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User Manual

Tektronix

VX4234
Digital Multimeter Module

070-9139-02

This document applies for firmware version 1.00
and above.

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IF/THEN Sets up a conditional IF/THEN statement. Used with other commands, so that IF the stated condition is met, THEN the command following is effective.

REM All characters following the REM command are not executed.

RETURN Ends a subroutine and returns operation to the line after the last executed GOSUB command.

<CR> Carriage Return character, decimal 13.

<LF> Line Feed character, decimal 10.

VX4234 Digital Multimeter Module
QUICK REFERENCE GUIDE

Numbers in parentheses refer to the page(s) in the Operating Manual.

SETUP

Be sure all switches are correctly set. (p. 1 - 3)
Follow Installation guidelines. (p. 2 - 1)

The default condition of the VX4234 Module after the completion of power-up self test is as follows:

- Unaddressed.
- DC, Range 6, Autorange.
- Empty Buffer value enabled.
- Settling time delays enabled.
- Error buffer empty.
- Front panel trigger selected.
- Trigger function disabled.
- Buffer operation disabled.
- Autozero function enabled.
- Interrupts disabled.

LEDs

When lit, the LEDs indicate the following:

Power	power supplies functioning
Failed	module failure
ERR	an error has been found in self test or programming
MSG	module is processing a VMEbus cycle
AC, DC, OHM	indicate the type of measurement being made
4W	the module has been programmed for 4-wire ohms measurement
CURR	a current measurement has been programmed
TRMS	a True-RMS measurement is programmed
R1 - R6	indicates the VX4234 Module's present selected or autoranged input range
Autorange	autoranging has been programmed
CAL	the VX4234 Module is in the calibration mode

SYSTEM COMMANDS

These non-data commands are initiated by the VX4234's commander. The following VXIbus Instrument Protocol commands will affect the VX4234:

- ABORT NORMAL OPERATION
- ASYNCHRONOUS MODE CONTROL
- BEGIN NORMAL OPERATION
- BYTE AVAILABLE
- BYTE REQUEST
- CLEAR
- CLEAR LOCK
- CONTROL EVENT
- END NORMAL OPERATION
- ERROR QUERY
- IDENTIFY COMMANDER
- READ INTERRUPTER LINE
- RESPONSE ENABLE
- SET LOCK
- TRIGGER

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COMMAND SYNTAX

Command protocol and syntax for the VX4234 Module is as follows: (?)

1) Each command consists of a single line, which is typically two characters. Parameters may not be wrapped around. <CR> or <LF> are optional.

2) If a given parameter is to be skipped, left at its previous value, or have its default value accepted, its position must still be denoted using consecutive commas.

3) If a character is not enclosed by brackets, that character itself is sent, otherwise:
[] encloses the symbol for the actual argument to be sent.
<CR> carriage return <LF> line feed <SP> space character.
<TM> terminator: indicates a line feed or a semicolon.

4) Any character may be sent in either upper or lower case form.

5) Any of the following white space characters:
00 hex
01 hex through 08 hex 0B hex through 19 hex
09 hex (TAB character) 20 hex (SPACE character)
are allowed in any of the following places: before any comma, semicolon, or <LF>; after any comma; in place of any SPACE character listed in the command formats. Any number of white space characters may be used together.

6) Any binary argument must be formatted as follows:
#0[B1][B2]...
The "#0" characters are only required at the beginning of the binary string.

MODULE COMMANDS

See the individual command descriptions for a full explanation of the parameters.

A Autorange - places the VX4234 Module in the Auto-Range mode. (3 - 5)

Bz Buffer - disable (or re-enable) the Empty Buffer value. (3 - 6)

CzCL Calibrate - initiates the calibration procedure. (3 - 7)

Dz Delay - disables or re-enables VX4234 firmware delays inserted to allow input conditions to settle. (3 - 8)

E Error - interrogates the error status of the VX4234 Module and clears the ERR LED or flashing ERR and CAL LEDs. (3 - 9)

Fz Function - programs the VX4234 Module's function: AC, DC, or OHMS (2- or 4-wire). (3 - 12)

Iz_1z_2 Interrupt - enables or disables the interrupt mode. (3 - 13)

Nz_1z_2 eNable - enables or re-disables hardware triggering. (3 - 14)

Rz Range - programs the VX4234 to a fixed input range. (3 - 15)

T Trigger - initiates a measurement cycle. (3 - 16)

Vz Verify - initiates a Built-In-Test of the DMM. (3 - 17)

Xz eXternal Trigger Select - programs the VX4234 Module's Encode trigger input. (3 - 18)

Zz Zero - controls the auto-zeroing of the A/D input. (3 - 19)

PROGRAMMING

The programming examples in the manual are written in Microsoft GW BASIC. For programming examples, see page ?.

CALL ENTER (R$, LENGTH%, ADDRESS%, STATUS%)
Inputs data into the string R$ from the IEEE-488 instrument whose decimal primary address is contained in the variable ADDRESS%. LENGTH% = the number of bytes read from the instrument. STATUS% = '0' if the transfer was successful; '8' if an operating system timeout occurred in the PC. To use the CALL ENTER statement, the string R$ must be set to a string of spaces whose length is greater than or equal to the maximum number of bytes expected from the 73A-332.

CALL SEND (ADDRESS%, WRT$, STATUS%)
Outputs the contents of the string variable WRT$ to the IEEE-488 instrument whose decimal primary address is in the variable ADDRESS%. The variable STATUS% = '0' if the transfer was successful and an '8' if an operating timeout occurred in the PC.

END Terminates the program.

FOR/NEXT Repeats the instructions between the FOR and NEXT statements for a defined number of iterations.

GOSUB n Runs the subroutine beginning with line n. The end of the subroutine is delineated with a RETURN statement. When the subroutine reaches the RETURN statement, execution will resume on the line following the GOSUB command.

GOTO n Program branches to line n.

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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.

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.

Injury Precautions

Avoid Electric Overload

To avoid electric shock or fire hazard, do not apply a voltage to a terminal that is outside the range specified for that terminal.

Ground the Product

This product is indirectly grounded through the grounding conductor of the 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.

Do Not Operate Without Covers

To avoid electric shock or fire hazard, do not operate this product with covers or panels removed.

Use Proper Fuse

To avoid fire hazard, use only the fuse type and rating specified for this product.

Do Not Operate in Wet/Damp Conditions

To avoid electric shock, do not operate this product in wet or damp conditions.

Do Not Operate in Explosive Atmosphere

To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

Avoid Exposed Circuitry

To avoid injury, remove jewelry such as rings, watches, and other metallic objects. Do not touch exposed connections and components when power is present.

Product Damage Precautions

Provide Proper Ventilation

To prevent product overheating, provide proper ventilation.

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Do Not Operate With Suspected Failures

If you suspect there is damage to this product, have it inspected by qualified service personnel.

Safety Terms and Symbols

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.

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



DANGER
High Voltage



Protective Ground
(Earth) Terminal



ATTENTION
Refer to
Manual



Double
Insulated

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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 main 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.

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VX4234
Digital Multimeter Module

Section 1
General Information and Specifications

Introduction

The VX4234 Digital Multimeter Module is a printed circuit board assembly for use in a mainframe conforming to the VXIbus Specification, such as the VX1400 "C" size mainframe used in the Tek/CDS IAC System. The VX4234 Module is a 4½ digit, guarded, dual slope integrating systems multimeter that takes measurements at a maximum rate of 15 readings per second. The card provides the following measurement functions and ranges:

VDC	±0.020000, ±0.20000, ±2.0000, ±20.000, ±200.00, ±700.0.
VAC	0.20000, 2.0000, 20.000, 200.00, 700.00.
Ohms	200.00, 2000.00, 20.000k, 200.00k, 2.0000M, 20.000M.
Amps	.000200, .00200, .02000, .20000, 2.0000, 10.000

Note that certain terms used in this manual have very specific meanings in the context of a VXIbus System. These terms are defined in the VXIbus Glossary (Appendix C).

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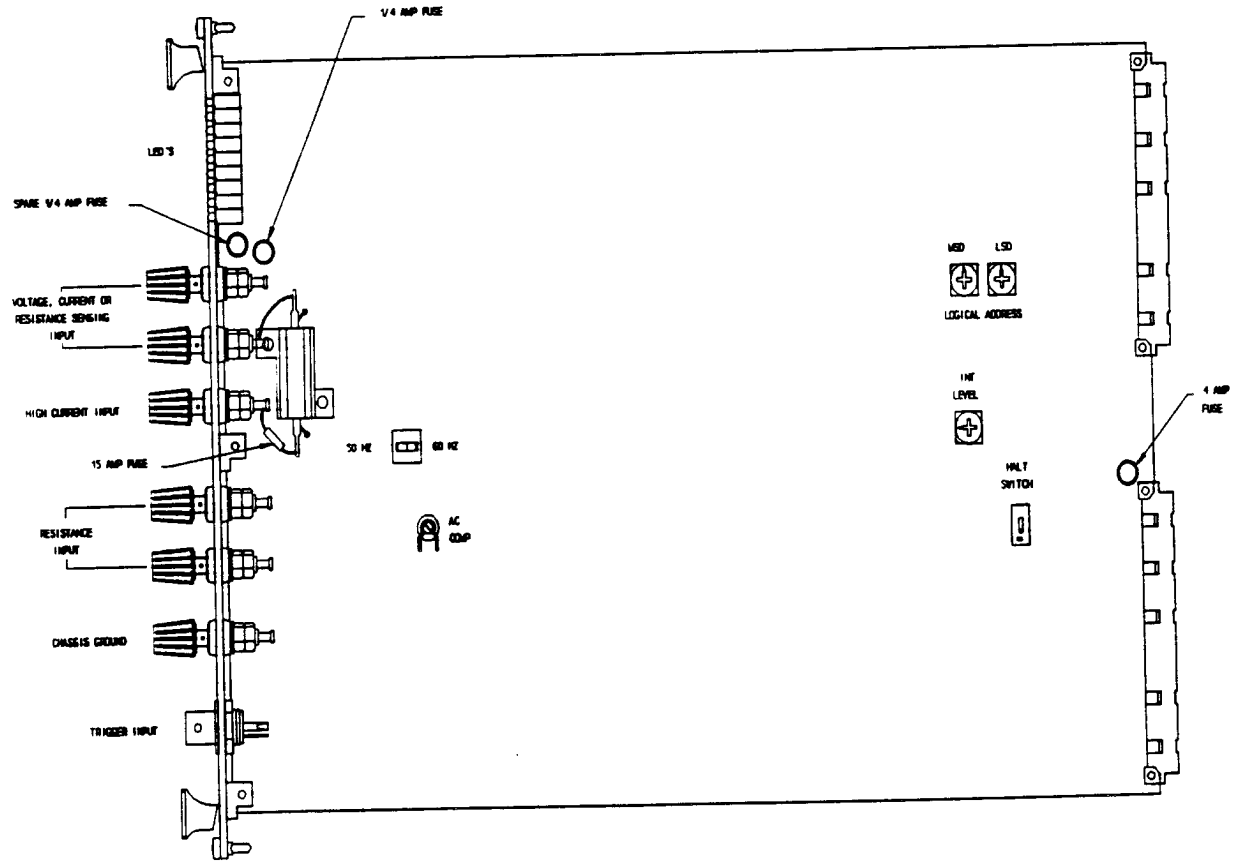


Figure 1: VX4234 Controls and Indicators

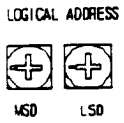
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Controls And Indicators

The following controls and indicators are provided to select and display the functions of the VX4234 Module's operating environment. See Figures 1 and 2 for their physical locations.

Switches

Logical Address Switches



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 VX4234 is set to a value between 1 and FFh (255d) by two hexadecimal rotary switches. Align the desired switch position with the arrow on the module shield.

The actual physical address of the VX4234 Module is on a 64 byte boundary. If the switch representing the most significant digit (MSD) of the logical address is set to position X and the switch representing the least significant digit (LSD) of the logical address is set to position Y, then the base physical address of the VX4234 will be [(64d * Xyh) + 49152d]. For example:

L.A.	MSD	LSD	Base Physical Addr. (d)
Ah	0	A	(64*10)+49152 = 49792d
15h	1	5	(64*21)+49152 = 50496d

where: L.A. = Logical Address
MSD = Most Significant Digit
LSD = Least Significant Digit

IEEE-488 Address

Using the VX4234 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.

If the VX4234 is being used in a Tek/CDS IEEE-488 IAC system, consult the operating manual of the VX4520 Slot 0 Device/Resource Manager.

If the VX4234 is being used in a MATE system, VXIbus logical addresses are converted to IEEE-488 addresses using the algorithm specified in the MATE IAC standard (MATE-STD-IAC). This algorithm is described in detail in the 73A-156 Operating Manual.

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If the VX4234 is not being used in a Tek/CDS IAC System, consult the operating manual of the IEEE-488 interface device being used for recommendations on setting the logical address.

VMEbus Interrupt Level Select Switch



Each function module in a VXIbus System can generate an interrupt on the VMEbus to request service from the interrupt handler located on its commander (for example, the 73A-151 RM/IEEE-488 Interface Module in a CDS 73A-IBX System). The VMEbus interrupt level on which the VX4234 Module generates interrupts is set by a BCD rotary switch. Align the desired switch position with the arrow on the module shield.

Valid Interrupt Level Select switch settings are 1 through 7, with setting 1 equivalent to level 1, etc. The level chosen should be the same as the level set on the VX4234's interrupt handler, typically the module's commander. Setting the switch to an invalid interrupt level (0, 8, or 9) will disable the module's interrupts. When using the VX4234 in a VX7401 System, set the interrupt level to the same level chosen on the VX4520.

Interrupts are used by the module to return VXIbus Protocol Events to the module's commander. Refer to the Operation section for information on interrupts. The VXIbus Protocol Events supported by the module are listed in the Specifications section.

Halt Switch



This two-position slide switch selects the response of the VX4234 Module when the Reset bit in the module's VXIbus Control register is set. Control of the Reset bit depends on the capabilities of the VX4234's commander.

If the Halt switch is in the ON position, the VX4234 Module is reset to its power-up state and all programmed module parameters are reset to their default values.

If the Halt switch is in the OFF position, the module will ignore the Reset bit and no action will take place.

Note that the module is not in strict compliance with the VXIbus Specification when the Halt switch is OFF.

60Hz/50Hz Switch

The 60Hz/50Hz switch is a single rocker switch that selects the power line frequency for which the VX4234 Module will provide maximum power line rejection.

Switch Position	Function Selected
C1	Maximum @ 60Hz rejection
C2	Maximum @ 50Hz rejection

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Fuses

The VX4234 Module has one +5V power fuse and two measured current fuses. The +5V power fuse protects the module in case of an accidental shorting of the power bus or any other situation where excessive power might be drawn.

If the +5V fuse opens, the VXIbus Resource Manager will be unable to assert SYSFAIL INHIBIT on this module to disable SYSFAIL*.

There are two fuses to protect against excessive current during a current measurement. If the fuse opens, it will disable the current measuring capability. The excessive current should be reduced before proceeding with the measurement, or a higher range should be selected if the smaller fuse has failed.

If any fuse opens, remove the fault, turn off the system power and unplug the board before replacing the fuse. Replacement fuse information is given in the Specifications section of this manual.

LEDs

The following LEDs are visible at the top of the VX4234 Module's front panel to indicate the status of the module's operation:

Power LED
This green LED is normally lit and is extinguished if the +5V power supply fails or if the +5V fuse blows.

Failed LED
This normally off red LED is lit whenever SYSFAIL* is asserted, indicating a module failure. Module failures include failure to correctly complete a 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 be lit and SYSFAIL* asserted. A module power failure is indicated when the module's Power LED is extinguished.

MSG LED
This green LED is normally off. When lit, it indicates that the module is processing a VMEbus cycle. The LED is controlled by circuitry that appears to stretch the length of the VMEbus cycle. For example, a five microsecond cycle will light the LED for approximately 0.2 seconds. The LED will remain lit if the module is being constantly addressed.

Function LEDs (AC, DC, OHM, 4W, CURR, TRMS)
One of the three function LEDs lights to indicate the type of measurement being made: AC Volts, DC Volts, or Resistance. The 4W LED lights when the module has been programmed for 4-wire ohms measurement. The Current LED lights when a current measurement has been programmed. The TRMS LED lights if a True-RMS measurement is programmed.

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Range LEDs

One of the six Range LEDs will light to indicate the VX4234 Module's present selected or autoranged input range, as follows:

Range	VDC	VAC	Ohms	AmpsDC	AmpsAC
R1	±0.020000	----	200.00	±0.000200	----
R2	±0.20000	0.20000	2000.0	±0.00200	0.00200
R3	±2.0000	2.0000	20.000k	±0.0200	0.0200
R4	±20.000	20.000	200.00k	±0.2000	0.2000
R5	±200.00	200.00	2.0000M	±2.0000	2.0000
R6	±700.0	700.00	20.000M	±10.00	10.000

Autorange LED

The Autorange LED lights whenever autoranging has been programmed.

Error LED

When the VX4234 Module is being used to make measurements, the Error LED lights whenever an improper command is sent to the module. For example, the incorrect R (Range) command R8 would cause the Error LED to light.

When the VX4234 Module is in the calibration mode, the Error LED and the Calibration LED both flash to indicate an unsuccessful calibration attempt.

Calibration LED

The Calibration LED lights when the VX4234 Module is in the calibration mode. In addition, the Calibration LED and the Error LED both flash to indicate an unintentional or unsuccessful attempt to calibrate the VX4234 Module.

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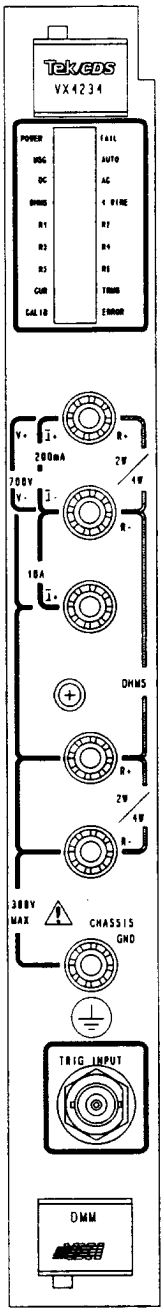


Figure 2: VX4234 Front Panel

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Specifications

DC Voltage:

Range	Maximum Value	Overrange Value
20 mV	±0.019999	±0.020000
200 mV	±0.19999	±0.20000
2 V	±1.9999	±2.0000
20 V	±19.999	±20.000
200 V	±199.99	±200.00
700 V	±699.9	±700.0

Sensitivity: 1 µV on 20 mV range.

Accuracy and Temperature Coefficient: 1 year at 23°C, ±(gain error + offset error)

Range	Accuracy	Coefficient/°C
20.000 mV	0.04% + 14µV	0.003% + 2µV
200.00 mV	0.04% + 40µV	0.003% + 3µV
2.0000 V	0.03% + 0.3mV	0.003% + 5µV
20.000 V	0.04% + 6mV	0.003% + 0.5mV
200.00 V	0.04% + 30mV	0.003% + 0.5mV
700.0 V	0.04% + 0.3V	0.003% + 5mV

Input Resistance: 10 megohms ±0.5%, 20V, 200V, 700V range.
>1 gigohm, all other DC ranges.

Normal Mode Rejection: >73 dB at 50/60Hz.

Effective Common Mode Rejection (1k ohm unbalance): >115 dB @ DC; >125 dB @ 50/60Hz

DC Current:

Range	Maximum Value	Overrange Value
200 µA	±0.00019999	±0.00020000
2.0 mA	±0.0019999	±0.0020000
20 mA	±0.019999	±0.020000
200 mA	±0.19999	±0.20000
2.0 A	±1.9999	±2.0000
10.0 A	±9.999	**

** Overrange can cause damage, (fuse protection).

Sensitivity: 10 nA on 200 µA range.

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Burden:

Range	Ohms	Volts (Max.)
200 µA	100	20 mV
2.0 mA	100	200 mV
20 mA	10	200 mV
200 mA	1	200 mV
2.0 A	0.1	200 mV
10.0 A	0.1	1 V

Accuracy and Temperature Coefficient: 1 year at 23°C, ± (gain error + offset error)

DC Current:

Range	Accuracy	Coefficient/°C
200 µA	**N/A**	**0.08% + 300 nA**	**0.008% + 30 nA**
2.0 mA	**N/A**	**0.08% + 600 nA**	**0.008% + 60 nA**
20 mA	**N/A**	**0.08% + 6 µA**	**0.013% + 0.6 µA**
200 mA	**N/A**	**0.12% + 60 µA**	**0.033% + 6 µA**
2.0 A	**N/A**	**0.08% + 600 µA**	**0.013% + 60 µA**
10.0 A	**N/A**	**0.12% + 6 mA**	**0.013% + 0.6 mA**

AC Voltage, RMS

Range	Maximum Value	Overrange Value
200 mV	0.19999	0.20000
2 V	1.9999	2.0000
20 V	19.999	20.000
200 V	199.99	200.00
700 V	699.9	700.0

Sensitivity: 10 µv on 200 mV range.

Accuracy*: 1 year at 23°C, ± (% of reading + offset error)

Range		Maximum Value	Overrange Value
200 mV	**15 Hz – 25 Hz**	**1.25% + 1 mV**	**0.008% + 9 µV**
	25 Hz – 50 Hz	**0.8% + 1 mV**	
	50 Hz – 7.5 kHz	**0.6% + 1 mV**	
	7.5 kHz – 12 kHz	**1.0% + 1 mV**	
	12 kHz – 20 kHz	**1.5% + 1 mV**	
2 V	**15 Hz – 25 Hz**	**1.25% + 6 mV**	**0.008% + 60 µV**
	25 Hz – 50 Hz	**0.8% + 6 mV**	
	50 Hz – 7.5 kHz	**0.6% + 6 mV**	
	7.5 kHz – 12 kHz	**1.0% + 6 mV**	
	12 kHz – 20 kHz	**2.0% + 6 mV**	
20 V	**15 Hz – 25 Hz**	**1.25% +80 mV**	**0.008% + 8 mV****
	25 Hz – 50 Hz	**0.8% + 80 mV**	
	50 Hz – 7.5 kHz	**0.6% + 80 mV**	
	7.5 kHz – 12 kHz	**1.6% + 80 mV**	
	12 kHz – 20 kHz	**3.9% + 80 mV**	
200 V	**15 Hz – 25 Hz**	**1.25% + 0.8 V**	**0.008% + 6 mV****
	25 Hz – 50 Hz	**0.8% + 0.8 V**	
	50 Hz – 7.5 kHz	**0.6% + 0.8 V**	
	7.5 kHz – 12 kHz	**1.6% + 0.8 V**	
	12 kHz – 20 kHz	**3.9% + 8 V**	
700 V	**15 Hz – 25 Hz**	**1.25% + 8 V**	**0.008% + 60 mV****
	25 Hz – 50 Hz	**0.8% + 0.8 V**	

**** with input voltage greater than 10% of full scale.**

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Temperature Coefficient:	Range	
	200.00 mV	±(0.008% of reading + 9µV)/°C
	2.0000 V	±(0.008% of reading + 60µV)/°C
	20.000 V	±(0.008% of reading + 0.9mV)/°C
	200.00 V	±(0.008% of reading + 6mV)/°C
	700.0 V	±(0.008% of reading + 60mV)/°C

Settling Time: 0.1 second to 99% of final value.
1.2 seconds to within .015% of final value.

Crest Factor:

2:1 for specified accuracy.
3:1 for additional −0.1% error.
7:1 for additional −1% error.

NOTE: **Crest factor is the ratio between peak and RMS value. The range should be selected so that the peak input voltage does not exceed 1.75 times the full scale RMS value of the range selected.**

AC Current:

	Range	Maximum Value	Overrange Value
2 mA	15 Hz – 25 Hz	1.87% + 15 µA	0.015% + 1.5 µA
	25 Hz – 50 Hz	1.2% + 15 µA	
	50 Hz – 7.5 kHz	0.9% + 15 µA	
	7.5 kHz – 12 kHz	1.5% + 15 µA	
	12 kHz – 20 kHz	2.25% + 15 µA	
20 mA	15 Hz – 25 Hz	1.87% + 150 µA	0.02% + 15 µA
	25 Hz – 50 Hz	1.2% + 150 µA	
	50 Hz – 7.5 kHz	0.9% + 150 µA	
	7.5 kHz – 12 kHz	1.5% + 150 µA	
	12 kHz – 20 kHz	2.25% + 150 µA	
200 mA	15 Hz – 25 Hz	1.87% + 1.5 mA	0.04% + 150 µA**
	25 Hz – 50 Hz	1.2% + 1.5 mA	
	50 Hz – 7.5 kHz	0.9% + 1.5 mA	
	7.5 kHz – 12 kHz	1.5% + 1.5 mA	
	12 kHz – 20 kHz	2.25% + 1.5 mA	
2 A	15 Hz – 25 Hz	1.87% + 15 mA	0.02% + 1.5 mA**
	25 Hz – 50 Hz	1.2% + 15 mA	
	50 Hz – 7.5 kHz	0.9% + 15 mA	
	7.5 kHz – 12 kHz	1.5% + 15 mA	
	12 kHz – 20 kHz	2.25% + 15 mA	
10 A	15 Hz – 25 Hz	1.87% + 90 mA	0.02% + 9 mA**
	25 Hz – 50 Hz	1.2% + 90 mA	
	50 Hz – 7.5 kHz	0.9% + 90 mA	
	7.5 kHz – 12 kHz	1.5% + 90 mA	
	12 kHz – 20 kHz	3.00% + 90 mA	

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Input Resistance: 1 megohm ±0.5%.

Sensitivity 10 mA on 200 mA range.

Resistance (2-Wire or 4-Wire):

Range	Maximum Value	Overrange Value
200 ohm	+199.99	+200.00
2k ohm	+1999.9	+2000.0
20k ohm	+19999.0	+20000.0
200k ohm	+199990.0	+200000.0
2M ohm	+1999900.0	+2000000.0
20M ohm	+19999000.0	+20000000.0

Sensitivity: 0.01 ohms on 200-ohm range.

Accuracy (1 year at 23° C):

	Range	Maximum Value	Overrange Value
200 ohm	1 mA	0.14% + 0.03 ohm	not specified
2 Kohm	1 mA	0.08% + 0.3 ohm	not specified
20 Kohm	100 µA	0.08% + 3 ohm	not specified
200 Kohm	10 µA	0.08% + 30 ohm	not specified
2 Mohm	1 µA	0.14% + 300 ohm	not specified
20 Mohm	0.1 µA	0.98% + 3000 ohm	not specified

Drift: ±(0.007% of reading + 0.025% of full scale)/°C on low ranges.
Add 0.007% of reading/°C on 2-megohm range.
Add 0.07% of reading/°C on 20-megohm range.

Current Through Unknown:
1mA on 200-ohm range.
1mA on 2-kilohm range.
100µA on 20-kilohm range.
10µA on 200-kilohm range.
1µA on 2-megohm range.
0.1µA on 20-megohm range.

Modes: Programmable, 2-wire or 4-wire ohms measurement.

GENERAL

Programmed By: ASCII characters.

Data Returned As: ASCII characters, base 10 decimal notation.

Type: Dual slope integrating, guarded.
4½ digit multimeter.

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Functions:	VDC, VAC True RMS, Resistance: 2-wire or 4-wire. VAC RMS, AmpsDC, AmpsAC True RMS, AmpsAC RMS
Calibration Cycle:	Every 12 months.
Range Selection:	Programmable-autorange or specified range.
Autoranging Levels:	Up-ranging for >100% FS. Down-ranging for <9% FS.
Maximum Input:	700V maximum, DC or AC RMS. 500V if powered off on lowest three ranges.
Input Type:	Floating, ±300 VDC common to ground, ±200 VDC common to guard.
Maximum Reading Rates: (Auto-Range Off)	15 readings/second, 60Hz. 12.5 readings/second, 50Hz.
External Trigger:	Type Input: TTL, Low true Loading: Two TTL loads Minimum pulse width: 50 ns. Maximum pulse width: 33.3 ms.
Max. Buffer Size:	2000 measurements. ±200 VDC common to guard.

Measurement Rate:
(Auto-Range Off)

Samples/Second	Buffer Storage
15.0 (1 per 66.67 msec)	Free-Running w/60Hz rejection
12.5 (1 per 80 msec)	Free-Running w/50Hz rejection
14.6 (1 per 68 msec)	Triggered w/60Hz rejection.
12.2 (1 per 82 msec)	Triggered w/50Hz rejection.
12.5 (1 per 80 msec)	Single measurement w/60Hz rejection.
10.4 (1 per 96 msec)	Single measurement w/50Hz rejection.

Power-Up: When power is turned on, the card goes to the following known states:

- Unaddressed (Power LED is lit).
- DC, Range 6, Autorange (LEDs lit: DC, AUTO, and R6).
- Settling time delays enabled.
- Encode function disabled.
- Front panel trigger selected.

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VXIbus Compatibility:	Fully compatible with the VXIbus Specification for message-based instruments with the Halt switch in the ON position.
VXI Device Type:	VXI message based instrument, Revision 1.2.
VXI Protocol:	Word serial.
VXI Card Size:	C size, one slot wide.
Module-Specific Commands:	All module-specific commands and data are sent via the VXIbus Byte Available command. All module-specific commands are made up of ASCII characters. Module-specific data may be in either ASCII or binary format.
VMEbus Interface:	Data transfer bus (DTB) slave - A16, D16 only.
Interrupt Level:	Switch selectable, levels 1 (highest priority) through 7 (lowest).
Interrupt Acknowledge:	D16; lower 8 bits returned are the logical address of the module.
VXIbus Data Rate:	Buffered mode write: 200K bytes/sec maximum. Nonbuffered mode write: 20K bytes/sec maximum.
VXIbus Commands Supported:	All VXIbus commands are accepted (e.g. DTACK* will be returned). The following commands have effect on this module; all other commands will cause an Unrecognized Command event: ABORT NORMAL OPERATION ASYNCHRONOUS MODE CONTROL BEGIN NORMAL OPERATION BYTE AVAILABLE (with or without END bit set) BYTE REQUEST CLEAR CLEAR LOCK CONTROL EVENT END NORMAL OPERATION ERROR QUERY IDENTIFY COMMANDER READ INTERRUPTER LINE RESPONSE ENABLE SET LOCK TRIGGER
VXIbus Protocol Events Supported:	VXIbus events are returned via VME interrupts. The following events are supported and returned to the VX4234 Module's commander:

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REQUEST TRUE (In IEEE-488 systems such as the 73A-IBX, this interrupt will cause a Service Request (SRQ) to be generated on the IEEE-488 bus.)

VXIbus Registers:

ID
Device Type
Status
Control
Protocol
Response
Data Low
See Appendix A for definition of register contents.

Device Type Register Contents: 1111 0111 0001 0101 (1s complement of binary value of model number).

Power Requirements: All required dc power is provided by the Power Supply in the VXIbus mainframe.

Voltage: +5 Volt Supply: 4.75 V dc to 5.25 V dc.

Current (Peak Module, I_{PM}): +5 volt supply: 1.6 A

Replacement Fuses:

(+5V) Littlefuse P/N 273 004
(¼-A) Littlefuse P/N 273.250
(15A) Littlefuse P/N 273 015

NOTE: The ¼-A fuse is located directly above and at the end of the V+/I+ binding post screw, and a spare fuse is located in the socket immediately adjacent to it (closer to the front panel). The 15A fuse is to protect against currents greater than 10A. This fuse may blow if the 10A limit is exceeded.

Cooling: Provided by the fan in the VXIbus mainframe.

Temperature:

0°C to +50°C, operating.
-40°C to +85°C, storage.

Humidity:

Less than 95% R.H. non-condensing, 0°C to +30°C.
Less than 75% R.H. non-condensing, +31°C to +40°C.
Less than 45% R.H. non-condensing, +41°C to +50°C.

Radiated Emissions: Complies with VXIbus Specification.

Conducted Emissions: Complies with VXIbus Specification.

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Module Envelope Dimensions:	VXI C size. 262 mm x 353 mm x 30.5 mm (10.3 in x 13.9 in x 1.2 in)
Dimensions, Shipping:	When ordered with a Tek/CDS mainframe, this module will be installed and secured in one of the instrument module slots (slots 1 - 12). When ordered alone, the module's shipping dimensions are: 406 mm x 305 mm x 102 mm. (16 in x 12 in x 4 in).
Weight:	1.36 kg. (3 lb).
Weight, Shipping:	When ordered with a Tek/CDS mainframe, this module will be installed and secured in one of the instrument module slots (slots 1-12). When ordered alone, the module's shipping weight is: 1.56 kg. (4 lb).
Mounting Position:	Any orientation.
Mounting Location:	Installs in an instrument module slot (slots 1-12) of a C or D size VXIbus mainframe. Refer to D size mainframe manual for information on required adapters.
Front Panel Signal Connectors:	Banana Plug Socket/Binding Post connectors for Analog inputs, BNC connector for the TTL trigger input. Refer to Appendix B for connector pinouts.
Equipment Supplied:	1 - VX4234 Module.
Software Revision:	V2.4.

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Section 2
Preparation For Use

Installation Requirements And Cautions

The VX4234 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 the Controls and Indicators subsection for information on selecting and setting the VX4234 Module's logical address.

Tools Required

The following tools are required for proper installation:

Slotted screwdriver set.

CAUTION

Note that there are two printed ejector handles on the card. To avoid installing the card incorrectly, make sure the ejector marked "VX4234" 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 the 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.

CAUTION

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

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If the VX4234 is used in a VX1X Series Mainframe, all VX4234 cooling requirements will be met.

CAUTION

If the VX4234 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 VX4234 Module to operate properly. Check the manual of the mainframe being used for jumpering instructions.

If a VX1400 Mainframe is being used, the jumper points may be reached through the front of the mainframe. There are five (5) jumpers that must be installed for each empty slot. The five jumpers are the pins to the left of the empty slot.

Installation Procedure

CAUTION

The VX4234 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 module's Revision Level, Serial Number (located on the CDS label on the top shield of the VX4234), and switch settings on the Installation Checklist. Only qualified personnel should install the VX4234 Module.

2) Verify that the Logical Address and Interrupt Level switches are switched to the correct value. The Halt switch should be in the ON position unless it is desired to not allow the resource manager to reset this module.

   Note that with either Halt switch position, a "hard" reset will occur at power-on and when SYSRST* is set true on the VXIbus backplane. If the Module's commander is a VX4520 Slot 0 Device/Resource Manager, SYSRST* will be set true whenever the Reset switch on the front panel of the VX4520 is depressed. Also note that when the Halt switch is in the OFF position, the operation of this module is not VXIbus compatible.

3) The module can now be inserted into any slot of the chassis other than slot 0.

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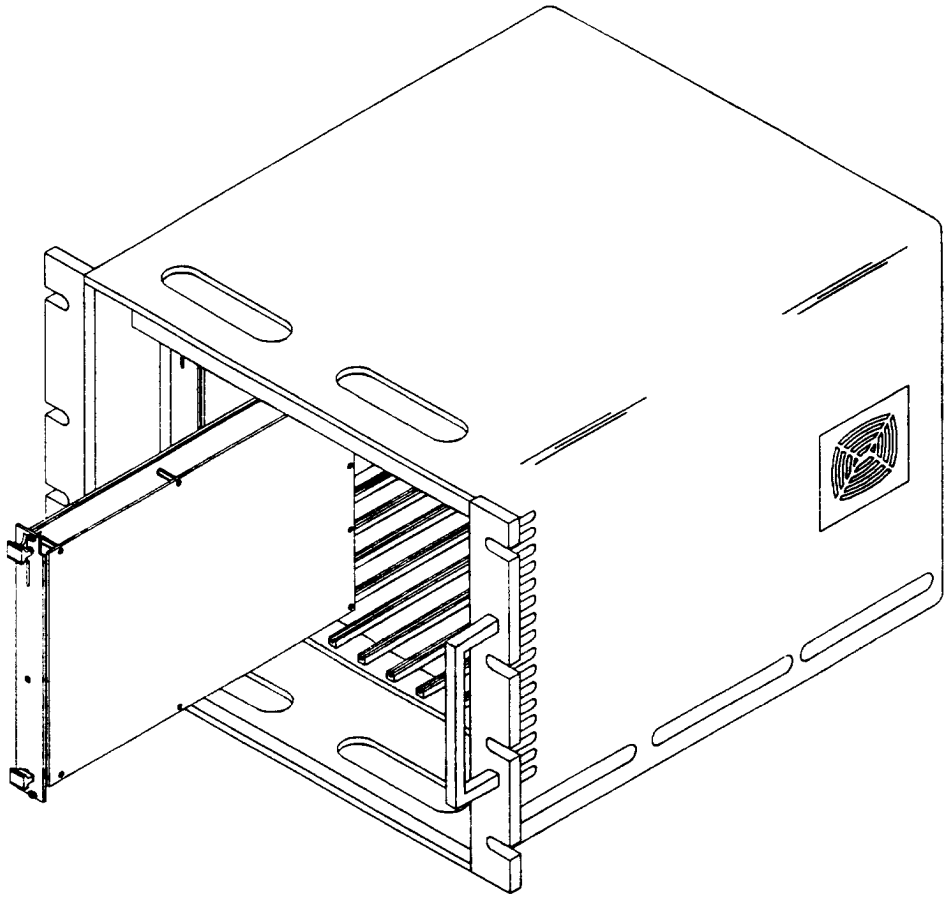


Figure 3: Module Installation

4) **Installation of Cables -**
Use the appropriate cable to interface between the module I/O connector and the Unit Under Test (UUT). If the module is being installed in a CDS 73A Series mainframe, route the cable from the front panel of the module down through the cable tray at the bottom of the mainframe and out the rear of the mainframe.

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Installation Checklist

Installation parameters may vary depending on the mainframe being used. Be sure to consult the mainframe Operating Manual before installing and operating the VX4234 Module.

Revision Level: _____

Serial No.: _____

Mainframe Slot Number: _____

Switch Settings:

VXIbus Logical Address Switch: _____

Interrupt Level Switch: _____

Halt Switch: _____

60 Hz/50 Hz Switch: _____

Scanner Enable Switch: _____

Encode Enable Switch: _____

Cable Hooded Connector Installed: (if any)

73A-7522Y Cable: ___

73A-78XX Hooded Connector: ___

Performed by: _____ Date: _____

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Section 3
Operation

Overview

The VX4234 Module is programmed by ASCII characters issued from the system controller to the VX4234 Module via the module's VXIbus commander and the VXIbus mainframe backplane. The module is a VXIbus Message Based instrument and communicates using the VXIbus Word Serial Protocol. Refer to the manual for the VXIbus device that will be the VX4234 Module's commander for details on the operation of that device.

If the module is being used in a Tek/CDS IEEE-488 IAC System, the module's commander will be the VX4520 Slot 0 Device/Resource Manager. Refer to the VX4520 Operating Manual and the Programming Examples in this manual for information on how the system controller communicates with the module.

If the system controller requests input after the module has been addressed, a 5-digit decimal number with sign and decimal point, followed by carriage-return and line-feed <CR><LF>, would be returned to the system controller. If ohms measurements are being made, the decimal number returned will vary in length from five digits to eight digits.

The <CR><LF> characters must be read by the system controller for proper operation of the VX4234. <CR> or <LF> characters are optional following card commands. To take full advantage of the T (Trigger) command, it is recommended that the <CR><LF> be suppressed.

Power-up

The VX4234 Module will complete its self test and be ready for programming five seconds after power-up. 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-up sequence as the VXIbus Resource Manager addresses all modules in the mainframe. The default condition of the module after power-up is described in the SYSFAIL, Self Test and Initialization subsection.

System Commands

Although these non-data commands are initiated by the VX4234's commander (for example, the VX4520 Module) rather than the system controller, they have an effect on

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the VX4234 Module. The following VXIbus Instrument Protocol Commands will affect the VX4234:

Command	Effect
Clear	The module clears its VXIbus interface and any pending commands. Current module operations are unaffected.
Trigger	Initiates a measurement cycle.
Begin Normal Operation	The module will begin operation if it has not already done so.
Read Protocol	The module will return its protocol to its commander.
Read Status	The module will return its status to its commander.

Module Commands

A summary of the VX4234's Module's commands is listed below. The summary also shows any required order of programming needed for commands. This is followed by detailed descriptions of each of the commands. A sample BASIC program using these commands is shown at the end of this section.

Command Syntax

Command protocol and syntax for the VX4234 Module are as follows:

1) Each command consists of a single line, which is typically two characters (the Calibrate command may be longer). Parameters may not be "wrapped around" (continued on the next line). Carriage returns <CR> or line feeds <LF> are optional.

2) If a given parameter is to be skipped, left at its previous value, or have its default value accepted, its position must still be denoted using consecutive commas.

3) If a character is not enclosed by brackets, that character itself is sent, otherwise:

   [] encloses the symbol for the actual argument to be sent. These argument symbols are defined under each command heading.

   <CR> carriage return.

   <LF> line feed.

   <SP> space character.

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<TM> terminator: indicates a line feed or a semicolon.

4) Any character may be sent in either upper or lower case form.

5) Any of the following white space characters:

00 hex
01 hex through 08 hex
09 hex (TAB character)
0B hex through 19 hex (including carriage return)
20 hex (SPACE character)

are allowed in any of the following places:

- before any comma, semicolon, or <LF>.
- after any comma.
- in place of any SPACE character listed in the following command formats.

Any number of white space characters may be used together.

6) Any binary argument must be formatted as follows:

#0[B1][B2]...

The "#0" characters are only required at the beginning of the binary string.

System Controller Timeout Recommendations

Modern system controller/IEEE-488 interface cards provide a system timeout capability to "un-hang" a system if an instrument does not respond within some specified time. The VX4234 is designed to hold off the system controller when making mode or range changes to guarantee that a valid measurement can be made before allowing the system controller to proceed. The AC measurement requires 1.2 seconds to accept a range change to allow settling of the TRMS value. In autorange, four range changes may be required in AC. It is recommended that any system controller timeout be programmed for greater than 10 seconds or for no timeout for proper operation of the VX4234.

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Summary

Detailed descriptions of each command (in alphabetical order) are given following the summary. An overview of the commands is as follows:

A Autorange - places the VX4234 Module in the Auto-Range mode.

B Buffer - disable (or re-enable) the Empty Buffer value.

C Calibrate - initiates the calibration procedure.

D Delay - disables or re-enables VX4234 firmware delays inserted to allow input conditions to settle.

E Error - interrogates the error status of the VX4234 Module and clears the ERR LED or flashing ERR and CAL LEDs.

F Function - programs the VX4234 Module's function: AC, DC, or OHMS (2- or 4-wire).

I Interrupt - enables or disables the interrupt mode.

N eNable - enables or re-disables hardware triggering.

R Range - programs the VX4234 to a fixed input range.

T Trigger - initiates a measurement cycle.

V Verify - initiates a Built-In-Test of the DMM.

X eXternal Trigger Select - programs the VX4234 Module's Encode trigger input.

Z Zero - controls the auto-zeroing of the A/D input.

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Command Descriptions

Command: A (Autorange)

Syntax: A

Purpose: The Autorange command places the VX4234 Module in the Auto-Range mode.

Description: If a reading is taken while in this mode, the VX4234 will hunt for the lowest range within which the reading does not cause an overrange indication or a higher range if the reading is less than 9% of the present scale.

During DC Voltage or Resistance measurements, the DMM will Autorange throughout ranges 1 to 6, and AC Voltage Autoranging will encompass ranges 2 to 6.

Current measurements will Autorange appropriate to the Range/Binding Post selection. That is, if the Range selected before the A command is Range-5 or Range-6 (for the 10-A max. binding post), then Autoranging will encompass range 5 and range 6, if the range selected before the A command is less that 5 (200-mA max. binding post), then Autoranging will encompass ranges 1 through 4. The A command for autoranging during a current measurement should be preceded by the appropriate R command.

A delay will occur after each Autoranging step to insure that the input condition is settled before the next reading is taken. A 1-second delay is inserted after each AC step for RMS integration, and after each step into a range-6 (20-MΩ) resistance measurement. A 125-ms delay is inserted before a resistance range-5 (2-MΩ) measurement. An additional 66-ms delay is inserted after the relay coil is energized for each range change. For this reason, the time before a measurement, while using Autorange, is variable. This should be taken into account, so that strict timing requirements are relaxed when taking triggered or periodic measurements.

The VX4234 Module is taken out of the Auto-Range mode by issuing any R command.

NOTE: This command should not be issued after buffer storage is activated (T Command). The Error LED will be lit if the command is given, error code 60 will be input after an E command and the command itself will be ignored.

Example: A enables the Autorange mode.

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Command: B (Buffer)

Syntax: Bz

Purpose: The Buffer command is used to disable (or re-enable) the Empty Buffer value ("88888888") returned during Buffer operation (N Command) when there are no measurements stored and an input request is made by the System Controller.

Description: z is a decimal number, 0 or 1:

z	Function
0	Disable Empty Buffer inputs.
1	Enable Empty Buffer inputs.

When reading measured values during a Buffered storage period, it may be considered undesirable for the System Controller to wait until each measurement becomes available. A better way would be for the System Controller to wait until a known quantity of measurements have been stored and then initiating that quantity of System Controller inputs. The quantity may be known either through knowledge of system operation, a predetermined interval having elapsed, or an interrupt generated (I Command). Under these circumstances, an Empty Buffer indication will not be input.

When it is not practical to input a known quantity of inputs, the System Controller can input measurements at any time, receiving measured values when they are available or Empty Buffer indications when measured values are not available. If it is considered desirable to maximize the input rate of measured values, and the additional burden of the VXI Resource Manager's waiting for each value is not a consideration, then the Empty Buffer output may be disabled (B0). It should be understood that when the VXI Resource Manager has the burden of waiting for each measurement, other tasks of the Resource Manager and the VXI system may be slowed down.

When the number of measurements specified in the N command have been input and additional System Controller inputs are made, a Buffer Finished value ("99999999") will be returned. The Buffer Finished value will be returned for all inputs unless the buffer operation is terminated (N command), or buffer storage is re-triggered (T command). The Buffer Finished value is not affected by the B command.

Example: B0 disables Empty Buffer inputs.

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Command: C (Calibrate)

Syntax: CzCL

Purpose: The Calibrate command initiates the calibration procedure.

Description:

z a decimal number, with or without a decimal point, that specifies the value of the voltage or resistance that will be measured in order to perform a calibration. Examples of valid decimal numbers are 1.8746, 15000000., 0, -.18. (Leading and trailing zeroes will not affect the calibration.)

CL instructs the VX4234 Module that the input specified has been applied to the VX4234 Module input terminals and that the card is to begin its calibration cycle. A 2-character calibration command is used to help avoid the possibility of inadvertently issuing a calibration command.

This command is typically used every 12 months when the VX4234 Module requires calibration. The calibration data is stored in the card's non-volatile memory and will not be lost when power is turned on or off.

NOTE: The calibration attempt will cause a calibration error (flashing Calibration and Error LED plus an Error Code) if any of these conditions occur:

- Autorange is selected
- the value given is non-zero, or a 1.5% of scale (AC) for an offset calibration, or greater than mid-scale for a Voltage gain calibration
- if the uncalibrated VX4234 reading is not within 3% of the value given.

Example: C-19.5CL this command calibrates a DC voltage (Range 4) so that the present VX4234 reading is made equal to -19.5 Volts.

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Command: D (Delay)

Syntax: Dz

Purpose: The Delay command disables or re-enables VX4234 firmware delays inserted to allow input conditions to settle.

Description: z is a decimal number, 0 or 1:

z	Function
0	Disable firmware delays.
1	Enable firmware delays.

If firmware delays are enabled, the VX4234 Module will generate a delay each time a function (F) or range (R) is initiated wherein the measurement requires settling time (e.g., an AC measurement or a resistance measurement in range-6). If delays are disabled, the system controller software will be left with the task of taking measurements only when they have stabilized, or taking unstabilized measurements.

Example: D0 disables firmware delays.

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Command: E (Error)

Syntax: E

Purpose: The Error command is used to interrogate the error status of the VX4234 Module and to clear the ERR LED or flashing ERR and CAL LEDs.

Description: An "E" in the command sequence instructs the VX4234 Module to send back to the system controller, on its next data input request, a 2-digit ASCII number error code followed by (optional) carriage return and line-feed <CR><LF> characters.

Since the VX4234 queues error codes for successive error conditions, the procedure of the system controller issuing an "E" command followed by an input request should be repeated until an error code of "99" is returned. Error code 99 indicates that all pending errors have been returned to the system controller.

The ERR LED will extinguish after error code 99 is returned to the system controller. In the calibration mode, the ERR and CAL LEDs will continue to flash until error code 99 is returned to the system controller.

Error Codes

Calibration Error Codes:

10 Input request occurred while processing calibration command.

11 C (Calibration) command value not followed by trailing "C" character.

12 C (Calibration) command value not formatted properly.

13 Calibration attempted in autorange.

14 C (Calibration) command value not terminated by "L" character.

15 Calibration input value not between 315.0 and 699.9 volts for DC or AC voltage range 6.

17 C (Calibration) command value is not consistent with programmed range.

18 C (Calibration) command value is not within the required calibration values (.009 to .019999, .09 to .19999, etc.) for the range specified.

19 Calibration input level not reasonably close to input level specified in C command.

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Command Error Codes:

50 Illegal command.

51 Unexpected ASCII output character prior to completion of previous command argument. (New command is processed and previous command ignored for this error condition).

52 Unexpected character as command argument.

53 Unexpected character as F command argument. F command not processed.

54 Unexpected character as R command argument. R command not processed.

55 Unexpected character as I command argument. I command ignored.

56 Unexpected character as N command argument. N command not processed.

57 Unexpected character as X command argument. X command ignored.

58 Unexpected character as V command argument. V command ignored.

59 Unexpected character as Z command argument. Z command ignored.

60 Command not allowed during buffer operation.

70 Built-In-Test failed at DC Autozero.

71 Built-In-Test failed at DC Mid-Scale.

72 Built-In-Test failed at AC Mid-Scale.

66 Input request prior to completion of previous command argument. (Input request is processed and previous command ignored).

80 Unexpected character in buffer length.

81 Buffer size too large.

85 Unexpected character in counts before interrupt.

86 Counts before interrupt too large.

87 Unexpected character as B command argument. B command not processed.

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88 Buffer storage of current w/Autorange forbidden.

89 Counts before interrupt greater than buffer size.

99 No more errors.

Example: E requests the next error code with the next input request.

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Command: F (Function)

Syntax: Fz

Purpose: The Function command programs the VX4234 Module's function to be AC, DC, or OHMS (2- or 4-wire).

Description: z is one of the following 1-digit decimal numbers:

z	Programs
1	DC Voltage
2	AC True RMS Voltage
3	Ohms (2-wire)
4	Ohms (4-wire)
5	AC RMS Voltage
6	DC Current
7	AC True RMS Current
8	AC RMS Current

NOTE: This command should not be issued after buffer storage is activated (T command). The Error LED will be lit if the command is given, error code 60 will be input after an E command and the command itself will be ignored.

Example: F2 this command causes the VX4234 Module to switch to the AC True RMS Volts function.

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Command: I (Interrupt Enable)

Syntax: Iz_1z_2

Purpose: The Interrupt command enables or disables the interrupt mode.

Description: z_1 is a decimal number, 0 or 1, or the ASCII character N:

z	Function
0	Disable interrupt generation.
1	Enable interrupt generation.
N	z_2 follows, indicating a four-digit number will follow.

z_2 is a four-digit decimal value indicating the number of buffer measurements to be stored before each interrupt. Four digits are required; use leading zeros if necessary.

If the interrupt mode is enabled and buffer storage is not enabled, the VX4234 Module will generate an interrupt each time a measurement is available.

If the interrupt is enabled, buffer storage is enabled, and the z_2 parameter is not used (I1), the VX4234 Module will generate an interrupt when the buffer becomes full.

If the interrupt is enabled, buffer storage is enabled, and the z_2 parameter is used (IN0123), the VX4234 Module will generate an interrupt each time that number of measurements have been stored and when the buffer becomes full.

If the number of readings specified in z_2 is greater than the maximum buffer size (Specifications), an Error will be generated when the I command is given. If the number of readings in z_2 is greater than the number of readings to be taken (N command, z_2 value), an Error will be generated when the T command is given.

The interrupt is cleared when the system controller requests input from the VX4234 Module. (See the Control Card Operating Manual for a further description of the detection and handling of interrupts.

Example: I0 disables interrupt generation.

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Command: N (eNable)

Syntax: Nz_1z_2

Purpose: The eNable command enables or re-disables hardware triggering.

Description: z_1 is a decimal number, 0 or 1, or the ASCII character T or F:

z	Function
0	Disable hardware triggering.
1	Enable hardware triggering.
T	Enable hardware triggering, z_2 follows, indicating a four-digit number will follow to indicate the size of buffer storage.
F	Disable hardware triggering, z_2 follows, indicating a four-digit number will follow to indicate the size of buffer storage. Buffer measurements will be made at the Free-Running A/D rate (Measurement Rate-Specifications)

z_2 is used only when z_1 is T or F. It is a four-digit decimal value indicating the number of buffer measurements to be stored. Four digits are required; insert leading zeros if necessary.

If z_2 is 0000, the buffer will be set to the maximum buffer size and measurements will continue indefinitely as long as subsequent input requests continue to empty buffer storage positions (i.e., a First-In-First-First-Out buffer will be created having the maximum buffer size).

If z_2 is not 0000, the buffer will be set to the size specified and that number of measurements will be taken awaiting subsequent input requests.

If hardware triggering is enabled and buffer storage is specified (NF0000), the VX4234 Module will take a measurement of the input signal using the present function (F command) and range, the measurement will be stored in a buffer until subsequent input requests empty the buffer or empty that position in the buffer.

If the number of readings specified in z_2 is greater than the maximum buffer size (see Specifications), an error will be generated when the N command is given.

When a System Controller input request is made and a measurement is not available, a Buffer Empty value ("88888888") may be returned (B command). When the number of measurements specified in the N command have been input and additional System Controller inputs are made, a Buffer Finished value ("99999999") will be returned. The Buffer Finished value will be returned for all inputs unless the buffer operation is terminated (N command), or buffer storage is re-triggered (T command).

Example: N0 disables hardware triggering.

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Command: R (Range)

Syntax: Rz

Purpose: The Range command programs the VX4234 to a fixed input range.

Description: z is a decimal number 1 through 6 which selects the range:

z	VDC	VAC (RMS)	OHMS	AMPS
1	±0.020000	----	200.00	±0.00020000
2	±0.20000	0.20000	2000.0	±0.0020000
3	±2.0000	2.0000	20.000k	±0.020000
4	±20.000	20.000	200.00k	±0.20000
5	±200.00	200.00	2.0000M	±2.0000
6	±700.0	700.00	20.000M	±10.000

One of the six range LEDs will light to indicate the VX4234 Module's present selected or autoranged input range.

NOTE: This command should not be issued after buffer storage is activated (T command). The Error LED will be lit if the command is given, error code 60 will be input after an E command and the command itself will be ignored.

Example: F2R3 causes the VX4234 Module to switch to the AC VOLTS function and the 2.0000-Volt (maximum) range.

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Command: T (Trigger)

Syntax: T

Purpose: The Trigger command initiates a measurement cycle, or, if buffer storage (N command) has been programmed, initiates buffer storage.

Description: The T command is optional for single measurements and is required to initiate (or re-initiate) buffer storage.

Without buffer storage, if input is requested by the system controller when the VX4234 Module is addressed, a measurement cycle will automatically be initiated and the measurement returned when completed. The T command allows the system controller to trigger the VX4234 Module and then perform other tasks during the time measurement conversion is taking place. A <CR> or <LF> character following the T character will "hang" the system controller until the measurement is complete. To take advantage of the T command, the <CR><LF> characters should not be sent following the T character. When the system controller later addresses the VX4234 Module and requests input, the measurement taken by the T command will be returned.

When buffer storage has been programmed using the NTxxxx or NFxxxx command, the T command causes buffer storage to begin. If the T command is given again after buffer storage has begun, buffer storage will be re-started using the original (or updated) storage parameters.

Example: T causes the VX4234 to take a measurement using the present function and range.

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Command: V (Verify)

Syntax: Vz

Purpose: The Verify command initiates a Built-In-Test of the DMM.

Description: z is a decimal number, 0 or 1:

z	Function
0	Requests the DC Autozero test.
1	Requests the DC Autozero test, the DC mid-scale test, and the AC mid-scale test.

The V command is optional. The DC Autozero Built-In-Test is automatically initiated after power-up or board reset. It tests the instrument's capability to measure a 0-Voltage and convert the measurement to a digital result. The DC and AC mid-scale tests generate an internal 1-Volt test voltage. This voltage is then measured with the analog-to-digital conversion circuitry and with the true-RMS conversion circuitry for verification of the instrument's functionality. Since the 1-Volt test voltage is generated using the card's resistance-measuring constant current source and its current-measuring series resistance, the Verify command will test most of the VX4234's voltage, current, and resistance measuring capability.

The ERR LED will begin flashing if there is a failure. Use the Error command to determine the type of failure.

NOTE: The AC and DC mid-scale tests (V1) verify the operation of the components up to the point where the test signals are input to the VX4234. It is therefore necessary to disconnect all cables from the front panel before conducting those tests.

Example: V1 causes the VX4234 to conduct a test of its DMM capability.

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Command: X (eXternal Trigger Select)

Syntax: Xz

Purpose: The eXternal Trigger Select command programs the VX4234 Module's Encode trigger input. If the Encode function is enabled (N1), a low level on the selected trigger input will cause the VX4234 to take a measurement.

Description: z is one of the following decimal numbers:

z	Triggers
0	VXI TTL Trigger 0
1	VXI TTL Trigger 1
2	VXI TTL Trigger 2
3	VXI TTL Trigger 3
4	VXI TTL Trigger 4
5	VXI TTL Trigger 5
6	VXI TTL Trigger 6
7	VXI TTL Trigger 7
8	Front Panel Trigger
9	IEEE-488 Group Execute Trigger

Example: X2 this command causes the VX4234 Module to select TTL trigger-2 as an Encode signal input.

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Command: Z (autoZero)

Syntax: Zz

Purpose: The autoZero command disables or re-enables the automatic zeroing of the DMM.

Description: z is a decimal number, 0 or 1:

z	Function
0	Disables the Autozero function.
1	Enables the Autozero function.

The Autozero function normally occurs periodically whenever the DMM is making DC measurements (voltage or current) using Range-1. It is used to calibrate out internal bias errors of the DMM. Since the Autozero function requires the operation of relays to enter the Autozero mode and the re-operation of relays to return to the DC Range-1 mode, it may be considered undesirable due to the measurement delays involved.

Whenever the Z command is given (Z0 or Z1), the Autozero function will be initiated if DC Range-1 has been selected. If buffer storage is initiated, Autozeroing will be suspended during storage to eliminate timing uncertainties. The Autozero function will be initiated before beginning buffer storage if DC Range-1 or DC Autoranging (A) has been selected.

NOTE: This command should not be issued after buffer storage is activated (T command). The Error LED will be lit if the command is given, error code 60 will be input after an E command and the command itself will be ignored.

Example: Z0 causes the Autozeroing function to be suspended. A final Autozeroing function will be done if DC Range-1 has been selected.

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SYSFAIL, Self Test, and Initialization

The VX4234 Module will execute a self test at power-up, or upon direction of a VXIbus hard or soft reset condition, or upon command. 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 VX4234's commander, sets the Reset bit in the VX4234's Control register.

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

During a power-up, or 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 lit. If this is a commanded self test, SYSFAIL* is not asserted. In the case of a soft reset, SYSFAIL* is set. However, all CDS commanders will simultaneously set SYSFAIL INHIBIT. This is done to prevent the Resource Manager from prematurely reporting the failure of a card.

3) If the self test completes successfully, the SYSFAIL* line is released, and the module enters the VXIbus PASSED state (ready for normal operation). SYSFAIL* will be released within five seconds in normal operation.

If the self test fails, the SYSFAIL* line remains active (or is set active, in the case of a commanded self test or soft reset), and the module makes an internal record of what failure(s) occurred. It then enters the VXIbus FAILED state, which allows an error message to be returned to the module's commander.

The default condition of the VX4234 Module after the completion of power-up self test is as follows:

Unaddressed (Power LED is lit).
DC, Range 6, Autorange (LEDs lit: DC, AUTO, and R6).
Empty Buffer value enabled.
Settling time delays enabled.
Error buffer empty (Error LED extinguished).
Interrupts disabled.
Autozero function enabled.
Buffer operation disabled.
Trigger function disabled.
Front panel trigger selected.

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

During a commanded self test:

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1) SYSFAIL* is not asserted.

2) The module executes the same self test as in the power-up case.

3) If the self test completes successfully, the module restores itself to its pre-test state. If the test fails, the SYSFAIL* line is asserted and the module sets itself to the following known programming state:

SYSFAIL* Operation

SYSFAIL* becomes active during power-up, 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 VX4234 Module to deactivate SYSFAIL* in all cases except when +5 volt power is lost.

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Section 4
Programming Examples

This section contains example programs which demonstrate how the various programmable features of the VX4234 are used. The examples are written in BASIC using an IBM PC or equivalent computer as the system controller.

Definition of BASIC Commands

The programming examples in this manual are written in Microsoft GW BASIC, using the GW BASIC commands described below. If the programming language you are using does not conform exactly to these definitions, use the command in that language that will give the same result.

Command	Result
CALL ENTER (R$, LENGTH%, ADDRESS%, STATUS%)	The CALL ENTER statement inputs data into the string R$ from the IEEE-488 instrument whose decimal primary address is contained in the variable ADDRESS%. Following the input, the variable LENGTH% contains the number of bytes read from the instrument. The variable STATUS% contains the number '0' if the transfer was successful or an '8' if an operating system timeout occurred in the PC. Prior to using the CALL ENTER statement, the string R$ must be set to a string of spaces whose length is greater than or equal to the maximum number of bytes expected from the VX4234.
CALL SEND (ADDRESS%, WRT$, STATUS%)	The CALL SEND statement outputs the contents of the string variable WRT$ to the IEEE-488 instrument whose decimal primary address is contained in the variable ADDRESS%. Following the output of data, the variable STATUS% contains a '0' if the transfer was successful and an '8' if an operating timeout occurred in the PC.
END	Terminates the program.
FOR/NEXT	Repeats the instructions between the FOR and NEXT statements for a defined number of iterations.
GOSUB n	Runs the subroutine beginning with line n. EX: GOSUB 750 - runs the subroutine beginning on line 750. The end of the subroutine is delineated with a RETURN statement. When the subroutine reaches the RETURN

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statement, execution will resume on the line following the GOSUB command.

GOTO n — Program branches to line n. EX: GOTO 320 - directs execution to continue at line 320.

IF/THEN — Sets up a conditional IF/THEN statement. Used with other commands, such as PRINT or GOTO, so that IF the stated condition is met, THEN the command following is effective. EX: IF I = 3 THEN GOTO 450 - will continue operation at line 450 when the value of variable I is 3.

REM — All characters following the REM command are not executed. REM statements are used for documentation and user instructions. EX: REM **CLOSE ISOLATION RELAYS**

RETURN — Ends a subroutine and returns operation to the line after the last executed GOSUB command.

<CR> — Carriage Return character, decimal 13.

<LF> — Line Feed character, decimal 10.

Programming Examples In BASIC

The following sample BASIC program shows how commands for the VX4234 might be used. This example assumes that the VX4234 has logical address 24 and is installed in a VXIbus mainframe that is controlled through an IEEE-488 interface from an external system controller, such as an IBM PC or equivalent using a Capital Equipment Corp. IEEE-488 interface. The VXIbus IEEE-488 interface is assumed to have an IEEE-488 primary address of decimal 21 and to have converted the VX4234 Module's logical address to an IEEE-488 primary address of decimal 24.

Example 1:

Lines 10 through 40 initialize the PC's IEEE-488 interface card as a system controller with an IEEE-488 address of decimal 21. Line 50 assigns the decimal IEEE-488 address of the VX4234 to the variable ADDR522%.

```
10  GOSUB 1000
        Go to a sub-routine which identifies the memory location of CEC IEEE-488 Interface
        Card ROM.
20  SEND = 9 : INIT = 0 : ENTER = 21
        Initialize PROM offsets for IBM PC IEEE-488 Interface Module.
30  PC.ADDRESS% = 0 : CONTROL% = 0
        Define IEEE-488 Interface Module's IEEE-488 address, and define it to be a controller.
```


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```
40    CALL INIT (PC.ADDRESS%, CONTROL%)
50    ADDR522% = 24
          Define VX4234's IEEE-488 address.
60    ADDR4234% = 2
          Define VX4234's IEEE-488 address.
70    CR$ = CHR$(13) : LF$ = CHR$(10) : CRLF$ = CR$ + LF$
1000 WRT$ = "F1" + CRLF$: CALL SEND(ADDR4234%,WRT$,STATUS%): GOSUB2000
          Select DC Voltage measurements.
1010 WRT$ = "A"  + CRLF$: CALL SEND(ADDR4234%,WRT$,STATUS%): GOSUB2000
          Select Autoranging.
1020 WRT$ = "X8"  + CRLF$: CALL SEND(ADDR4234%,WRT$,STATUS%): GOSUB2000
          Select Front-Panel trigger input.
1030 WRT$ = "I0"  + CRLF$: CALL SEND(ADDR4234%,WRT$,STATUS%): GOSUB2000
          Disable interrupts.
1040 WRT$ = "B0"  + CRLF$: CALL SEND(ADDR4234%,WRT$,STATUS%): GOSUB2000
          Disable Empty Buffer readings.
1050 WRT$ = "NT0000"  + CRLF$: CALL SEND(ADDR4234%,WRT$,STATUS%)
          Set infinite length buffer.
1060 GOSUB2000
1070 WRT$ = "Z1"  + CRLF$: CALL SEND(ADDR4234%,WRT$,STATUS%): GOSUB2000
          Do Autozero function, leave Autozero function in default state.
1080 WRT$ = "T"  + CRLF$: CALL SEND(ADDR4234%,WRT$,STATUS%): GOSUB2000
          Trigger buffer operation.

1100 RD$ = SPACE$(12)
          Set maximum length for string input.
1200 CALL ENTER(RD$,LENGTH%,ADDR4234%,STATUS%)
          Read the voltage when a trigger occurs.
1210 LOCATE 20,30,1 : PRINT RD$;
1220 GOTO 1200
          Print the voltage each time a trigger occurs.


1000 '  Sub-routine identifies the memory location of CEC IEEE-488 Interface Card ROM.
1020 '
1030 FOR I = &H40 TO &HEC STEP &H4
1040 FAILED =0: DEF SEG = (I * &H100)
1050 IF CHR$ ( PEEK (50) ) <> "C" THEN FAILED =1
1060 IF CHR$ ( PEEK (51) ) <> "E" THEN FAILED =1
1070 IF CHR$ ( PEEK (52) ) <> "C" THEN FAILED =1
1080 IF FAILED = 0 THEN CECLOC = (I * &H100 ): I = &HEC
1090 NEXT I
1100 RETURN


2000 REM
          Reading the module's error status can accomplish two things: first, if a programming
          error was made reading the error status will indicate the type of error made; second,
          reading the error status gives the module enough time to complete the command just
```


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programmed. This is especially important if the module is triggered for measurement immediately following the command string and the module has not yet finished its setup.

```
2010 WRT$ = "E" + CRLF$
2020 CALL SEND(ADDR4234%,WRT$,STATUS%)
2030 RD$ = SPACE$(10)
2040 CALL ENTER(RD$,LENGTH%,ADDR4234%,STATUS%
2050 IF VAL(RD$) < > 99 THEN PRINT "ERROR";RD$ : STOP
2060 RETURN
```


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Appendix A
VXIbus Operation

CAUTION

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 VX4234 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 VX4234 Module is neither a VXIbus commander nor a VMEbus master, and therefore it does not have a VXIbus Signal register. The VX4234 is a VXIbus message based servant.

The module supports the Normal Transfer Mode of the VXIbus, using the Write Ready and Read Ready bits of the module's Response register.

A Normal Transfer Mode Read of the VX4234 Module proceeds as follows:

1. The commander reads the VX4234's Response register and checks if the Write Ready bit is true. If it is, the commander proceeds to the next step. If not, the commander continues to poll the Write Ready bit until it becomes true.

2. The commander writes the Byte Request command (0DEFFh) to the VX4234's Data Low register.

3. The commander reads the VX4234's Response register and checks if the Read Ready bit is true. If it is, the commander proceeds to the next step. If not, the commander continues to poll the Read Ready bit until it becomes true.

4. The commander reads the VX4234's Data Low register.

A Normal Transfer Mode Write to the VX4234 Module proceeds as follows:

1. The commander reads the VX4234's Response register and checks if the Write Ready bit is true. If it is, the commander proceeds to the next step. If not, the commander continues to poll the Write Ready bit until it becomes true.

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2. The commander writes the Byte Available command which contains the data (0BCXX or 0BDXX depending on the state of the End bit) to the VX4234's Data Low register.

The VX4234 Module has no registers beyond those defined for VXIbus message based devices. All communications with the module are through the Data Low register, the Response register, or the VXIbus interrupt cycle. Any attempt by another module to read or write to any undefined location of the VX4234's address space may cause incorrect operation of the module.

CAUTION:

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.

As with all VXIbus devices, the VX4234 module has registers located within a 64 byte block in the A16 address space.

The base address of the VX4234 device's registers is determined by the device's unique logical address and can be calculated as follows: Base Address = V * 40H + C000H, where V is the device's logical address as set by the Logical Address switches.

VX4234 Configuration Registers.

Below is a list of the VX4234 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.

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	WO	Not used
Protocol	0008H	RO	1111 0111 1111 1111 (F7FFh)
Response	000AH	RO	Defined by state of the interface
Data High	000CH		Not used
Data Low	000EH	W	See Data Low definition below
Data Low	000EH	R	See Data Low definition below

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REGISTER BIT DEFINITIONS

ID:	BFFCh
Device:	F715h
Protocol:	F7FFh

Word Serial Commands

A write to the Data Low register causes this module to execute some action based on the data written. This section describes the device-specific Word Serial commands this module responds to and the results of these commands.

Read Protocol command response: FE6Bh

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Appendix B
Input/Output Connections

NOTE: **Do not connect a voltage to V+ or V- posts when making a 2-wire Ohms measurement.**

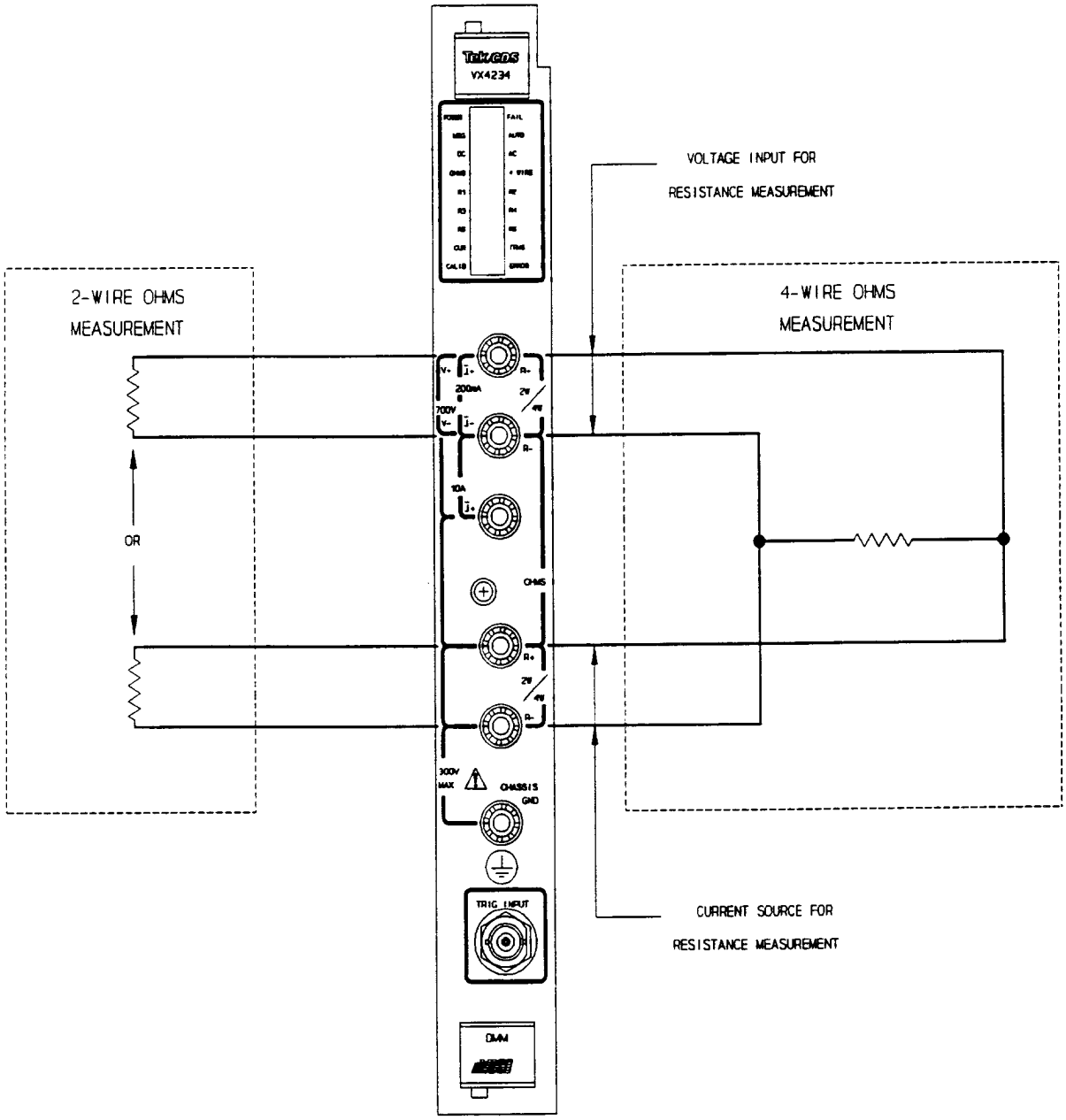


Figure 4: Resistance Measurement

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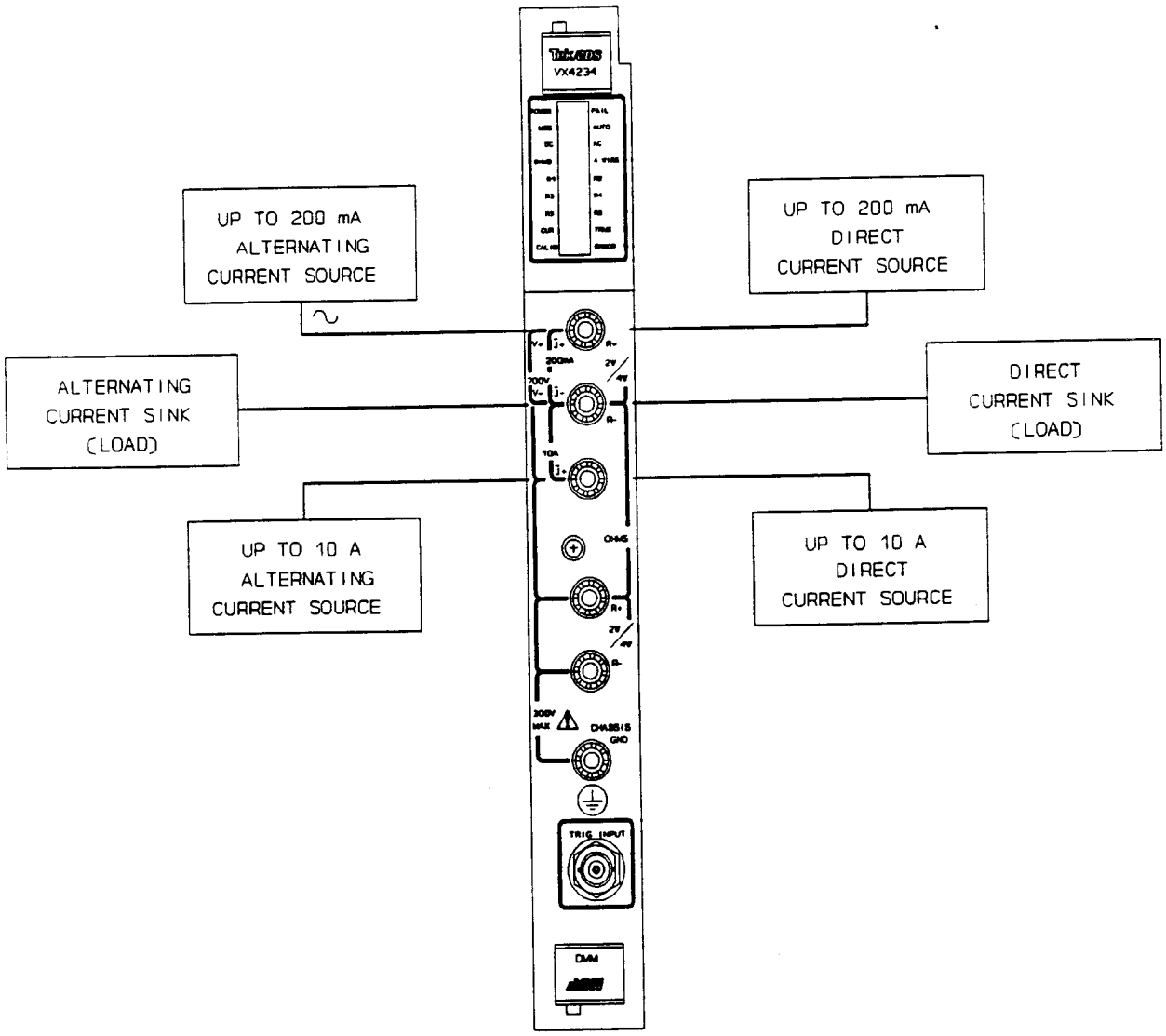


Figure 5: Current Measurement

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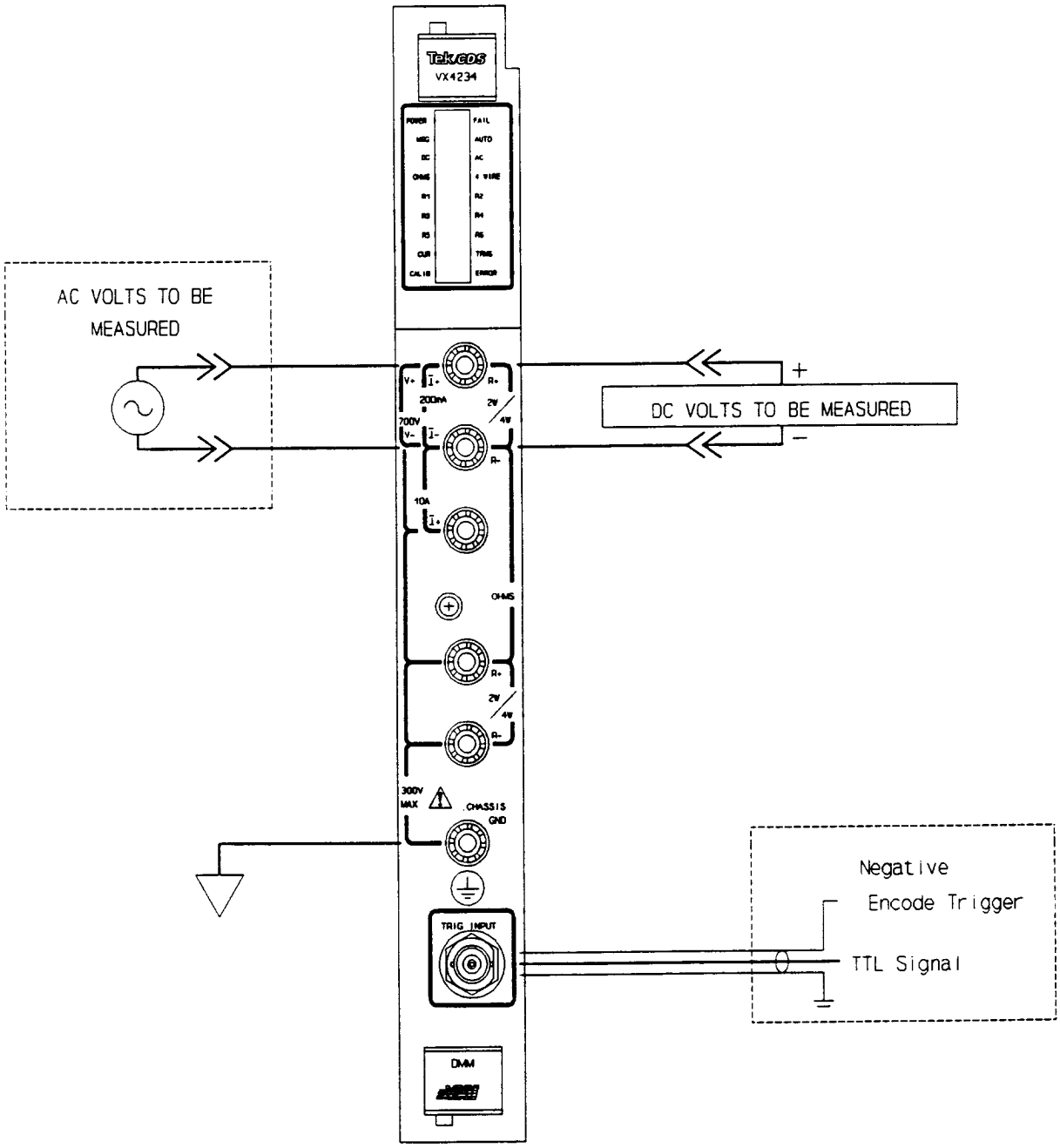


Figure 6: Voltage Measurement

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DC or AC Voltage Measurements -
connect the signal to be measured between Posts V+ and V-.

2-Wire Ohms Measurements -
connect the resistance to be measured between Posts R+ and R-.

4-Wire Ohms Measurements -
connect the resistance to be measured between Posts V+ and V-. Connect Posts R+ (sense) and R- (sense) at the point the unknown resistance is to be measured. Connecting the sense inputs directly to the unknown resistance eliminates errors due to lead resistance, which can become significant for low values of resistance.

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Appendix C
VXI 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 are used in every manual.

Term	Definition
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/STANDBY switch when switched to STANDBY.
A-Size Card	A VXIbus instrument module that is 100.0 by 160 mm by 20.32 mm (3.9 by 6.3 in by 0.8 in), the same size as a VMEbus single-height short module.
Asynchronous Communication	Communications that occur outside the normal "command-response" cycle. Such communications have higher priority than synchronous communication.
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.
B-Size Card	A VXIbus instrument module that is 233.4 by 160 mm by 20.32 mm (9.2 by 6.3 in by 0.8 in), the same size as a VMEbus double-height short module.
Bus Arbitration	In the VMEbus interface, a system for resolving contention for service among VMEbus Master devices on the VMEbus.
Bus Timer	A functional module that measures the duration of each data transfer on the Data Transfer Bus (DTB) and terminates the DTB cycle if the duration is excessive. Without the termination capability of this module, a Bus Master attempt to transfer data to or from a non-

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existent Slave location could result in an infinitely long wait for the Slave response.

Client — In shared memory protocol (SMP), that half of an SMP channel that does not control the shared memory buffers.

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.

Command — A directive to a device. There are three types of commands:

In Word Serial Protocol, a 16-bit imperative to a servant from its commander.

In Shared Memory Protocol, a 16-bit imperative from a client to a server, or vice versa.

In a Message, an ASCII-coded, multi-byte directive to any receiving device.

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).

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Custom Device A special-purpose VXIbus device that has configuration registers so as to be identified by the system and to allow for definition of future device types to support further levels of compatibility.

Data Transfer Bus One of four buses on the VMEbus backplane. The Data Transfer Bus allows Bus Masters to direct the transfer of binary data between Masters and Slaves.

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

Device Specific Protocol A protocol for communication with a device that is not defined in the VXIbus specification.

D-Size Card A VXIbus instrument module that is 340.0 by 366.7 mm by 30.48 mm (13.4 x 14.4 in x 1.2 in).

DTB See Data Transfer Bus.

DTB Arbiter A functional module that accepts bus requests from Requester modules and grants control of the DTB to one Requester at a time.

DUT Device 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.

Embedded Address An address in a communications protocol in which the destination of the message is included in the message.

ESTST Extended STart/STop protocol; used to synchronize VXIbus modules.

Extended Self Test Any self test or diagnostic power-up routine that executes after the initial kernel self test program.

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.

IACK Daisy Chain Driver The circuit that drives the VMEbus Interrupt Acknowledge daisy chain line that runs continuously through all installed modules or through jumpers across the backplane.

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ID-ROM	An NVRAM storage area that provides for non-volatile storage of diagnostic data.
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.
Interface Device	A VXIbus device that provides one or more interfaces to external equipment.
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.
Local Controller	The instrument module that performs system control and external interface functions for the instrument modules in a VXIbus mainframe or several mainframes. See Resource Manager.
Local Processor	The processor on an instrument module.
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.
Memory Device	A storage element (such as bubble memory, RAM, and ROM) that has configuration registers and memory attributes (such as type and access time).
Message	A series of data bytes that are treated as a single communication, with a well defined terminator and message body.
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.

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MODID Lines	Module/system identity lines.
Physical Address	The address assigned to a backplane slot during an access.
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.
P3	The bottom backplane connector for a given module slot in a vertical D-size mainframe such as the Tektronix VX1500.
Query	A form of command that allows for inquiry to obtain status or data.
READY Indicator	A green LED indicator that lights when the power-up 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.
Requester	A functional module that resides on the same module as a Master or Interrupt Handler and requests use of the DTB whenever its Master or Interrupt Handler requires it.
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-up.
Servant	A VXIbus message-based device that is controlled by a commander.
Server	A shared memory device that controls the shared memory buffers used in a given Shared Memory Protocol channel.

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Shared Memory Protocol A communications protocol that uses a block of memory that is accessible to both client and server. The memory block operates as a message buffer for communications.

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.

SMP See Shared Memory Protocol.

STARX Two (2) bi-directional, 50 ohm, differential ECL lines that provide for inter-module asynchronous communication. These pairs of timed and matched delay lines connect slot 0 and each of slots 1 through 12 in a mainframe. The delay between slots is less than 5 nanoseconds, and the lines are well matched for timing skew.

STARY Two (2) bi-directional, 50 ohm, differential ECL lines that provide for inter-module asynchronous communication. These pairs of timed and matched delay lines connect slot 0 and each of slots 1 through 12 in a mainframe. The delay between slots is less than 5 nanoseconds, and the lines are well matched for timing skew.

STST STart/STop protocol; used to synchronize modules.

SYNC100 A Slot 0 signal that is used to synchronize multiple devices with respect to a given rising edge of CLK100. These signals are individually buffered and matched to less than 2ns of skew.

Synchronous Communications A communications system that follows the "command-response" cycle model. In this model, a device issues a command to another device; the second device executes the command; then returns a response. Synchronous commands are executed in the order received.

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 Clock Driver A functional module that provides a 16-MHz timing signal on the Utility Bus.

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.

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Test Monitor	An executive routine that is responsible for executing the self tests, storing any errors in the ID-ROM, and reporting such errors to the Resource Manager.
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.

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Appendix D
Application Note

Using the VX4234 Module with External Encode

An external encode line is provided at the VX4234 Module front-edge connector and via the eight backplane trigger inputs to allow triggering of a measurement cycle based on an external event.

The external encode is treated the same as a T (Trigger) command to the VX4234 Module. It initiates a measurement cycle. The measurement will be returned to the system controller when input is requested. If input is requested prior to completion of the measurement cycle, input will be returned when the measurement cycle is complete. To protect against accidental mode or range change commands being issued to the VX4234 Module during a measurement cycle, any command to the VX4234 Module besides an input request will terminate the measurement cycle. If no interim commands are issued, however, and input is requested, even at some later time, the VX4234 Module will return the measurement caused by the last received External or T command encode.

Multiple encodes or a continuous low at the encode input will result in the successive new measurements being initiated, but only the last measurement initiated prior to an input request will be returned to the system controller.

The external encode, like the T command, may be used in conjunction with the I (Interrupt) command. The VX4234 Module interrupt capability is first initiated using the I command. To determine when an external trigger has occurred and a valid measurement is available for the system controller, the system controller periodically polls the Slot 0 Device/Resource Manager to determine if the VX4234 Module has interrupted. When the VX4234 Module interrupts, a valid measurement caused by the external encode is available.

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Appendix E
User Service

This appendix contains service-related information that covers the following topics:

- Preventive maintenance
- User-replaceable Parts

Preventive Maintenance

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

1. Turn off power and remove the module 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 lint-free cloth dampened in a general purpose detergent-and-water solution. Do not use abrasive cleaners.

User-Replaceable Parts

Replacement parts are available through your local Tektronix field office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available. Therefore, when ordering parts, it is important to include the following information in your order.

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable.

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User-Replaceable Parts

Part Description	Part Number
User Manual	070-9139-XX
Label, Tek CDS	950-0643-00
Label, VXI	950-0948-00
Fuse, Sub-min 15 Amp	159-0373-00
Fuse, Micro 4 Amp 125 V Fast	159-0374-00
Fuse, Micro .25 Amp 125 V Fast	159-0375-00
Collar Screw, Metric 2.5 × 11 Slotted	950-0952-00
Shield, Front	950-1318-00
Screw, Phillips Metric 2.5 × 4 FLHD SS	211-0867-00

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Appendix F: Performance Verification

This Performance Verification contains test sequences suitable for determining if the VX4234 is functioning properly and meets the characteristics as warranted.

The following skills are required to perform this procedure:

- Thorough knowledge of test instrument operation and proper measurement techniques
- Knowledge of VXIbus system components and command language programming
- Ability and facility to construct interconnections and fixtures as needed to perform the procedure

General Information and Conventions

The following conventions apply throughout this procedure:

- Each test sequence begins with a table, similar to the one below, which provides information and requirements specific to that section. The item number appearing after each piece of equipment refers to an entry in Table 1, *Required Test Equipment.* Following the table, you will be given instructions for interconnecting the VX4234 under-test and for checking the performance parameters. Results may be recorded on a photocopy of the Test Record on page A–24.

Equipment Requirements	Calibrator-Generator (item 1) Coaxial Cable (item 2) Dual Banana Connector, two (item 3)
Prerequisites	All prerequisites listed on page A–22

- This procedure assumes that you will be using a VX4521 Slot 0 Resource Manager and a National Instruments PC-GPIB controller configuration as described in Table 3. If you are using a different controller and software, simply substitute the commands for that system to achieve the equivalent results. In the test sequences, you will be instructed to issue Interface Bus Interactive Control (ibic) commands to set up the VX4234 under-test and other associated VXIbus test instruments. Please refer to the NI-488.2M User Manual for additional information.
- Commands to the VX4234 may be entered in upper or lower case. To avoid confusion between alphanumeric characters, for example between a one (1)

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and an “L” or a zero (0) and and the letter “o”, all commands in this procedure are illustrated in the case which provides the greatest visual distinction. However, when entering these commands you may use any combination of upper and/or lower case.

Prerequisites

The verification sequences in this procedure are valid under the following conditions:

- The VX4234 module covers are in place and the module is installed in an approved VXIbus mainframe as described in Section 2 of the User Manual
- The VX4234 has passed the power-on self test
- The VX4234 has been operating for a warm-up period of 10 minutes in an ambient environment as specified in Section 1 of the User Manual

Equipment Required

This procedure uses traceable test equipment as specified in Table 1 to directly check warranted characteristics. You may use instrumentation other than the recommended example if it meets the minimum requirements.

Table 1: Required Test Equipment

Item Number and Description	Minimum Requirements	Example	Purpose
1. Calibrator-Generator	Variable DC Voltage to ± 700 V DC, accuracy to 0.005% Variable DC Current to 2.0 Amps, accuracy to 0.005% Variable True RMS to 700 V AC, 50 Hz to 7500 Hz; accuracy to 0.005% Variable Resistance to 10 M Ω, accuracy to 0.005%	Fluke 5700A Calibrator	Checking AC & DC Voltage, DC Amps, and Resistance accuracy.
2. Coaxial BNC Cable (two required)	50 Ω, 36 inch, male to male BNC connectors	Tektronix part number 012-0482-00	Interconnecting electrical signals
3. Adapter, BNC female to dual banana (four required)	50 Ω, BNC female to dual banana	Tektronix part number 103-0090-00	Interconnecting electrical signals
4. 1 k Ω, Resistor	1 k Ω, ¼ Watt, 5%	Tektronix part number 315-0102-00	Checking CMRR

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Table 1: Required Test Equipment (Cont.)

Item Number and Description	Minimum Requirements	Example	Purpose
5. Adapter, BNC male to Dual Binding post	50 Ω, BNC male to Dual Binding post	Tektronix part number 103-0035-00	Interconnecting electrical signals
6. Adapter, BNC female to Clip Leads	50 Ω, BNC female to dual Clip Leads	Tektronix part number 013-0076-00	Interconnecting electrical signals

VX4234 Under-Test Configuration

The VX4234 under-test must be installed in an approved VXIbus system. At a minimum, the system must contain the elements listed in Table 2.

Table 2: Elements of a Minimum VX4234 Under-Test System

Item Number and Description	Minimum Requirements	Example	Purpose
1. VXIbus Mainframe	One available slot (in addition to the Slot 0 Resource Manager) for the VX4234 under-test	Tektronix VX1410 IntelliFrame	Provides power, cooling, and backplane for VXIbus modules
2. Slot 0 Resource Manager	Resource Mgr., Slot 0 Functions, IEEE 488 GPIB Interface	VX4521 Slot 0 Resource Mgr.	Provides Slot 0 Resource Mgr. functions, and GPIB interface
3. VXIbus System Controller	VXIbus-Talker/Listener/Controller	486 PC with National GPIB PC2A & NI-488.2M software, GPIB cable	Provides VXIbus command and response interface

Test System Configuration

Table 3 describes the VXIbus system configuration assumed in this procedure. If your configuration is different, please note that you will observe your device names and addresses in test sequences. No secondary addressing is assumed.

Table 3: Test System Configuration Assumed

Device	GPIB Device Name	VXI Slot	VXIbus Logical Address	GPIB Primary Address
GPIB0	GPIB0	(PC card)	NA	30
VX4521	VX4521	Slot 0	0D (hex)	13
VX4234 under-test	VX4234	Slot 1	01	1

Test Record

Photocopy the Test Record which follows to record your results.

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Table 4: VX4234 Test Record

VX4234 Serial Number:	Temperature and Relative Humidity:
Date of Last Calibration:	Verification Performed by:
Certificate Number:	Date of Verification:

VXIbus Interface	**Logical Address, IEEE Address, Slot No., MFG., Model, etc.**	
System Configuration Response		
Extended Self Test Verification (S1)	**Passed**	**Failed**

DC Voltage Accuracy				
20 mV Range (R1) (0.04% + 14 uV)	**Calibrator**	+18.0000 mV	+0.00000 mV	–18.0000 mV
	Max.	+.018021 . .	+.000014	–.017979 . .
	Measure			
	Min.	+.017979 . .	–.000014	–.018021 . .
200 mV Range (R2) (0.04% + 40 uV)	**Calibrator**	+180.000 mV	+0.0000 mV	–180.000 V
	Max.	+.18011 . .	+.00004 . .	–.17989 . .
	Measure			
	Min.	+.17989 . .	–.00004 . .	–.18011 . .
2.0 V Range (R3) (0.03% + 0.3 mV)	**Calibrator**	+1.80000 V	+0.0000 mV	–1.80000 V
	Max.	+1.8008 . .	+.0003 . .	–1.7992 . .
	Measure			
	Min.	+1.7992 . .	–.0003 . .	–1.8008 . .
20.0 V Range (R4) (0.04% + 6.0 mV)	**Calibrator**	+18.0000 V	+0.0000 mV	–18.0000 V
	Max.	+18.013 . .	+.006 . .	–17.987 . .
	Measure			
	Min.	+17.987 . .	–.006 . .	–18.013 . .

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Table 4: VX4234 Test Record (Cont.)

DC Voltage Accuracy				
200.0 V Range (R5) (0.04% + 30 mV)	**Calibrator**	+180.000 V	+0.0000 mV	–180.000 V
	Max.	+180.10 . .	+.03 . .	–179.90 . .
	Measure			
	Min.	+179.90 . .	–.03 . .	–180.10 . .
700.0 V Range (R6) (0.04% + 0.3 mV)	**Calibrator**	+630.000 V	+0.0000 mV	–630.000 V
	Max.	+630.3 . .	+.0 . .	–629.7 . .
	Measure			
	Min.	+629.7 . .	–.0 . .	–630.3 . .
Normal Mode Rejection	≤ 73 dB @ 50/60 Hz			
Common Mode Rejection	≤ 115 dB @ DC			
(1 kΩ unbalance)	≤ 125 dB @ 50/60 Hz			
DC Current Accuracy				
200 µA Range (R1) (0.04% + 14 µA)	**Calibrator**	+180.000 µA	+10.000 µA	–180.000 µA
	Max.	+.00019407 . .	+.00002400	–.00016592 . .
	Measure			
	Min.	+.00016592 . .	–.00000400	–.00019407 . .
2.0 mA Range (R2) (0.04% + 40 µA)	**Calibrator**	+1.80000 µA	+10.000 µA	–1.80000 µA
	Max.	+.0018407 . .	+.0000500 . .	–.0017593 . .
	Measure			
	Min.	+.0017593 . .	–.0000300 . .	–.0018407 . .
20 mA Range (R3) (0.04% + 40 µA)	**Calibrator**	+18.0000 mA	+10.000 mA	–18.0000 mA
	Max.	+.018407 . .	+.000050 . .	–.017953 . .
	Measure			
	Min.	+.017953 . .	–.000030 . .	–.018407 . .
200 mA Range (R4) (0.04% + 40 µA)	**Calibrator**	+180.000 mA	+10.000 mA	–180.000 mA
	Max.	+.18011 . .	+.00005 . .	–.17989 . .
	Measure			

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Table 4: VX4234 Test Record (Cont.)

DC Current Accuracy				
	Min.	+.17989 . .	–.00003 . .	–.18011 . .
2.0 A Range (R5) (0.04% + 40 µA)	**Calibrator**	+1.8000 A	+10.000 µA	–180.000 A
	Max.	+1.8008 . .	+.0000 . .	–1.8000 . .
	Measure			
	Min.	+1.8000 . .	–.0000 . .	–1.8008 . .
10.0 A Range (R6) (0.04% + 0.3 mA)	**Calibrator**	+1.90000 A	+10.000 µA	–1.90000
	Max.	+1.901 . .	+.000 . .	–1.899 . .
	Measure			
	Min.	+1.899 . .	–.000 . .	–1.901 . .

AC RMS Voltage Accuracy	Calibrator	Maximum	Measure	Minimum
200 mV Range (R2) (0.6% + 1 mV)	+180.000 mV (6 kHz)	+.18208 . .		+.17792 . .
2.0 V Range (R3) (0.6% + 6 mV)	+1.80000 V (6 kHz)	+1.8168 . .		+1.7832 . .
20.0 V Range (R4) (0.6% + 80 mV)	+18.0000 V (6 kHz)	+18.188 . .		+17.812 . .
200.0 V Range (R5) (0.6% + 30 mV)	+180.000 V (6 kHz)	+181.88 . .		+178.12 . .
700.0 V Range (R6) (0.6% + 8.0 V)	+630.000 V (6 kHz)	+641.8 . .		+618.2 . .

Resistance Accuracy	Calibrator	Maximum	Measure	Minimum
200 Ω Range (R1) ±(0.14% Value + 0.015% FS)	100.000 Ω	+100.17 . .		+99.83 . .
2 kΩ Range (R1) ±(0.08% Value + 0.015% FS	1000.00 Ω	+1001.1 . .		+998.9 . .
20 kΩ Range (R1) ±(0.08% Value + 0.015% FS	10.0000 kΩ	+10011.0 . .		+9989.0 . .
200 kΩ Range (R1) ±(0.08% Value + 0.015% FS	100.000 kΩ	+100110.0 . .		+99890.0 . .
2 MΩ Range (R1) ±(0.14% Value + 0.015% FS	1.00000 MΩ	+1001700.0 . .		+998300.0 . .
20 MΩ Range (R1) ±(0.17% Value + 0.015% FS	10.0000 MΩ	+10020000.0 . .		+9980000.0 . .

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Self Test

The VX4234 includes a built-in self test function (BITE) which runs automatically each time the power is turned on and when the internal self-tests (V0 and V1) are executed.

BITE uses internal routines and reference circuitry to confirm the instrument's capability to measure voltage, current, and resistance, and convert the measurement to a digital result. You may additionally execute the extended AC and DC mid–scale tests with the V1 command.

NOTE. *Because these tests verify operation up to the front panel, you must disconnect all input signals before executing the extended verification.*

In addition to BITE, the front panel indicator lights display the current status of module power, module self test results (including the central processor), and the assertion of SYSFAIL*. If the module loses any of its power voltages, the Failed light will be on, the Power light will be off, and SYSFAIL* will be asserted.

Following a successful VXIbus system startup sequence, the green PWR light on the VX4234 front panel indicates that the self test has passed and that the +5 V power supply is operational.

NOTE. *If you experience an error indication from the VX4234-under-test, or any other VXIbus module, investigate and correct the problem before proceeding. Common items to check are logical address conflicts (primary and secondary; see Table 3), breaks in the VXIbus daisy chain signals, improper seating of a module, loose GPIB cable, or loose or blown fuses.*

Performance Verification Tests

This Performance Verification procedure may be executed in any order. You may use any VXIbus system which meets the requirements described in Table 2, however, the test sequences are structured for a system configuration as described in Table 3.

NOTE. *If at any time you do not observe the expected result, check the front panel ERROR light. If it is on, perform error Queries (ibwrt "e"<cr> ibrd 100<cr>) until you receive a response of "99 . .". Following a response of "99 . .", the front panel ERROR light should be off.*

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VXIbus Interface

This sequence verifies that the VX4234 configures correctly and communicates properly with your system controller. It assumes a VXIbus system configuration as specified in Table 3, and in particular, utilizes the VX4521 Resource Manager "table" command for verification of the system configuration. If your VXIbus system uses a different Resource Manager, you must substitute commands specific to that Resource Manager-Controller to verify your system configuration.

Equipment Requirements	No test equipment required.
Prerequisites	All prerequisites listed on Page A–22

1. If you are using the VX4521 Slot 0 Resource Manager, send the TABLE command to verify the system configuration. (If you are using a different Controller, perform the equivalent function to confirm the responses shown in Table 5.) Your configuration may not be identical, but the information should be the same.

Table 5: VXIbus System Configuration

Command to Type	Response to Verify
`ibic`	
`buffer 1`	(Allows more comfortable viewing of responses)
`ibfind VX4521`	
`ibwrt "table"`	
`ibrd 200`	02 (Implies two modules in this system)
!	`LA 0, IEEE 13, Slot 0, MFG FFDh, MODEL VX4521, PASS, , RM..`
!	`LA 1, IEEE 01, Slot 1, MFG FFCh, MODEL VX4234, PASS TRIGGER;LOCK;READ STB, MESG, 0, V1.3, NORMAL ..`

2. To verify overall module functionality, send the extended self-test (verification) command and an Error query. Then confirm that the front panel ERROR light is off and that there are no errors (code 99 indicates no errors).

   `ibfind VX4234`

   `ibwrt "V1E"` (Observe that the ERROR light is off)

   and the tables and figures are thru numbered Arabic. `ibrd 100` (Observe a response of: 99 . .)

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DC Voltage Accuracy

This sequence verifies the accuracy of the six DC voltage ranges.

Equipment Requirements	Calibrator (item 1) Coaxial Cable, one (item 2) Dual Banana Connectors, two (item 3)
Prerequisites	All prerequisites listed on page A–22

1. Set the Calibrator to +0.0000 mV DC .
2. Connect the Calibrator to the VX4234 Voltage Input using two Dual-Banana connectors and a Coaxial cable.
3. Set the Calibrator to +18.0 mV DC.
4. With the following commands, set the VX4234 to DC volts and for the 20 mV range (Function 1, Range 1). Then perform an acquisition and verify the response relative to the limits shown in the Test Record.

   ```
   set VX4234

   ibwrt "F1R1"

   ibrd 100
   ```
   (Observe: +.01800 ±0.0000212 VDC, see Table 6)
5. Set the Calibrator to –18.0 mV DC.
6. Re-acquire and verify the response to the limits shown in the Test Record:

   `ibrd 100` (Observe: –.01800 ±0.0000212 VDC, see Table 6)
7. Check the additional voltages listed in Table 6 . (Note that the first entry in Table 6 is a repeat of steps 4 through 6 above .)

Table 6: DC Voltage Accuracy

Set Calibrator	Command To VX4234	Response to Verify

+18.0000 mV DC
 	
–18.0000 mV DC
(Steps 3 to 6 repeated for table continuity)
	`ibwrt "F1R1"`
	`ibrd 100`
	`ibrd 100`
		
		+.018021 . . to +.017979 . .
		–.017979 . . to –.018021 . .

+180.000 mV DC
 	
–180.000 mV DC
	`ibwrt "R2"`
	`ibrd 100`
	`ibrd 100`
		
		+.18011 . . to +.17989 . .
		–.17989 . . to –.18011 . .

+1.80000 VDC
 	
–1.80000 VDC
	`ibwrt "R3"`
	`ibrd 100`
	`ibrd 100`
		
		+1.8008 . . to +1.7992 . .
		–1.7992 . . to –1.8008 . .

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Table 6: DC Voltage Accuracy (Cont.)

Set Calibrator	Command To VX4234	Response to Verify
+18.0000 VDC	`ibwrt "R4"` `ibrd 100`	+18.013 . . to + 17.987 . .
–18.0000 VDC	`ibrd 100`	–17.987 . . to –18.013 . .
+180.000 VDC	`ibwrt "R5"` `ibrd 100`	+180.10 . . to +179.90 . .
–180.000 VDC	`ibrd 100`	–179.90 . . to –180.10 . .
+630.00 VDC	`ibwrt "R6"` `ibrd 100`	+630.3 . . to +629.7 . .
–630.00 VDC	`ibrd 100`	–629.7 . . to –630.3 . .

8. Set the Calibrator to +0.0000 mV.

DC Common Mode Rejection

This sequence verifies the capability of the VX4234 to reject Common Mode voltage when operating in the DC Voltage measurement mode.

Equipment Requirements	Calibrator (item 1) Coaxial Cable, one (item 2) Dual Banana Connectors, two (item 3) Binding Post Connector (item 5) Clip Lead Connector (item 6) 1 kΩ Resistor (¼ Watt, 5%)
Prerequisites	All prerequisites listed on page A–22

1. Set the Calibrator to +0.0000 mV DC.

2. Connect the Calibrator to the VX4234 as follows:

a. Connect a BNC to Dual Banana connector to the Voltage input of the VX4234.

b. Connect a BNC to Dual Binding post connector to the BNC to Dual Banana connector on the VX4234.

c. Connect a 1 kΩ resistor between the binding posts.

d. Connect a BNC to Dual Banana adapter to the calibrator then connect one end of a coaxial cable to the Dual Banana adapter and the opposite end of the coaxial cable to a BNC to Clip Lead adapter.

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e. Connect the red lead of the Clip Lead adapter to the red Dual Binding post adapter on the VX4234 (one side of the resistor).

f. Connect the black lead of the Clip Lead adapter to the Chassis Ground binding post of the VX4234.

3. Set the Calibrator to +100.0 VDC, and enable the output.

4. Using the following commands, set the VX4234 to read DC volts on the 20 mV range (Function 1, Range 1). Perform two acquisitions and verify the second response to be ≤ 177.8 µV (Note: The first reading returned is stale data).

```
set VX4234

ibwrt "F1R1"

ibrd 100 (Disregard this reading.)

ibrd 100 (Observe: ≤ [+/-].000018 . .)
```

5. Set the Calibrator to +100.0 V, 50 or 60 Hz. Perform two acquisitions and verify the second response to be ≤ 56.8 µV

```
ibrd 100 (Disregard this reading.)

ibrd 100 (Observe: 3 [+/–].000056 . .)
```

6. Set the Calibrator to +0.0000 mV DC.

DC Normal Mode Rejection

This sequence verifies the ability of the VX4234 to reject residual AC voltage present on the input when operating in a DC Voltage mode.

Equipment Requirements	Calibrator (item 1) Coaxial Cable, one (item 2) Dual Banana Connectors, two (item 3)
Prerequisites	All prerequisites listed on page A–22

1. Set the Calibrator to +0.0000 mV DC.

2. Verify the VX4234-under-test 50/60 Hz reject switch (side panel) is in the 60 Hz position.

3. Connect the Calibrator to the VX4234 Voltage Input using two Dual-Banana connectors and a Coaxial cable.

4. Set the Calibrator to +10.0 V, 60 Hz and enable the output.

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5. Using the following commands, set the VX4234 to read DC volts on the 20 mV range (Function 1, Range 1). Perform two acquisitions and verify the second response to be ≤ 2.24 mV (Note: The first reading returned is stale data).

```
set VX4234

ibwrt "F1R1"

ibrd 100 (Disregard this reading.)

ibrd 100 (Observe: 3 [+/–].002239 . .)
```

6. Power down the VXI system, remove the VX4234-under-test and set the 50/60 Hz reject switch to the 50 Hz position. Reinstall the VX4234 under-test and power-on the system.

7. Set the Calibrator to +10.0 V, 50 Hz.

8. Perform two acquisitions and verify the second response to be ≤ 2.24 mV.

```
ibrd 100 (Disregard this reading.)

ibrd 100 (Observe: 3 [+/–].002239 . .)
```

9. Set the Calibrator to +0.0000 mV DC.

10. Reset the VX4234-under-test 60 Hz reject switch to the AC power source frequency being used by the VXI system.

DC Current Accuracy

This sequence verifies the accuracy of the six DC Current ranges.

Equipment Requirements	Calibrator (item 1) Coaxial Cable, one (item 2) Dual Banana Connector, two (item 3)
Prerequisites	All prerequisites listed on page A–22

1. Set the Calibrator to +0.0000 mV *(If using the Fluke 5700A, press the clear button twice).*

2. Connect the Calibrator to the VX4234 Voltage input using two Dual-Banana connectors and a Coaxial cable.

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3. Set the VX4234 to DC Current on the 200 µA range (Function 6. Range 1) .

   ```
   set VX4234

   ibwrt "F6R1"
   ```

4. Set the Calibrator to +180.000 µA.

5. Acquire a reading from the VX4234 and verify the response relative to the limits shown in the Test Record (limits also shown in Table 7 and 8):

   `ibrd 100` (Observe; +.00018000 ±0.00001407A {table 7})

6. Set the Calibrator to –180.000 µA.

7. Acquire a reading from the VX4234 and verify the response to the limits shown in the Test Record:

   `ibrd 100` (Observe: –.00018000 ±0.00001407 A {table 7})

8. Check the additional currents listed in Table 7 and 8. *(Note that the first entry in Table 7 is a repeat of steps 3 through 7 above*.)

Table 7: DC Current Accuracy

Set Calibrator	Command to VX4234	Response to Verify

+180.000 µA
 	
–180.000 µA
(Steps 3 to 7 repeated for continuity)
	`ibwrt "F6R1"`
	`ibrd 100`
	`ibrd 100`
		
		+.00019407 to +.00016593
		–.00016593 to –.00019407

+1.80000 mA
 	
–1.80000 mA
	`ibwrt "R2"`
	`ibrd 100`
	`ibrd 100`
		
		+.0018407 to +.0017593
		–.0017593 to –.0018407

+18.0000 mA
 	
–18.0000 mA
	`ibwrt "R3"`
	`ibrd 100`
	`ibrd 100`
		
		+.018047 . . to +.017953 . .
		–.017953 . . to –.018047 . .

+180.000 mA
 	
–180.000 mA
	`ibwrt "R4"`
	`ibrd 100`
	`ibrd 100`
		
		+.18011 . . to + .17989 . .
		–.17989 . . to –.18011 . .

9. Remove the Calibrator signal from the VX4234 “200 mA max” input and connect to the “10 A max” input. Continue the DC Current checks as directed in Table 8. *(Be careful to reconnect the Calibrator cable in the proper polarity. This will require rotating the dual banana connector 180 degrees.)*

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Table 8: High Range DC Current Accuracy

Set Calibrator	Command to VX4234	Response to Verify
+1.80000 A	`ibwrt "R5"` `ibrd 100`	+1.8008 . . to +1.7992 . .
–1.80000 A	`ibrd 100`	–1.7992 . . to –1.8008 . .
+1.90000 A	`ibwrt "R6"` `ibrd 100`	+1.901 . . to +1.899 . .
–1.90000 A	`ibrd 100`	–1.899 . . to –1.901 . .

10. Set the Calibrator to +0.0000 mV.

AC Voltage Accuracy

This sequence verifies the accuracy of the five AC RMS voltage ranges.

Equipment Requirements	Calibrator (item 1) Dual Banana Connectors, two (item 3) Coaxial cable, one (item 2)
Prerequisites	All prerequisites listed on page A–22

1. Set the Calibrator to 180.000 mV and 6.0 kHz.

2. Connect the Calibrator to the VX4234 Voltage input using two Dual-Banana connectors and a Coaxial cable.

3. Set the VX4234 to AC volts and the 200 mV range (Function 5, Range 2). (Note: There is no Range 1 for AC). Acquire a reading from the VX4234 and verify the response relative to the limits shown in the Test Record (limits are also shown in Table 9):

`set VX4234`

`ibwrt "F5R2"` (Note: there is no R1 range for AC Volts)

`ibrd 100` (Observe: +.18000 ±.00208, see Table 9)

4. Check the additional voltages as directed in Table 9 . (Note that the first entry in Table 9 is a repeat of step 3 above.)

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Table 9: AC RMS Voltage Accuracy

Set Calibrator	Command to VX4234	Response to Verify
+180.000 mV, 6.0 kHz (Step 3 above repeated for table continuity.)	`ibwrt "F5R2"` `ibrd 100`	+.18208 . . to +.17792 . .
+1.80000 V, 6.0 kHz	`ibwrt "R3"` `ibrd 100`	+1.8168 . . to +1.7832 . .
+18.0000 V, 6.0 kHz	`ibwrt "R4"` `ibrd 100`	+18.188 . . to + 17.812 . .
+180.000 V, 6.0 kHz	`ibwrt "R5"` `ibrd 100`	+181.88 . . to +178.12 . .
+630.00 V, 1.0 kHz	`ibwrt "R6"` `ibrd 100`	+641.8 . . to +618.2 . .

5. Set the Calibrator to +0.0000 mV DC.

Resistance Accuracy

This sequence verifies the accuracy of the six (6) Resistance ranges.

Equipment Requirements	Calibrator (item 1) Coaxial Cable, two (item 2) Dual Banana Connectors, four (item 3)
Prerequisites	All prerequisites listed on page A–22

1. Set the Calibrator to 100 Ω.

2. Connect the Calibrator Hi/Lo Output to the top Ω input (R+/R-) of the VX4234 using two Dual-Banana connectors and a Coaxial cable.

3. Connect the Calibrator Hi/Lo Sense to the bottom Ω input (R+/R-) of the VX4234 using a second Coaxial cable and two Dual-Banana connectors.

4. Set the VX4234 to Ω 4-Wire and the 200 Ω range (Function 4, Range 1). Acquire a reading from the VX4234 and verify the response relative to the limits shown in the Test Record (the limits are also shown in Table 9):

```
set VX4234

ibwrt "F4R1"

ibrd 100 (Observe: +100.00 +0.170W, see Table 10)
```


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5. Check the additional resistance ranges listed in Table 10. (Note that the first entry in Table 10 is a repeat of steps 4 above.)

Table 10: Resistance Accuracy

Set Calibrator	Command to VX4234	Response to Verify
+100.000 Ω (Step 4 repeated for continuity)	`ibwrt "F4R1"` `ibrd 100`	+100.17 . . to +99.83 . .
+1000.00 Ω	`ibwrt "R2"` `ibrd 100`	+1001.1 . . to +998.9 . .
+10.0000 kΩ	`ibwrt "R3"` `ibrd 100`	+10011.0 . . to +9989.0 . .
+100.000 kΩ	`ibwrt "R4"` `ibrd 100`	+100110.0 . . to + 99890.0 . .
+1.00000 MΩ	`ibwrt "R5"` `ibrd 100`	+1001700.0 to +998300.0 . .
+10.0000 MΩ	`ibwrt "R6"` `ibrd 100`	+10020000.0 to +9980000.0

This completes the VX4234 verification procedure.

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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.

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Appendix G
Adjustment and Calibration

The VX4234 Module must be calibrated every 12 months for the card to meet its published accuracy specifications. Calibrate the VX4234 Module at the temperature at which it will be operating. If this is not feasible, or the module will be operating under a wide temperature variation, consult the temperature drift specifications. Allow a ten minute warm-up period before performing the calibration.

The calibration of the VX4234 Module is somewhat different from that of most multimeters in that no manual adjustments are made by the operator during calibration. During calibration, the microprocessor on the VX4234 Module updates a non-volatile memory containing correction terms canceling the difference between a signal input measured by the VX4234 Module and the Calibration command specifying the real value for that input. These "Correction Terms" are later used by the microprocessor to transform measured values of the VX4234 Module's integrating A/D before the measurements are returned to the user.

Calibration	Input Binding Post
DC	V+, V-
AC	V+, V-
Resistance	R+, R-; R+, R- (sense)
Current (0 to 200mA)	I+ (200mA), I-
Current (200mA to 10A)	I+ (10A), I-

Test Equipment Required

A precision voltage source capable of putting out the following voltages to within 0.005% of full scale in each range being calibrated:

1. A known positive DC voltage between 45% and 100% of full scale for each DC-voltage range to be calibrated.

2. A known negative DC voltage between 45% and 100% of full scale for each DC-voltage range to be calibrated.

3. A known True RMS voltage between 1% and 100% of full scale for each AC-voltage range to be calibrated. A positive DC voltage or an AC voltage from 60 Hz to 7500 Hz may be used.

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A known resistance whose value is between 45% and 100% of full scale is required for each resistance range to be calibrated. The value of the resistance must be known to within 0.005%.

Precautions

When calibrating the VX4234 Module, the following precautions must be observed:

1. DC calibration for a given range must be performed before AC calibration.

2. The null or offset calibration must be performed before the gain calibration on any range is performed.

3. If a DC voltage is used to calibrate the AC ranges, a positive DC voltage must be used.

4. The known calibration voltage or resistance must be applied to the DMM input terminals for a period of 1 second prior to sending the C (Calibration) command to the VX4234 Module. This insures that settling time errors caused by stray capacitance in the cabling between the DMM and calibration source will not effect the calibration.

5. The ERR and CAL LEDs must both be extinguished before a C (Calibration) command is sent to the VX4234 Module. (See E (Error) command).

6. Resistance calibration must be done in the 4-wire mode.

Procedure

To calibrate a given function and range proceed as follows:

1. Program the function and range to be calibrated, i.e., "F1R3" for DC Volts, Range 3.

2. Program the null or offset value as follows:

   Place a short across the required input for DC Volts (F1), DC Amperes (F6), or for resistance (F3, F4). A short may be used for AC Volts (F2 and F5) and for AC Amperes (F7 and F8), but a signal equal to 1.5% of the range's maximum will provide better accuracy across the range.

   When a short is used, the calibration command is "C0CL". When the 1.5% signal is used the calibration command is as shown:

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Range	AC Voltage	Command	AC Current	Command
2	2.5mV	C.0025CL	25µA	C.000025CL
3	25Mv	C.025CL	250µA	C.00025CL
4	250mV	C.25CL	2.5mA	C.0025CL
5	2.5V	C2.5CL	25mA	C.025CL
6	25V	C25CL	250mA	C.25CL

Although a positive DC voltage (or current) may be used to calibrate the AC offset and gain, better results will be obtained across the entire frequency range by using an AC signal. Calibration at the factory uses a frequency of 7500 Hz. This frequency may be used for periodic re-calibration. A frequency which is more easily obtainable with the available calibration equipment may be used, or a frequency may be selected for the particular tests to be conducted. For best results, the same frequency should be used to calibrate both the gain and the offset.

3. Issue the C (Calibration) command, e.g., "C0.0CL", or "C2.5CL".

4. Check to see that the ERR and CAL LEDs are not flashing after each calibration command is completed. If the ERR and CAL LEDs are flashing, use the E (Error) command to determine the reason for the unsuccessful calibration and repeat the calibration step.

5. Program the gain value as follows:

   a. Input the known calibration voltage or resistance.

   b. Issue the C command. If DC voltage, Range 3 were being calibrated, using a calibration voltage of +1.5000, the correct C command would be "C1.5000CL".

   c. If a DC voltage (F1) range or DC current (F6) range is being calibrated, repeat the calibration step using the negative input voltage.

6. Check to see that the ERR and CAL LEDs are not flashing after each calibration command is completed. If they are flashing, proceed as in Step 4.

CAUTION

The adjustable capacitor calibration provided on the VX4234 is a one time calibration performed at the factory. It does not require re-calibration during the lifetime of the product, and should never require adjustment. If the capacitor has been re-adjusted by mistake, the VX4234 may not meet its published frequency response specifications above AC range 3. If this occurs, consult the factory.

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8000	K62	Set	Y0 (7)	1 DCV	K62	K522	TBL	K1121	K1222	K1221	K1021	K911	K82	K722	K721	K912
8001	K62	Reset	Y0 (6)													
8002	K522	Set	Y0 (5)	.02V R1	R	R	02	R	R	R	R	R	R	S	R	R
8003	K522	Reset	Y0 (4)	.2V R2	R	R	42	R	S	R	R	R	R	S	R	R
8004			Y0 (3)	2V R3	R	R	62	R	S	S	R	R	R	S	R	R
8005			Y0 (2)	20V R4	R	R	CA	S	S	R	R	S	R	S	R	R
8006	A/D RUN-		Y0 (1)	200V R5	R	R	EA	S	S	S	R	S	R	S	R	R
8007	Clr Str F/F		Y0 (0)	700V R6	R	R	E3	S	S	S	R	R	R	S	S	R
8008	K1121 Set		Y1 (7)													
8009	K1121 Reset		Y1 (6)	2 ACV	K62	K522	TBL	K1121	K1222	K1221	K1021	K911	K82	K722	K721	K912
800A	K1222 Set		Y1 (5)													
800B	K1222 Reset		Y1 (4)	.2V R2	R	R	52	R	S	R	S	R	R	S	R	S
800C	K1221 Set		Y1 (3)	2V R3	R	R	7A	R	S	S	S	S	R	S	R	S
800D	K1221 Reset		Y1 (2)	20V R4	R	R	FA	S	S	S	S	S	R	S	R	S
800E	K1021 Set		Y1 (1)	200V R5	R	R	D6	S	S	R	S	R	S	S	R	S
800F	K1021 Reset		Y1 (0)	700V R6	R	R	F6	S	S	S	S	R	S	S	R	S
8010	K911 Set		Y2 (7)													
8011	K911 Reset		Y2 (6)	3 2WΩ	K62	K522	TBL	K1121	K1222	K1221	K1021	K911	K82	K722	K721	K912
8012	K82 Set		Y2 (5)													
8013	K82 Reset		Y2 (4)	200Ω R1	S	S	42	R	S	R	R	R	R	S	R	R
8014	K722 Set		Y2 (3)	2kΩ R2	S	S	62	R	S	S	R	R	R	S	R	R
8015	K722 Reset		Y2 (2)	20kΩ R3	S	S	23	R	R	S	R	R	R	S	S	R
8016	K721 Set		Y2 (1)	.2MΩ R4	S	S	2A	R	R	S	R	S	R	S	R	R
8017	K721 Reset		Y2 (0)	2MΩ R5	S	S	26	R	R	S	R	R	S	S	R	R
8018	DC	LED on	Y3 (7)	20MΩ R6	S	S	22	R	R	S	R	R	R	S	R	R
8019	AC	LED on	Y3 (6)													
801A	Ohms	LED on	Y3 (5)	4 4WΩ	K62	K522	TBL	K1121	K1222	K1221	K1021	K911	K82	K722	K721	K912
801B	4W	LED on	Y3 (4)													
801C	Auto	LED on	Y3 (3)	200Ω R1	R	S	42	R	S	R	R	R	R	S	R	R
801D	R1	LED on	Y3 (2)	2kΩ R2	R	S	62	R	S	S	R	R	R	S	R	R
801E	R2	LED on	Y3 (1)	20kΩ R3	R	S	23	R	R	S	R	R	R	S	S	R
801F	R3	LED on	Y3 (0)	.2MΩ R4	R	S	2A	R	R	S	R	S	R	S	R	R
8020	R4	LED on	Y4 (7)	2MΩ R5	R	S	26	R	R	S	R	R	S	S	R	R
8021	R5	LED on	Y4 (6)	20MΩ R6	R	S	22	R	R	S	R	R	R	S	R	R
8022	R6	LED on	Y4 (5)													
8023	Err	LED on	Y4 (4)	5 ACV	Same as	2 ACV	except K22 set.	AC RMS Volts								
8024	Cal	LED on	Y4 (3)													
8025	RMS	LED on	Y4 (2)													
8026	Curr	LED on	Y4 (1)	6 DCA	K62	K522	TBL	K1121	K1222	K1221	K1021	K911	K82	K722	K721	K912
8027			Y4 (0)													
8028	EEPROM Clk-		Y5 (7)	.2mA R1	R	R	02	R	R	R	R	R	R	S	R	R
8029	EEPROM Data		Y5 (6)	2mA R2	R	R	42	R	S	R	R	R	R	S	R	R
802A	EndReset		Y5 (5)	20mA R3	R	S	42	R	S	R	R	R	R	S	R	R
802B	LastByte on		Y5 (4)	.2A R4	R	R	42	R	S	R	R	R	R	S	R	R
802C	Tsel3		Y5 (3)	2A R5	R	R	42	R	S	R	R	R	R	S	R	R
802D	Tsel2		Y5 (2)	10A R6	R	R	62	R	S	S	R	R	R	S	R	R
802E	Tsel1		Y5 (1)													
802F	Tsel0		Y5 (0)	7 ACA	K62	K522	TBL	K1121	K1222	K1221	K1021	K911	K82	K722	K721	K912
8030	K521	Set	Y6 (7)													
8031	K521	Reset	Y6 (6)	2mA R2	R	R	52	R	S	R	S	R	R	S	R	S
8032	K42	Set	Y6 (5)	20mA R3	R	S	52	R	S	R	S	R	R	S	R	S
8033	K42	Reset	Y6 (4)	.2A R4	R	R	52	R	S	R	S	R	R	S	R	S
8034	K32	Set	Y6 (3)	2A R5	R	R	52	R	S	R	S	R	R	S	R	S
8035	K32	Reset	Y6 (2)	10A R6	R	R	7A	R	S	S	S	S	R	S	R	S
8036	K22	Set	Y6 (1)													
8037	K22	Reset	Y6 (0)	8 ACA	Same as	8 ACA	except K22 set.	AC RMS Amps								

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