test. The commanded self test performs only the instrument self test. A VXIbus hard reset occurs when another device, such as the VXIbus Resource Manager, asserts the backplane line SYSRST*. A VXIbus soft reset occurs when another device, such as the VX4237's commander, sets the Reset bit in the VX4237's Control register.

At power-on, as well as during self test, all module outputs remain isolated from the module's front panel connector.

During power-on, or a hard or soft reset, the following actions take place:

1. The SYSFAIL* (VME system-failure) line is set active, indicating that the module is executing a self test, and the Failed LED is on. In the case of a soft reset, SYSFAIL* is set. However, all Tektronix/CDS commanders will simultaneously set SYSFAIL INHIBIT. This is done to prevent the resource manager from prematurely reporting the failure of a card.

2. On completion of the interface self test, SYSFAIL* is de-asserted. If the test fails, the SYSFAIL* line remains active. If the interface self test passed, the SYSFAIL* line is released, and the module enters the VXIbus PASSED state (ready for normal operation). If it failed, the module enters the VXIbus FAILED state.

3. The instrument self test, as described in the IEEE 488.2 *TST? command, is then executed. If the self test fails, the module makes an internal record of what failure(s) occurred.

The default condition of the VX4237 Module after the completion of power-on self test is as follows:

DC voltage mode
300 V range
6.5 digit resolution
filter OFF
INPUT OFF (no input on either channel)
GUARD LCL (4-wire connection internal grounding)
TSRCE SYS (internal trigger source)
DELAY DFLT (default time delays)

Self test can also be run at any time during normal operation by using the *TST? command. At the end of a self test initiated by this command, the module is restored to its pre-test state.

During a commanded self test:

- SYSFAIL* is not asserted.

- The module executes the same instrument self test as in the power-on case.
- When the self test is completed, the module sets itself to the power-on state.

SYSFAIL* Operation

SYSFAIL* becomes active during power-on, hard or soft reset, self test, or if the module loses any of its power voltages. When the mainframe Resource Manager detects SYSFAIL* set, it will attempt to inhibit the line. This will cause the VX4237 Module to deactivate SYSFAIL* in all cases except when +5 V power is lost.

Operating Basics

Operating Basics

Functional Overview

The VX4237 Module is programmed by ASCII characters issued from the system controller to the VX4237 Module via the module's VXIbus commander and the VXIbus mainframe backplane. The module is a VXIbus Message Based Device and communicates using the VXIbus Word Serial Protocol. Refer to the manual for the VXIbus device that will be the VX4237 Module's commander for details on the operation of that device.

If the module's commander is a Tektronix/CDS Resource Manager/IEEE-488 Interface Module, refer to that Operating Manual and the programming examples in this manual for information on how the system controller communicates with the commander being used.

The VX4237 is a fully compatible VXIbus C-size Digital Multimeter (DMM) that has the following measurement capabilities and features:

- Five DC voltage ranges from 200 mV – 300 V with 100 nV resolution
- Five AC voltage ranges from 200 mV – 300 V with 1 μV resolution
- Six resistance ranges from 200 Ω – 20 MΩ with 100 μΩ resolution
- Selectable 4.5 – 6.5 digit resolution
- External trigger with delay
- Programmable external calibration

Operating Status

You can determine the module's current operating status from the LEDs on the front panel.

Ready LED

This green LED is normally on and is off if the +5 V power supply fails or if the +5 V fuse blows.

Fail LED

This normally off red LED is on whenever SYSFAIL* is asserted, indicating a module failure. Module failures include failure to correctly complete an interface self test, loss of a power rail, or failure of the module's central processor.

If the module loses any of its power voltages, the Failed LED will go on and SYSFAIL* will be asserted. A module power failure is indicated when the module's Ready LED is extinguished.

Trig LED The TRIG light is turned on when the VX4237 is triggered to make a measurement.

Power-on

The VX4237 Module will complete its self test and be ready for programming five seconds after power-on. The VXIbus Resource Manager may add an additional one or two second delay. The Power LED will be on, and all other LEDs off. The MSG LED will blink during the power-on sequence as the VXIbus Resource Manager addresses all modules in the mainframe. The default condition of the module after power-on is described in *Functional Check*.

When power is applied to the VX4237, all functions are forced to a safety default state. Once a function is configured to a desired state, it remains in that state until changed or the power is removed.

The *LRN? command can be used to query the VX4237 for its current settings. More information on this command is provided in the *Command Description* sub-section.

Instrument I/O – VXIbus Basics

***NOTE**. If the user's mainframe has other manufacturer's computer boards operating in the role of VXIbus foreign devices, the assertion of BERR* (as defined by the VXIbus Specification) may cause operating problems on these boards.*

The VX4237 Module is a C size single slot VXIbus Message-Based Word Serial instrument. It uses the A16, D16 VME interface available on the backplane P1 connector and does not require any A24 or A32 address space. The module is a D16 interrupter.

The VX4237 Module is neither a VXIbus commander or VMEbus master, and therefore it does not have a VXIbus Signal register. The VX4237 is a VXIbus message based servant.

The module supports the Normal Transfer Mode of the VXIbus, using the Write Ready, Read Ready, Data In Ready (DIR), and Data Out Ready (DOR) bits of the module's Response register.

A Normal Transfer Mode read of the VX4237 Module proceeds as follows:

1. The commander reads the VX4237's Response register and checks if the Write Ready and DOR bits are true. IF they are, the commander proceeds to the next step. If not, the commander continues to poll these bits until they become true.

2. The commander writes the Byte Request command (0DEFFh) to the VX4237's Data Low register.

3. The commander reads the VX4237's Response register and checks if the Read Ready and DOR bits are true. If they are, the commander proceeds to the next step. If not, the commander continues to poll these bits until they become true.

4. The commander reads the VX4237's Data Low register.

A Normal Transfer Mode Write to the VX4237 Module proceeds as follows:

1. The commander reads the VX4237's Response register and checks if the Write Ready and DIR bits are true. If they are, the commander proceeds to the next step. If not, the commander continues to poll the Write Ready and DIR bits until they are true.

2. The commander writes the Byte Available command which contains the data (0BCXX or 0BDXX, depending on the End bit) to the VX4237's Data Low register.

VX4237 Configuration Registers

Below is a list of the VX4237 Configuration registers with a complete description of each. In this list, RO = Read Only, WO = Write Only, R = Read, and W = Write. The offset is relative to the module's base address:

Table 2–1: Register Definitions

Register	Address	Type	Value (Bits 15–0)
ID Register	0000H	RO	1011 1111 1111 1100 (BFFCh)
Device Type	0002H	RO	See Device Type definition below
Status	0004H	R	Defined by state of interface
Control	0004H	W	Defined by state of interface
Offset	0006H	W	Not used
Protocol	0008H	RO	1111 0111 1111 1111 (F7FFh)
Response	000AH	RO	Defined by state of the interface
Data High	000CH		Not used

Table 2–1: Register Definitions (Cont.)

Register	Address	Type	Value (Bits 15–0)
Data Low	000EH	W	Command-dependent
Data Low	000EH	R	Command-dependent

Register Bit Definitions

ID:	BFFCh
Device:	
Protocol:	F7FFh

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 in *Appendix C*.

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

Low Level Interface

This section describes the low-level VXI interface.

VXI-to-DMM Communications Cycle

This 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:

If the DMM indicated with a flag that it was ready to receive, the commander writes a word and sets a flag indicating that data is available. The DMM reads the word and clears its flag.

To get data from the DMM, the commander asks for a byte using the same sequence as previously explained. 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 reads the data. This read clears the flag, allowing the cycle to repeat.

In addition to the Word Serial Protocol, there is an Interrupt Protocol that can be used. For further explanation of the registers used in VXI communications, refer to the VXIbus Specification, Version 1.3, July 14, 1989.

Word Serial Protocol

Following is a more detailed explanation of the low-level communications sequences that can take place between the DMM and its commander. For the following descriptions, assume that all power-up sequences have been completed and that the DMM is in a quiescent state awaiting a command. There are three possible interactions: data sent from the commander to the DMM, data sent from the DMM to the commander, and the DMM generated interrupt cycle.

Data is sent from the Commander to the DMM with the following steps:

1. The commander waits for the DMM to set the Write Ready bit in the VXI Response Register. (This bit indicates that the DMM is ready for data.)

2. The commander writes a word of data into the Data Low Register of the DMM. The write action clears the Write Ready bit in the DMM. The write also generates an internal interrupt to inform the DMM that data has arrived.

3. The DMM reads the data from the Data Low Register and parses the data word to see which VXI Word Serial Command the high order byte contains. The parser then acts on this command. If the low byte of the word contains data, this will be passed on to the high level command parser.

4. When the data word has been processed, the DMM can again set the Write Ready bit to indicate that it is ready for another exchange.

Data is sent from the DMM to the Commander with the following steps:

1. The commander can only obtain a word of data from the DMM by requesting it. This request comes in the form of a Word Serial Protocol Byte Request command. The commander must send a word of data that is the Byte Request command using the previously described sequence before it can gain a response.
2. On receiving the Byte Request command, the DMM gets a word of data from the output buffer and places it in the Data Low Register. The action of writing the data into the register sets the Read Ready bit in the DMM VXI Response Register.
3. If the DMM is set to interrupt the commander, it will do so at this time. (Refer to the following discussion of *The Interrupt Cycle*.)
4. Either in response to an interrupt, or by polling, the commander will become aware of the setting of the DMM Read Ready bit. The commander then reads the word of data from the DMM Data Low Register. The read action clears the DMM Read Ready bit.
5. This completes the transfer of data. To obtain another word of data from the DMM, the commander must send another Byte Request command.

The Interrupt Cycle

The VXI Specifications allow for two type of interrupt cycles: response or event. The two types are mutually exclusive and have to be selected by the controller before they become active.

1. The commander uses several Word Serial Protocol commands to select when, how, and with what the DMM will interrupt. The “when” could be on any of the Read Ready, Write Ready, or ERR* bits going true. The “how” is selected from the VME interrupt levels (IRQ1* <197> IRQ7*). The “with what” can be either a Response Interrupt or an Event Interrupt.
2. When the condition for the DMM to interrupt the controller occurs, the DMM initiates the interrupt cycle. For example, directly 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 responds with the VME interrupt acknowledge cycle. The DMM returns 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 places the contents of the Event Register in the high byte of the vector (instead of the upper half of the Response Register).

Trigger Combinations

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

Type/Mode	IMM	Bus	Hold	EXT	TTL
READ? [3]	1 reading taken and returned	–214, 'Trigger deadlock'	–213, 'Init ignored'	Holds bus until trigger occurs, then returns result.	Holds bus until trigger occurs, then returns result.
MEAS? [3]	1 reading taken and returned	–214, 'Trigger deadlock'	–213, 'Init ignored'	Holds bus until trigger occurs, then returns result.	Holds bus until trigger occurs, then returns result.
TRIG:IMM [2]	–211, 'Trigger ignored.'	1 reading taken and stored.	1 reading taken and stored.	1 reading taken and stored.	1 reading taken and stored.
TTL	No error, trigger ignored.	No error, trigger ignored.	No error, trigger ignored.	No error, trigger ignored.	1 reading taken and stored.
EXT	No error, trigger ignored.	No error, trigger ignored.	No error, trigger ignored.	1 reading taken and stored.	No error trigger ignored.
GET	–211, 'Trigger ignored.'	1 reading taken and stored.	–211, 'Trigger ignored.'	–211, 'Trigger ignored.	–211, 'Trigger ignored.'
• TRG	–211, 'Trigger ignored.'	1 reading taken and stored.	–211, 'Trigger ignored.'	–211, 'Trigger ignored.'	–211, 'Trigger ignored.'
INIT [1]	1 reading taken and stored.	Enables this mode	Enables this mode	Enables this mode	Enables this mode

[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 five 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 device clear.

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

The VX4237 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.

Syntax and Commands

Command Syntax

Commands follow the conventions established by the March 1987 Draft IEEE Standard 488.2, Codes, Formats, Protocols, and Common Commands. Command protocol and syntax for the VX4237 Module are as follows:

< >	Delimits a required user-defined argument, element, or parameter.
[ ]	Delimits an optional argument, element, or parameter.
{ }	Delimits groups in which at least one argument, element, or parameter must be selected.
|	Delimits exclusive-OR selectable arguments, elements, or parameters.
::=	Means ‘is defined as’.
[ ]*	Indicates that an argument, element, or parameter may be repeated zero or more times.
; (semicolon)	Is a message unit separator, and is used to separate parts of multiple commands.
: (colon)	Is a compound header separator, and is used to separate multiple header mnemonics in a compound command.
, (comma)	Delimits command elements.

Case

Command elements printed in upper-case letters are predefined command words; and command elements printed in lower-case letters are user-defined words.

Program Data Formats

Program data message formats for the instrument include: decimal numeric, ASCII string, and arbitrary block.

Decimal Numeric Program Data

The decimal numeric program data types and formats are as follows:

<NR1>, Implicit point (integer), 1, +3, –2, +10, –20

<NR2>, Explicit point, unscaled (fixed point), 1.2, +2.3, –5.1

<NR3>, Explicit point, scaled (floating point), 1E+2, +3.36E–2, –1.02E+3

VX4237 Command Set NRf Format

NRf means any format (NR1, NR2, or NR3) is acceptable.

Functional Command Groups

The VX4237 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.

IEEE 488.2 defines sets of Mandatory Common Commands and Optional Common Commands along with a method of Standard Status Reporting. The VX4237 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.

This section summarizes the SCPI and Native (IEEE-488.2) language commands for the VX4237.

SCPI Commands

The following table shows SCPI Command and Queries supported by the VX4237.

<table>
<tr><th>Command Format</th><th>Description</th></tr>
<tr><td>ABORt</td><td>Abort current trigger state and return to idle state.</td></tr>
<tr><td>CALibration</td><td></td></tr>
<tr><td>:HIGH? [<numeric_value>]</td><td>Perform full scale calibration using the <numeric_value>.</td></tr>
<tr><td>:LOW? [<numeric_value>]</td><td>Performs zero scale calibration using the <numeric>.</td></tr>
<tr><td>:SECure <Boolean></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<function> <function></td><td>General configuration command.</td></tr>
<tr><td><parameter> <source_list>
<parameter>[,<source_list>]</td><td>Parameters for the <function>.</td></tr>
<tr><td>:CURRent[:DC}|:AC</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]I :AC</td><td>Selects Voltage; respectively DC or AC.</td></tr>
<tr><td>[<expected_value[, <resolution]]
[1,(@I)]1(@2)|(@1,2)1(@1:2)]</td><td>This selects channel (if option fitted) to be measured.</td></tr>
</table>

Command Format	Description
CONFigure?	This returns the current selected function, range and resolution of the DMM.
FETCh?	Returns the last set of measurements taken.
INITiate	
[:iMMediate]	Places DMM in the wait for trigger state.
INPut	
:COUPling AC|DC	Selects input coupling source.
:COUPling?	Queries the state of the input coupling.
:FILTer[:LPASs][:STATe]<Boolean>	Selects or Deselects the input filter.
:FILTer[:LPASs][:STATe]?	Query the state of the input filter.
GUARd LOW I FLOat	Connect the guard to signal low, or allow the guard to float.
GUARd?	Query the status of the guard connection.
[:STATe]<Boolean>	Selects input connection or isolation.
[:STATe]?	Queries the state of the input connection.
ZERO?	Performs an input zero offset correction.
MEASure	Configure the DMM and take a measurement and INITiates that measurement.
<function> <parameter> <source_list> *<function> ? <parameters>[, <source_list>]*	Parameters for the <function>.
:CURRent[[:DC]I :AC]?	Selects Current, either DC or AC
:FRESistance	Selects four wire Ohms.
:RESistance	Selects two wire Ohms.
:VOLTage[[:DC]I :AC]?	Selects voltage, either DC or AC
[<expected_value[, <resolution]] [[,(@1)]1(@2)1(@1,2)1(@1:2)]	This selects channel (if option fitted) to be measured.
OUTput	
:TTLTrg0[1121314151617 :PROTocol SYNChronous IASYNchronous	Set the VXI trigger line protocol mode.
:TTLTrg01112|314151617 :PROTocol ?	Query the VXI lines protocol.
READ?	Places the DMM in a wait for trigger state and then returns the measurement after the trigger.
[SENSe:]	
CURRent[:DC] I :AC <parameter>	Selects either DC or AC current.
CURRent[:DC] I :AC <parameter>?	Query the setting current function setting.

Command Format	Description
RESistance I :FRESistance <parameter>	Selects either 2 or 4 wire resistance measurement.
RESistance I :FRESistance <parameter>?	Query the setting resistance setting.
VOLTage[:DC]I :AC <parameter>	Selects either DC or AC Voltage.
VOLTage[:DC]I :AC <parameter>?	Query voltage setting.
<parameter>	
:RANGe<numeric_value>	Selects the value expected to be measured.
:AUTO<Boolean>	Selects Autorange.
:RESolution<numeric value>	Selects the resolution for the function selected.
MAXimum	Selects the maximum resolution for the function selected.
:MINimum	Selects the minimum resolution for the function selected.
:AUTO ON	Explicitly setting a value for RESolution will turn Auto:Off.
FILTer{:LPASs][:STATe] <Boolean>	Selects or deselects the input filter.
FILTer[:LPASs][:STATe]?	Query the state of the input filter.
LFRequency<numeric_value>	Set the integration time related to line frequency setting.
LFRequency?	Query the line frequency setting.
STATus	
:OPERation :CON Dition ?	Queries the operational condition register.
:OPERation[:EVENt]?	Queries the operation event register.
:OPERation:ENABle<Nrf>	Sets conditions in the operation status register.
:OPERation:ENABle?	Queries set conditions in operation status register.
:QUEStionable:CONDition?	Queries the questionable condition register.
:QU EStionable:[:EVENt] ?	Queries the questionable event register.
:QUEStionable:ENABle<NRf>	Sets conditions in questionable status enable register.
:QUEStionable:ENABle?	Queries set conditions in questionable status register.
:PRESet	Resets the state of the STATus register.
SYSTem	
:ERRor?	Query the next error in the error queue.
LANguage NATive	Causes DMM to switch to another command interpreter.
:VERSion?	Returns the version of SCPI to which the instrument conforms.
TEST	
[:ALL]?	Performs complete self test.
:TYPE?<Nrf>	Performs a specific numbered test.
TRIGger	
[:IMMediate]	Trigger the DMM immediately

<table>
<tr><th>Command Format</th><th>Description</th></tr>
<tr><td>:COUNt <numeric_value></td><td>Sets the number of triggers.</td></tr>
<tr><td>:COUNt?</td><td>Query the count setting.</td></tr>
<tr><td>:DELay<numeric_value></td><td>Sets the time delay between the trigger and the measure.</td></tr>
<tr><td>:AUTO<Boolean></td><td>Selects default delay settings.</td></tr>
<tr><td>:DELay?</td><td>Queries the current trigger delay.</td></tr>
<tr><td>:SOURce BUS |EXTernal|HOLD |IMMediate|TTLTrg<n>
(n = 1 to 7)</td><td>Specify the trigger source.</td></tr>
<tr><td>:SOURce?</td><td>Query the trigger source setting.</td></tr>
</table>

Native Language Commands

The following is an overview of the Native language commands.

Command	Action
ACV	Selects the AC voltage mode and sets the range, resolution, filter, and coupling.
ATOD?	Recalls the A/D calibration constants.
BKNO?	Queries the number of readings present in the Block Reading buffer.
BLOCK	Sets the number of readings to be taken in a block.
BRCL?	Recalls readings from the Block Reading buffer.
CAL	Enables or disables the Calibration mode.
CALH?	Performs an autocalibration at the upper end of the currently selected range.
CALL?	Performs an autocalibration at the lower end of the currently selected range.
CLRM?	Clears the stored calibration constants.
DCV	Selects DC voltage measurement mode, and sets the range, resolution and filter.
DDQ?	Recalls the last error from the queue of device-dependent errors.
DELAY	Sets a trigger delay.
DUMP?	Recalls result from the Test buffer.
GUARD	Selects local (internal) or remote (external) grounding.
INPUT	Enables or disables the input port.
LINE	Selects the line frequency setting.
LINE?	Reads the setting of the line frequency switch.
OHMS	Selects the resistance measurement mode, and sets the range, resolution, and measurement mode.
RDG?	Queries the last data reading.
STOR?	Recalls the calibration constants for the currently selected function and range.
TEST?	Performs an individual test from the self test list.
TSRCE	Selects the trigger source.
X?	Performs a system trigger and outputs the result.
ZERO?	Performs an input zero.

IEEE-488.2 Common Commands

The following is an overview of the IEEE-488.2 Common Commands.

Command	Action
*OPC	Sets the Operation Complete (OPC) bit in the Event Status register when all pending operations have completed.
*OPC?	Places a 1 in the device output queue when all pending operations have been completed.
*PUD	Stores data in the non-volatile memory.
*PUD?	Recalls stored data from the non-volatile memory.
*RST	Resets the VX4237 to the power-up state and resets all instrument variables to the default values.
*SRE	Sets the bits in the Service Request Enable register.
*SRE?	Queries the setting of the bits in the Service Request Enable register.
*STB?	Reads the status byte from the Service Request Enable and Event Status registers.
*TRG	Generates a trigger pulse.
*TST?	Executes self test diagnostic routines.

SCPI Commands

This section lists the SCPI commands supported by the VX4237 in alphabetical order.

ABORt

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 3–61, Figure 3–1.

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 3–60.

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>]
    :LOW?         [<numeric_value>]
    :SECure       <Boolean>
    :SLFRequency?
```

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

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.

Error 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 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 Condition**

There is no associated *RST condition.

***NOTE**. 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 the 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 CALENABLE.

Query Format

`CALibration:SECure?`

This queries the current setting of the secure mode. It returns either 0 for disabled, or l for enabled.

***RST Condition**

`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.

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’ will be generated if either the calibration switch is not set to enable and the CAL:SECure ON command has not been received.

Query Format

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

***RST Condition**

Last value set with an CAL:SLFR? command.

Native Equivalents

`CALibration:SECure`	≡ CALON/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 3–29 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 3–29.

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 fight show the modes selected by <resolution> commands:

Table 3–1: DC Current: Numeric Values Used to Select Required Resolutions

Function	Range	Required Digits		
		6.5	5.5	4.5
CURR:DC	1A	<1E–6> (1.000000A)	<1E–5> (1.00000A)	<1E–4> (1.0000A)

Table 3–2: DC Current: Resolutions Selected by Command

Function	<resolution>	Selected Digit
CURR[:DC]	MAXimum	6.5 digit
	MINimum	4.5 digit
	AUTO	6.5 digit
	AUTO ON	6.5 digit
	AUTO OFF	Resolution as last set
	DEFault	6.5 digit

Table 3–3: AC Voltage: Numeric Values Used to Select Required Resolutions

Function	Range	Required Digits	
		5.5	4.5
CURR:AC	1A	<1E–5> (1.00000A)	<1E–4> (1.0000A)

Table 3–4: AC Current: Resolutions Selected by Command

Function	<resolution>	Selected Digit
CURR:AC	MAXimum	5.5 digit
	MINimum	4.5 digit
	AUTO	5.5 digit
	AUTO ON	5.5 digit
	AUTO OFF	Resolution as last set
	DEFault	5.5 digit

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

Query Format See CONFigure? command page 3–14.

***RST Condition** CONF:CURR:DC 1, 1E–5 (Note that this function is inactive.)

CONFigure:FRESistance[<expected_value>[,<resolution>]]
CONFigure:RESistance[<expected_value>[,<resolution>]]

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.

<expected_value>	Range
0 to 199.9999	100 Ω
200 to 1999.999	1 kΩ
2000 to 19999.99	10 kΩ
20000 to 199999.9	100 kΩ
200000 to 1999999	1 MΩ
>2000000	10 MΩ
MINimum	100 Ω
MAXimum	10 MΩ
DEFault no parameter	Autorange
AUTO ON	Select Autorange
AUTO OFF	Deselect Autorange

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:

Table 3–5: Resistance (2- and 4-Wire): Numeric Values Used to Select Required Resolutions

Function	Range	Required Digits		
		6.5	5.5	4.5
RES/FRES	100 Ω	<1E–4> (100.0000Ω)	<1E–3> (100.000Ω)	<1E–2> (100.00Ω)
	1 kΩ	<1E–6> (1.000000kΩ)	<1E–5> (1.00000kΩ)	<1E–4> (1.00000kΩ)
	10 kΩ	<1E–5> (10.00000kΩ)	<1E–4> (10.0000kΩ)	<1E–3> (10.000kΩ)
	100 kΩ	<1E–4> (100.0000kΩ)	<1E–3> (100.000kΩ)	<1E–2> (100.00Ω)
	1 MΩ	<1E–6> (1.000000MΩ)	<1E–5> (1.00000MΩ)	<1E–4> (1.0000MΩ)
	10 MΩ	<1E–5> (10.00000MΩ)	<1E–4> (10.0000MΩ)	<1E–3> (10.000MΩ)

Table 3–6: Resistance (2- and 4-Wire): Resolutions Selected by Command

Function	<resolution>	Selected Digit
RES/FRES	MAXimum	6.5 digit
	MINimum	4.5 digit
	AUTO	6.5 digit
	AUTO ON	6.5 digit
	AUTO OFF	Resolution as last set
	DEFault	6.5 digit

Errors

None

Query Format

See CONFigure? command page 3–14.

***RST Condition**

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

`CONF:RES: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 the INPut Subsystem.

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

<expected_value>	Range
0 to .1999999	100 mV
0.2 to 1.999999	1 V
2.0 to 19.99999	10 V
20.0 to 199.9999	100 V
>200	300 V
MINimum	100 mV
MAXimum	300 V
DEFault no parameter	Autorange
AUTO ON	Select Autorange
AUTO OFF	Deselect Autorange

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 fight show the modes selected by <resolution> commands:

Table 3–7: DC Voltage: Numeric Values Used to Select Required Resolutions

Function	Range	Required Digits		
		6.5	5.5	4.5
VOLT:[DC]	100 mV	<1E–4> (100.0000mV)	<1E–3> (100.000mV)	<1E–2> (100.00mV)
	1 V	<1E–6> (1.000000V)	<1E–5> (1.00000V)	<1E–4> (1.00000V)
	10 V	<1E–5> (10.00000V)	<1E–4> (10.0000V)	<1E–3> (10.000V)
	100 V	<1E–4> (100.0000V)	<1E–3> (100.000V)	<1E–2> (100.00V)
	300 V	<1E–3> (300.000V)	<1E–2> (300.00V)	<1E–1 > (300.0V)

Table 3–8: DC Voltage: Resolutions Selected by Command

Function	<resolution>	Selected Digit
VOLT[:DC]	MAXimum	6.5 digit
	MINimum	4.5 digit
	AUTO	6.5 digit
	AUTO ON	6.5 digit
	AUTO OFF	Resolution as last set
	DEFault	6.5 digit

Table 3–9: AC Voltage: Numeric Values Used to Select Required Resolutions

Function	Range	Required Digits	
		5.5	4.5
VOLT:AC	100 mV	<1E–3> (100.000mV)	<1E–2> (100.00mV)
	1 V	<1E–5> (1.00000V)	<1E–4> (1.00000V)
	10 V	<1E–4> (10.0000V)	<1E–3> (10.000V)

Table 3–9: AC Voltage: Numeric Values Used to Select Required Resolutions (Cont.)

Function	Range	Required Digits	
		5.5	4.5
	100 V	<1E–3> (100.000V)	<1E–2> (100.00V)
	300 V	<1E–2> (300.00V)	<1E–1 > (300.0V)

Table 3–10: AC Voltage: Resolutions Selected by Command

Function	<resolution>	Selected Digit
VOLT:AC	MAXimum	5.5 digit
	MINimum	4.5 digit
	AUTO	5.5 digit
	AUTO ON	5.5 digit
	AUTO OFF	Resolution as last set
	DEFault	5.5 digit

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 Format See the CONFigure? command.

***RST Condition** `CONF:VOLT:DC 300,1E–3`. This function is active.

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 CONF command.

Syntax

`CONFigure? (Query Only)`

Related Commands

`CONFigure, MEASure?, SENSe`

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:

Function	Range	<resolution>	<source_list>
CURR	1	1E–6	(@1}
CURR:AC	1E–5	1E–5	(@2)
	1E–4	1E–4	(@1,2)
RES	1E2	<range>/1E–6	(@1)
FRES	1E3	<range>/1E–5	(@2)
	1E4	<range>/1E–4	(@1,2)
	1E5		
	1E6		
	1E7		
VOLT	1E–1	<range>/1E–6	(@1)
VOLT:AC	1E0	<range>/1E–5	(@2)
	1E1	<range>/1E–4	(@1,2)
	1E2		
	3E2		

If AUTO, DEF, MIN or MAX was selected for <range> or <resolution> then the CONF? 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, (@1)
```

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

***RST Condition**

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 Format

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+331

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 CONE, 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.

Native Equivalents

Subsystem:

```
INPut
```

Alternatives/Parameters:

```
:COUPling           AC|DC
:FILTer
   [:LPASs]
      [:STATe]      <Boolean>
:GUARd    LOW|FLOat
[:STATe]            <Boolean>
:ZERO?
```

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 CONF 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 Format 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 Condition** `INPut:COUPling AC` – but inactive (See CONF: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 Format `INPut:FILTer[:LPASs] [:STATe]?`

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

***RST Condition** `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:

Option	Guard Connection
LOW	internally connected to signal common
FLOat	connected to front panel guard terminal

Errors No associated errors

Query Format `INPut:GUARd?`

This queries the setting of the guard shield. Will return either “LOW” for internally connected, or “FL0” for connected to guard terminal.

***RST Condition** `INPut:GUARd LOW`

INPut[:STATe] <Boolean>

Errors

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.

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 Format

`INPut[:STATe]?`

Returns either '0' if the input is disconnected or '1' if the input is connected.

***RST Condition**

`INPut:[STATe] 0`

Note that this is different to that mandated by SCPI, but it is Datron's 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 Format `INPut:ZERO?`

This command returns 1 for a fail, 0 for a successful input zero.

***RST Condition** 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. ZERO?
`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 CONE command followed by a READ? command.

Syntax

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

Subsystem:

```
MEASure
```

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

READ?, INPut, CONFigure

NOTE*. INPut:STATe <Boolean> should be ON before measurement takes place. See page 3–29 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 VX4237.

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/l, 2/3, 4/5, 6/7.

In this configuration the trigger is received on the lower number (i.e. TTLT0 / 2 / 4 / 6) and the measurement complete signal is output on the higher number (i.e. TTLT1/3/5/7).

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

Refer to VXI Specifications revision 1.4 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 Format

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?

[SENSe:]

This command is used to configure the DMM to a more detailed level that the CONFigure command.

Note that :SENSe is a root level command and can be omitted. Thus only the VOLTage, FILTer etc. part of the command need be sent. This command also selects the line frequency that the measurements are taken over.

Syntax

```
[:SENSe]

Function
   :CURRent
      [:DC]
         :RANGe         <numeric_value>
            :AUTO       <Boolean>
         :RESolution    <numeric_value>
      :AC
         :RANGe         <numeric_value>
            :AUTO       <Boolean>
         :RESolution    <numeric_value>
   :FRESistance
      :RANGe            <numeric_value>
         :AUTO          <Boolean>
      :RESolution       <numeric_value>
   :RESistance
      :RANGe            <numeric_value>
         :AUTO          <Boolean>
      :RESolution       <numeric_value>
   :VOLTage
      [:DC]
         :RANGe         <numeric_value>
            :AUTO       <Boolean>
         :RESolution    <numeric_value>
      :AC
         :RANGe         <numeric_value>
            :AUTO       <Boolean>
         :RESolution    <numeric_value>
   :FILTer
      [:LPASs]
         [:STATe]       <Boolean>
   :LFRequency          <numeric_value>
```

Related Commands CONFigure, MEASure? INPut

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

```
[:SENSe]
 :CURRent[:DC]
 :CURRent:AC
 :FRESistance
 :RESistance
 :VOLTage[:DC]
 :VOLTage:AC
```

[:SENSe]:<function>:RANGe <numeric_value>
[:SENSe]:<function>:RANGe:AUTO <Boolean>

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 Format

```
[: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>.

Current	Resistance	Voltage
1	1E2	1E–1
	1E3	1E0
	1E4	1E1
	1E5	1E2
	1E6	3E2
	1E7	

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

Parameter	Current	Resistance	Voltage
MAXimum	1	1E2	1E–1
MINimum	1	1E7	3E2

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

***RST Condition**

`[: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 3–14).

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

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

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

<function>	<resolution>
CURRI CURR:AC	1E–6
	1E–5
	1E–4
RES I FRES	<range> / 1E–6
	<range> / 1E–5
	<range> / 1E–4
VOLT I VOLT:AC	<range> / 1E–6
	<range> / 1E–5
	<range> / 1E–4

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

<parameter>	<resolution>
MINimum	<range> / 1E–4
MAXimum	<range> / 1E–6

***RST Condition**

```
[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[:LPASs] [: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 :LPASs and :STATe are optional. For a <Boolean> value of 0 or OFF, the falter is deselected. For a <Boolean> value of 1 or ON the filter is selected.

Errors No associated errors

Query Format `[SENSe:]<funCtiOn>:FILTer [:LPASs:] [STATe] ?`

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

***RST Condition** `[SENSe:]<function>:FILTer:LPASs:STATe:OFF`

[:SENSe]LFRequency<numeric_value>

This command is a Datron 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.

<numeric_value> (nv)	Line Frequency Selected
0 < nv ≤55	50 Hz
55 < nv ≤100	60 Hz
100 < nv	400 Hz
MINimum	50 Hz
MAXimum	400 Hz
DEFault	60 Hz

Errors

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

Query Format

`[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:

```
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 Condition**

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

```
STATus
    :OPERation
    [:EVENt]?                    (Query Only)
    :CONDition?                  (Query Only)
    :ENABle      <NRf>
    :ENABle?                     (Query Only)
    :QUEStionable
    [:EVENt]?                    (Query Only)
    :CONDition?                  (Query Only)
    :ENABle      <NRf>
    :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:

Bit	Description
0	DMM is performing a calibration
2	DMM is currently range changing
4	DMM is currently measuring
5	DMM in wait for trigger state

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 Condition** As this is a query command, there is no associated *RST condition. However, SCPI defines that the *RST will not affect the SCPI Event registers. The operational register is cleared with a *CLR,OPER:EVENt? command or a 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 Condition**

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

STATus:OPERation:ENABle <NRf>

This command is used to enable the summary and reporting of operational status bits in the 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 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 6 5 5 3 5.

Query Format

`STATus:OPERation:ENABle?`

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

***RST Condition**

SCPI defines that the *RST will not affect the SCPI Enable registers. The only way to clear the operational register is with a *CLR command or at 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:

Bit	Description
0	Voltage Overhang
1	Current Overrange
8	Invalid Calibration
9	Resistance Overrange

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 Condition**

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 *CLR, 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 Condition**

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 *CLR 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 Format `STATus:QUEStionable:ENABle?`

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

***RST Condition** SCPI defines that the *RST will not effect the SCPI Enable registers. The only way to clear the questionable register is with a *CLR 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 Condition** 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
    :VERSion?            (Query only)
```

Related Commands None.

Query Format `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 VX4237 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 Format There are no associated errors.

***RST Condition** An *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 Condition** No associated *RST.

TEST

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

Syntax

```
TEST
   [:ALL] ?                 (Query only)
   TYPE ? <numeric_value>   (Query only)
```

Related Commands *TST

TEST[:ALL]?

This query command performs the complete self test and then returns a number to indicate the result of the test. This will be either ‘0’ if all tests pass or the specific test number of the test that failed. These will be the numbers already defined for the VX4237 native self test. During the self test, once a test falls the DMM does not proceed with the testing.

Errors Only the test failed number.

***RST Condition** There is no associated *RST condition. Self test is not active.

TEST:TYPE? <numeric_value>

This query command performs the specified number test. It then returns the same data as the native VX4237 TEST? command.

Errors None

Native Equivalents TEST?, *TST?. Note that this will use the current VX4237 self test structure.

TRIGger

This command controls the behavior of the trigger system. It specifies 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 Figure 3–1. This is the state after an *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 VX4237 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. There are two routes out of this state – either an ABORt (or equivalent) command to return the DMM to IDLE, or the specified trigger Event. In this later 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 = 1 to 7

***NOTE**. See Operating Basics for further information on the trigger subsystem*

Related Commands `ABORt, MEASure?, CONFigure, READ?, INITiate, FETCh?`

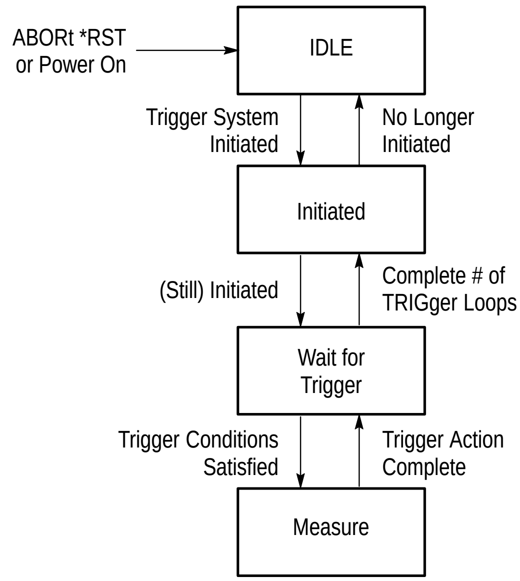


Figure 3–1: Trigger State Diagram

TRIGger[:IMMediate]

If the DMM is in the Wait-for-trigger state set by the INITiate command, then the DMM will take a measurement. The measurements can then be recalled using the FETCh? command. Note that the DMM must be in either TRIG:SOUR BUS or 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 INIT command. (Thus from this command the error will be generated if TRIG:SOURce IMM is selected).

Query Format

This is an event and thus cannot be queried.

***RST Condition**

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 INIT command. The subsequent readings taken can be recalled with the FETCh? command. Alternatively, the DMM can be placed into the wait-for-trigger state using the 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 MAXimum is sent then the DMM will expect 1000 triggers, If MINimum is sent then the DMM will expect 1 trigger.

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

TRIGger:COUNt? [MINimum | MAXimum]

This query command returns the current setting of the number of triggers expected. If MINimum is present ‘1’ is returned, if MAXimum is present, then ‘1000’ is returned.

***RST Condition** `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 VX4237 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 Format

`TRIGger:DELay:AUTO?`

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

***RST Condition**

`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 VX4237 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 that 0 or greater than 10 seconds.

Query Format

```
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 Condition**

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

TRIGger:SOURce BUS|EXTernal|HOLD|IMMediate|TTLTrg<n> (n = 1 to 7)

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

BUS	This will accept Group Execute Trigger (GET), *TRG.
EXTernal	This selects the DMM front panel EXT TRIG connector.
HOLD	This deselects all triggers. However, the TRIGger:IMMediate command will override this 'HOLD' state and cause a measurement to be taken.
IMMediate	In this mode, an INIT, READ? or MEAS? command will cause a measurement to be taken.
TTLTrg<n>(n = 1 to 7)	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<n>:PROTocol ASYNchronous mode is selected, then TTLTrg1|3|5|7 will generate an error of –221, 'Settings conflict'. Note that this command only selects the trigger mode; it does not cause a trigger.

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 Format

`TRIGger:SOURce?`

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

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

***RST Condition**

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

Native Equivalents

BLOCK

Related Commands

`OUTPut, INITiate`

Native Language Commands

This section lists the VX4237-specific commands and queries in alphabetic order. The IEEE 488.2 Common Commands are listed in the next section.

ACV

Purpose Selects the AC voltage mode and sets the range, resolution, filter and coupling.

Syntax
```
ACV [<range>|AUTO],[RESL4|RESL5|RESL6],[FILT0|FILT1], [ACCP|DCCP]
```

Parameters [<range>|AUTO]

<range> = an NRf value in the range 0 – 300 as follows:

0 – 0.1999999 selects the 100 mV range
0.2 – 1 .999999 selects the 1 V range
2.0 – 19.99999 selects the 10 V range
20 – 199.9999 selects the 100 V range
NRf values >200 select the 300 V range

NOTE*. Excessive digits in the NRf value are rounded to 5.5 digits.*

AUTO selects the Autoranging mode, in which the DMM attempts to select the most appropriate range, moving up-range on overload and down-range on less than 18% of range.

[RESL4|RESL5|RESL6] Selects the number of digits displayed:

RESL4 selects 4.5 digit resolution
RESL5 selects 5.5 digit resolution
RESL6 selects 6.5 digit resolution

[FILT0|FILT1] Turns the filter off and on as follows:

FILT0 = OFF
FILT1 = ON

[ACCP|DCCP] Selects AC or DC coupling as follows:

ACCP = AC coupling
DCCP = DC coupling

Description

This command sets the VX4237 to perform AC voltage measurements. On exit from the ACV setting, the values for the range, resolution, filter, and coupling are stored. When a new ACV command is given, if no new parameters are specified, the stored values are used.

On power-on or reset, the default values of ACV are:

ACV (300 V),RESL5,FILT0,ACCP

In Autoranging mode, if an overload exists on the 300 V range, a measurement error is generated.

Examples

In the following example, the ACV command selects the 1 V range, 5.5 digit resolution, the filter ON, and DC coupling:

ACV 0.25,RESL5,FILT1,DCCP

Related Commands

INPUT, TSRCE, DELAY

ATOD?

Purpose Recalls the A/D calibration constants.

Syntax `ATOD?`

Parameters None

Description This command recalls the A/D calibration constants in the following response format:

snxxxnnnnEsnn
snxxxnnnnEsnn
snxxxnnnnEsnnt

where:

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

The response is only related to the currently selected line frequency and resolution.

The first line of the response is the positive gain factor, the second line is the negative gain factor, and the third line is the zero offset.

Related Commands None

BKNO?

Purpose Queries the number of readings present in the Block Reading buffer.

Syntax `BKNO?`

Parameters None

Description This query returns the number of readings present in the block store. The response is as follows:

nnnn<lf>

where:

n = an ASCII digit (0 – 9)
<lf> = line feed or ;

The BKNO? query terminates the BLOCK operation if sufficient triggers have not been received to fill the Block Reading buffer as set by the BLOCK command.

Related Commands `BLOCK`

BLOCK

Purpose Sets the number of readings to be taken in a block.

Syntax `BLOCK <number>`

Parameters <number> = an NRf, in the range of 1 – 1000, that is the number of triggers to read the results from. These results are then put into the Block Reading buffer.

Description This command arms the VX4237 to take the next <number> of readings and put the results into the Block Reading buffer. The readings accumulated in the Block Reading buffer may be accessed by the BRCL? command.

After all the readings required to fill the Block Memory buffer have been acquired, the DMM generates a URQ in the Standard Event Status register and resumes placing single measurements in the output queue.

An execution error results if an NRf value out of the range of 1 – 1000 is given with the BLOCK command.

***NOTE**. Receipt of the X? command terminates the BLOCK operation.*

Examples In the following example, the BLOCK command sets a block of 500 readings:

BLOCK 500

Related Commands `BRCL?`

BRCL?

Purpose Recalls the reading from the Block Reading buffer.

Syntax `BRCL? <NRf1>,<NRf2>`

Parameters

<NRf1>	An NRf specifying the start point for the readings.
<NRf2>	An NRf specifying the end point of the readings.

Description The BRCL? query recalls the reading from the block reading buffer in the format given for the RDG? query. Successive readings are separated by commas.

The BRCL? query will generate an execution error if the <NRf1> value is greater than the <NRf2> value, or if the <NRf2> value is greater than the number of reading in the Block Reading buffer.

***NOTE**. The BRCL? query terminates the BLOCK operation if sufficient triggers have not been received.*

Examples In the following example, the BRCL? query requests the first 10 readings stored in the Block Reading buffer:

BRCL? 1,10

Related Commands `BLOCK`

CAL

Purpose Enables or disables the Calibration mode.

Syntax `CAL {ON|OFF}`

Parameters

ON	Enables Calibration mode.
OFF	Disables Calibration mode.

Description The CAL command causes the VX4237 to enter the calibration mode. If the external CAL switch (on the front panel) is not ON when the CAL command is received, an execution error is issued.

Related Commands `CALH?`, `CALL?`

CALH?, CALL?

Purpose Performs an autocalibration.

Syntax

```
CALH? [<value>]
CALL? [<value>]
```

Parameters <value>

The autocalibration will use the NRf specified in this parameter as the non-nominal target in the requested calibration.

Description The CALH? command corrects the full range point in the two-point calibration.

The CALL? command corrects the zero point (1% point for AC) in the two-point calibration.

The response to a CALL? or CALH? command will be either a 0 (calibration complete with no errors) or a 1 (calibration complete but errors present).

The CALL? and CALH? commands will generate an execution error if any of the following conditions are not met:

The external CAL switch must be ON.

The Calibration mode must be enabled (using the CAL command).

If a <value> has been specified, it must be compatible with the setting.

Examples In the following example, the CALL? command performs an autocalibration with a non-nominal target of 1.5 specified:

CALL? 1.5

Related Commands `CAL`

CLRM?

Purpose Clears the stored calibration constants.

Syntax `CLRM?`

Parameters None

Description

NOTE. *This command clears all calibration constants from the non-volatile memory (except those stored using the *PUD command).*

The response to the CLRM? command is either a 0 (operation successful, no errors present) or a 1 (errors present).

If any errors are present, the relevant error codes are placed in a queue that is accessible using the DDQ? command.

The CLRM? command cannot clear the calibration constants unless the following conditions are met:

The external CAL switch must be ON.

The DMM must be in the Calibration mode (CAL ON command).

If either of these conditions is not met, an execution error will result.

Related Commands `DDQ?`

DCV

Purpose

Selects DC voltage measurement mode, range, filter, and accuracy.

Syntax

```
DCV [<range>|AUTO],[RESL4|RESL5|RESL6],[FILT0|FILT1]
```

Parameters

[<range>|AUTO]

<range> = an NRf value in the range 0 – 300 as follows:

0 – 0.1999999 selects the 100 mV range
0.2 – 1.999999 selects the 1 V range
2.0 – 19.99999 selects the 10 V range
20 – 199.9999 selects the 100 V range
NRf values >200 select the 300 V range

***NOTE**. Excessive digits in the NRf value are rounded to 6.5 digits.*

AUTO selects the Autoranging mode, in which the DMM attempts to select the most appropriate range for the voltage being measured. When in Autoranging mode, the DMM moves up-range on overload and down-range on less than 18% of range. If an overload exists on the 300 V range, a measurement error is issued.

A valid <range> deselects the Autoranging mode.

[RESL4|RESL5|RESL6] Selects the number of digits displayed:

RESL4 selects 4.5 digit resolution
RESL5 selects 5.5 digit resolution
RESL6 selects 6.5 digit resolution

[FILT0|FILT1] Turns the filter off and on as follows:

FILT0 = OFF
FILT1 = ON

Description

This command sets the VX4237 to measure DC voltage. On exit from the DCV setting, the values for the range, resolution, and filter are stored. When a new DCV command is given, if no new parameters are specified, the stored values are used.

On power-on or reset, the default values of DCV are:

DCV (300V),RESL6,FILT0

Examples In the following example, the DCV command selects the 1 V range with 5.5 digit resolution and the filter ON:

DCV 0.25,RESL5,FILT1

Related Commands INPUT, TSRCE, DELAY

DDQ?

Purpose Recalls the last error from the queue of device-dependent errors.

Syntax `DDQ?`

Parameters None

Description The DDQ? query generates a response as follows:

nnnn<lf>

where:

n = an ASCII digit (0 – 9)
<lf> = line feed

The error codes are:

Code	Description
0	Error queue empty
100	A/D transfer; bad data
101	Internal calculation error
102	System queue overflow
150	Calibration measurement overflow
151	Calibration constants corrupted
152	Illegal cal store access
153	Invalid non-nominal calibration value
160	Illegal test number
500	Selftest: +10 VDC
501	Selftest: –10 VDC
505	Selftest: –10 VDC filter
506	Selftest: +10 VDC filter
507	Selftest: +10 VDC filter
510	Selftest: +1 VDC
515	Selftest: +100 mVDC
520	Selftest: divider check
530	Selftest: +10 VAC
531	Selftest: –10 VAC

Code	Description
532	Selftest: +1 VAC
533	Selftest: +100 mVAC
535	Selftest: 10 V zero filter
536	Selftest: +10 V filter
537	Selftest: +10 V filter
540	Selftest: 1 kΩ
541	Selftest: 10 kΩ
542	Selftest: 100 kΩ
543	Selftest: 1 MΩ
550	Selftest:
551	Selftest:
552	Selftest:

Related Commands CLRM?, *TST, ZERO?

DELAY

Purpose

Sets a trigger delay.

Syntax

```
DELAY {<delay>|DFLT}
```

Parameters

<delay>	An NRf value that sets the delay time in seconds.
DFLT	Selects the default delay (fixed in the instrument firmware).

Description

The DELAY command sets the time delay between the reception of the trigger and the start of the analog-to-digital conversion.

The delay counter (set by the <delay> parameter) has a range of .001 to 10 seconds. A <delay> value of less than 1 ms (0.001) results in no delay. A <delay> value greater than 10 seconds (10) results in a 10-second delay.)

If a fast read-rate is desired, the <delay> parameter must be set to 0.

Once a non-default delay is set, it remains set until a new value is set or a DELAY DFLT command is issued (even if there is a range or function change), or until a power-on or reset occurs. However, a default delay will be forced when there is an update during a measurement cycle, such as when autoranging.

At power-on or reset, the DELAY command default parameter is DFLT. The default delays are as follows:

Function	Range	Filter	Delay
DCV & DCI	all	Out In	5 ms 300 ms
ACV & ACI	all	Out In	200 ms 500 ms (2.5S if DCCP is selected)
OHM	100 Ω – 100 kΩ	Out In	5 ms 750 ms
OHM	1 MΩ	Out In	30 ms 1 s
OHM	10 MΩ	Out In	300 ms 10 s

Examples

In the following example, the DELAY command sets a 5 second delay:

DELAY 5

Related Commands

ACV, DCV

DUMP?

Purpose Recalls the result of a test from the Test buffer.

Syntax `DUMP?`

Parameters None

Description The recalled test result is reported in a normalized format: 0 – 1.9999. The response is as follows:

snxxxnnnnEsnnt

where:

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

The Test buffer is organized to increment on each read until the ‘empty’ marker (the number –19.0000E33) is reached. It will then reset to the beginning. A new test will overwrite previously stored values.

Related Commands None

GUARD

Purpose Selects local (internal) or remote (external) grounding.

Syntax `GUARD {LCL|REM}`

Parameters

LCL	Selects local (internal) grounding.
REM	Selects remote (external) grounding.

Description At power-on or reset, the GUARD command default parameter is LCL.

Examples In the following example, the GUARD command sets remote grounding:

GUARD REM

Related Commands None

INPUT

Purpose Selects the input port.

Syntax `INPUT {OFF|CH_A}`

Parameters

OFF	Disconnects the input connector.
CH_A	Connects the input connector, enabling measurements.

Description At power-on or reset the default value of the INPUT command is:

INPUT OFF

Examples In the following example, the INPUT command enables the input:

INPUT CH_A

Related Commands ACV, DCV, OHMS

LINE

Purpose Sets the line frequency parameter.

Syntax `LINE {50|60|400}`

Parameters

50	Sets the line frequency to 50 Hz.
60	Sets the line frequency to 60 Hz.
400	Sets the line frequency to 400 Hz.

Description The LINE command enables you to match the line frequency of the VX4237 to that of the input line power for accurate operation.

Examples The following example sets the line frequency to 60 Hz:

LINE 60

Related Commands `LINE?`

LINE?

Purpose Reads the setting of the line frequency switch.

Syntax `LINE?`

Parameters None

Description The LINE? command generates a response in the form of <X,Y>, where X is the line setting parameter value and Y is the actual line frequency.

Related Commands None

OHMS

Purpose

Selects the resistance measurement mode, range, filter, and accuracy.

Syntax

```
OHMS [<range>|AUTO],[RESL4|RESL5|RESL6],[FILT0|FILT1]
[WIRE2|WIRE4]
```

Parameters

[<range>|AUTO]

<range> = an NRf value in the range 0 – >2000000 as follows:

0 – 199.9999 selects the 100 Ω range
200 – 1999.999 selects the 1 kΩ range
2000 – 19999.99 selects the 10 kΩ range
20000 – 199999.9 selects the 100 kΩ range
200000 – 1999999 selects the 1 MΩ range
NRf values >2000000 select the 10 MΩ range

***NOTE**. Excessive digits in the NRf value are rounded to 6.5 digits.*

AUTO selects the Autoranging mode, in which 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 10 MΩ range, a measurement error is issued.

[RESL4|RESL5|RESL6] Selects the number of digits displayed:

RESL4 selects 4.5 digit resolution
RESL5 selects 5.5 digit resolution
RESL6 selects 6.5 digit resolution

[FILT0|FILT1] Turns the filter off and on as follows:

FILT0 = OFF
FILT1 = ON

[WIRE2|WIRE4] Selects 2- or 4-wire connection as follows:

WIRE2 = 2 wire connection
WIRE4 = 4 wire connection

Description

This command sets the VX4237 for 2- and 4-wire resistance measurements. On exit from the OHMS setting, the values for the range, resolution, filter, and 2/4 wire connection are stored. When a new OHMS command is given, if no new parameters are specified, the stored values are used.

On power-on or reset, the default values of OHMS are:

OHMS (10 MΩ),RESL6,FILT0,WIRE4

If there is an overload on the 10 MΩ range, a measurement error is generated.

Examples

In the following example, the OHMS command selects the 1 kΩ range with 5.5 digit resolution, filter ON, and 4-wire connection:

OHMS 225,RESL5,FILT1,WIRE4

Related Commands

INPUT, GUARD

RDG?

Purpose Queries the last reading.

Syntax `RDG?`

Parameters None

Description The response to an RDG? query is an <NRf> as follows:

In 4.5 digit resolution:	snxxxnnEsnn<lf>
In 5.5 digit resolution:	snxxxnnnEsnn<lf>
In 6.5 digit resolution:	snxxxnnnnEsnn<lf>

where:

s = the sign (+ or –)
n = an ASCII digit (0 – 9)
x = either n or an ASCII decimal point (.)
E = an ASCII character identifying the exponent
<lf> = line feed

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

If a trigger is received while the DMM analog-to-digital conversion is still in process, that conversion will be completed and the result is given as the response to the RDG? query.

The RDG? query will generate an execution error if no trigger has been received since a power-on or reset. The response for an execution error is:

20.0000E+36

An overload will generate the following response:

200.000E+33

Related Commands None

STOR?

Purpose Recalls the calibration constants.

Syntax `STOR?`

Parameters None

Description The calibration constants returned by this command are in the following format:

snxxxnnnnEsnn,
snxxxnnnnEsnn,
snxxxnnnnEsnnt

where:

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

The response relates only to the currently selected function and range.

The first line of the response is the positive gain factor, the second line is the negative gain factor, and the third line is the zero offset. For AC and ohm functions, the negative gain factor returned is always unity.

Related Commands None

TEST?

Purpose Performs an individual test from the self test list.

Syntax `TEST? <number>`

Parameters <number> An NRf specifying the number of the test to be performed.

Description After the specified test is performed, this command leaves the instrument in the configuration of that test.

The individual test numbers used in the <number> parameter are a subset of the numbers of the failed tests reported by the DDQ? query. The valid tests are listed in the table below.

Test	Description
500	Selftest: +10 VDC
501	Selftest: <196>10 VDC
505	Selftest: <196>10 VDC filter
510	Selftest: +1 VDC
515	Selftest: +100 mVDC
520	Selftest: divider check
530	Selftest: +10 VAC
531	Selftest: <196>10 VAC
532	Selftest: +1 VAC
533	Selftest: +100 mVAC
535	Selftest: 10 V zero filter
540	Selftest: 1 kΩ
541	Selftest: 10 kΩ
542	Selftest: 100 kΩ
543	Selftest: 1 MΩ
550	Selftest:
551	Selftest:
552	Selftest:

The TEST? command generates a response of the following format:

n1,n2,n3,n4<lf>

where:

n1 = an NR1 value, either a 1 (test fail) or a 0 (test pass)
n2 = an NR3 value, the value measured by the DMM during the test
n3 = an NR3 value, the absolute high limit of the test
n4 = an NR3 value, the absolute low limit of the test

Examples

In the following example, the TEST? command runs test 500:

```
TEST? 500
```

Related Commands

None

TSRCE

Purpose Selects the trigger source.

Syntax `TSRCE {SYS|EXT}`

Parameters

SYS	Selects the system (internal) trigger.
EXT	Selects external trigger.

Description This command selects either the system or an external trigger to initiate a measurement. If the SYS parameter is specified with the TSRCE command, measurements can be taken with the VXI word serial trigger command, the *TRG command, or the X? command.

If the EXT parameter is specified, measurements will be taken upon receipt of a suitable hardware trigger through the front panel EXTERNAL TRIGGER BNC connector.

At power-on or reset, the default parameter for the TSRCE command is SYS.

Examples In the following example, the TSRCE commands selects an external trigger:

TSRCE EXT

Related Commands ACV, ACV

X?

Purpose Performs a system trigger and outputs the result.

Syntax `X?`

Parameters None

Description This command causes the DMM to acquire an input and terminates a block measurement if it is in progress.

The X? command generates an execution error if the input is disconnected. The following response is also generated:

20.0000E+36

An overload gives the following response:

200.000E+33

Related Commands `TSRCE`

ZERO?

Purpose Performs an input zero.

Syntax `ZERO?`

Parameters None

Description The ZERO? command is provided 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. These corrections are stored in volatile memory and are only cleared on power down.

The ZERO? command generates an integer response of either 0 (no errors present) or 1 (errors present).

If errors are present, the relevant error codes are placed in a queue that is accessible using the using the DDQ? query.

***NOTE**. ZERO? is not accepted in Autorange or AC functions. In these cases an execution error is generated.*

Related Commands `DDQ?`

IEEE 488.2 Common Commands

This section lists the IEEE 488.2 common commands and queries recognized by the VX4237.

*OPC

Syntax `*OPC?`

Parameters None

Description The *OPC command causes the device to set the Operation Complete (OPC) bit in the Event Status register when all pending operations have completed.

The *OPC? query places a 1 in the device output queue when all pending operations have been completed.

Related Commands None

*PUD, *PUD?

Purpose

*PUD stores data in the non-volatile memory.

*PUD? recalls stored data from the non-volatile memory.

Syntax

```
*PUD <data>
```

```
*PUD?
```

Parameters

<data>	Arbitrary block program data, formatted in 8-bit bytes, to be stored in non-volatile memory.

Description

The data stored by the *PUD command is protected (the protection mechanism is implemented by the device designer).

When the number of 8-bit data bytes in the <data> parameter exceeds the storage area available, an execution error is generated. If the protection mechanism is enabled when a *PUD command is received, an execution error will be generated.

Related Commands

None

*RST

Purpose Resets the VX4237.

Syntax `*RST`

Parameters None

Description This command resets the VX4237 to the power-on state and resets all instrument variables to the default values.

Related Commands None

*SRE, *SRE?

Purpose

*SRE sets the bits in the Service Request Enable register.

*SRE? queries the setting of the bits in the Service Request Enable register.

Syntax

```
*SRE <integer>
```

```
*SRE?
```

Parameters

<integer> An integer (in the range of 0 – 255) that indicates the bits to be set in the Service Request Enable register.

Description

The bits of the Service Request Enable register are defined as follows:

Bit:	7	6	5	4	3	2	1	0
Definition:	N/U	RQS	ESB	MAV	N/U	N/U MSS	N/U	N/U

where:

N/U = Not Used
RQS = Request for Service
MSS = Master Status Summary
ESB = Event Status Summary
MAV = Message Available

If an out-of-range integer is entered for the value of <integer>, an execution error is generated.

The *SRE? query generates an NR1 integer response (in the range of 0 – 63, or 128 – 191) that corresponds to the bits set in the Service Request Enable register.

Examples

In the following example, the *SRE command sets bit 6 in the Service Request Enable register:

*SRE 64

In the following example, the *SRE? query indicates that bit 6 in the Service Request Enable register is set:

*SRE? 64

Related Commands

None

*STB?

Purpose

Reads the status byte from the Service Request Enable and Event Status registers.

Syntax

```
*STB?
```

Parameters

None

Description

The response to the *STB? query is an NR1 that corresponds to the bits set in the Status Byte register. The Status Byte register is composed of bits from both the Service Request Enable and Event Status registers as follows:

Bits 0 and 2 – 7 of the Events Status register correspond to Bit 1 – 6 of the Status Byte register.

Bit 5 of the Service Request Enable register corresponds to Bit 7 of the Status Byte register.

Refer to the *ESE and *SRE commands for descriptions of the register bits.

Examples

In the following example, the *STB? query indicates that bits 0 and 2 of the Events Status register and Bit 5 of the Service Request Enable register are set:

*STB? 133

Related Commands

None

*TRG

Purpose Causes a trigger event.

Syntax `*TRG`

Parameters None

Description This asynchronous command causes a trigger pulse to be generated. The trigger pulse can override the usual triggering operation.

Related Commands None

*TST?

Purpose Executes self test diagnostic routines.

Syntax `*TST?`

Parameters None

Description This command causes the VX4237 to execute its internal self test diagnostic routines. The response to the *TST query is an NR1. A 0 indicates the test completed with no errors. A 1 indicates the test completed with errors detected.

Related Commands None

Status and Events

Status and Events

This section describes the status and event reporting system for the VX4237.

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 VX4237 interface model can provide helpful background. This is shown in Figure 4–1, together with brief descriptions of the actions of its functional blocks.

VX4237 STATUS Subsystem

Input/Output Control transfers messages from the VX4237 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.

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 VX4237 functions and facilities. If a message is not viable (for example, 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 VX4237 functions, facilities etc. Execution does not ‘overlap’ commands; instead, the VX4237 Execution Control processes all commands ‘Sequentially’ (ie. waits for actions resulting from the previous command to complete before executing the next).

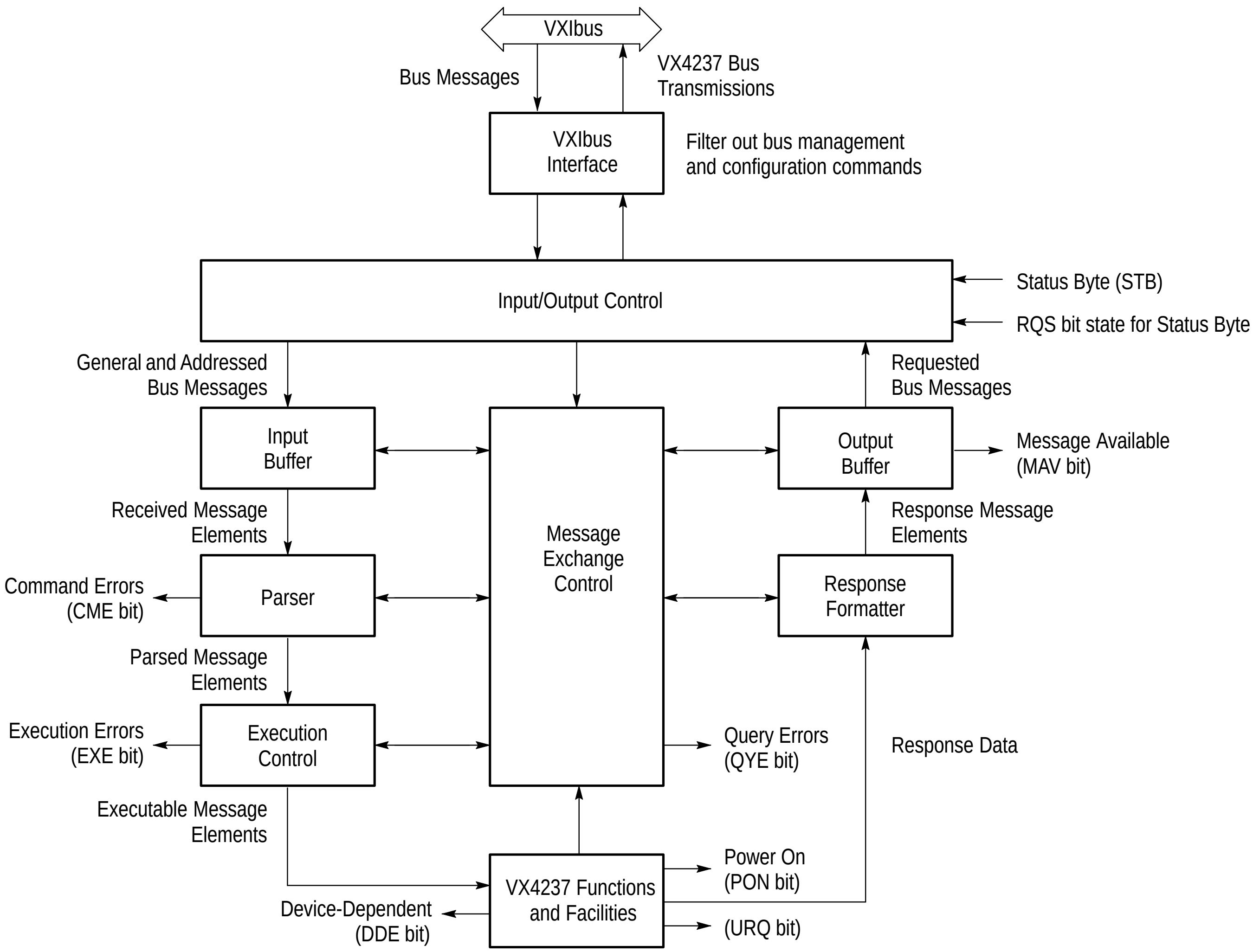


Figure 4–1: VX4237 Status Reporting Structure

VX4237 Functions and Facilities

The VX4237 Functions and Facilities block contains all the device-specific functions and features of the VX4237, 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 VX4237 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 VX4237 A-D into taking a measurement:

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

In the VX4237 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.

‘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’ in the subsection on *IEEE488.2-defined Event Status Register.*

The Standard document defines the VX4237 response, part of which is to set true bit 2 (QYE) of the Standard-defined Event Status register.

Request Service

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

- When the VX4237 message exchange interface discovers a system programming error.
- When the VX4237 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 the application programmer are both met.

This structure is described in the next sub-section.

Retrieval of Device Status Information

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.

Standard-Defined Features

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 – see Figure 4–2). The application program can enable or disable any individual bit in these registers.

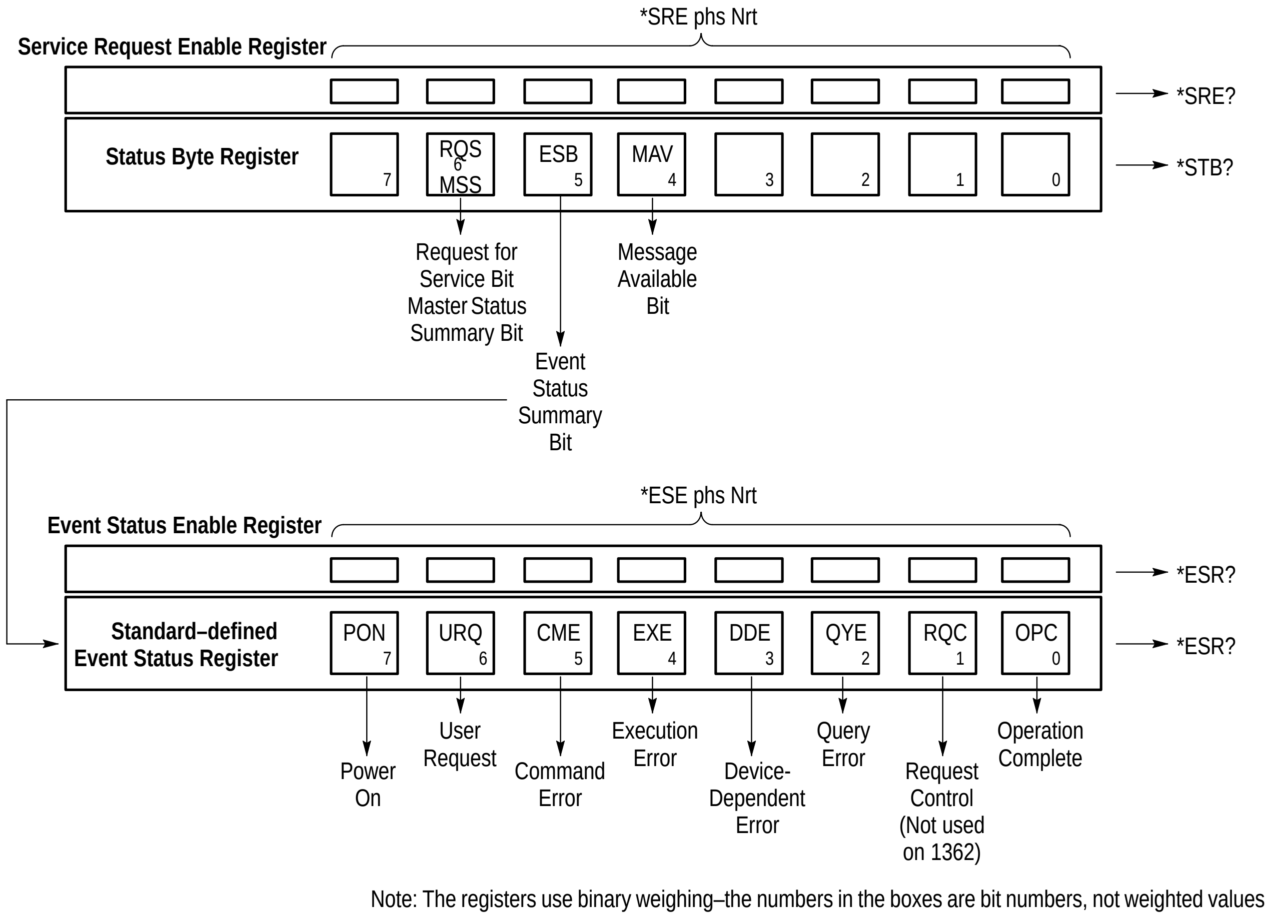


Figure 4–2: VX4237 Status and event Reporting Structure

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 VX4237 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.

VX4237 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 Figure 4–2.

VX4237 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 mast be included, if the device is to claim conformance with the Standard. The VX4237 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 VX4237.

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 VX4237 status byte. They are always false.

Bit 4 (DIO5) is the IEEE 488.2-defined Message Available Bit (MAY).

The MAV bit helps to synchronize information exchange with the controller. It is true when the VX4237 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) is the IEEE 488.2-defined Standard Event Summary Bit (ESB).

This bit 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 VX4237).

Bit 7 (DIO8) is not used in the VX4237 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 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 VX4237, 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 VX4237 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 VX4237 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 VXlbus. Refer to *Operating Basics*.

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'; ie. 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 VX4237 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 *i*f 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 VX4237, 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 VX4237 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 VX4237 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 – VX4237 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 000 11000 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 VX4237 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 Figure 4–3. The registers are detailed in the STATus subsystem of this handbook.

SCPI Syntax and Styles

Where possible the syntax and styles used in this section follow those deemed 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 VX4237 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 short form (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 VX4237 SCPI command capabilities are an extension to the existing language now known as ‘Native’. Native and SCPI are both resident on the VX4237. Native was maintained to support those existing customers who may wish to retain their current programs. The VX4237 defaults to SCPI on power on. The commands associated with switching to Native language can be found on page 3–69.

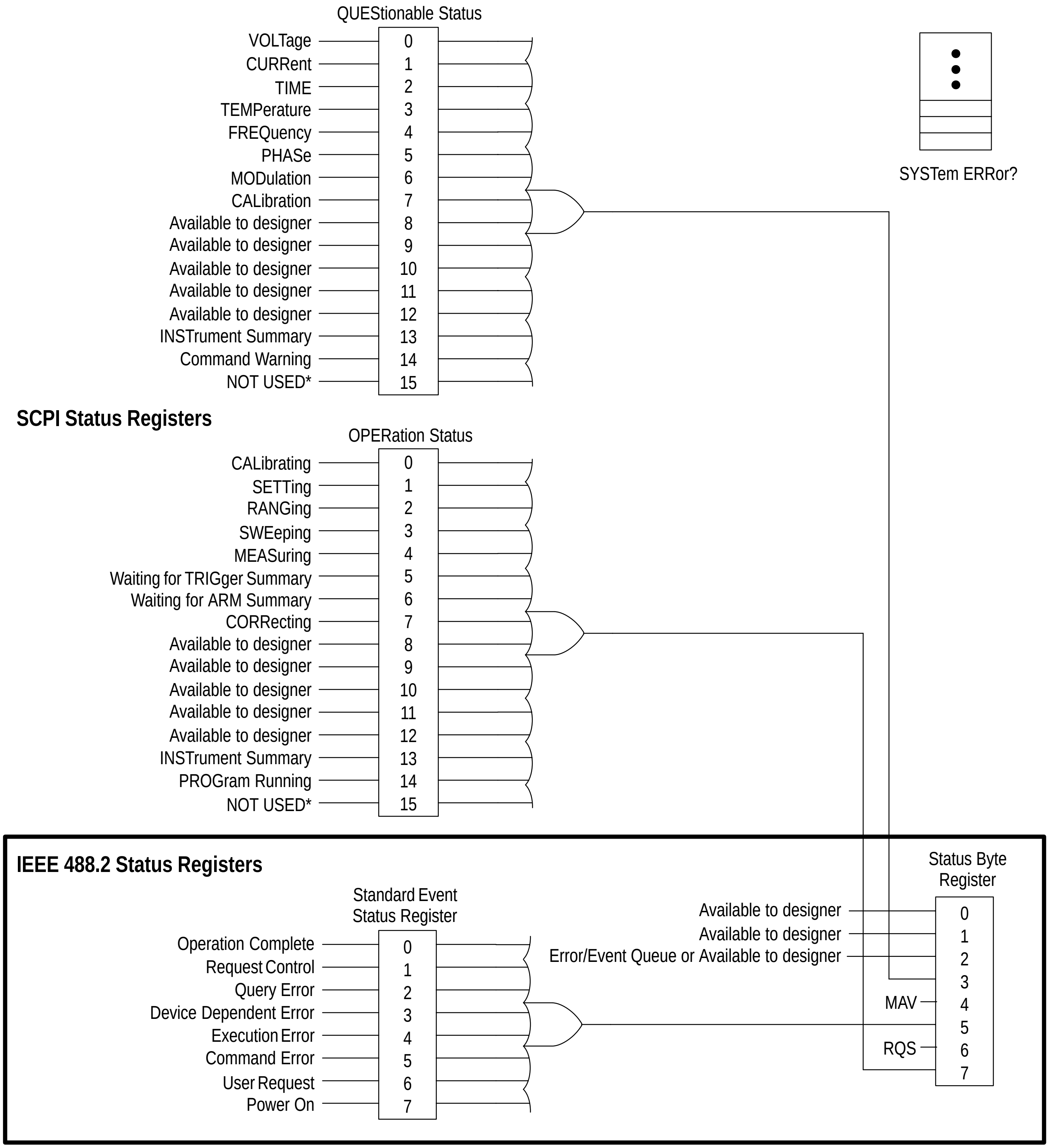


Figure 4–3: SCPI & IEEE 488.2 Status and Event Registers

SCPI Error Codes and Messages

The following is a table of error codes that have been implemented in the VX42375. The system errors all have negative values, the DMM specific errors have positive values.

Error Number and Message		Comments
0	No error	This message is reported when there are no more errors to report.
–100	Command error	This is generated when the DMM parser detects an error in the command string, but which cannot be specified.
–101	Invalid Character	A syntactic element contains a character which is invalid for that type.
–105	GET not allowed	A Group Execute Trigger was received within a program message.
–120	Numeric data error	An error has been detected in the numeric data string.
–200	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.
–211	Trigger ignored	Indicates that a GET or *TRG signal was received but ignored for either timing or dram setting reasons.
–213	Init Ignored	An INIT was received when the DMM was already in the wait for trigger state.
–221	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.
–222	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.
–230	Data corrupt or stale	Invalid data, e.g. a FETCh? after a *RST.
–241	Hardware missing	An operation was requested that could not be performed because the option (eg Current) is not fitted.
–350	Queue Overflow	This indicates that there is no more room available in the error queue.
100	Input not connected	A measurement has been attempted without connecting to the signal input.
110	Calibration switch disabled.	A calibration operation has been attempted without fully enabling the calibration security mechanism.
120	Calibration operation invalid	An invalid calibration has been attempted.
122	Calibration operation failed	This message is reported if the calibration operation was started but not completed

Device-Dependent Error Messages

Use the DDQ? command to recall the last error code from the queue of device-dependent errors. See the DDQ? command description for more details. The error codes are:

Code	Description
0	Error queue empty
100	A/D transfer; bad data
101	Internal calculation error
102	System queue overflow
150	Calibration measurement overflow
151	Calibration constants corrupted
152	Illegal cal store access
153	Invalid non–nominal calibration value
160	Illegal test number
500	Selftest: +10 VDC
501	Selftest: –10 VDC
505	Selftest: –10 VDC filter
506	Selftest: +10 VDC filter
507	Selftest: +10 VDC filter
510	Selftest: +1 VDC
515	Selftest: +100 mVDC
520	Selftest: divider check
530	Selftest: +10 VAC
531	Selftest: –10 VAC
532	Selftest: +1 VAC
533	Selftest: +100 mVAC
535	Selftest: 10 V zero filter
536	Selftest: +10 V filter
537	Selftest: +10 V filter
540	Selftest: 1 kΩ
541	Selftest: 10 kΩ
542	Selftest: 100 kΩ
543	Selftest: 1 MΩ
550	Selftest:

Code	Description
551	Selftest:
552	Selftest:

Appendices

Appendix A: Specifications

This appendix contains the VX4237 specifications.

Reading Rates:

Function	Resolution	Readings/second			Additional Errors (ppmR+ppmFS)
DC and Ω	6.5 5.5 4.5	5 50 1000			0 + 0 0 + 5 0 + 150
		10 Hz	**40 Hz**	**360 Hz**	
ACV	5.5 4.5	1/3 1/3	1 1	12 12	0 + 0 0 + 150

Accuracy:

Function	Range	Current/Frequency	Accuracy[1] (±% of reading + counts)		Temperature Coefficient (ppm/° C) 10–40° C
			90-day Tcal[2] ±5° C	1 Year Tcal ±5° C	
DC Volts 6.5 digits	200 mV	N/A	0.003% + 12	0.005% + 12	3
	2 V	N/A	0.002% + 6	0.003% + 6	2
	20 V	N/A	0.002% + 4	0.003% + 4	2
	200 V	N/A	0.003% + 6	0.005% + 6	3
	300 V[3]	N/A	0.003% + 1	0.005% + 1	3
Ω[4] 6.5 digits	200 Ω	1 mA	0.0035% + 12	0.005% + 12	4
	2 kΩ	1 mA	0.003% + 6	0.004% + 6	3
	20 kΩ	100 μA	0.003% + 6	0.004% + 6	3
	200 kΩ	10 μA	0.004% + 6	0.006% + 6	4
	2 MΩ	4 μA	0.008% + 6	0.015% + 8	4
	20 MΩ	400 nA	0.02% + 8	0.03% + 8	7

1 **Accuracy specifications are given for maximum resolution. For all other resolution modes, add one count to the least significant digit.**

2 **Tcal = the calibration temperature (in the range of 15 – 35° C).**

3 **Maximum resolution on the 300 V range is 1 mV (5.5 digits).**

4 **4-wire resistance specifications.**

Accuracy: (Cont.)

Function	Range	Current/Frequency	Accuracy[1] (±% of reading + counts)		Temperature Coefficient (ppm/° C) 10–40° C
			90-day Tcal[2] ±5° C	1 Year Tcal ±5° C	
AC Volts[5] 5.5 digits	All ranges[6]	10 – 40 Hz	0.4% + 0.1%	0.4% + 0.1%	100
		40 Hz – 20 kHz	0.035% + 0.01%	0.05% + 0.01%	50
		20 – 50 kHz	0.1% + 0.02%	0.12% + 0.02%	80
		50 – 100 kHz	0.16% + 0.03%	0.2% + 0.03%	150
	200mV, 2V, 20V	100 – 300 kHz	1% + 0.1% (typical)		
		300 kHz – 1 MHz	2% + 1.0% (typical)		

[5] **Valid for signals >1% of range, 300 V × 100 Hz V-Hz product.**

[6] **Available ranges are: 200 mV, 2 V, 20 V, 200 V, and 300 V.**

DC Voltage:

Characteristic	Description
DC Voltage:	
Input Impedance	
0.2 – 20 V Ranges	100 GΩ
200 & 300 V Ranges	10 MΩ
CMRR (1 kΩ unbalanced)	>140 dB @ DC >80 dB + NMRR @ 1 = 60 Hz
NMRR	
Filter Out	>54 dB @ 50/60 Hz ± 0.1%
Filter In	add 20 dB to above
Settling Time	
Filter Out	5 ms
Filter In	350 ms
Protection (all ranges)	300 V_{RMS}
Maximum Input Current	50 pA
Resistance	
Maximum Lead Resistance (all leads)	100 Ω
Settling Time	Same as DC voltage up to 10 kΩ
Open Circuit Voltage	15 V
Protection (all ranges)	250 V_{RMS}

DC Voltage: (Cont.)

Characteristic	Description
AC Voltage	
Input Impedance	1 MΩ / 100 pF
Crest Factor	5:1 @ full range
Settling Time (to 0.1% of step)	
10 Hz (DC coupled)	2.5 s
40 Hz	500 ms
360 Hz	200 ms
CMRR (1 kΩ unbalanced)	>80 dB @ DC – 60 Hz
VXIbus Specifications	
Module	C-size, single slot width.
Device Type	Message based instrument, Word Serial Protocol, A16 slave only.
Logical Address	Manual selection 1 – 255 (address 255 supports dynamic configuration).
Interrupt Level	User programmable 1 – 7.
External Trigger Input	
Maximum Input Voltage Rating	Normal TTL level: 0 to +5 V
Current Protection Fuse	1.6 A, 250V, fast blow, high breaking capacity

Environmental

Characteristic	Description
Temperature	
Operating	0 ° to + 50° C
Non-operating	-40 ° to + 70° C
Electrical	
Power Consumption	
Peak	1.4 A (5 V) 0.5 A (±12 V)
Dynamic	0.06 A (5 V) 0.15 A (±12 V)
Mechanical	
Dimensions	
Height	233.68 mm (9.2 in)
Depth	340.36 mm (13.4 in)
Width	40.48 mm (1.2 in)

Environmental (Cont.)

Characteristic	Description
Dimensions, Shipping	When ordered with a Tektronix/CDS mainframe, the module is installed and secured in one of the instrument module slots (slot 1 – 12). When ordered alone, shipping dimensions are: TBD
Weight	Approx. 1.6 kg (3.5 lb)
Weight, Shipping	When ordered with a Tektronix/CDS mainframe, the module is installed and secured in one of the instrument module slots (slots 1 – 12). When ordered alone, shipping weight is: 2.02 kg (4.5 lb)
Mounting Position	Any orientation.
Mounting Location	Installs in an instrument module slot (slots 1 – 12) of a C size VXIbus mainframe.
Airflow	1 L/s (10° C rise).
Pressure Drop	0.05 mm H_2O
Humidity	Less than 95% R.H. non-condensing, 0° C to +25° C Less than 75% R.H. non-condensing, 25° C to +40° C Less than 45% R.H. non-condensing, 40° C to +50° C

Table A–1: Certifications and compliances

EC Declaration of Conformity – EMC	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities: EN 55011 — Class A Radiated and Conducted Emissions EN 50082-1 Immunity: IEC 801-2 — Electrostatic Discharge Immunity IEC 801-3 — RF Electromagnetic Field Immunity IEC 801-4 — Electrical Fast Transient/Burst Immunity To ensure compliance with EMC requirements, only high quality shielded cables having a reliable, continuous outer shield (braid & foil) that has low impedance connections to shielded connector housings at both ends should be connected to this product.
EC Declaration of Conformity – Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC; Amended by 93/68/EEC. EN 61010-1/A2 1995 — Safety requirements for electrical equipment for measurement, control, and laboratory use
Approvals	UL3111-1 – Standard for electrical measuring and test equipment CAN/CSA C22.2 No. 1010.1 – Safety requirements for electrical equipment for measurement, control and laboratory use

Table A–1: Certifications and compliances (cont.)

Safety Certification of Plug-in or VXI Modules	For modules (plug-in or VXI) that are safety certified by Underwriters Laboratories, UL Listing applies only when the module is installed in a UL Listed product. For modules (plug-in or VXI) that have cUL or CSA approval, the approval applies only when the module is installed in a cUL or CSA approved product.	
Conditions for Safety Certification	Operating temperature:	+5 to +40 °C
	Max. Operating altitude:	2000 m
	Equipment Type:	Test and measuring
	Safety Class:	Class I (as defined in IEC1010-1, Annex H) grounded product.
	Overvoltage Category:	
	Supply Input:	Overvoltage Category I (as defined in IEC1010-1, Annex J).
	Measuring Inputs:	Overvoltage Category I (as defined in IEC1010-1, Annex J).
	Pollution Degree:	Pollution Degree 2 (as defined in IEC1010-1). Rated for indoor use only.
Installation Category Descriptions	Terminals on this product may have different installation category designations. The installation categories are:	
	CAT III	Distribution-level mains (usually permanently connected). Equipment at this level is typically in a fixed industrial location
	CAT II	Local-level mains (wall sockets). Equipment at this level includes appliances, portable tools, and similar products. Equipment is usually cord-connected
	CAT I	Secondary (signal level) or battery operated circuits of electronic equipment

Appendix B: Rear-Panel Connections

The rear-panel interface consists of VXIbus connectors P1 and P2. Those pins used by the DMM on P1 and the inner row (Row B) on P2 are configured as defined in the VMEbus Specification, IEEE Standard 1014. Those pins used by the DMM on the outer rows of P2 (Rows A and C) are configured as defined in the VXIbus System Specification, Revision 1.3, July 14, 1989.

The pin assignments used by the DMM on these connectors are listed in the tables below. For detailed information regarding the signals on the pins, refer to the VMEbus Standard and the VXIbus Specification referenced above.

P1 Pinout (nc = no connection)

Pin Number	Row A Signal Mnemonic	Row B Signal Mnemonic	Row C Signal Mnemonic
1	D00	nc	D08
2	D01	nc	D09
3	D02	ACFAIL*	D10
4	D03	nc	D11
5	D04	nc	D12
6	D05	nc	D13
7	D06	nc	D14
8	D07	nc	D15
9	GND	nc	GND
10	SYSCLK	nc	nc
11	GND	nc	nc
12	DS1*	nc	SYSRESET*
13	DS0*	nc	nc
14	WRITE*	nc	AM5
15	GND	nc	nc
16	DTACK*	AM0	nc
17	GND	AM1	nc
18	AS*	nc	nc
19	GND	AM3	nc
20	IACK*	GND	nc
21	IACKIN*	nc	nc

P1 Pinout (nc = no connection) (Cont.)

Pin Number	Row A Signal Mnemonic	Row B Signal Mnemonic	Row C Signal Mnemonic
22	IACKOUT*	nc	nc
23	AM4	GND	A15
24	A07	IRQ7*	A14
25	A06	IRQ6*	A13
26	A05	IRQ5*	A12
27	A04	IRQ4*	A11
28	A03	IRQ3*	A10
29	A02	IRQ2*	A09
30	A01	IRQ1*	A08
31	–12 V	nc	+12 V
32	+5 V	+5 V	+5 V

P2 Pinout (nc = no connection)

Pin Number	Row A Signal Mnemonic	Row B Signal Mnemonic	Row C Signal Mnemonic
1	nc	nc	nc
2	nc	GND	nc
3	nc	nc	nc
4	nc	nc	nc
5	nc	nc	nc
6	nc	nc	nc
7	nc	nc	nc
8	nc	nc	nc
9	nc	nc	nc
10	nc	nc	nc
11	nc	nc	nc
12	nc	GND	nc
13	nc	nc	nc
14	nc	nc	nc
15	nc	nc	nc
16	nc	nc	nc

P2 Pinout (nc = no connection) (Cont.)

Pin Number	Row A Signal Mnemonic	Row B Signal Mnemonic	Row C Signal Mnemonic
17	nc	nc	nc
18	nc	nc	nc
19	nc	nc	nc
20	nc	nc	nc
21	nc	nc	nc
22	nc	GND	nc
23	nc	nc	nc
24	nc	nc	nc
25	nc	nc	nc
26	nc	nc	nc
27	nc	nc	nc
28	nc	nc	nc
29	nc	nc	nc
30	MODID	nc	nc
31	nc	GND	nc
32	nc	nc	nc

Appendix C: *RST Condition

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

Subsystem	Keyword	Default Condition
ABORt		None
CALibration	:HIGH ?	None
	:LOW?	None
	:SECure	OFF
	:SLFRequency?	Last Stored Value
CONFigure	:CURRent	CONF:CURR:DC 1, 1E–6, (@ 1)
	:FRESistance	CONF:FRES 1E7, 1E2, (@1)
	:RESistance	CONF:RES 1E7, 1E2, (@1)
	:VOLTage	CONF:VOLT:DC 300, 1E–3, (@1)
CON Figure ?		None
FETCh?		None
I N I Tiate	[:1M Medi ate]	None
INPut	:COUPling	INP:COUP:AC
	:FILTer[:LPASs][:STATe]	INP:FILT:LPAS:STAT OFF
	:GUARd	INP:GUAR'LOW
	[: STAT]	I N P :STAT :OF F
	ZERO	Unaffected.
MEASure	:CURRent	MEAS:CURR:DC 1,1 E–6, (@1)
	:FRESistance	MEAS:FRES 1E7, 1E2, (@ 1)
	:RESistance	MEAS:RES 1E7, 1E2, (@1)
	:VOLtage	MEAS:VOLT:DC 300, 1E–3, (@1)
OUTput	TI'LTrg0111213|41516|7 :PROTocol	OUTP TTLTrg011|213141516|7:PROT SYNC
READ?		None
[SENSe:]	:CURRent	SENS:CURR:DC 1, 1E–6, (@1)
	:FRESistance	SENS:FRES 1E7, 1E2, (@1)
	:RESistance	SENS:RES 1E7, 1E2, (@1)
	:VOLTage	SENS:VOLT:DC 300, 1E–3, (@ 1)
	:RANGe	

Subsystem	Keyword	Default Condition
	:AUTO	SENS:<function>:RANG:AUTO OFF
	FILTer[:LPASs][:STATe]	SENS:FILT:LPAS:STAT OFF
	LFRequency	As last set.
STATus	:OP E Ration	None
	:CON Dition ?	None
	:OPERation[:EVENt]?	Unaffected
	:OPERation :ENABle	None
	:QUEStionable:CONDition?	None
	:QUEStionable:[:EVENt]?	Unaffected
	:QUEStionable:ENABle :PRESet	See SCPI Specification.
SYSTem	:ERRor?	None
	LANguage NATive	SCPI Parser
	:VERSion?	None
TEST	[:ALL]?	None
	:TYPE?<Nrf>	None
TRIGger	[:IMMediate]	None
	:COUNt	TRIG:COUN 1
	:DELay	Default values (see Section 5; p5–21)
	:AUTO	TRIG:DEL:AUTO ON
	:SOU Rca	TRIG:SOUR IMM

Appendix D: Performance Verification

The VX4237 is calibrated at the factory using equipment that is traceable to national standards. The performance of the VX4237 when received is somewhat dependant upon the time since calibration, as described in the *Specifications* section of this manual. It is strongly recommended that this Performance Check Procedure be performed upon receipt to verify the calibration accuracy of the VX4237. This Performance Check verifies the VX4237 to the 90 day specification limits, as described in the *Specifications*.

User Uncertainty Calculations

The accuracy of the user's test equipment affects the accuracy to which the VX4237 can be verified. For this reason, the user will need to calculate their test equipment uncertainties in conjunction with those of the VX4237 before the comparison to specification limits can be accomplished.

The measurements in this procedure are intended to establish that the VX4237 performs within its specifications, meaning that it operates within the tolerance of its accumulated uncertainties. Since the test equipment also contributes uncertainties, these must be added to those of the VX4237 in order to set a Validity Tolerance.

The Validity Tolerance is obtained by adding together all the relevant uncertainties in the measurement process at the time the measurement is made. The specification sets out the worst case allowances (relative tolerances) for the VX4237's performance. When obtaining test equipment uncertainties, worst case tolerances must also be assumed.

Tables and calculations are provided in this Performance Check Procedure. The user should complete the Verification Work Sheets and calculate the Validity Tolerance limits using the formulae provided. If any range fails to meet specification and the instrument is to be returned, please be certain to include copies of the Verification Work Sheets and a list of the test equipment used. Any other relevant information that can be provided will help speed repairs.

Using the Verification Work Sheets

Incoming Inspection

The VX4237 has a calibration sticker placed over the front panel calibration switch at the factory. Verify the calibration sticker is intact before starting this procedure. If this sticker has been removed or otherwise disturbed, the factory calibration is void and recalibration as described in *Servicing* is required.

The tables in this performance check provide columns to enter both the user's calculations of tolerance limits and the results of the measurements made. The relative accuracy tolerance limits for the 90 day specification are already entered in the columns. These figures include the factory test equipment uncertainties. A relevant formula for calculating the validity tolerances is given with each table.

After User Recalibration

Once the VX4237 has been recalibrated with the user's test equipment, the factory uncertainties no longer apply. Validity tolerance limits must then be recalculated to include the user's test equipment uncertainties, which replaces the factory uncertainties. For convenience, a separate column is provided for the user's test equipment uncertainties. A relevant formula for calculating the validity tolerances is given with each table.

Preparation

This Performance Verification must be performed using the IEEE-488.2 (GPIB) command syntax as described in *Syntax and Commands*.

1. Install the VX4237 in an appropriate VXI mainframe, and allow at least 15 minutes warm-up time.

2. Verify the front panel calibration switch is in the disable (down) position unless the factory calibration sticker is still securely attached.

3. Program and execute the self test (*TST? command). Should the VX4237 fail, contact the local Tektronix Service Center.

4. Program the VX4237 to enable the front panel inputs (INPUT CH_A command).

Abbreviations used in this procedure:

H_r	VX4237 upper relative accuracy tolerance limit
L_r	VX4237 lower relative accuracy tolerance limit
U_f	Factory calibration standard uncertainty relative to national standards
U_m	Sum of uncertainties from the VX4237 terminals through the user's measurement process to national standards

DC Voltage Check

1. Set the DC Volts calibrator as follows:

   Output OFF
   0 V Output
   Local Guard

2. Program the VX4237 as follows:

   DCV 0,FILT0,RESL6;GUARD LCL;INPUT CH_A

3. Connect a shorting bar between the VX4237 HI and LO input connectors (pins 1 and 5).
4. Send ZERO? to the VX4237 to set the 0V adjustment.
5. Connect the DC Volts calibrator output leads to the VX4237. Turn the calibrator output ON.
6. Send X? to the VX4237 to obtain the user's instrument tolerance.
7. Set the DC Volts calibrator to 100.0000 mV.
8. Send X? to the VX4237 and enter the displayed value into the VX4237 Reading column of Table D–2.
9. Turn the DC Volts calibrator output OFF.
10. Reverse the calibrator connections the VX4237 to input a negative voltage.
11. Turn the calibrator output ON.
12. Send X? to the VX4237 and enter the displayed value into the VX4237 Reading column of Table D–2.
13. Turn the DC Volts calibrator output OFF.
14. Reverse the DC Volts calibrator connections to their normal position.
15. Repeat steps 1 through 14 to verify the 1 V, 10 V, 100 V and 300 V ranges, substituting the DC Volts calibrator settings and VX4237 commands shown in the Table D–1.
16. Calculate the Validity Tolerance Limits using the appropriate formula beneath Table D–2.
17. CHECK that the values in the VX4237 Reading column are at or within the corresponding upper and lower Validity Tolerance Limits.

Table D–1: DC Voltage Check Sequence

Step/Range	Calibration Setting	VX4237 Command
1 VDC Range		
1	0 V	
2		DCV 1
4		ZERO?
6		X?
7	1.000000 V	
8		X?
10	1.000000 V	
12		X?
10 VDC Range		
1	0 V	
2		DCV 10
4		ZERO?
6		X?
7	10.00000 V	
8		X?
10	10.00000 V	
12		X?
100 VDC Range		
1	0 V	
2		DCV 100
4		ZERO?
6		X?
7	100.0000 V	
8		X?
10	100.0000 V	
12		X?

Table D–1: DC Voltage Check Sequence (Cont.)

Step/Range	Calibration Setting	VX4237 Command
300 VDC Range		
1	0 V	
2		DCV 300
4		ZERO?
6		X?
7	199.0000 V	
8		X?
10	199.0000 V	
12		X?

Table D–2: DC Voltage Full Range Checks

Range & Calibrator Output	Relative Accuracy Tolerance Limits		Factory Calibration Standards $\pm U_r$	User's Measurement Tolerance $\pm U_m$	Validity Tolerance Limits		VX4237 Reading
	Lower L_r	Higher H_r			Lower	Higher	
+100 mV	+99.9958	+100.0042	0.00045 mV				
–100 mV	–100.0042	–99.9958	0.00045 mV				
+1 V	+0.999974	+1.000026	0.000035 V				
–1 V	–1.000026	–0.999974	0.000035 V				
+10 V	+9.99976	+10.00024	0.000025 V				
–10 V	–10.00024	–9.99976	0.000025 V				
+100 V	+99.9964	+100.0036	0.00045 V				
–100 V	–100.0036	–99.9964	0.00045 V				
+199 V	+198.9932	+199.0068	0.0009 V				
–199 V	–199.0068	–198.9932	0.0009 V				

Validity Tolerance Limits calculation, factory test equipment uncertainty:

Higher Limit = $H_r + U_m$
Lower Limit = $L_r – U_m$

Validity Tolerance Limits calculation after user calibration:

Higher Limit = $H_r – U_f + U_m$
Lower Limit = $L_r + U_f – U_m$

AC Voltage Check

1. Set the AC Volts calibrator as follows:

   Output OFF
   100 mV_{RMS}
   1 kHz
   Local Guard

2. Program the VX4237 as follows:

   ACV 0,FILT0,RESL5;GUARD LCL

3. Connect the AC Volts calibrator output leads to the VX4237. Turn the calibrator output ON.
4. Send X? to the VX4237 and enter the displayed value into the VX4237 Reading column of Table D–4.
5. Change the AC Volts calibrator frequency to 30 kHz
6. Send X? to the VX4237 and enter the displayed value into the VX4237 Reading column of Table D–4.
7. Turn the AC Volts calibrator output OFF.
8. Repeat steps 1 through 7 to verify the 1 V, 10 V, 100 V and 300 V ranges, substituting the AC Volts calibrator settings and VX4237 commands shown in Table D–3.
9. Calculate the Validity Tolerance Limits using the appropriate formula beneath Table D–4.
10. CHECK that the values in the VX4237 Reading column are at or within the corresponding upper and lower Validity Tolerance Limits.

Table D–3: AC Voltage Check Sequence

Step/ Range	Calibration Setting	VX4237 Command
1 VDC Range		
1	1.00000 V_{RMS}, 1 kHz	
2		ACV 1
4		X?
5	1.00000 V_{RMS}, 30 kHz	
6		X?

Table D–3: AC Voltage Check Sequence (Cont.)

Step/ Range	Calibration Setting	VX4237 Command
10 VDC Range		
1	10.0000 V_{RMS}, 1 kHz	
2		ACV 10
4		X?
5	10.0000 V_{RMS}, 30 kHz	
6		X?
100 VDC Range		
1	100.000 V_{RMS}, 1 kHz	
2		ACV 100
4		X?
5	100.000 V_{RMS}, 30 kHz	
6		X?
300 VDC Range		
1	199.000 V_{RMS}, 1 kHz	
2		ACV 300
4		X?
5	199.000 V_{RMS}, 30 kHz	
6		X?

Table D–4: AC Volts Full Range Checks

Range & Calibrator Output	Calibration Frequency	Relative Accuracy Tolerance Limits		Factory Calibration Standards $\pm U_r$	User's Measurement Tolerance $\pm U_m$	Validity Tolerance Limits		VX4237 Reading
		Lower L_r	Higher H_r			Lower	Higher	
100 mV	1 kHz	99.945	100.055	0.004 mV				
100 mV	30 kHz	99.860	100.140	0.045 mV				
1 V	1 kHz	.99945	1.00055	0.00003 V				
1 V	30 kHz	.99860	1.00140	0.00007 V				
10 V	1 kHz	9.9945	10.0055	0.0003 V				
10 V	30 kHz	9.9860	10.0140	0.0007 V				
100 V	1 kHz	99.945	100.055	0.003 V				
100 V	30 kHz	99.860	100.140	0.007V				

Table D–4: AC Volts Full Range Checks (Cont.)

Range & Calibrator Output	Calibration Frequency	Relative Accuracy Tolerance Limits		Factory Calibration Standards	User's Measurement Tolerance	Validity Tolerance Limits		VX4237 Reading
		Lower L_r	Higher H_r	$\pm U_r$	$\pm U_m$	Lower	Higher	
199 V	1 kHz	198.901	199.099	0.100 V				
199 V	30 kHz	198.741	199.259	0.200 V				

Validity Tolerance Limits calculation, factory test equipment uncertainty:

Higher Limit = $H_r + U_m$
Lower Limit = $L_r - U_m$

Validity Tolerance Limits calculation after user calibration:

Higher Limit = $H_r - U_f + U_m$
Lower Limit = $L_r + U_f - U_m$

AC Linearity Check

1. Set the AC Volts calibrator as follows:

Output OFF
1 V_{RMS}
1 kHz
Local Guard

2. Program the VX4237 as follows:

ACV 10,FILT0,RESL5;GUARD LCL

3. Connect the AC Volts calibrator output leads to the VX4237. Turn the calibrator output ON.

4. Send X? to the VX4237 and enter the displayed value into the VX4237 Reading column of Table D–5.

5. Set the calibrator to output 10 VAC at 1 kHz. Do not change the VX4237 range.

6. Send X? to the VX4237 and enter the displayed value into the VX4237 Reading column of Table D–5.

7. Repeat steps 5 and 6, with a calibrator output of 19 VAC at 1 kHz.

8. Calculate the Validity Tolerance Limits using the appropriate formula beneath Table D–5.

9. CHECK that the values in the VX4237 Reading column are at or within the corresponding upper and lower Validity Tolerance Limits.

Table D–5: AC Linearity Checks

Calibrator Voltage	Calibration Frequency	Relative Accuracy Tolerance Limits		Factory Calibration Standards $\pm U_r$	User's Measurement Tolerance $\pm U_m$	Validity Tolerance Limits		VX4237 Reading
		Lower L_r	Higher H_r			Lower	Higher	
1 V	1 kHz	.9977	1.0023	0.0003 V				
10V	1 kHz	9.9945	10.0055	0.0003 V				
19V	1 kHz	18.9934	19.0066	0.0003 V				

Validity Tolerance Limits calculation, factory test equipment uncertainty:

Higher Limit = $H_r + U_m$
Lower Limit = $L_r - U_m$

Validity Tolerance Limits calculation after user calibration:

Higher Limit = $H_r - U_f + U_m$
Lower Limit = $L_r + U_f - U_m$

Resistance Check

1. Set the Resistance calibrator as follows:

   Output OFF (if available)
   0 Ω Resistance
   Remote Guard

2. Program the VX4237 as follows:

   OHMS 100,FILT0,RESL6, WIRE4;GUARD LCL

3. Connect the resistance calibrator to the VX4237. Turn the calibrator output ON if applicable. If the calibrator does not provide 4-wire connection capability, disconnect the calibrator and short together the four pins 1, 2, 5 and 6 of the VX4237 input connector, using as short a jumper as possible.

4. Send ZERO? to the VX4237.

5. If a short circuit was connected in step 3, remove the shorting jumper and reconnect the resistance calibrator.

6. Set the calibrator to 100 Ω.

7. Send X? to the VX4237 and enter the displayed value into the VX4237 Reading column of Table D–7.

8. Enter the actual calibrator resistance value (as provided by the manufacturer's or calibration lab's correction sheet) in the Calibrator Resistance (V_r) column of Table D–7.

9. Calculate ΔR by subtracting the actual calibrator resistance from the calibrator nominal resistance setting. Enter the value in the ΔR column of Table D–7.

10. Turn the Resistance calibrator output OFF, if available.

11. Repeat steps 1 through 10 to verify the 1 kΩ, 10 kΩ, 1 MΩ and 10 MΩ ranges, substituting the Resistance calibrator settings and VX4237 commands shown in Table D–6.

12. Calculate the Validity Tolerance Limits using the appropriate formula beneath Table D–7.

13. CHECK that the values in the VX4237 Reading column are at or within the corresponding upper and lower Validity Tolerance Limits.

Table D–6: Resistance Check Sequence

Step/ Range	Calibration Setting	VX4237 Command
1 kΩ Range		
1	0 Ω	
2		OHMS 1000
4		ZERO?
6	1000.000 Ω	
7		X?
10 kΩ Range		
1	0 Ω	
2		OHMS 10000
4		ZERO?
6	10000.00 Ω	
7		X?
100 kΩ Range		
1	0 Ω	
2		OHMS 100000
4		ZERO?
6	100000.0 Ω	
7		X?
1 MΩ Range		
1	0 Ω	
2		OHMS 1000000,FILT1
4		ZERO?
6	1000000 Ω	
7		X?
10 MΩ Range		
1	0 Ω	
2		OHMS 10000000,FILT1
4		ZERO?
6	10000000 Ω	
7		X?

Table D–7: Resistance Checks

Range & Nominal Calibration Setting	Relative Accuracy Tolerance Limits		Factory Calibration Standards $\pm U_r$	User's Measurement Tolerance $\pm U_m$	Validity Tolerance Limits		Actual Calibration Resistance (V_r)	DR (V_r – Nom)	VX4237 Reading
	Lower L_r	Higher H_r			Lower	Higher			
100 Ω	99.9953	100.0047	0.00045						
1 kΩ	0.999964	1.000036	0.0000045						
10 kΩ	9.99964	10.00036	0.000045						
100 kΩ	99.9954	100.0046	0.0008						
1 MΩ	0.999912	1.000088	0.000012						
10 MΩ	9.00762	10.00208	0.00015						

Validity Tolerance Limits calculation, factory test equipment uncertainty:

Higher Limit = $H_r + \Delta R + U_m$
Lower Limit = $L_r + \Delta R - U_m$

Validity Tolerance Limits calculation after user calibration:

Higher Limit = $H_r + \Delta R - U_f + U_m$
Lower Limit = $L_r + \Delta R + U_f - U_m$

WARNING

The following servicing instructions are for use only by qualified personnel. To avoid injury, do not perform any servicing other than that stated in the operating instructions unless you are qualified to do so. Refer to all Safety Summaries before performing any service.

Appendix E: User Service

This appendix provides information about user service. For additional service assistance, please contact your Tektronix field office or representative.

Preventive Maintenance

You should perform inspection and cleaning as preventive maintenance. Preventive maintenance, when done regularly, may prevent VX4237 malfunction and enhance reliability. Inspect and clean the VX4237 as often as conditions require by following these steps:

1. Turn off power and remove the VX4237 from the VXIbus mainframe.
2. Remove loose dust on the outside of the instrument with a lint-free cloth.
3. Remove any remaining dirt with a lint-free cloth dampened with water or a 75% isopropyl alcohol solution. Do not use abrasive cleaners.

User-Replaceable Parts

There are no user-replaceable parts in the VX4237. If you suspect a failure, contact your Tektronix field office or representative for assistance.

Adjustment

The VX4237 provides full external calibration of all ranges and functions through the VXIbus. Calibration commands are programmed using the IEEE-488.2 command set.

The DMM should be periodically calibrated against external inputs of known value. The recommended adjustment interval is at least every 2000 hours of operation. The differences in the reading of the DMM and the known value of the input are stored as calibration constants in the non-volatile memory of the VX4237. The VX4237 assumes that nominal values are used, unless the user specifies otherwise.

During normal use, the VX4237 calculates and applies any necessary calibration corrections using the most recently stored calibration constants for the parameters of the measurement in progress. In this manner, each measurement made by the DMM receives an individual calibration correction using the stored calibration constants.

Calibration Security

Accidental use of calibration facilities can be prevented by the use of a screwdriver-operated switch that is accessible through the front panel.

Adjustment Procedure

To verify instrument accuracy without affecting the calibration constants, refer to the *Performance Verification* section of this manual.

Introduction

NOTE*. This Adjustment Procedure must be performed using the IEEE-488.2 (GPIB) command syntax, as described in Section 4 of this manual.*

The adjustment interval will depend largely upon the requirements of the user. Refer to the *Specification* section of this manual to determine the level of accuracy available with different adjustment intervals. It is recommended that the VX4237 be adjusted at least every 2000 hours of operation, or once per year if used infrequently.

Adjustment accuracy is directly related to the accuracy of the calibration standards used. Refer to the Performance Verification section of this manual for calculations used to determine the effect of calibration standard uncertainties on overall VX4237 accuracy.

Preparation

1. Install the VX4237 in an appropriate VXI mainframe, and allow at least 15 minutes warmup time. If practical, best results will be obtained if the VX4237 can be adjusted while installed in its normal operating location.
2. Verify the front panel calibration switch is in the disable (down) position.
3. Program and execute the selftest (*TST command). If the VX4237 returns an error, correct the cause of the error before proceeding.
4. Set the front panel calibration switch to the enable (up) position.
5. Check the line frequency using the LINE? query.
6. If necessary, change the frequency using the (LINE Nrf) setting command to match the local power mains line frequency. Store the line frequency as the power-on default setting (STLN?).
7. Program and execute the CAL ON command to enable the calibration mode.
8. Program and execute the INPUT CH_A command to enable the input connectors.

To disable the calibration mode at any time, either send the CAL OFF command, or set the front panel calibration switch to the disable (down) position. However, it is recommended that once the adjustment procedure has been started that it be completed before putting the VX4237 back into service. A partial adjustment may cause unexpected results in some functions.

Input Connections

The input connector must be wired to accept the calibrator output. The table below shows the required input connections as well as the connector pins to which they should be wired:

Signal Name	Input Pin #
High	1
I + (Sense)	2
Low	5
I – (Sense)	6
Guard	7

Adjustment Levels

The levels at which adjustments are performed in the following procedure are the “nominal” points for the functions and ranges. Nominal levels need not be programmed into the VX4237; they are assumed when the CALL? and CALH? commands are sent without arguments.

For users who wish to adjust the VX4237 at non-nominal levels, the CALL? and CALH? commands accept Nrf format arguments for the non-nominal values. This causes the VX4237 to adjust to the level specified by the command argument.

The acceptable range of arguments for the CALL? and CALH? commands are:

CALL? Any value between 0% and 25% of full range, except for the 300 DCV and ACV ranges, which are limited to 75 V.

CALH? Any value between 75% and 100% of full range.

Verification After Adjustment

Once the VX4237 has been adjusted to the user’s calibration standards, performance can be verified using the procedure defined in the *Performance Verification* section of this manual. Note that VX4237 factory calibration uncertainties are no longer valid after user adjustment. Therefore, when performing the Performance Verification, the Validity Tolerance Limits must be calculated as described in the verification procedure to include the user’s equipment uncertainties instead of the factory uncertainties.

WARNING. *Hazardous voltages exist at the calibrator outputs during several steps in this procedure. To avoid electric shock, hazard be sure the calibrator output is programmed or switched off before changing connections or switching ranges.*

DC Voltage

DCV Zero and Full Range

1. Set the DC Volts calibrator as follows:

Output OFF
0 V Output
Local Guard

2. Program the VX4237 as follows:

DCV 10,FILT0,RESL6;GUARD LCL

3. Connect the DC volts calibrator sense and output leads to the VX4237. Turn the calibrator output ON.

4. Send CALL? to the VX4237 to set the 0 V adjustment point.

5. Set the calibrator output to 10.00000 V.

6. Send CALH? to the VX4237 to set the +10.00000 V adjustment point.

7. Turn the calibrator output OFF.

8. Reverse the calibrator connections to the VX4237 to input a negative voltage.

9. Turn the calibrator output ON.

10. Send CALH? to the VX4237 to set the –10.00000 V adjustment point.

11. Turn the calibrator output OFF.

12. Reverse the calibrator connections to their normal position.

13. Repeat steps 1 through 12 to calibrate the 0 and ±full range adjustment points on the 100 mV, 1 V and 100 V ranges, and to adjust the 0 and ±199 V points on the 300 V range. Refer to Table E–1 for the sequence of steps, VX4237 and calibrator settings to be performed.

Table E–1: DC Voltage Adjustment Sequence

Step	Calibration Setting	VX4237 Command
100 mV Range		
1	0 V	
2		DCV 0
4		CALL?
5	+100.0000 mV	
6		CALH?
8	–100.0000 mV	

Table E–1: DC Voltage Adjustment Sequence (Cont.)

Step	Calibration Setting	VX4237 Command
10		CALH?
1 V Range		
1	0 V	
2		DCV 1
4		CALL?
5	+1.000000 mV	
6		CALH?
8	–1.000000 mV	
10		CALH?
100 V Range		
1	0 V	
2		DCV 100
4		CALL?
5	+100.0000 mV	
6		CALH?
8	–100.0000 mV	
10		CALH?
300 V Range		
1	0 V	
2		DCV 300
4		CALL?
5	+199.0000 mV	
6		CALH?
8	–199.0000 mV	
10		CALH?

Resistance

These steps adjust the 4-Wire Zero and Full Range operation:

1. Set the Resistance calibrator as follows:

   Output OFF (if available)
   0 Ω Resistance
   Remote Guard

2. Program the VX4237 as follows:

   OHMS 100,FILT0,RESL6,WIRE4;GUARD LCL

3. Connect the resistance calibrator to the VX4237. Turn the calibrator output ON if appropriate. If the calibrator does not provide 4-wire connection capability, disconnect the calibrator and short together the four pins 1, 2, 5 and 6 of the VX4237 input connector, using as short a jumper as possible.

4. Send CALL? to the VX4237 to set the 0 Ω adjustment point.

5. If a short circuit was connected in step 3, remove the shorting jumper and reconnect the resistance calibrator.

6. Set the calibrator to 100 Ω.

7. Send CALH? to the VX4237 to set the 100 Ω adjustment point. If the calibrator does not have a 100 Ω nominal value available, send the CALH? Nrf command, substituting the nearest available value for Nrf in the command.

8. Set the calibrator output to OFF, if appropriate.

9. Repeat steps 1 through 8 to calibrate the 0 and full range adjustment points on the 1 kΩ, 10 kΩ, 1 MΩ and 10 MΩ ranges. Refer to Table E–2 for the sequence of steps, VX4237 and calibrator settings to be performed.

Table E–2: Resistance Adjustment Sequence

Step	Calibration Setting	VX4237 Command
1 kΩ Range		
1	0 Ω	
2		OHMS 1000
4		CALL?
6	+1000.000 Ω	
7		CALH?
10 kΩ Range		
1	0 Ω	
2		OHMS 10000

Table E–2: Resistance Adjustment Sequence (Cont.)

Step	Calibration Setting	VX4237 Command
4		CALL?
6	+10000.00 Ω	
7		CALH?
100 kΩ Range		
1	0 Ω	
2		OHMS 100000
4		CALL?
6	+100000.0 Ω	
7		CALH?
1 MΩ Range		
1	0 Ω	
2		OHMS 100000,FILT1
4		CALL?
6	+1000000 Ω	
7		CALH?
1 kΩ Range		
1	0 Ω	
2		OHMS 1000000,FILT1
4		CALL?
6	+10000000 Ω	
7		CALH?

These steps adjust the 2-Wire Zero operation:

1. Disconnect the calibrator.

2. Short together pins 1 and 5 on the VX4237 input connector. Use as short a jumper as possible.

3. Program the VX4237 as follows:

OHMS 100,FILT0,RESL6,WIRE2;GUARD LCL

4. Send CALL? to the VX4237 to set the 0 Ω adjustment point.

5. Repeat steps 3 and 4 for the 1 kΩ range.

6. Repeat steps 3 and 4 for the 10 kΩ range.

7. Repeat steps 3 and 4 for the 100 kΩ range.

8. Program the VX4237 as follows:

   OHMS 1000000,FILT1,RESL6,WIRE2;GUARD LCL

9. Send CALL? to the VX4237 to set the 0 Ω adjustment point.

10. Repeat steps 8 and 9 for the 10 MΩ Range.

AC Voltage

ACV Low and Full Range

1. Set the AC Volts calibrator as follows:

   Output OFF
   10.0000 mV_{RMS}
   1 kHz
   Local Guard

2. Program the VX4237 as follows:

   ACV 0,FILT0,RESL5;GUARD LCL

3. Connect the AC Volts calibrator sense and output leads to the VX4237. Turn the calibrator output ON.

4. Send CALL? to the VX4237 to set the low range adjustment point.

5. Set the calibrator output to 100.000 mV_{RMS}, 1 kHz.

6. Send CALH? to the VX4237 to set the 100 mV adjustment point.

7. Turn the calibrator output OFF.

8. Repeat steps 1 through 7 to calibrate the low and full range adjustment points on the 1 V, 10 V and 100 V ranges, and to adjust the low range and 199V points on the 300V range. The calibrator frequency must remain at 1 kHz for all adjustments. Refer to Table E–3 for the sequence of steps, VX4237 and calibrator settings to be performed.

Table E–3: AC Voltage Adjustment Sequence

Step	Calibration Setting	VX4237 Command
1 V Range		
1	10.0000 mV_{RMS}	
2		ACV 1
4		CALL?
5	1.00000 V_{RMS}	
6		CALH?
10 V Range		

Table E–3: AC Voltage Adjustment Sequence (Cont.)

Step	Calibration Setting	VX4237 Command
1	100.000 mV_{RMS}	
2		ACV 10
4		CALL?
5	10.0000 V_{RMS}	
6		CALH?
100 V Range		
1	1.00000 mV_{RMS}	
2		ACV 100
4		CALL?
5	100.000 V_{RMS}	
6		CALH?
300 V Range		
1	3.00000 mV_{RMS}	
2		ACV 300
4		CALL?
5	199.000 V_{RMS}	
6		CALH?

Turn the calibrator output OFF and disconnect the calibrator. Send the CAL OFF command to the VX4237. Set the front panel calibration switch to the disable (down) position.

This completes the VX4237 adjustment procedure.

Glossary

Glossary

The terms in this glossary are defined as used in the VXIbus System. Although some of these terms may have different meanings in other systems, it is important to use these definitions in VXIbus applications. Terms which apply only to a particular instrument module are noted. Not all terms appear in every manual.

Accessed Indicator
An amber LED indicator that lights when the module identity is selected by the Resource Manager module, and flashes during any I/O operation for the module.

ACFAIL*
A VMEbus backplane line that is asserted under these conditions: 1) by the mainframe Power Supply when a power failure has occurred (either ac line source or power supply malfunction), or 2) by the front panel ON/STAND-BY switch when switched to STANDBY.

Backplane
The printed circuit board that is mounted in a VXIbus mainframe to provide the interface between VXIbus modules and between those modules and the external system.

Bus Arbitration
In the VMEbus interface, a system for resolving contention for service among VMEbus Master devices on the VMEbus.

CLK10
A 10-MHz, ±100 ppm, individually buffered (to each module slot), differential ECL system clock that is sourced from Slot 0 and distributed to Slots 1–12 on P2. It is distributed to each module slot as a single source, single destination signal with a matched delay of under 8 ns.

CLK100
A 100-MHz, ±100 ppm, individually buffered (to each module slot), differential ECL system clock that is sourced from Slot 0 and distributed to Slots 1–12 on P3. It is distributed to each module slot in synchronous with CLK10 as a single source, single destination signal with a maximum system timing skew of 2 ns, and a maximum total delay of 8 ns.

Commander
In the VXIbus interface, a device that controls another device (a servant). A commander may be a servant of another commander.

Communication Registers
In word serial protocol, a set of device registers that are accessible to the

commander of the device. Such registers are used for inter-device communications, and are required on all VXIbus message-based devices.

Configuration Registers
A set of registers that allow the system to identify a (module) device type, model, manufacturer, address space, and memory requirements. In order to support automatic system and memory configuration, the VXIbus standard specifies that all VXIbus devices have a set of such registers, all accessible from P1 on the VMEbus.

C-Size Card
A VXIbus instrument module that is 340.0 by 233.4 mm by 30.48 mm (13.4 by 9.2 in by 1.2 in).

DC Supplies Indicator
A red LED indicator that illuminates when a DC power fault is detected on the backplane.

DUT
Device Under Test. Also UUT – Unit Under Test.

ECLTRG
Six single-ended ECL trigger lines (two on P2 and four on P3) that function as inter-module timing resources, and that are bussed across the VXIbus subsystem backplane. Any module, including the Slot 0 module, may drive and receive information from these lines. These lines have an impedance of 50 ohms; the asserted state is logical High.

External System Controller
The host computer or other external controller that exerts overall control over VXIbus operations.

FAILED Indicator
A red LED indicator that lights when a device on the VXIbus has detected an internal fault. This might result in the assertion of the SYSFAIL* line.

Instrument Module
A plug-in printed circuit board, with associated components and shields, that may be installed in a VXIbus mainframe. An instrument module may contain more than one device. Also, one device may require more than one instrument module.

Interrupt Handler
A functional module that detects interrupt requests generated by Interrupters and responds to those requests by requesting status and identity information.

Interrupter
A device capable of asserting VMEbus interrupts and performing the interrupt acknowledge sequence.

IRQ
The Interrupt ReQuest signal, which is the VMEbus interrupt line that is asserted by an Interrupter to signify to the controller that a device on the bus requires service by the controller.

Local Bus
A daisy-chained bus that connects adjacent VXIbus slots.

Logical Address
The smallest functional unit recognized by a VXIbus system. It is often used to identify a particular module.

Mainframe
Card Cage. For example, the Tektronix VX1400 Mainframe, an operable housing that includes 13 C-size VXIbus instrument module slots.

Message Based Device
A VXIbus device that supports VXI configuration and communication registers. Such devices support the word serial protocol, and possibly other message-based protocols.

MODID Lines
Module/system identity lines.

Power Monitor
A device that monitors backplane power and reports fault conditions.

P1
The top-most backplane connector for a given module slot in a vertical mainframe such as the Tektronix VX1400. The left-most backplane connector for a given slot in a horizontal mainframe.

P2
The bottom backplane connector for a given module slot in a vertical C-size mainframe such as the VX1400; or the middle backplane connector for a given module slot in a vertical D-size mainframe such as the VX1500.

Query
A form of command that requires a response.

READY Indicator
A green LED indicator that lights when the power-on diagnostic routines have been completed successfully. An internal failure or failure of +5-volt power will extinguish this indicator.

Register Based Device
A VXIbus device that supports VXI register maps, but not high level VXIbus communication protocols; includes devices that are register-based servant elements.

Resource Manager
A VXIbus device that provides configuration management services such as address map configuration, determining system hierarchy, allocating shared system resources, performing system self test diagnostics, and initializing system commanders.

Self Calibration
A routine that verifies the basic calibration of the instrument module circuits, and adjusts this calibration to compensate for short- and long-term variables.

Self Test
A set of routines that determine if the instrument module circuits will perform according to a given set of standards. A self test routine is performed upon power-on.

Servant
A VXIbus message-based device that is controlled by a commander.

Slot 0 Controller
See Slot 0 Module. Also see Resource Manager.

Slot 0 Module
A VXIbus device that provides the minimum VXIbus slot 0 services to slots 1 through 12 (CLK10 and the module identity lines), but that may provide other services such as CLK100, SYNC100, STARBUS, and trigger control.

SYSFAIL*
A signal line on the VMEbus that is used to indicate a failure by a device. The device that fails asserts this line.

System Hierarchy
The tree structure of the commander/servant relationships of all devices in the system at a given time. In the VXIbus structure, each servant has a commander. A commander may also have a commander.

Test Program
A program, executed on the system controller, that controls the execution of tests within the test system.

Test System
A collection of hardware and software modules that operate in concert to test a target DUT.

TTLTRG
Open collector TTL lines used for inter-module timing and communication.

VXIbus Subsystem
One mainframe with modules installed. The installed modules include one module that performs slot 0 functions and a given complement of instrument modules. The subsystem may also include a Resource Manager.

Word Serial Protocol
A VXIbus word oriented, bi-directional, serial protocol for communications between message-based devices (that is, devices that include communication registers in addition to configuration registers).

Word Serial Communications
Inter-device communications using the Word Serial Protocol.

WSP
See Word Serial Protocol.

10-MHz Clock
A 10 MHz, ±100 ppm timing reference. Also see CLK10.

100-MHz Clock
A 100 MHz, ±100 ppm clock synchronized with CLK10. Also see CLK100.

488-To-VXIbus Interface
A message based device that provides for communication between the IEEE-488 bus and VXIbus instrument modules.