VX4332
Scanner Module
Operating Manual

Tektronix

01/19/93 9111-01-A

WARRANTY

This Tektronix, Inc. product is warranted against defects in materials and workmanship, and is warranted to meet the performance specifications as listed in the current catalog and/or data sheet for this product. This warranty applies for three (3) years following the date of shipment. Tektronix will, at its option, repair or replace, at no cost to the customer, this product should it prove to be defective during the warranty period, provided the defect or failure is not due to misuse or abuse of the product. The customer is responsible for shipment of the defective product to the Tektronix repair facility. NO OTHER WARRANTY IS EXPRESSED OR IMPLIED, INCLUDING WARRANTY FOR FITNESS OF PURPOSE. TEKTRONIX INC. SHALL, IN NO CASE, BE LIABLE FOR CONSEQUENTIAL DAMAGES.

TRADEMARK NOTIFICATION

GW BASIC and MS-DOS are registered trademarks of the Microsoft Corporation.

IBM and PC are registered trademarks of the IBM Corporation.

VXIbus is a trademark of the VXI Consortium.

All other brand and product names are trademarks
or registered trademarks of their respective companies.

Printed in U.S.A.

RESET<tm> - reset the VX4332 to its power-up state. (3 - 46)
SET [type]<tm> - specify operating parameters:
SET CLOSE_TIME - sets the time the module will delay after commanding a relay closed before continuing. (3 - 47)
SET NAME - enable or disable the use of the symbolic name assigned to a relay when it is read back and on the four-character display on the front panel. (3 - 48)
SET OPEN_TIME - sets the time the module will delay after commanding a relay open before continuing. (3 - 49)
SET TRIGGER IN - enable or disable monitoring of a VXIbus TTLTRG line by the VX4332. (3 - 50)
SET TRIGGER OUT - enable or disable pulsing a VXIbus TTLTRG line by the VX4332 during the encode signal. (3 - 51)
TRIGGER [n]<tm>
pulse the VXIbus TTL trigger line n. (3 - 52)
TRIGGER WAIT<tm>
causes the VX4332 to wait for a VXIbus TTL trigger line pulse on the line selected by the SET TRIGGER IN command. (3 - 53)
USER_INTERRUPT [n]<tm>
causes a Request True Interrupt on the VXIbus. (3 - 54)
WAIT [n]<tm>
causes the module to wait n milliseconds. (3 - 55)

- **Program Mode**

The VX4332 may be loaded with a sequence of commands (scan table) which may then be executed with a single command. The PROGRAM commands support this mode. (3 - 6)

ERROR MESSAGES

The front panel ERR light is lit whenever an error message is generated, and is off after they have all been read.

Use the LIST? ERRORS command to read back any error messages that have been generated since the last LIST? ERRORS command.

The error message buffer is limited to 10 messages. If an overflow occurs, new messages will be lost, but a buffer overflow error will be added to the buffer.

One error message is returned per read and is terminated by a <cr><lf>. The list of errors is terminated by a <sp><cr><lf>.

The error messages are generally self-explanatory. See Appendix D for a complete listing and description of each message.

VX4332 Scanner 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 - 4). If slave scanners are used, set Local Bus Out Enable switches to ENABLE, be sure a front panel TTL To The Right' key is installed. If no slaves are used, set Local Bus Out Enable switches to DISABLE. Follow Installation guidelines. (p. 2 - 1)

The default condition of the VX4332 after completion of power-up self test is:

All relays are open.	Program memory is cleared.
Joining relays are open.	Interrupts are disabled.
Front panel display shows "open".	Trigger Wait is disabled.
Relay name assignments are cleared.	The error list is cleared.
Open and close delay times are set to default values.	

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

- **Front Panel Display** - This normally displays either "open" or the last relay closed in either mmrr format or name format (capital letters). It also displays status or error messages (lower case letters). For a full listing of display messages, see p. 3 - 9.

test	displayed during power-up or a hardware reset, during self test.
romE	displayed on power-up or reset if the firmware checksum is not zero.
ramE	displayed on power-up or reset if the RAM self test fails.
open	the normal message when no relays are closed.
0012	indicates the last relay closed, in mmrr format.
NAME	indicates the last relay closed, in symbolic format.
inpt	the VX4332 has received a PROGRAM INPUT command and has not yet received a PROGRAM END command.
ovrf	memory was exceeded while inputing a program with the PROGRAM INPUT command.
odly	displayed during the open delay time when a relay is opened.
wait	displayed for the duration of WAIT commands.
trgw	the VX4332 is waiting for a trigger.
clsf	the last relay closed did not verify closed.
opnf	a relay is detected closed after an attempt to open it.

SYSTEM COMMANDS

These non-data commands are initiated by the VX4332's commander. These VXIbus Instrument Protocol commands will affect the VX4332:

BEGIN NORMAL OPERATION	TRIGGER	CLEAR
READ PROTOCOL	READ STATUS	CLEAR LOCK
BYTE AVAILABLE	BYTE REQUEST	SET LOCK

COMMAND SYNTAX

Command protocol and syntax for the VX4332 Module is as follows: (3 - 14)

1) Each command is a series of characters, terminated by a ; or <LF>. Parameters may not be continued after a terminator. Use spaces and tabs to separate fields in commands. All other control characters will be ignored.
2) If a character is not enclosed by brackets, that character itself is sent, otherwise:
   [ ] encloses the symbol for the actual argument.
   <cr> carriage return <lf> line feed.
   <sp> space character <tm> terminator: <lf> or ;
3) Any character may be sent in either upper or lower case form.
4) Any of the following white space characters:
   00 hex 0B hex through 19 hex
   01 hex through 08 hex 20 hex (space character)
   09 hex (tab character)
   are allowed in any of the following places: before any semicolon or <lf>; in place of any space character. Any number of white space characters may be used together.
5) data returned by the module is shown underlined in the examples.

Many of the commands have a long and short form (the first letters of the command). Either form may be used at any time.

MODULE COMMANDS

See the individual descriptions or the summary on p. 3 - 15 for complete syntax listings.

ASSIGN [mmrr]<tm>
: assigns a symbolic [name] to a module/relay [mmrr] number. (3 - 18)

CLOSE [mmrr]<tm>
: causes relay [mmrr] to be connected to the analog bus. (3 - 19)

DISJOIN [mm]<tm>
: disjoin(s) (splits) module mm so its A and B sections are two separate sections. (3 - 20)

FAST [mmrr]<tm> !!
: causes the specified relay to be connected to the analog bus. Same as a CLOSE command, except that the relay drivers involved are not verified. (3 - 21)

INTERRUPT [type]<tm>
: enable or disable generating a Request True interrupt on the VXIbus on the specified events:
  INTERRUPT ERROR - enable or disable a Request True interrupt for an error condition. (3 - 23)
  INTERRUPT PROGRAM_DONE - enable or disable a Request True interrupt at the end of a program. (3 - 24)
  INTERRUPT RELAY_CLOSED - enable or disable a Request True interrupt after a relay has been closed. (3 - 25)
  INTERRUPT TRIGGER_IN - enable or disable a Request True interrupt when a trigger is received. (3 - 26)

JOIN [mm]<tm>
: joins the A and B sections of module mm. (3 - 27)

LIST? [type]<tm>
: make data available from the VX4332. LIST? commands are not valid in a program. (3 - 28)
  LIST? ASSIGNMENTS - read back the [name]/[mmrr] assignments that are currently in memory. (3 - 29)
  LIST? CONFIGURATION - read back from the VX4332: the status of the program, values of the timing parameters, trigger line and interrupt settings. (3 - 30)
  LIST? ERRORS - read back any error messages that have been generated since the last LIST? ERRORS command. (3 - 31) See Appendix D for a list of error messages.
  LIST? MODULE - reads back the status of module n, where the VX4332 is 0 and any slaves are 1 through 11. (3 - 32)
  LIST? PROGRAM - reads back the program stored in the VX4332. (3 - 35)
  LIST? STEPS - reads back the program stored in the VX4332 one command or step at a time preceded by a step number. (3 - 36)
  LIST? VERSION - reads back the version of firmware from the VX4332. (3 - 37)

OPEN [mmrr]<tm> / OPENALL<tm>
: OPENALL command opens all closed relays. The OPEN [mmrr] command opens relay [mmrr] or any relay closed in any sections joined to [mmrr]. (3 - 38)

PROGRAM [function]<tm>
: controls the use of programs for the VX4332:
  PROGRAM END - terminates the PROGRAM INPUT command. (3 - 40)
  PROGRAM GO - execute the sequence of commands stored in it with the PROGRAM INPUT command. (3 - 41)
  PROGRAM INPUT - Commands sent to the VX4332 after this command are stored for execution later. (3 - 42)
  PROGRAM PAUSE - The program stops and returns to accepting commands from the system controller. Only valid as part of a program definition. (3 - 43)
  PROGRAM STEP - executes one portion of a program at a time or continues a paused program. (3 - 44)

Table of Contents

Table of Contents - Continued

List of Illustrations

Operators Safety Summary

The general safety information in this summary is for both operating and servicing personnel. Additional specific warnings and cautions are found throughout the manual where they apply, and may not appear in this summary.

TERMS

In This Manual

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

CAUTION statements identify conditions or practices that could result in damage to the module or other property.

Marked on the Module

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property, including the module itself.

SYMBOLS

In This Manual

This symbol indicates where applicable cautionary or other information is to be found.

This symbol indicates where special explanatory information is included in the manual. There is no caution or danger associated with the information.

Marked on the Module

DANGER — High Voltage.

Protective ground (earth) terminal.

ATTENTION — Refer to the manual.

Refer to manual before using.

Power Source

This module is intended to operate in a mainframe whose power source does not apply more than 250V rms between the supply conductors or between either supply conductor and ground. A protective ground connection through the grounding conductor in the power cord(s) is essential for safe operation.

Grounding the Module

This module is grounded through the grounding conductor of the mainframe power cord(s). To avoid electrical shock, plug the mainframe power cord(s) into a properly wired receptacle before connecting to the module connectors. A protective ground connection through the mainframe is essential for safe operation.

Danger Arising from Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts can render an electric shock.

Use the Proper Fuse

To avoid fire hazard, use only fuses specified in the module parts list. A replacement fuse must meet the type, voltage rating, and current rating specifications required for the fuse that it replaces.

Do Not Operate in Explosive Atmosphere

To avoid explosion, do not operate the module in an explosive atmosphere.

Do Not Remove Covers or Panels

To avoid personal injury, the module covers should be removed only by qualified service personnel. Do not operate the module without covers and panels properly installed.

VX4332
Scanner Module

Section 1
General Information and Specifications

Introduction

The VX4332 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 Tektronix/CDS IAC System. The VX4332 is a 2-wire scanner with 40 reed relays on a message based VXIbus C size module. In addition, it is designed to act as a scanner master that can control up to 11 slave scanners via the VXIbus local bus. The master/slaves system can be configured under program control into one or more scanner systems. The slaves are also C size modules, but connect only to the VXIbus local bus (plus power and ground), and are programmed by sending commands to the master.

Slave modules are added to a scanning system to increase the number of input channels in the system. They may all be joined together to form one large section with a common output, used separately with two sections per module, or almost any combination in between.

The VX4332 allows programming the scanner system to:

- select a scanner channel
- reset the module to a power-up state
- assign symbolic names to relays
- switch the module between being a 1-of-40 or two 1-of-20 scanners
- adjust the length of the various delays
- enable or disable VXIbus interrupts for different events
- enable using a VXIbus TTL trigger line for the encode signal
- send a trigger on any of the eight VXIbus TTL trigger lines
- select information to be read back

The VX4332 has a four-character alpha-numeric front panel display that shows either the last channel closed or an error message.

The module can also store a program for a command sequence (also called a scan table) that can be executed multiple times with only one command. This command sequence can include triggers, interrupt generation for up to six different events, and commands to set different delays for each of its slave modules, as well as the Close Relay commands.

The block diagram of the VX4332 in Figure 1 shows how the module is organized. It may be used alone as a 40-channel scanner, selecting one of 40 2-wire inputs, or as two 20-channel scanners each independently selecting one of 20 2-wire inputs. The VX4332 can also be part of a scanning system in multiple mainframes with up to three masters, with each master controlling up to 11 slaves. The slaves are C size VXIbus modules, but connect only to the VXIbus local bus. No analog signals are connected to the local bus, allowing switching of voltages up to ±200 volts. Refer to the Using Multiple Masters subsection for information on implementing a multiple master system.

The VX4332 is one of a series of 1- to 4-wire master and slave scanners. Any of the slaves may be used with any of the masters. The slaves may be used to expand the number of channels of the master or as separate scanning systems controlled by the VX4332.

When used with slave scanners in this series, the VX4332 and the slaves may be used as a 1-of-N scanner, where N is the total number of relays on all the modules, or split into smaller scanners of varying size. For instance, a system with one VX4332 and two VX4372 48-channel slave scanners could be used in any of the following configurations (as well as others):

1-of-136 or
1-of-64 and 1-of-72 or
1-of-40 and 1-of-48 and 1-of-48 or
1-of-40 and 1-of-48 and 1-of-24 and 1-of-24 or
1-of-40 and 1-of-24 and 1-of-24 and 1-of-24 and 1-of-24 or
1-of-20 and 1-of-20 and 1-of-24 and 1-of-24 and 1-of-24 and 1-of-24

Each group is independent, and only one relay may be closed in each group. Within any group, there is hardware and software protection against closing more than one relay at a time.

The basic function of a scanning system is to connect one of many analog inputs to an analog bus. To do this, the system uses the following sequence of signals and timing:

1. A program command is given to close a particular relay.

2. A scan clear signal is issued to open any relay that is currently closed.

3. A programmable open delay occurs to allow a closed relay time to open.

4. The new relay is energized.

5. A programmable close delay occurs to allow the new relay time to close.

6. The module with a closed relay is read to verify that the correct relay is closed.

7. An encode signal is generated to signal a device to make a measurement.

8. The system is ready to accept a new command.

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).

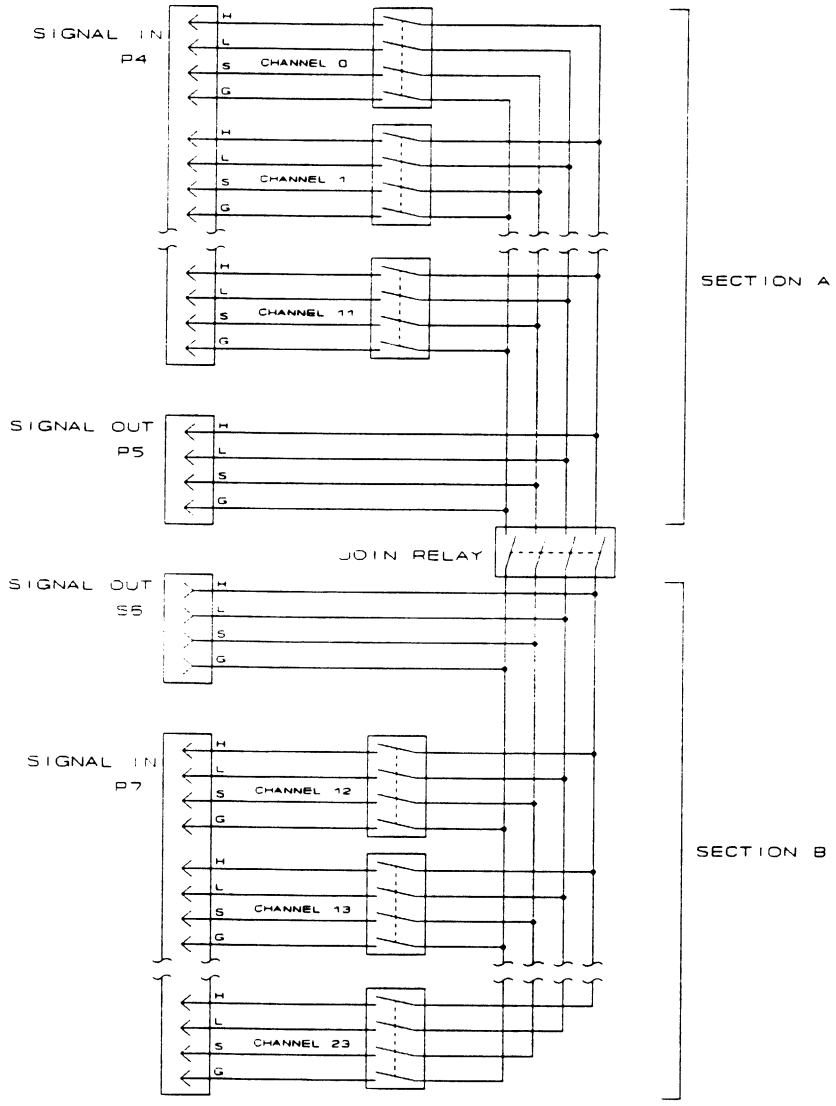
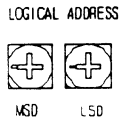


Figure 1: VX4334 Block Diagram (not all signals shown)

Controls And Indicators

The following controls and indicators are provided to select and display the functions of the VX4332 Module's operating environment. See Figures 2 and 3 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 VX4332 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 VX4332 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 VX4332 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 VX4332 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 VX4332 is being used with a Tektronix/CDS IEEE-488 interface module, consult the operating manual of the Tektronix/CDS Resource Manager/IEEE-488 Interface Module being used.

If the VX4332 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.

If the VX4332 is not being used with a Tektronix/CDS Resource Manager/IEEE-488 Interface Module, consult the operating manual of the IEEE-488 interface device being used for recommendations on setting the logical address.

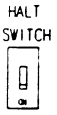
VMEbus Interrupt Level Select Switch

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, a Tektronix/CDS VX4521 Enhanced Slot 0/Resource Manager/IEEE-488 Module or VX4544 embedded PC-386 compatible system controller). The VMEbus interrupt level on which the VX4332 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 VX4332's interrupt handler, typically the module's commander. Setting the switch to 0 or 8 will disable the module's interrupts. Switch setting 9 should not be used.

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

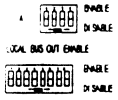


This two-position slide switch selects the response of the VX4332 Module when the Reset bit in the module's VXIbus Control register is set. Control of the Reset bit depends on the capabilities of the VX4332's commander.

If the Halt switch is in the ON position, the VX4332 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.

Local Bus Out Enable Switches



If any slave scanner modules, such as the VX4372, are to be used with the VX4332, the Local Bus Out Enable switches should all be set to ENABLE (closed).

If the VX4332 is used without any slaves, the Local Bus Out Enable switches should all be set to DISABLE (open) to avoid any possible damage from a module in the next slot to the right.

The Local Bus Out Enable switches consist of two blocks of DIP switches: one block of four and one block of eight.

LEDs

The following LEDs are visible at the top of the VX4332 Module's front panel to indicate the status of the module's operation:

Power LED

This green LED is normally lit to indicate that this module and all its slaves have +5V. It is extinguished if the +5V fuse blows.

Failed LED
This normally off red LED is lit whenever SYSFAIL* is asserted, indicating a module failure on this module or one of its slaves. 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.

Error LED
When lit, this red LED indicates errors such as syntax or relay errors.

Fuses

The VX4332 Module has a +5V fuse. The fuse protects the module in case of an accidental shorting of the power bus or any other situation where excessive current 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*.

If the +5V fuse opens, remove the fault before replacing the fuse. Replacement fuse information is given in the Specifications section.

BITE (Built in Test Equipment)

Visual Built in Test Equipment (BITE) is provided by a series of LEDs at the top of the VX4332, and by a four character alpha-numeric display. LEDs indicate the presence of required power; module failure as a result of an incorrectly completed self test, loss of a power rail, or failure of the module's central processor; a VMEbus processing cycle; or a syntax or relay closure error.

Front Panel Display

The four-character alphanumeric display on the front panel of the VX4332 normally displays either "open" or the last relay closed in either mmrr format (two digits for the module number plus two digits for the relay number) or symbolic name format. It also displays status or error messages. (See Display Messages.)

Front Panel Connectors

The VX4332 has the following connectors on its front panel (see Figure 2):

- a 10-pin male connector containing the 4-wire analog bus and digital signals to daisy chain to a measurement device or another scanner system. The digital signals are: scan clear, encode, relay closed, and chain.

- a 10-pin female connector containing the 4-wire analog bus and digital signals to daisy chain to a slave module controlled by this master or to another scanner system. The digital signals are: scan clear, encode, relay closed, and chain sense.

- two DD-50P connectors for signal inputs to this module's relays.

See the Installation section for a description of how these connectors are used, and Appendix B for detailed connector pin assignments.

Options

Optional current limit and/or bleed resistors may be installed on the VX4332 for increased reliability in higher voltage applications. Resistor locations are shown in Figure 3. See Installation for information on installing and using the resistors.

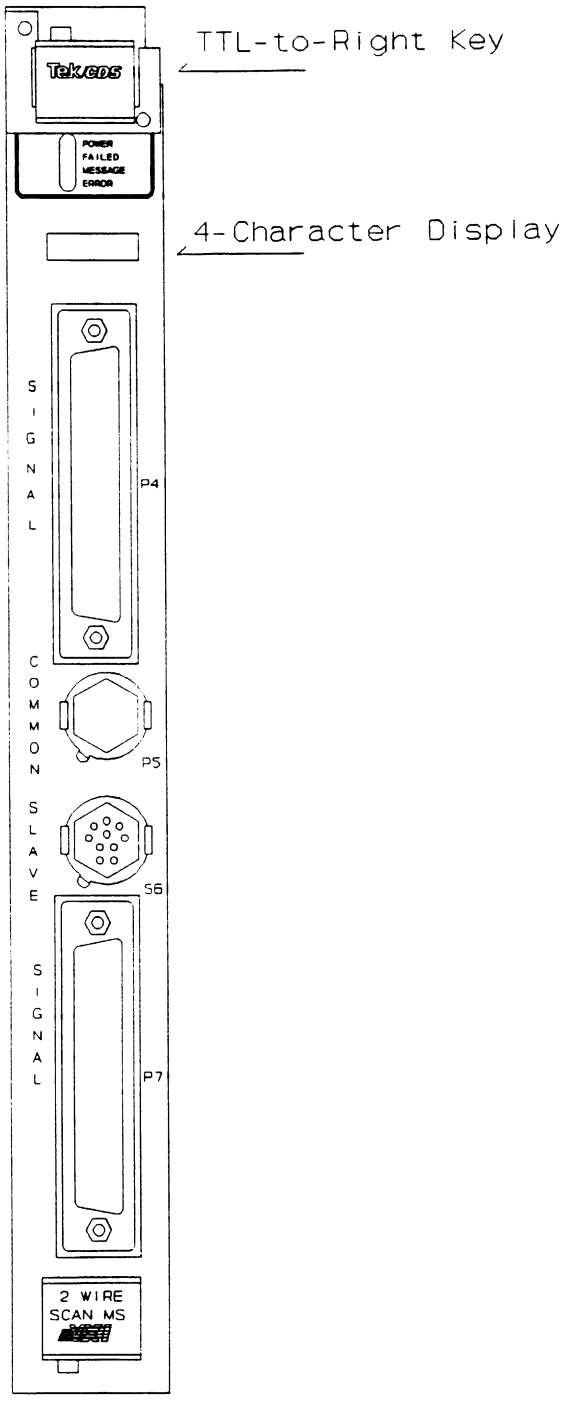


Figure 2: VX4332 Front Panel

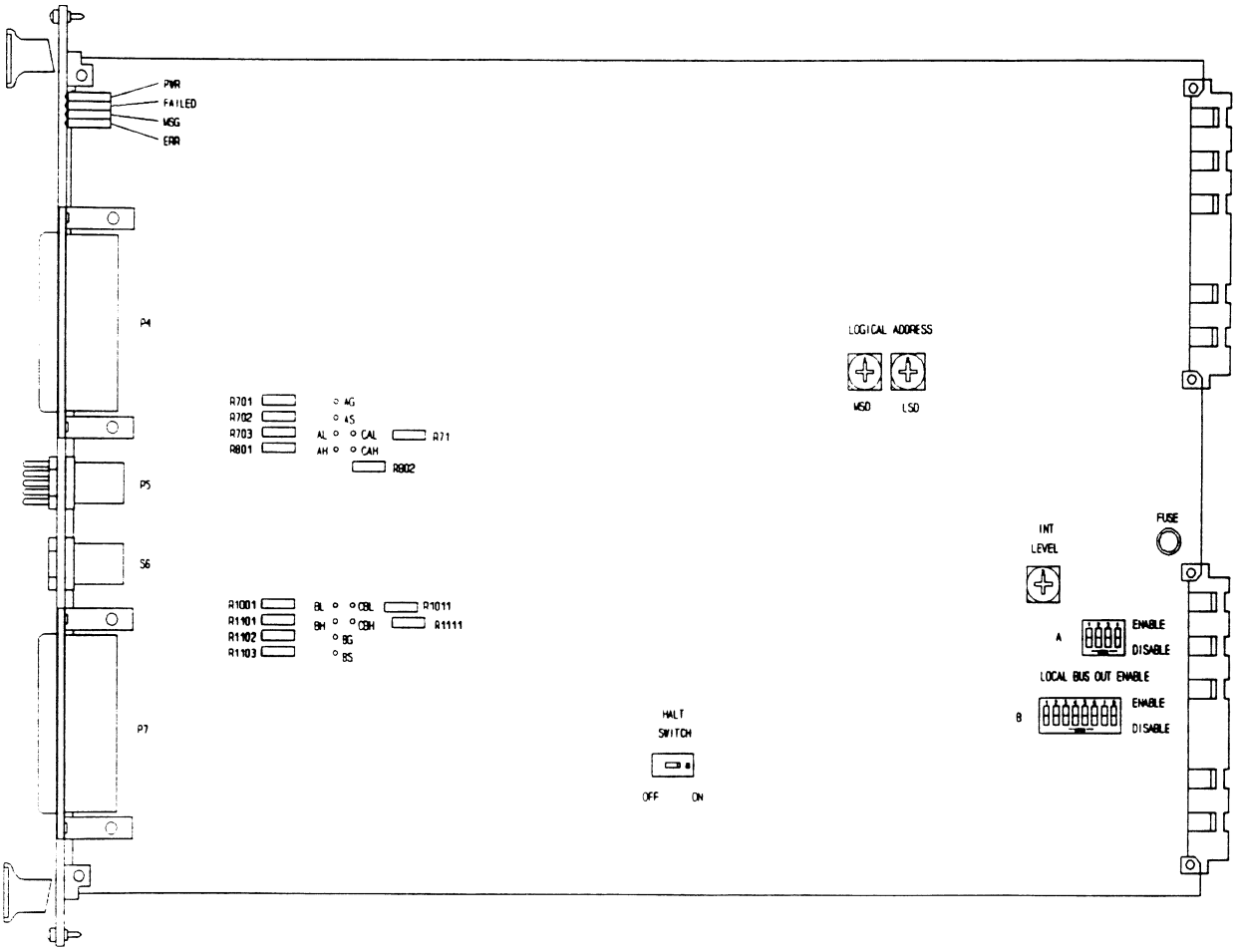


Figure 3: VX4332 Controls and Indicators

Specifications

Configuration:	Two 20-channel 2-wire scanners each with a common 4-wire output bus. Software programmable to a 40-channel 2-wire scanner with a 4-wire output bus.
Relay Type:	Model: Coto 3400-0092 or equivalent, dry reed, 3 pole, form A, third pole for readback.
Contacts:	
Maximum Switching Power Resistive:	10W.
Maximum Switching Voltage:	200V DC. 120V AC RMS, balanced input. 240V AC RMS, balanced input with 1 megohm bleed resistors. 60V AC RMS, one side grounded. 120V AC RMS, one side grounded with 1 megohm bleed resistors.
Maximum Switching Current:	0.5A.
Reed Life:	At least 10^7 operations per channel at rated load of 10W. Less as channel and common capacitance increase at higher voltages.
Duty:	Continuous.
Scanning rate:	Random channel selection as fast as 150 channels per second.
Signal Path Specifications:	
Differential Thermal Offset:	Less than 10 µV.
Initial Signal Path Resistance:	Less than 700 milliohms. Signal path resistance increases by the value of the current limit series resistors (if used).
Signal Path Resistance at End of Reed life:	Less than 1.5 ohms. Signal path resistance increases by the value of the current limit series resistors (if used).
Insulation Resistance:	Greater than 10 gigohms between all insulated parts.
Crosstalk Between Channels:	Measured at scanner common output with closed channel terminated with 600 ohms and signal applied to unselected channels. 1 kHz - Less than -105 dB. 10 kHz - Less than -85 dB. 100 kHz - Less than -65 dB. 1 MHz - Less than -45 dB.

Crosstalk Between Sections:	1 kHz - Less than -115 dB. 10 kHz - Less than -95 dB. 100 kHz - Less than -75 dB. 1 MHz - Less than -55 dB.
Signal Bandwidth:	Sections disjoined: 20 MHz (< 3 dB). Sections joined: 10 MHz (< 3 dB). (Frequency response measured with a 600 ohm load.)
Isolation:	
Without Bleed Resistors:	Greater than 10 gigohms signal to ground or signal to signal.
With 1 Mohm Bleed Resistors:	Scanner commons to ground, 1 Mohm. Open input to ground, greater that 10 gigohms.
Program Memory:	15,000 characters (approximately 2500 commands).
Relay Name Assignments:	Capacity, 850 assignments. 1- to 4-character names.
Encode Signal:	Negative TTL compatible pulse, 24mA max, 30 µsecs. Occurs at end of relay close delays.
VXIbus TTL Trigger Outputs:	Programmable for any one of eight VXIbus TTL Trigger lines. 30 µsec pulse.
VXIbus TTL Trigger Inputs:	Programmable for any one of eight VXIbus TTL Trigger lines. Minimum assertion time 30 ns.
VXIbus Compatibility:	Fully compatible with the VXIbus Specification for message-based instruments with the Halt switch in the ON position; keyed for TTL right.
VXI Device Type:	VXI message based instrument, Revision 1.3.
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:	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 error: BEGIN NORMAL OPERATION BYTE AVAILABLE (with or without END bit set) BYTE REQUEST CLEAR CLEAR LOCK READ PROTOCOL READ STATUS SET LOCK TRIGGER
VXIbus Protocol Events Supported:	VXIbus events are returned via VME interrupts. The following events are supported and returned to the VX4332 Module's commander: REQUEST TRUE (In IEEE-488 systems, this interrupt will cause a Service Request (SRQ) to be generated on the IEEE-488 bus.) REQUEST FALSE (indicates that the need for the request has been removed).
VXIbus Registers:	ID Device Type Status Control Protocol Response Data Low See Appendix A for definition of register contents.
ID Register Contents:	1111 1110 1011 0011 (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: 2.3 A
Current (Dynamic Module, I_{DM}):	5 volt supply: 0.1 A

Fuses:	Replacement fuse: Littlefuse P/N 273004; CDS P/N 42202-73050.
Cooling:	Provided by the fan in the VXIbus mainframe. Less than 10°C temperature rise with 1.0 liters/sec of air at a pressure drop of 0.04 mm of H_2O.
Temperature:	0°C to +50°C, operating (assumes ambient temperature of 55° and airflow to assure less than 10°C temperature rise). -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.
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 Tektronix/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:	1.9 kg. (4.2 lbs.)
Weight, Shipping:	When ordered with a Tektronix/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: 2.4 kg. (5.2 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:	2 - DD 50 pin connectors, pin. 1 - 10 pin circular connector, pin.

	1 - 10 pin circular connector, socket. Refer to Appendix B for connector pinouts.
Recommended Cable or Connector:	VX1638S Data cable.
Equipment Supplied:	1 - VX4332 Module. 1 - Operating Manual (Part # 00000-34332). 1 - Service Manual (Part # 00000-44332).
Optional Equipment:	2 - VX1638S Cables, or VX1780S Hooded Connectors. 1 - VX1632S Cable, or VX1786S Circular Connector. 1 - VX1632P Cable, or VX1786P Circular Connector. 1 - VX1635 Cable, or VX1786S and VX1786P Circular Connectors.
Software Version:	V2.3D.

Section 2
Preparation For Use

Installation Requirements And Cautions

The VX4332 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 VX4332 Module's logical address. To avoid confusion, it is recommended that the slot number and the logical address be the same.

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 "VX4332" is at the top.

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

Based on the number of instrument modules ordered with a Tektronix/CDS 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.

If the VX4332 is used in a VX1X Series Mainframe, all VX4332 cooling requirements will be met.

CAUTION

If the VX4332 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 VX4332 Module to operate properly. Check the manual of the mainframe being used for jumpering instructions.

If a Tektronix/CDS VX1400 or VX1401 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 VX4332 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 label on the top shield of the VX4332), and switch settings on the Installation Checklist. Only qualified personnel should install the VX4332 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 Tektronix/CDS Resource Manager/IEEE-488 Interface Module, SYSRST* will be set true whenever the Reset switch on the front panel of that module is depressed. Also note that when the Halt switch is in the OFF position, the operation of this module is not VXIbus compatible.

3) Set the Local Bus Out Enable switches (see Figure 3). If any slave scanner modules, such as the VX4372, are to be used with the VX4332, the Local Bus Out Enable switches should all be set to ENABLE (closed).

CAUTION

If the VX4332 is used without any slaves, the Local Bus Out Enable switches should all be set to DISABLE (open) to avoid any possible damage from a module in the next slot to the right.

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

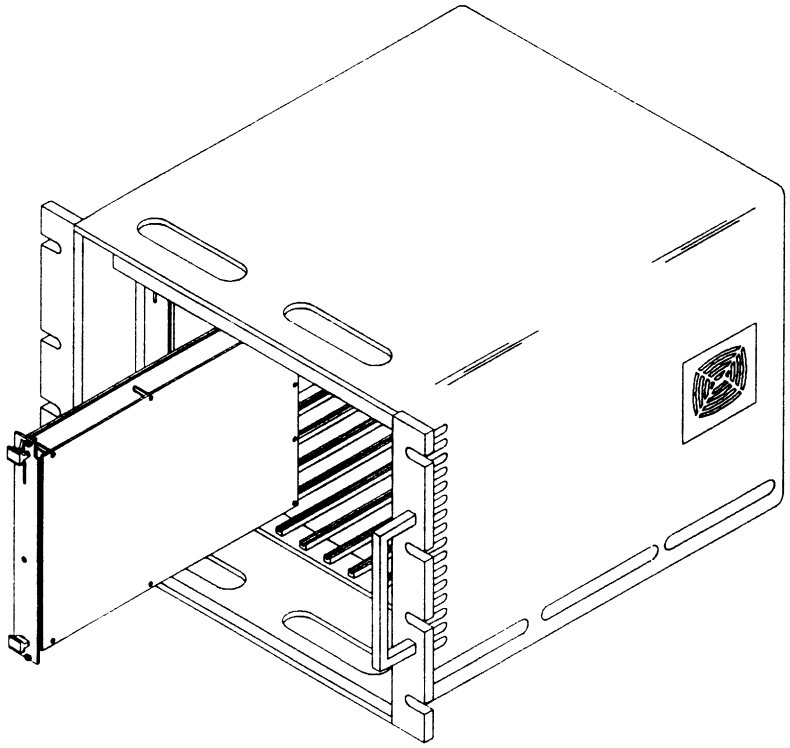


Figure 4: Module Installation

5) **Installation of Cables -**
Use a VX1638S Cable to interface between the module I/O connector and the Unit Under Test (UUT). If the module is being installed in a Tektronix/CDS VX1400 or VX1401 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.

If a special cable is needed, a VX1780S Hooded Connector may be used to cable between the module's output connector and the UUT.

Master/slave to slave interface cables: To chain the VX4332 to a slave module, use a VX1635 cable. VX1635 Option 003 is a long version to chain another mainframe.

Master/slave to measurement device cables: If the VX4332 is configured as two 20-by-1 scanners, use a VX1632S Cable to interface between Section A connector P5 and a measurement device, and use a VX1632P Cable to interface between Section B connector S6 and a measurement device. If the module is configured as a single 40-by-1 scanner (sections A and B are joined), only one cable is necessary.

See Figure 5 for cabling examples.

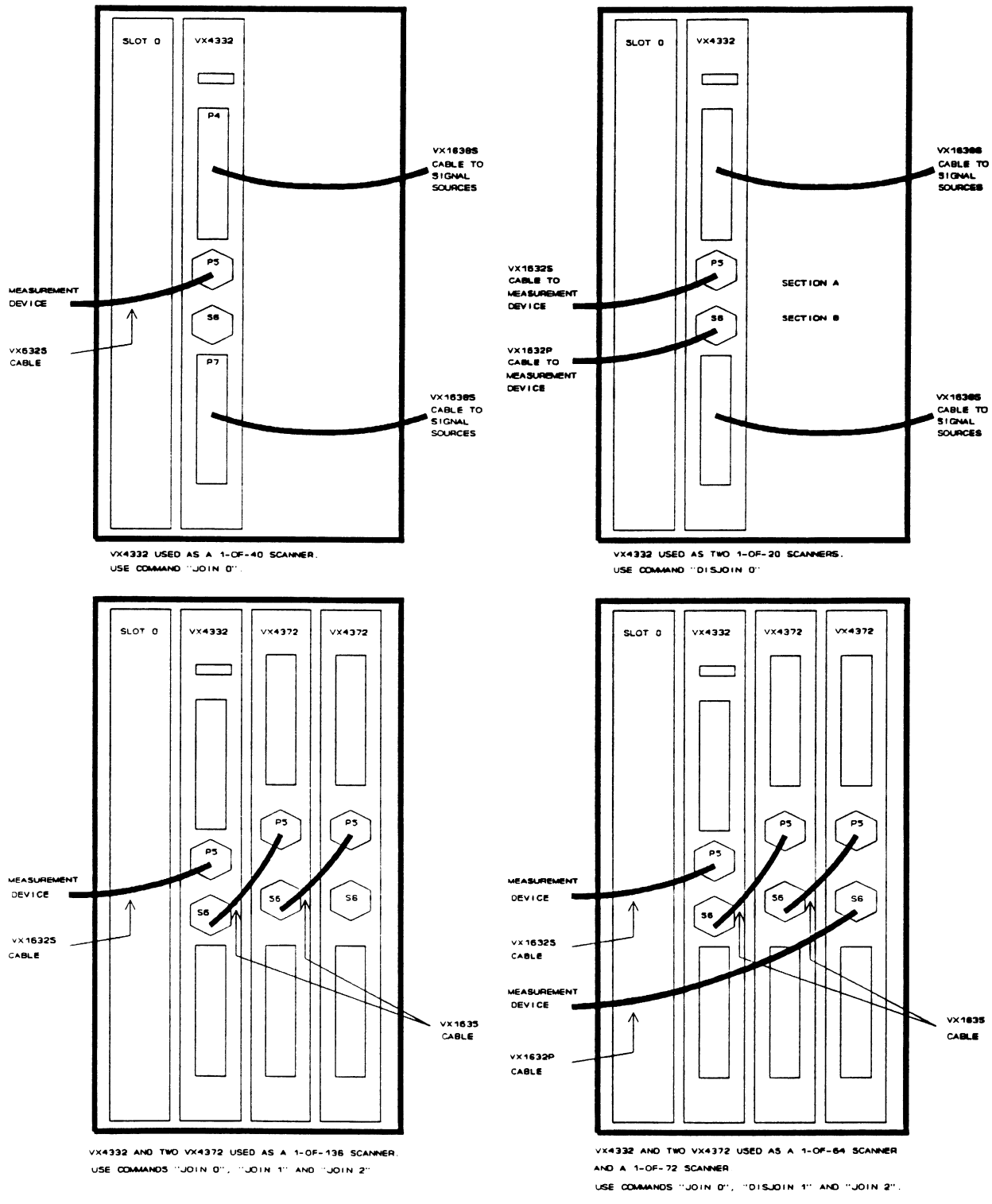


Figure 5: Cabling Examples

Board Options

Analog Bus:

The VX4332 has a 4-wire common or analog bus. These four lines are labeled High, Low, Guard, and Shield. The factory configuration connects the Section A and Section B 2-wire common lines to the High and Low lines via traces on the PC board. It is also possible to jumper the Section common lines to any combination of the 4-wire analog bus. To change the connections, cut the traces for the standard configuration before adding jumpers. Refer to points marked CAH, CAL, AH, AL, AS, AG, CBH, CBL, BH, BL, BS and BG in Figure 3 and to Figure 6.

Bleed and Current Limit Resistors:

Switching high voltages can lower the useful life of the relay contacts. The stray capacitance of the module and cabling, coupled with a large voltage difference between the signal line and common line, creates brief but high current pulses. The VX4332 Module provides two ways of limiting this current: bleed resistors and current limit resistors.

Bleed resistors are useful when switching large voltage signals that are both positive and negative. They provide a high resistance path to ground from the common bus to bleed off high voltage of one polarity before closing a relay with a signal of the opposite polarity. A typical value for these resistors is 1 megohm. Holes are provided on the VX4332 to install bleed resistors on all four analog lines of both the A and B Section. Refer to Figure 6 and Figure 3.

Current limit resistors limit the current to the relay contacts by adding a series resistance between the common lines of a section and its relays. A typical value for these resistors is 100 ohms. If this added resistance will not adversely affect measurements, it will extend the life of the relay contacts in high voltage applications, particularly those with a significant amount of capacitance (for example, many modules chained together, or long cables). The module has factory installed 0 ohm resistors, which can be replaced. Refer to Figure 6 and Figure 3.

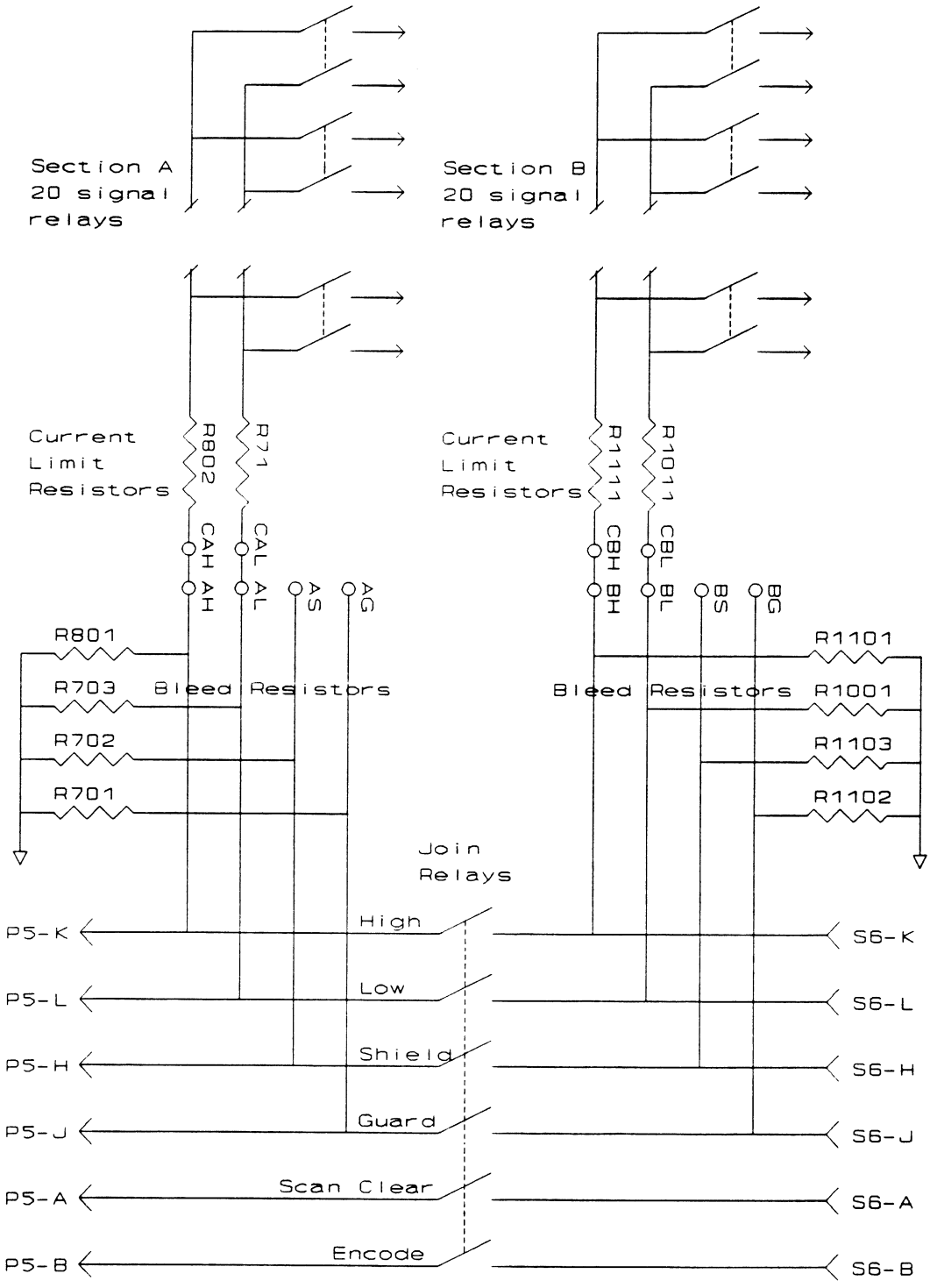


Figure 6: Jumpers and Optional Resistors

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 VX4332 Module.

Revision Level: _____

Serial No.: _____

Mainframe Slot Number: _____

Switch Settings:

VXIbus Logical Address Switch: _____

Interrupt Level Switch: _____

Halt Switch: _____

Local Bus Out Enable Switches: _____

Cable/Hooded Connector Installed:

VX1638S Cable: __

VX1780S Hooded Connector: __

VX1632S Cable: __

VX1632P Cable: __

VX1635 Cable: __

Options:

Section Common Lines Jumpered: _____

Bleed Resistors Installed: _____

Current Limit Resistors Installed: _____

Performed by: _____ Date: _____

Section 3
Operation

Overview

The VX4332 is a 2-wire scanner with 40 reed relays on a message based VXIbus C size module. In addition, it is designed to act as a scanner master that can control up to 11 slave scanners via the VXIbus local bus. The master/slaves system can be configured under program control into one or more scanner systems. The slaves are also C size modules, but connect only to the VXIbus local bus (plus power and ground), and are programmed by sending commands to the master.

Slave modules are added to a scanning system to increase the number of input channels in the system. They may all be joined together to form one large section with a common output, used separately with two sections per module or almost any combination in between.

In a system with a master and slave modules, each slave module may have a different number of relays. Refer to the operating manual of each module to determine the number of relays.

The VX4332 allows programming the scanner system to:

- select a scanner channel
- reset the module to a power-up state
- assign symbolic names to relays
- switch the module between being a 1-of-40 or two 1-of-20 scanners
- adjust the length of the various delays
- enable or disable VXIbus interrupts for different events
- enable using a VXIbus TTL trigger line for the encode signal
- send a trigger on any of the eight VXIbus TTL trigger lines
- select information to be read back

The module can also store a program for a command sequence (also called a scan table) that can be executed multiple times with only one command. This command sequence can include triggers, interrupt generation for up to six different events, and commands to set different delays for each of its slave modules, as well as the Close Relay commands.

The VX4332 Module is programmed by ASCII characters issued from the system controller to the VX4332 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 VX4332 Module's commander for details on the operation of that device.

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

Basic Operation

This subsection outlines the basic operation of the VX4332. A complete description of all the commands and additional features is included later. This subsection will only use the long forms of the commands. A short form of each command is given in the detailed command section.

Commands must be terminated by a semi-colon character (;) or line feed character. Carriage returns are optional.

Section Configuration

On power-up or reset, the VX4332 is configured as two separate 2-wire scanners, each with 20 channels of input and a 1-channel output. These two scanners are referred to as Section A and Section B. The two sections may be joined to make the VX4332 into a single 2-wire scanner with 40 channels of input and one channel of output.

When the VX4332 is used with Section A and Section B separate, Section A's inputs are through front panel 50-pin connector P4 and its output is through front panel 10-pin connector P5. Section B's inputs are through front panel 50-pin connector P7 and its output is through front panel 10-pin connector S6. Commands to close or open Section B relays (20 through 39) do not affect Section A.

The two sections may be joined together to form one 40-input 2-wire scanner by using the JOIN command.

JOIN 0	will join Sections A and B of the VX4332.
DISJOIN 0	will separate Sections A and B of the VX4332.

When joined, closing a relay in section A will automatically open any relay in either Section A or Section B. The same is true when closing a relay in Section B.

When joined, the output for both sections appears on both P5 and S6. Normally, P5 would be used as the output, and S6 would be used as input from another scanner module.

A typical application with section A and B separate might have up to 20 2-wire signal sources connected to P4, a measurement device such as a DVM connected to P5, up to 20 2-wire signal sources connected to P7, and a counter connected to S6.

The VX4332 A or B section can then be commanded to connect any one of the 20 2-wire inputs to the 2-wire output, using the CLOSE command.

CLOSE 5 will close relay 5, connecting input pair 5 to the section A output.

When a CLOSE command is executed, any previously closed relay in section A is opened before the new relay is closed.

CLOSE 10 will open relay 5 and then close relay 10, connecting input 10 to the output.

To open a relay without closing another, use the OPEN command.

OPEN 10 will open relay 10 (or any other relay in Section A).

After the above CLOSE commands, the four-character front panel display will show the number of the relay that is closed. When no relays are closed, the display will show "open".

In addition to the display, relay status may be read from the module. The default message returned from the VX4332 when no relays are closed is "OPEN OPEN". The first OPEN refers to Section A and the second OPEN to Section B. After a CLOSE 5 command, the read back message would be "0005 OPEN".

When the A and B sections are joined, the default read message is either "OPEN" or the number of the relay that is closed.

Using Slave Modules With the VX4332

The VX4332 is designed to control slave modules, such as the VX4372. Slave modules are added to a scanning system to increase the number of input channels in the system. They may all be joined together to form one large section with a common output, used separately with two sections per module or almost any combination in between.

Sections A and B on one module are joined with the JOIN command, and different modules are joined together by cabling. Power-up, or the RESET or DISJOIN commands will open joining relays, which disconnects all four wires between sections of a module.

The join relays and cabling support the VX4332's control of slave modules. If the VX4332 is controlling a VX4372, the B Section of the VX4332 may be joined to the A Section of the VX4372 by a cable from the VX4332 S6 to the VX4372 P5 connector. Another slave module may be joined to the VX4372 by cabling the VX4372 S6 to the added slave's P5 connector. Other slave modules may be joined in a similar fashion.

Specific modules are referred to by their sequence number in commands. The VX4332 is module 0. The slave immediately to the right is module 1, the next slave is module 2, etc.. Up to 11 slave modules may be controlled by one VX4332. Control connections are via the VXIbus local bus. Each module that has a slave on its right must have its Local Bus Out Enable switches enabled.

To refer to relays on slave cards, the module number times 100 is added to the relay number.

CLOSE 105	closes relay 5 on the module to the right of the VX4332
CLOSE 1042	closes relay 42 on the 10th slave.

Note that leading zeros are omitted in the command CLOSE 105. Since the VX4332 is module number zero, and leading zeros may be omitted, only the relay number is required for programming the VX4332.

The default read back message will contain a field for each set of joined sections. If a VX4332 has a VX4372 as a slave and none of the sections are joined (four separate sections), the default readback message will be "OPEN OPEN OPEN OPEN". If relays 5, 29, 103, and 140 are closed, the default readback message will be "0005 0029 0103 0140". If JOIN 0 and JOIN 1 commands are issued, then the readback message will be "OPEN OPEN". If the two modules are also joined together with a cable, the default readback message becomes "OPEN".

Using Names For Relay Numbers

A name up to four characters long, starting with an alphabetic character, may be assigned to a relay number. The name may then be used in CLOSE or OPEN commands for that relay. If the name is used in a CLOSE command, then the name will appear in the front panel display and in the default read back message.

ASSIGN TP1 5	assigns the name TP1 to relay 5
ASSIGN BUS5 107	assigns the name BUS5 to relay 107
CLOSE TP1	closes relay 5
CLOSE BUS5	closes relay 107

On power-up or after a RESET command all name assignments will be lost.

Setting Parameters

The VX4332 has a series of SET commands to allow changing the default timing parameters, disabling the name display feature, and selecting trigger lines.

Timing Parameters

When the VX4332 opens a relay, it delays before it continues. A default open delay time appropriate to the physical relay used is programmed into the VX4332 and each slave. The VX4332 will use these default open delay times unless a SET OPEN_TIME command is used to change it.

The delay times may be set for each module or for all modules. The time is specified as an integer in millisecond units. The maximum value is 32767 ms (or 32.767 seconds). The VX4332 will not accept a delay time less than the default value for any module.

SET OPEN_TIME 0 1000	sets the open delay time for module 0 to 1 second.
SET OPEN_TIME ALL 500	sets the open delay time for all modules to 0.5 seconds.

In the same way, default times are used for a delay after a CLOSE command to insure that a relay is closed before verifying and accepting the next command. These times can be changed with the SET CLOSE_TIME command.

SET CLOSE_TIME 3 25	sets the close delay time for module 3 to 25 msecs.
SET CLOSE_TIME ALL 10	sets the close delay time for all modules to 10 msecs.

The default times are adequate to insure that a relay is open or closed before a command continues, but programming longer times is useful with certain measurement devices.

Disable Name Display

To disable displaying the assigned relay names, use the following command:

SET NAME DISABLE	disables displaying the assigned relay name.
SET NAME ENABLE	enables displaying the assigned relay name.

Select Trigger Lines

The following commands disable or define a specific VXIbus TTL trigger line for trigger in and trigger out commands and conditions.

SET TRIGGER IN DISABLE	the VX4332 will not monitor any of the VXIbus TTL trigger lines.
SET TRIGGER IN 3	the VX4332 will monitor VXIbus TTL trigger line 3 for the TRIGGER WAIT command.
SET TRIGGER OUT DISABLE	the VX4332 will not pulse any of the VXIbus TTL trigger lines after each relay close delay.
SET TRIGGER OUT 5	the VX4332 will pulse the VXIbus TTL trigger line 5 after each relay close delay or TRIGGER command.

Program Mode

Using the program mode, the VX4332 may be loaded with a program (scan table), which may then be executed with a single command. The following commands support the program mode.

PROGRAM INPUT

erases any program in memory and places the VX4332 into a program input mode. All commands sent to the VX4332 after this command will not be executed but placed in volatile RAM. There is no syntax checking at this time. Some of the commands (such as PROGRAM INPUT) are not valid as part of a program. The individual command descriptions specify which commands are not valid in a program.

PROGRAM END

terminates the program input mode.

PROGRAM GO

starts execution of the program in memory at its first step and executes the program one time. The VX4332 will stop executing the program if another command is sent to it. The interrupting command will then be executed. If a delay time is being executed, the interrupting command will not be executed until after the delay time interval.

PROGRAM GO n

is the same as above except the program will be executed n times. A value of 0 will cause the program to loop until interrupted.

PROGRAM PAUSE

in a program, causes the VX4332 to end program mode and return to waiting for a command from the system controller. The program may be continued with the PROGRAM STEP command.

PROGRAM STEP 0

causes the VX4332 to continue after it is paused. The program continues until the original loop count is satisfied. If the program is not in a paused state, the program will be executed from the start with a loop count of 1.

PROGRAM STEP 3

causes the VX4332 to execute three commands from the program and then pause.

PROGRAM STEP

causes the VX4332 to execute one command from the program and then pause.

When the VX4332 is executing a program, the read back message is the following:

LOOP xxxxx, STEP xxxxx, PROGRAM RUNNING
or
LOOP xxxxx, STEP xxxxx, TRIGGER WAIT

Interrupts

The VX4332 will interrupt its VXI commander with a Request True interrupt for a variety of conditions. With a Tektronix/CDS Resource Manager/IEEE-488 Interface Module, a Request True interrupt will cause a SRQ on its IEEE-488 interface. A subsequent Serial Poll to the VX4332 will return a serial poll value that identifies the cause of the interrupt. The following commands enable or disable Request True interrupts for specific conditions. Refer to the Command Descriptions section for more information.

INTERRUPT ERROR ENABLE or DISABLE
: controls whether a relay open or close failure or a syntax error will cause an interrupt.

INTERRUPT PROGRAM_DONE ENABLE or DISABLE
: controls whether an interrupt will be generated upon completion of a program.

INTERRUPT RELAY_CLOSED ENABLE or DISABLE
: controls whether an interrupt will be generated after the close delay each time a relay is closed.

INTERRUPT TRIGGER_IN ENABLE or DISABLE
: if this interrupt is enabled, an interrupt will be generated by a pulse on the VXIbus trigger line selected by the SET TRIGGER IN command.

USER_INTERRUPT n
: causes a Request True interrupt. It would be most useful in program mode to signal the system controller at desired points in the program.

LIST? Commands

The LIST? commands return a variety of information. Most of these commands return more than one line of information and require several reads. It is not necessary to read back any or all of the data made available by a LIST? command. Sending a new command will purge any unread data. Refer to the Command Descriptions section for complete details.

LIST? ASSIGNMENTS
: lists all the names assigned to relays.

LIST? CONFIGURATION
: lists general information about the system.

LIST? ERRORS
: lists all detected errors that have not been read back.

LIST? MODULE n or ALL
: lists the state of modules.

LIST? PROGRAM
lists the program currently in VX4332 memory.

LIST? STEPS
lists the program as individual commands or steps preceded by a step number. This is useful as a reference, since errors generated while a program is running include a step number.

LIST? VERSION
lists the software version of the VX4332.

Using Triggers And The Encode Signal

Two types of triggers are used with this module: hardware and software triggers. The software trigger is referred to in this document as a VXIbus TRIGGER command. This command is a VXIbus command sent to the VX4332 by a VXI commander. This trigger could be the result of an IEEE-488 device sending an IEEE-488 Group Execute Trigger command to the IEEE-488 address of the VX4332.

A hardware trigger is a pulse on one of eight VXIbus lines on the VXIbus backplane. These lines are labeled TTLTRG0* through TTLTRG7* and are intended to allow modules to communicate with each other directly without creating any VME data bus transfers.

Modules that will communicate using the VXIbus trigger lines must be set up so that the source and acceptor(s) are on the same line and are not in conflict with other modules using TTL trigger lines. In this document these lines are referred to as VXIbus TTL trigger lines (TTLTRG).

The VX4332 can both generate a VXIbus TTLTRG and use a VXIbus TTLTRG from another module in a variety of ways. VXIbus TTL trigger lines may be used to coordinate the VX4332 with other modules in a VXI mainframe. This is especially useful when the VX4332 is used in program mode.

For example, the VX4332 can generate a trigger on one of the VXIbus TTL trigger lines when a channel has closed or with a TRIGGER command. This could signal a DMM in the same cage to take a reading.

In a similar manner, the DMM could signal the VX4332 on a different trigger line that it has completed the reading and the VX4332 should close the relay for a different channel. The VX4332 would wait for this trigger with a TRIGGER WAIT command.

The TRIGGER WAIT command can also be satisfied with a software trigger as described above.

The two 10-pin connectors on the VX4332 face plate have an ENCODE signal. This is a TTL signal that goes low for approximately 30 microseconds after a selected channel

has fully closed. A separate ENCODE signal is available for each scanner. For instance, if the two sections of a VX4332 are not joined, the ENCODE signal on P5 will go low only after a relay in Section A is closed. If the two sections are joined, the ENCODE signal on both P5 and S6 will go low after a relay in either Section A or Section B is closed.

The scanning system can be coordinated in many possible ways by communicating between a system controller, a measurement device(s), and the VX4332, using:

TRIGGER
SET TRIGGER OUT
    for selecting a VXIbus TTLTRG line for the TRIGGER command
TRIGGER WAIT

SET TRIGGER IN
    for selecting a VXIbus TTLTRG line for the TRIGGER WAIT command
Request True Interrupts
    including USER_ INTERRUPT
Encode Signal

Miscellaneous Commands

WAIT n — causes a delay of n milliseconds. This command would be useful to cause a delay between the end of a relay close time and the next CLOSE command to allow a device to make a measurement.

RESET — resets the VX4332 to its power-up state.

Display Messages

The four character alphanumeric display on the front panel of the VX4332 normally displays either "open" or the last relay closed in either mmrr (module/relay number) format or symbolic name format. It also displays status or error messages. The symbolic names are always in capital letters, and the status or error messages are lower case letters. Some errors also generate error messages that can be read back after the LIST? ERRORS command (see Appendix D).

The following is a list of the possible displays and a brief description:

test — This message is displayed briefly during power-up or a hardware reset, while the VX4332 is conducting a self test.

romE — This message is displayed on power-up or reset if the VX4332 firmware checksum is not zero. An error message is also generated (see Appendix D). If the VX4332 is able to continue, this display will be replaced by "open", but the software error message will remain.

ramE — This message is displayed on power-up or reset if the VX4332 RAM self test fails. An error message is also generated (see Appendix D). If the

VX4332 is able to continue, this display will be replaced by "open", but the software error message will remain.

open — This is the normal message when no relays are closed.

0012 — Four numbers indicate the last relay closed, in mmrr format (see Command Syntax). The display is not updated if a chained external master opens this relay. Reading the default readback message updates the display.

NAME — Capital letters indicate the last relay closed, in symbolic format. The display is not updated if a chained external master opens this relay. Reading the default readback message updates the display.

inpt — This message indicates the VX4332 has received a PROGRAM INPUT command and has not yet received a PROGRAM END command.

ovrf — The ovrf message indicates that the VX4332 memory was exceeded while inputting a program with the PROGRAM INPUT command. The VX4332 will continue to accept program input until a PROGRAM END command is received, but the entire program will be ignored. A software error message is also generated.

odly — This message is displayed during the open delay time when a relay is opened. The open delay time is usually short enough that this message is not readable.

wait — This message is displayed for the duration of WAIT commands.

trgw — This message indicates the VX4332 is waiting for a trigger.

clsf — This error message indicates that the last relay closed did not verify closed. A software error message is also generated.

opnf — This message indicates that the VX4332 hardware detected a relay closed after an attempt to open it. A software error message is also generated.

Using Multiple Masters

Up to three master/slave systems may be joined/chained together in one to three mainframes. A master/slave relationship is created by common connections on the VXIbus local bus. The JOIN command and cabling are used for joining/chaining.

Each master can only close its own and its slaves' relays. Any of the masters can open a relay controlled by another master, assuming they are joined/chained together. To chain two master/slave systems together, a VX1635 cable is used from the S6 connector of the last slave of one system to the P5 connector of the master of the next system. If the two systems are in different mainframes, the VX1635 cable is available in longer lengths.

Masters have limited knowledge of what is happening when they are chained together in systems. A master knows if another master "downstream" (lower in the hierarchy) is chained. It also knows if that system has a relay open or closed, although it does not know which relay. In its readback message, the master will indicate the status of the downstream master as "XOPN" or "XCLS" to indicate that an external master or a downstream master has a relay open or closed.

Using Figure 7 for example, assume that system A has received the commands JOIN 0, JOIN 1 and JOIN 2, and that system B has received the commands JOIN 0 and JOIN 1.

System A knows it is chained to system B. When no relays are closed, the default readback message from system A is "OPEN XOPN". If a relay is closed in system B by sending system B the message C 125, the system A readback message will be "OPEN XCLS". The system A front panel display will show "open" in both of these cases.

If the command C 5 is sent to system A, a scan clear signal is generated by system A that will open the relay in system B. The relay is verified open by system A, and relay 5 in system A is closed. The system A readback message will now be "0005 XOPN".

If system B is then commanded to close a relay, system B generates a scan clear signal to open system A's relay. System B does not know it is chained to system A nor can it know when system A has a relay closed.

A master module uses its own open delay time as part of its CLOSE command when it is unaware of any relay being closed. Both the system A and system B masters' open delay times should be programmed to the longest open time required by either system.

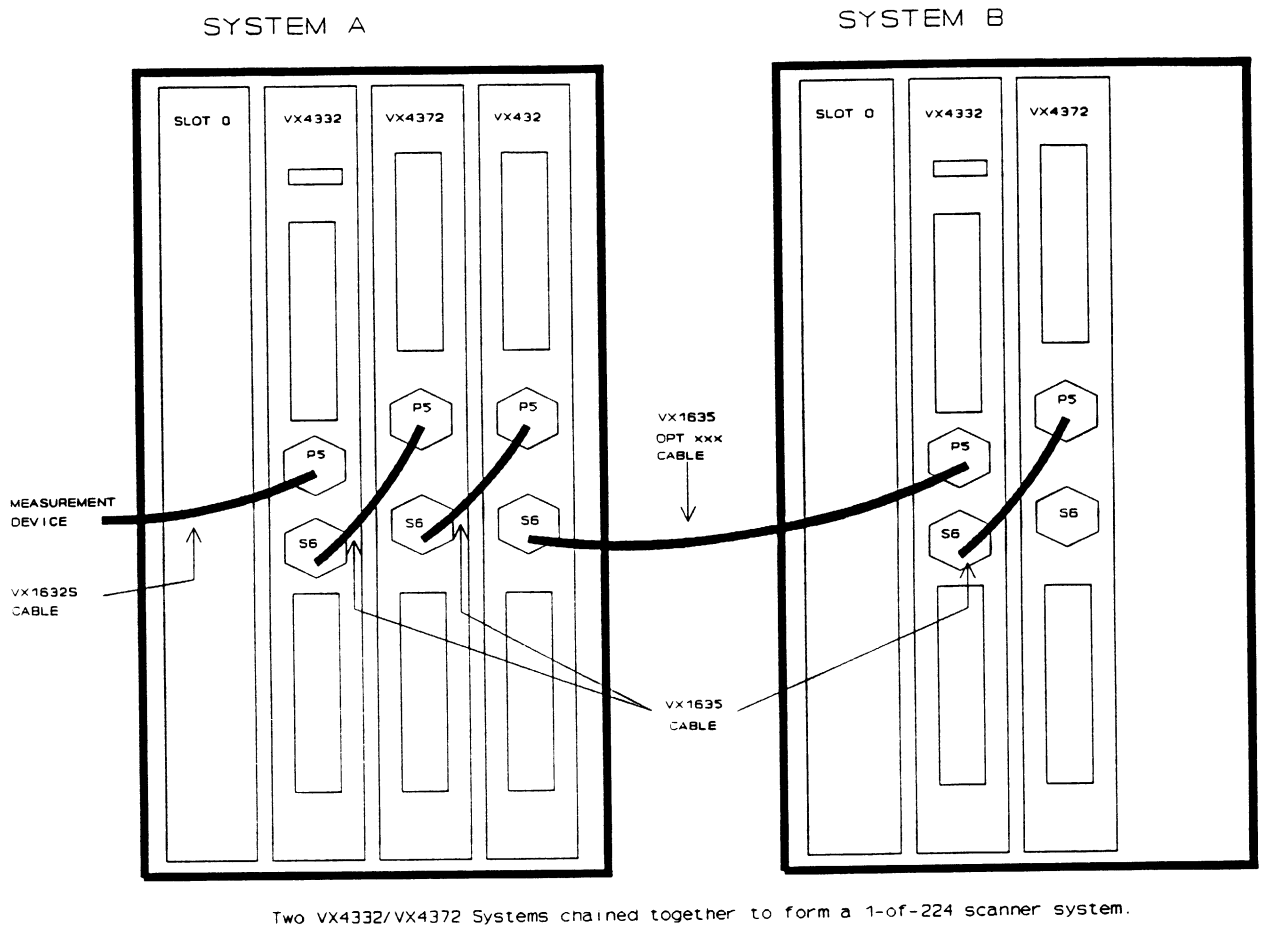


Figure 7: Multiple Masters Example

Power-up

The VX4332 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 front panel alphanumeric display will show "test". The default condition of the module after power-up is described in the SYSFAIL, Self Test and Initialization subsection.

System Commands

These low-level commands are typically sent by the module's commander, transparent to the user of the module. An exception is the Read Status command, which is sent whenever a Serial Poll on an IEEE-488 system is performed. Most commanders or Slot 0 devices have specific ASCII commands which will cause them to send one of these low-level commands to a specified instrument. Refer to the Operating Manual of the commander or Slot 0 device for information on these commands.

Command	Effect
Clear	The module clears its VXIbus interface and any pending commands. Current module operations are unaffected.
Trigger	If enabled, causes the VX4332 to continue from a TRIGGER WAIT command.
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.
Set Lock	Bit 7 of the Response register is cleared (true).
Clear Lock	Bit 7 of the Response register is set (false).

Module Commands

A summary of the VX4332's Module's commands is listed below. This is followed by detailed descriptions of each of the commands. A sample BASIC program using these commands is shown in the Programming Examples section.

Command Syntax

Command protocol and syntax for the VX4332 Module are as follows:

1) Each command consists of a series of characters, terminated by a ; or line-feed character. Parameters may not be "wrapped around" (continued after the terminator). Spaces and tabs should be used to separate fields within commands. All other control characters will be ignored. Several commands may be sent on one line by separating the commands with semi-colons and ending the line with a line feed character.

2) 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.

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

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

4) 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 semicolon or <lf>.

   - In place of any space character listed in the following command formats.

   Any number of white space characters may be used together.

5) Data returned by the module in response to an input request is shown underlined in the examples.

Most of the commands have a long and a short form. Either form may be used at any time. For example, all the following forms of the command LIST? MODULE 6 are correct:

list? module 6
LM 6
LIST? Module 6

Lst Mdl 6 would generate a syntax error.

In the following descriptions of the VX4332 commands, the term "mmrr" is used frequently. The "mm" represents the module number (00-11) and the "rr" represents the relay number on that module (00-99). Relay 17 on the third slave would be referred to as 0317. Leading zeros may be omitted. For example, relay 03 on the master could be referred to as 0003 or 003 or 03 or just 3. Relay 05 of the second slave could be 0205 or 205, but not 25.

Each slave module may have a different number of relays. Refer to the operating manual of each module to determine the number of relays.

Summary

Detailed descriptions of each command (in alphabetical order) are given following the summary. In this summary and the following detailed descriptions, the command words are in capital letters and the arguments in lower case. The short form of the command follows the full form listing.

Command	Action

ASSIGN associates a symbolic [name] with a module/relay [mmrr] number.
ASSIGN [name] [mmrr]<tm> or A [name] [mmrr]<tm>

CLOSE causes relay [name]/[mmrr] to be connected to the analog bus.
CLOSE [mmrr]<tm> or C [mmrr]<tm>
CLOSE [name]<tm> or C [name]<tm>

DISJOIN disjoins module mm so that its A and B sections are two separate sections.
DISJOIN [mm]<tm> or D [mm]<tm>

FAST causes relay [name/[mmrr] to be closed (same as the CLOSE command)
FAST [mmrr]<tm> or F [mmrr]<tm>
FAST [name]<tm> or F [name]<tm>

INTERRUPT enables or disables generating a Request True interrupt on the VXIbus on various events.
INTERRUPT ERROR ENABLE<tm> or IEE<tm>
INTERRUPT ERROR DISABLE<tm> or IED<tm>
INTERRUPT PROGRAM_DONE ENABLE<tm> or IPE<tm>
INTERRUPT PROGRAM_DONE DISABLE<tm> or IPD<tm>
INTERRUPT RELAY_CLOSED ENABLE<tm> or IRE<tm>
INTERRUPT RELAY_CLOSED DISABLE<tm> or IRD<tm>
INTERRUPT TRIGGER_IN ENABLE<tm> or ITE<tm>
INTERRUPT TRIGGER_IN DISABLE<tm> or ITD<tm>

JOIN joins the A and B sections of module mm.
JOIN [mm]<tm> or J [mm]<tm>

LIST? makes data available from the VX4332.

LIST? ASSIGNMENTS<tm> or LA<tm>
LIST? CONFIGURATION<tm> or LC<tm>
LIST? ERRORS<tm> or LE<tm>
LIST? MODULE [n]<tm> or LM [n]<tm>
LIST? MODULE ALL<tm> or LMA<tm>
LIST? PROGRAM<tm> or LP<tm>
LIST? STEPS<tm> or LS<tm>
LIST? VERSION<tm> or LV<tm> or REV?<tm>

OPEN opens all closed relays or opens relay [name]/[mmrr] or any relay closed in any sections joined to [name]/[mmrr].

OPENALL<tm> or OA<tm>
OPEN [mmrr]<tm> or O [mmrr]<tm>
OPEN [name]<tm> or O [name]<tm>

PROGRAM controls the use of programs for the VX4332.

PROGRAM END<tm> or PE<tm>
PROGRAM GO [n]<tm> or PG<tm>
PROGRAM INPUT<tm> or PI<tm>
PROGRAM PAUSE<tm> or PP<tm>
PROGRAM STEP [n]<tm> or PS [n]<tm>
PROGRAM STEP<tm> or PS<tm>

RESET resets the VX4332 to its power-up state.

RESET<tm> or R<tm>

SET sets various operating parameters.

SET CLOSE_TIME [mm] [n]<tm> or SC [mm] [n]<tm>
SET CLOSE_TIME ALL [n]<tm> or SCA [n]<tm>
SET NAME ENABLE<tm> or SNE<tm>
SET NAME DISABLE<tm> or SND<tm>
SET OPEN_TIME [mm] [n]<tm> or SO [mm] [n]<tm>
SET OPEN_TIME ALL [n]<tm> or SOA [n]<tm>
SET TRIGGER IN DISABLE<tm> or STID<tm>
SET TRIGGER IN [n]<tm> or STI [n]<tm>
SET TRIGGER OUT DISABLE<tm> or STOD<tm>
SET TRIGGER OUT [n]<tm> or STO [n]<tm>

TRIGGER trigger commands.

TRIGGER [n]<tm> or T [n]<tm>
TRIGGER<tm> or T<tm>
TRIGGER WAIT<tm> or TW<tm>

USER_INTERRUPT causes a Request True Interrupt on the VXIbus.

USER_INTERRUPT [n]<tm> or U [n]<tm>

WAIT causes the module to wait n milliseconds.

WAIT [n]<tm> or W [n]<tm>

Command Descriptions

Command: ASSIGN

Syntax: ASSIGN [name] [mmrr]<tm>
A [name] [mmrr]<tm>

Purpose: The ASSIGN or A command associates a symbolic [name] with a module/relay number [mmrr].

Description: The [name] must start with an alphabetic character, and may be up to four characters long. The alphabetic characters may be either upper or lower case, since they are internally converted to upper case. The other characters may be any printing character other than a semi-colon. The module can store up to 850 assignments.

After a name is assigned, the name may be used in place of the module/relay number.

Examples:

ASSIGN TP24 7	Relay 07 of the master may now be referred to as TP24.
A TP3 417	Relay 17 of the 4th slave may now be referred to as TP3.

Command: CLOSE

Syntax:
CLOSE [mmrr]<tm>
C [mmrr]<tm>
CLOSE [name]<tm>
C [name]<tm>

Purpose: The CLOSE or C command causes the specified relay to be connected to the analog bus.

Description: If CLOSE [mmrr] is used, relay [mmrr] is specified. CLOSE [name] or C [name] is the same except that the symbolic name is converted to its [mmrr] equivalent (see ASSIGN command).

The CLOSE command will verify that any previously closed relay is open before closing the new relay. Also, the new relay is verified closed. Failure of these steps will result in a OPNF (open fail) or CLSF (close fail) error display and message. See also the FAST command.

If the VX4332 is queried (other than after one of the LIST? commands and if not in the program state), a default query response returns the relay status of the scanner system. The response is of the form:

xxxx xxxx ... xxxx<sp><cr><lf>

with a "xxxx" field for each separate scan system under this master. As the JOIN and DISJOIN commands are used, the number of fields will change. The contents of the "xxxx" field for each of the scan systems will be one of the following:

OPEN	If no relay is closed.
[mmrr]	If relay mmrr was last closed or a relay name was used but the command SET NAME DISABLE was used.
[name]	If relay [name] was last closed and NAME is set enabled.
XOPN	If the last module is chained to another master and that master/slave system has no relay closed.
XCLS	If the last module is chained to another master and that master/slave system has a relay closed.

Examples:

CLOSE 1004	Relay 04 of the 10th slave will be closed.
C 2	The master's relay 02 will be closed.
C TP24	The relay number assigned to TP24 is closed.

Command: DISJOIN

Syntax: DISJOIN [mm]<tm>
D [mm]<tm>

Purpose: This command disjoins (splits) module mm.

Description: Module mm is disjoined (split) so that its A and B sections are two separate sections.

This is the power-up or reset condition.

Example:

DISJOIN 4	The join relays of the fourth slave are opened.
DISJOIN 0	The join relays of the master are opened.

Command: FAST

Syntax:
FAST [mmrr]<tm>
F [mmrr]<tm>
FAST [name]<tm>
F [name]<tm>

Purpose: The FAST or F command causes the specified relay to be connected to the analog bus.

Description: If FAST [mmrr] is used, relay [mmrr] is specified. FAST [name] or F [name] is the same except that the symbolic name is converted to its [mmrr] equivalent (see ASSIGN command).

This command is the same as a CLOSE command, except that the relays involved are not verified, which speeds up execution of the command. See also the CLOSE command.

If the VX4334 is queried (other than after one of the LIST? commands and if not in the program state), a default query response returns the relay status of the scanner system. The response is of the form:

xxxx xxxx ... xxxx<sp><cr><lf>

with a "xxxx" field for each separate scan system under this master. As the JOIN and DISJOIN commands are used, the number of fields will change. The contents of the "xxxx" field for each of the scan systems will be one of the following:

OPEN	If no relay is closed.
[mmrr]	If relay mmrr was last closed or a relay name was used but the command SET NAME DISABLE was used.
[name]	If relay [name] was last closed and NAME is set enabled.
XOPN	If the last module is chained to another master and that master/slave system has no relay closed.
XCLS	If the last module is chained to another master and that master/slave system has a relay closed.

Examples:

FAST 1004	Relay 04 of the 10th slave will be closed.
F 2	The master's relay 02 will be closed.
F TP14	The relay number assigned to TP14 is closed.

Command: INTERRUPT

Syntax:
INTERRUPT [type] ENABLE<tm>
INTERRUPT [type] DISABLE<tm>
I[type]E<tm>
I[type]D<tm>

Purpose: The interrupt commands enable or disable generating a Request True interrupt on the VXIbus on the occurrence of various events.

Description: [type] indicates the type of interrupt to be enabled or disabled. Each of the types is described on the following pages. This discussion applies to all the Interrupt commands.

A Request True interrupt to the VX4332's interrupt handler will alert the handler that the VX4332 requires service. In a typical system controlled by a system controller over the IEEE-488 interface, the VX4332's interrupt handler will be located on its commander, and the commander will generate an IEEE-488 Service Request (SRQ) to the system controller. If the system controller then issues a serial poll command to the VX4332, the VX4332 will return an eight-bit byte with a code to indicate the cause of the interrupt.

The decimal values of the byte returned by the serial poll are as follows:

1	User interrupt 1
2	User interrupt 2
4	Relay Closed
8	Program Done
16	Error (LIST? ERRORS command returns the error)
128	TTL trigger in

If the serial poll byte is non-zero, 64 decimal is added to the above values. If more than one event has occurred, the values plus the value 64 are added together.

For example, if a syntax error occurred, the byte returned to a serial poll would be 16 + 64 = 80 decimal. If both a TTL Trigger In and Program Done occurred, 128 + 8 + 64 = 200 would be returned.

Example: See examples for the various Interrupt commands on the following pages.

Command: INTERRUPT ERROR

Syntax:
INTERRUPT ERROR ENABLE<tm>
IEE<tm>
INTERRUPT ERROR DISABLE<tm>
IED<tm>

Purpose: These commands will enable or disable a Request True interrupt for an error condition.

Description: If enabled, the error interrupt occurs when the VX4332 detects one of the following conditions:

- a relay failed to open after the relay open delay.
- a relay failed to close after the relay close delay.
- a syntax error was detected.

Error messages are stored in a queue and are available for readback after a LIST? ERRORS command. An overflow of the error queue will result in new errors being lost. An overflow error will be added to the end of the queue. The Error LED will remain on until the error queue is emptied by reading after a LIST? ERRORS command.

See Appendix D for a list of error messages.

Example: IEE<tm> Request True interrupt for an error condition is enabled.

Command: INTERRUPT PROGRAM_DONE

Syntax: INTERRUPT PROGRAM_DONE ENABLE<tm>
IPE<tm>
INTERRUPT PROGRAM_DONE DISABLE<tm>
IPD<tm>

Purpose: These commands will enable or disable a Request True interrupt at the end of a program.

Description: When enabled, this interrupt will occur at the completion of a PROGRAM GO command.

Example:

IPE<tm>	Request True interrupt at the end of a program is enabled. This interrupt will occur at the completion of a program stored in the VX4332.

Command: INTERRUPT RELAY_CLOSED

Syntax:
INTERRUPT RELAY_CLOSED ENABLE<tm>
IRE<tm>
INTERRUPT RELAY_CLOSED DISABLE<tm>
IRD<tm>

Purpose: These commands will enable or disable a Request True interrupt after a relay has been closed.

Description: When enabled, the relay closed interrupt occurs at the end of the relay close delay time.

Example:
IRD<tm> Request True interrupt after a relay has been closed is disabled. When a relay closes, no interrupt will occur.

Command: INTERRUPT TRIGGER_IN

Syntax:
INTERRUPT TRIGGER_IN ENABLE<tm>
ITE<tm>
INTERRUPT TRIGGER_IN DISABLE<tm>
ITD<tm>

Purpose: These commands will enable or disable a Request True interrupt when a trigger is received.

Description: If enabled, an interrupt is generated when a pulse is detected on the VXIbus TTL trigger line selected by the SET TRIGGER IN command.

Example: ITD<tm> Request True interrupts generated after a trigger has been received are disabled.

Command: JOIN

Syntax: JOIN [mm] <tm>
J [mm]<tm>

Purpose: This command joins the A and B sections of module mm.

Description: On power-up and reset, the A and B sections are not joined. Therefore this command must be sent to the VX4332 for the VX4332 A and B sections to be joined. If the VX4332 is controlling slave modules, this command must be sent for each slave module that is to have its A and B sections joined. Whether adjacent modules are joined or not is determined by the cabling.

When joined, closing a relay in section A will automatically open any relay in either Section A or Section B. The same is true when closing a relay in Section B.

Examples:

J 0	Join the two sections of the VX4332 (master). It will then be a 1-of-40 scanner.
J 2	Join the two sections of the second slave module controlled by the VX4332.

Command: LIST?

Syntax: LIST? [type]<tm>
L[type]<tm>

Purpose: The LIST? commands specify the response to be returned from the VX4332 on a query following the command.

Description: [type] specifies the type of data to be listed. Each type is described on the following pages; this discussion applies to all the LIST? commands.

Following a LIST? command, data will be returned to the system controller in response to a subsequent read from the module. The returned data will be as defined for each type of LIST? command on the following pages. Any or all of the data may be read. If another command is received before all the data is read, the remaining data is discarded and the new command executed. With all LIST? commands, a <sp><cr><lf> is returned after all data has been read.

If the VX4332 is read other than after one of the LIST? commands, a default message returns the relay state of the scanner system, if not in the program state. The message is of the form:

xxxx xxxx ... xxxx<sp><cr><lf>

with a "xxxx" field for each separate scan system under this master. Response format details are given in the OPEN and CLOSE command descriptions.

If the VX4332 is executing a scan table (it is in the program state), reading from the module returns a message describing the program state. See the PROGRAM GO command description for response format details.

Command: LIST? ASSIGNMENTS

Syntax: LIST? ASSIGNMENTS<tm>
LA<tm>

Purpose: This command specifies that the response to the next input request from the VX4332 contain the [name]/[mmrr] assignments that are currently in memory.

Description: The assignments will be in alphabetical order by name. Names with less than four characters are left justified in a field of 4.

[NAME] [mmrr]<cr><lf>
.
.
<sp><cr><lf>

This command may not be included as part of a program definition (may not be included between a PROGRAM INPUT and a PROGRAM END command).

Example: A tree 7
A TP6 3
LA
TP6 0003<cr><lf>
TREE 0007<cr><lf>
<sp><cr><lf>

The name "tree" is assigned to relay 7 and the name "TP6" is assigned to relay 3. The command LA specifies that the relay name assignment list is to be returned in response to the next query. The lines following the LA command, shown underlined, are the responses returned. The space, carriage return, and line feed terminate the response list.

Command: LIST? CONFIGURATION

Syntax: LIST? CONFIGURATION<tm>
LC<tm>

Purpose: This command specifies that the response to the next input request from the VX4332 contain the status of the program, values of the timing parameters, trigger line and interrupt settings.

Description: The returned data will have the following format:

NO PROGRAM IN MEMORY
or
PROGRAM NOT CONTINUABLE
or
LOOP xxxxx, STEP xxxxx, PROGRAM PAUSED

PROGRAM MEMORY LEFT: xxxxx<cr><lf>
(The number of characters remaining for the program)

ASSIGNMENT MEMORY LEFT: xxx<cr><lf>
(The number of additional name assignments that may be made)

INTERRUPT PROGRAM DONE: ENABLED (or DISABLED)<cr><lf>
INTERRUPT ON ERROR: ENABLED (or DISABLED)<cr><lf>
INTERRUPT RELAY CLOSED: ENABLED (or DISABLED)<cr><lf>
INTERRUPT TRIGGER IN: ENABLED (or DISABLED)<cr><lf>
NAME: ENABLED (or DISABLED)<cr><lf>
TRIGGER OUT: n (or DISABLED)<cr><lf>
TRIGGER IN: n (or DISABLED)<cr><lf>
<sp><cr><lf>

This command may not be included as part of a program definition (may not be included between a PROGRAM INPUT and a PROGRAM END command).

Example: If the LIST? CONFIGURATION command is sent following power-up, before any other commands are sent, the response (shown underlined) to a query to the VX4332 will be the following (power-up or reset default settings):

NO PROGRAM IN MEMORY<cr><lf>
PROGRAM MEMORY LEFT: 15000<cr><lf>
ASSIGNMENT SPACE LEFT: 850<cr><lf>
INTERRUPT PROGRAM DONE: DISABLED<cr><lf>
INTERRUPT ON ERROR: ENABLED<cr><lf>
INTERRUPT RELAY CLOSED: DISABLED<cr><lf>
INTERRUPT TRIGGER IN: DISABLED<cr><lf>
NAME: ENABLED<cr><lf>
TRIGGER OUT: DISABLED<cr><lf>
TRIGGER IN: DISABLED<cr><lf>
<sp><cr><lf>

Command: LIST? ERRORS

Syntax: LIST? ERRORS<tm>
LE<tm>

Purpose: LIST? ERRORS specifies that the response to the next input request from the VX4332 contain any error messages that have been generated since the last LIST? ERRORS command.

Description: The error message buffer is limited to ten messages. If an overflow occurs, new messages will be lost but a buffer overflow error will be added to the buffer. One error message is returned per read and is terminated by a <cr><lf>. The list of errors is terminated by a <sp><cr><lf>. The front panel ERR light is lit whenever an error message is generated, and unlit when they have all been read.

See Appendix D for a list of the error messages.

This command may not be included as part of a program definition (may not be included between a PROGRAM INPUT and a PROGRAM END command).

Example:
r<cr><lf>
foobar<cr><lf>
c 99<cr><lf>
le<cr><lf>
A,SYNTAX ERROR<cr><lf>
Y,RELAY FAILED TO CLOSE<cr><lf>
<sp><cr><lf>

The r command resets the module and clears the error buffer. "foobar" causes a syntax error. Closing (non-existent) relay 99 causes a Relay Failed To Close error. The lines following the le command, shown underlined, are the responses returned when the VX4332 is subsequently queried. The space, carriage return, and line feed terminate the response list. The "A," and "Y," characters are unique letters that precede each error message (see Appendix D) that allow for simple error type detection in software.

Command: LIST? MODULE

Syntax: LIST? MODULE [n]<tm>
LM [n]<tm>

Purpose: This command specifies that the response to the next input request from the VX4332 contain the status of module n, where the VX4332 is module 0 and any slaves are modules 1 through 11.

Description: The returned data has the format:

mm ca cb Id Xd bsa bsb VX4ttt ra rb ooo ccc ooooo ccccc<cr><lf>

where:

- mm - module number (always 2 digits).
- ca - Section A closed relay number or ?? (always 2 digits).
- cb - Section B closed relay number or ?? (always 2 digits).
- Id - either IJ for joined or ID for disjoined internally.
- Xd - either XJ for cabled or XD for not cabled to a module to the right.
- bsa - base module and section for Section A (2 digits and the letter A or B).
- bsb - base module and section for Section B (2 digits and the letter A or B).
- VX4ttt - module type (VX4332, 372, etc.).
- ra - number of relays in Section A.
- rb - number of relays in Section B.
- ooo - default open time in milliseconds.
- ccc - default close time in milliseconds.
- ooooo - programmed open time in milliseconds.
- ccccc - programmed close time in milliseconds.

ca/cb: ?? is returned if a relay is not closed. Both ca and cb will be returned whether Sections A and B are joined or not. If Sections A and B are joined, the section without a relay closed will return ??.

bsa/bsb: bsa and bsb are the base module and section for Sections A and B of module n. For example, if an LM 1 command is issued to determine the base module and section of the first slave, and the master and slave are cabled, and both are joined, a value of 00A will be returned for both bsa and bsb. If the slave was not joined but the master was joined and cabled to Section A of the slave, then 00A would be returned for bsa and 01B would be returned for bsb.

Example:

c 135<cr><lf>
lm 1<cr><lf>
01 ?? 35 ID XD 01A 01B VX4372 24 24 1 1 1 1<cr><lf>

The command c 135 closes relay 35 on module 1. The lm 1 command requests status on module 1. The line following the lm1 command, shown underlined, is the returned status data. The status returned indicates status is for module 1, that Sections A and B are not joined, that no relay is closed on Section A and relay 35 is closed on Section B. XD indicates that it is not cabled to module 2.

01A indicates that the base module and section for Section A is module 1 Section A (this module is not cabled to module 0). 01B confirms that section B is not joined to Section A. The remaining characters indicate that module 1 is a VX4372 Module with 24 relays in each section, and with both default and programmed open and close delays of one millisecond.

Command: LIST MODULE ALL

Syntax: LIST? MODULE ALL<tm>
LMA<tm>

Purpose: This command specifies that the response to the next input request from the VX4332 contain the status of the VX4332 and any slaves connected to it on the local bus.

Description: The format is the same as for LIST? MODULE, except that a line is made available for the VX4332 and each slave. The data will be terminated by a <sp><cr><lf>.

This command may not be included as part of a program definition (may not be included between a PROGRAM INPUT and a PROGRAM END command).

Example:

```
r; j 1;c; 5;c 25;c 107;c 135;c 214;lma<cr><lf>
00 05 25 ID XD 00A 00B VX4332 20 20  1  1  1  1<cr><lf>
01 ?? 35 IJ XD 01A 01A VX4372 24 24  1  1  1  1<cr><lf>
02 14 ?? ID XD 02A 02B VX4372 24 24  1  1  1  1<cr><lf>
<sp><cr><lf>
```

The first line in the example programs the VX4332 master and two slaves, and the lma command requests status for all three modules. The last four lines, shown underlined, are the responses returned, indicating the status for modules 0, 1, and 2, and a space terminator to indicate that there is no module 3 connected via the VXIbus local bus.

The data returned for the three modules indicates that they are not cabled to each other and that only module 1 is joined. Relay closure data indicates that relay 5 in Section A of module 0, relay 25 in Section B of module 0, relay 35 in the joined A and B Sections of module 1, and relay 14 in Section A of module 2 are all closed. No relay is closed in Section B of module 2.

Command: LIST? PROGRAM

Syntax: LIST? PROGRAM<tm>
LP<tm>

Purpose: This command specifies that the response to the next input request from the VX4332 contain the program stored in the VX4332.

Description: The response will list the commands just as they were entered. A read is required for each line of commands that was terminated by a line feed character. The last line of program will be followed by a <sp><cr><lf>.

This command may not be included as part of a program definition (may not be included between a PROGRAM INPUT and a PROGRAM END command).

Example: Assume the following commands are sent:

```
program input;c 1;c 2<cr><lf>
c 3;program end<cr><lf>
list? program<cr><lf>
```

Then if the VX4332 is queried three times, the following will be returned:

```
c 1;c 2<cr><lf>
c 3;program end<cr><lf>
<sp><cr><lf>
```

Note that the module returns lower case letters if it was programmed with lower case letters. This is the only situation where the VX4332 will return lower case letters as part of a response. Response data is shown underlined.

Command: LIST? STEPS

Syntax: LIST? STEPS<tm>
LS<tm>

Purpose: This command specifies that the response to the next input request from the VX4332 contain the program stored in the VX4332, listed one command or step at a time with each step preceded by a step number.

Description: The response for each step includes its original terminator plus a <cr><lf>. A command that was terminated with a <cr><lf> will therefore generate <cr><lf> twice in the response. The last step is followed by a <sp><cr><lf>.

This command may not be included as part of a program definition (may not be included between a PROGRAM INPUT and a PROGRAM END command).

Example: If the following commands are sent:

```
program input;c 1;c 2<cr><lf>
c 3;program end<cr><lf>
list? steps<cr><lf>
```

and then if the VX4332 is queried until it returns a <sp><cr><lf>, the following will be returned:

```
1 c 1;
2 c 2

3 c 3;
4 program end
```

Or more exactly:

```
<4 spaces>1 c 1;<cr><lf>
<4 spaces>2 c 2<cr><lf>
<cr><lf>
<4 spaces>3 c 3;<cr><lf>
<4 spaces>4 program end<cr><lf>
<cr><lf>
<sp><cr><lf>
```

Note that the c2 command which was terminated with a <cr><lf> returned <cr><lf> twice in the response. Response data is shown underlined.

Command: LIST? VERSION

LIST? VERSION<tm>
LV<tm>
REV?<tm>

Purpose: These commands specify that the response to the next input request from the VX4332 contain the version of the firmware contained in the VX4332.

Description: The format of the response is: VERSION X.X<cr><lf>

Example: LV<cr><lf>

returns VERSION 1.4<cr><lf>. Response data is shown underlined.

Command: OPEN

Syntax:
OPENALL<tm>
OA<tm>
OPEN [mmrr]<tm>
O [mmrr]<tm>
OPEN [name]<tm>
O [name]<tm>

Purpose: The OPENALL command opens all closed relays. The OPEN [mmrr]/[name] command opens relay [mmrr]/[name] and any relay closed in any sections on any module joined to [mmrr]/[name].

Description: Following the OPENALL command and the opening of all relays, an open delay time occurs as part of the command. The length of the delay is the maximum of all the modules' programmed delay times.

The command does not open the relays that join the A and B sections of a module together.

For the OPEN or OPENALL command, an error is not generated if relays were not closed. However, an error is generated if a relay that was closed does not open.

If the VX4332 is queried following an OPEN command, a default response contains the open relay status of the scanner system. The returned message is of the form:

xxxx xxxx ... xxxx<sp><cr><lf>

with an "xxxx" field for each separate scan system under this master. As the JOIN and DISJOIN commands are used, the number of fields will change. The contents of the "xxxx" field for each of the scan systems will be one of the following:

OPEN	For each module that is part of this master/slave system.
XOPN	If the last module is chained to another master and that master has no relay closed in its system.
XCLS	If the last module is chained to another master and that master has a relay closed in its system (see the Using Multiple Masters subsection).

If an error condition exists such that a relay is still closed, the closed relay will be reported in the following format:

[mmrr]	If relay mmrr is closed. (This format is also used if relay [name] was assigned but the command SET NAME DISABLE was used.)
[name]	If relay [name] is closed and NAME is set enabled.

Example:	OPENALL	All relays are opened. The join relays are not affected.
	O 103<tm>	The closed relay in all sections joined to the section on module 1 containing relay 03 is opened.

Command: PROGRAM END

Syntax: PROGRAM END<tm>
PE<tm>

Purpose: This command terminates the PROGRAM INPUT command.

Example: PE<tm> will cause the VX4332 to exit the program creation mode that was entered by the PROGRAM INPUT command.

Command: PROGRAM GO

Syntax:
PROGRAM GO [n]<tm>
PG [n]<tm>
PROGRAM GO<tm>
PG<tm>

Purpose: This command causes the VX4332 to execute the sequence of commands stored in it with the PROGRAM INPUT command.

Description: The program is repeated n times (loop count), where n is 0 to 32767. If the loop count is 0, the program repeats until stopped. If the loop count value is omitted, the program is executed once. The program will be stopped and any closed relay opened by one of the following events:

- a VXIbus system reset.
- a VXI Abort Normal Operation command.
- a VXI End Normal Operation command.
- any hardware or syntax error.

A query of the VX4332 while the program is executing returns a message of the following format at the end of the currently executing step:

LOOP xxxxx, STEP xxxxx, PROGRAM RUNNING
or
LOOP xxxxx, STEP xxxxx, TRIGGER WAIT

If any command is sent to the VX4332, the program is terminated at the end of the currently executing step and the new command is executed. The program is then in a pause mode and may be continued with the PROGRAM STEP command.

A PROGRAM GO command is not valid as part of a program definition (should not be included between PROGRAM INPUT and PROGRAM END statements).

Example: PG 5 The program will repeat five times, assuming no interruptions.

Command: PROGRAM INPUT

Syntax: PROGRAM INPUT<tm>
PI<tm>

Purpose: Commands sent to the VX4332 after this command are stored in the VX4332's memory for execution later.

Description: The PROGRAM INPUT command initiates creation of an internal program in the VX4332. A PROGRAM END statement indicates the end of the program. A program is typically used to create a list of channels to be scanned in a specified order.

The PROGRAM GO or PROGRAM STEP will initiate execution of the program. The commands are stored as sent, so using the short form will greatly increase the number of commands that can be stored. The VX4332 has the capacity to store 15,000 command characters. The PROGRAM INPUT command, RESET command, or a hardware reset will erase any previously entered program.

Example:

PROGRAM INPUT<tm>	All statements following this statement until a PROGRAM END statement is sent will become an internal program stored in the VX4332 that may be executed with a subsequent PROGRAM GO or PROGRAM STEP statement.

Command: PROGRAM PAUSE

Syntax: PROGRAM PAUSE<tm>
PP<tm>

Purpose: An executing program pauses at this command and returns to accepting commands from the system controller.

Description: The internal VX4332 program stops when this command is encountered in the program. The VX4332 returns to accepting commands from the system controller and continues the next statement of the VX4332 internal program only after a PROGRAM STEP command is sent. This command is only valid as part of a program definition (is only valid when included between PROGRAM INPUT and PROGRAM END statements).

Example:

```
r;pi;c 0;c 1;pp;c 2;c 3;pe;pg<cr><lf>
0001 OPEN<cr><lf>
lc<cr><lf>
LOOP  1, STEP  4,  PROGRAM PAUSED<cr><lf>
ps 0<cr><lf>
0003 OPEN<cr><lf>
```

Line 1 of the above example first resets the module (R) then commands the module to accept a program (PI). The command string c 0;c 1;pp;c 2;c 3 instructs the module to close relay 0, then relay 1 and then pause. When restarted after the pause (program stop), the module will close relay 2 and then relay 3. The PE instructs the module to exit the program load mode, while PG instructs the module to begin executing the program.

After relay 1 has closed, the program will pause. In this example, the system controller next requests input from the module while it was paused and received the response 0001 OPEN, indicating relay 1 was closed and the A and B sections are not joined (see the Close command for a description of the module's response to an input request).

The controller next issues an LC (List Configuration) command to the module and reads back the response. A PS (program Step) command is issued to the module to continue the paused program and finally, the module status is again read by the system controller, indicating that relay 3 was closed.

Command: PROGRAM STEP

Syntax:
PROGRAM STEP [n]<tm>
PS [n]<tm>
PROGRAM STEP<tm>
PS<tm>

Purpose: The PROGRAM STEP command is used to execute a stored program one step at a time or to continue a paused program.

Description: The numeric parameter (n) of the PROGRAM STEP command is the number of steps within a program to execute. The valid range for n is 0 to 32767.

The PROGRAM STEP command will execute n steps of a program starting from the beginning of the program or from where the program is currently paused. Execution will continue until one of the following occurs:

- n steps have been executed (a value of n = 0 programs an infinite number of steps)
- the loop count is complete
- a PROGRAM PAUSE statement is encountered
- any command is sent to the module (the program will complete its currently executing step)

The program will then go to the pause state.

If n is omitted, only one program step will be executed. The PROGRAM STEP command may be executed without a PROGRAM GO command (a PROGRAM GO loop count of 1 is assumed). Specifying a step count greater than the number of steps left to execute will not extend the program.

If any of the following occurs, the program will stop before it is complete:

- a VXIbus system reset
- a VXIbus Abort Normal Operation command
- a VXIbus End Normal Operation command
- any hardware or syntax error

A query to the VX4332 while the program is executing returns a response of the following format at the end of the currently executing step:

LOOP xxxxx, STEP xxxxx, PROGRAM RUNNING

or

LOOP xxxxx, STEP xxxxx, TRIGGER WAIT

if a TRIGGER WAIT command is being executed.

If any command is sent, the program is terminated at the end of the currently executing step and the new command is executed. The program is then in a pause mode and may be continued with the PROGRAM STEP command.

A PROGRAM STEP command is not valid as part of a program definition (should not be included between PROGRAM INPUT and PROGRAM END statements).

Example: PS 5 If the program is not paused, the first five steps of the program will be executed. If the program is paused, the next five steps will be executed. After five steps, the program will pause.

Command: RESET

Syntax: RESET<tm>
R<tm>

Purpose: The RESET command resets the VX4332 to its power-up condition.

Description: On receipt of this command, all relays are opened including the join relays. All relay delay values are set to their default values. All relay name assignments and program information are lost. See SYSFAIL, Self Test and Initialization for a listing of the power-up status.

The VX4332 performs a shortened version of the power-up self test following a RESET command. It checks that all relays are open by monitoring a third contact of each relay. PROM and RAM memory self test is not performed following a RESET command.

Example: RESET resets the VX4332 to its power-up condition.

Command: SET CLOSE_TIME

Syntax:
SET CLOSE_TIME [mm] [n]<tm>
SC [mm] [n]<tm>
SET CLOSE_TIME ALL [n]<tm>
SCA [n]<tm>

Purpose: These commands set the time the module will delay executing another command after receiving a command to close a relay.

Description: [mm] is the module number and n is the time in milliseconds. ALL will set the close time of all modules to n. The maximum value is 32767 ms (or 32.767 seconds). The VX4332 will not accept a delay time less than the default value for any module. If a time is specified which is less than the default time, the default time will be used.

The close delay time is provided to protect from taking a measurement from the scanning system before a relay closes and the input signal has settled. The default time is long enough to ensure that a relay has fully closed, but a longer time may be desirable for some measurements.

To be effective, the delay protection assumes that the system controller (or commander) for the VX4332 waits for the VX4332 to finish processing a command before sending commands to another instrument.

Most resource managers and system controllers buffer commands to multiple instruments, and will send commands to a second instrument without waiting for the first instrument to fully process its command. To ensure a proper measurement in this case, either a) read the status of the VX4332 before software triggering the measurement instrument, b) use the ENCODE or VXIbus TTLTRG line capability of the VX4332 to hardware trigger the measurement function, or c) program a system controller WAIT statement following the CLOSE statement sent to the VX4332.

Example:

SC 03 15000<tm>	This would set the delay time for module 3 to 15 seconds.
SCA 10<tm>	This would set the delay time for all modules to 10 ms. If any module had a default delay time less than this value, the command would not be accepted.

Command: SET NAME

Syntax:
SET NAME ENABLE<tm>
SNE<tm>
SET NAME DISABLE<tm>
SND<tm>

Purpose: These commands enable or disable the use of the symbolic name assigned to a relay when data is returned by the module in response to a query, or when displayed on the four-character display on the front panel.

Description: SET NAME ENABLE enables the use of the symbolic name assigned to a relay when data is returned by the module, or when displayed on the four-character front panel display. The relay must be closed using the name, rather than its number, for this to occur.

SET NAME DISABLE will cause the VX4332 to use the numeric name of a relay when data is returned by the module, or when displayed on the four-character front panel display, whether or not it was closed by using its assigned name.

Example: SNE<tm> The use of the symbolic name assigned to a relay is enabled. Symbolic relay names will be returned by the module in response to a query, and shown on the four-character display on the front panel. If relay 5 had been assigned the name "TP1" and closed using this name, "TP1" would appear on the front panel display when the relay closed.

Command: SET OPEN_TIME

Syntax:
SET OPEN_TIME [mm] [n]<tm>
SO [mm] [n]<tm>
SET OPEN_TIME ALL [n]<tm>
SOA [n]<tm>

Purpose: These commands set the time the module will delay executing another command after receiving a command to open a relay.

Description: [mm] is the module number and [n] is the time in milliseconds. ALL will set the open time of all modules to n. The maximum value is 32767 milliseconds (or 32.767 seconds). The VX4332 will not accept a delay time less than the default value for any module. If a time is specified which is less than the default time, the default time will be used.

The open delay time is most useful if another instrument, not part of this scanner system, is sharing a measurement instrument with this scanner. The open delay time ensures that this scanner system is opened prior to connecting another source to the measurement system.

To be effective, the delay protection assumes that the system controller (or commander) for the VX4332 waits for the VX4332 to finish processing a command before sending commands to another instrument.

Most resource managers and system controllers buffer commands to multiple instruments, and will send commands to a second instrument without waiting for the first instrument to fully process its command. To ensure the relay is physically opened in this case, either a) read the status of the VX4332 before command triggering the measurement instrument, or b) program a VX4332 WAIT statement following the OPEN statement to the VX4332.

Example:

SET OPEN_TIME 0 1000	sets the open time for module 0 to 1 second.
SOA 500	sets the open time for all modules to 0.5 seconds.

Command: SET TRIGGER IN

Syntax:
SET TRIGGER IN [n]<tm>
STI [n]<tm>
SET TRIGGER IN DISABLE<tm>
STID<tm>

Purpose: These commands enable or disable monitoring of a VXIbus TTLTRG line by the VX4332.

Discussion: SET TRIGGER IN selects which VXIbus TTL trigger line the VX4332 will monitor when it is executing a TRIGGER WAIT command.

SET TRIGGER IN DISABLE disables the VX4332 from monitoring any of the VXIbus TTL trigger lines when it is executing a TRIGGER WAIT command. It does not affect receiving a software trigger in program mode.

The valid range for trigger lines is 0 through 7. This command will clear any previously received trigger.

Use of a TTLTRG line assumes that the trigger source is on the same VXIbus TTLTRG trigger line, and that use of that TTLTRG line is not in conflict with other modules using TTLTRG lines.

Example:

SET TRIGGER IN 3	the VX4332 will monitor VXIbus TTL trigger line 3 while executing a TRIGGER WAIT command.
STID	the VX4332 will not monitor any of the VXIbus TTL trigger lines.

Command: SET TRIGGER OUT

Syntax:
SET TRIGGER OUT [n]<tm>
STO [n]<tm>
SET TRIGGER OUT DISABLE<tm>
STOD<tm>

Purpose: These commands enable or disable pulsing a VXIbus TTLTRG line by the VX4332 when a relay channel is closed, or when a TRIGGER command is received.

Description: SET TRIGGER OUT selects and enables which VXIbus TTL trigger line is pulsed when a relay is closed or a TRIGGER command is received.

SET TRIGGER OUT DISABLE disables pulsing any of the VXIbus TTL trigger lines during the encode signal or TRIGGER command.

The valid range for trigger lines is 0 through 7. This command will clear any previously received trigger.

Use of a TTLTRG line assumes that the trigger acceptor is on the same VXIbus TTLTRG trigger line, and that use of that TTLTRG line is not in conflict with other modules using TTLTRG lines.

Example:

SET TRIGGER OUT 5	the VX4332 will pulse the VXIbus TTL trigger line 5 after each relay close delay or TRIGGER command.
STOD	the VX4332 will not pulse any of the VXIbus TTL trigger lines.

Command: TRIGGER

Syntax:
TRIGGER [n]<tm>
T [n]<tm>
TRIGGER<tm>
T<tm>

Purpose: This command will pulse the VXIbus TTL trigger line n.

Description: n specifies the trigger line. If n is omitted, this command will pulse the VXIbus TTL trigger line that is currently selected by the SET TRIGGER OUT command.

This command may be used at any time either in the user's program or in a VX4332 internal program (see PROGRAM INPUT) to trigger some other instrument.

Use of a TTLTRG line assumes that the trigger acceptor is on the same VXIbus TTLTRG trigger line, and that use of that TTLTRG line is not in conflict with other modules using TTLTRG lines.

Example:

TRIGGER 4	Causes a pulse on the VXIbus TTL trigger line 4.
T	Causes a pulse on the VXIbus TTL trigger line previously selected by a SET TRIGGER OUT command.

Command: TRIGGER WAIT

Syntax: TRIGGER WAIT<tm>
TW<tm>

Purpose: The TRIGGER WAIT command will cause the VX4332 to wait for a VXIbus TTLTRG line pulse on the line selected by the SET TRIGGER IN command before processing any additional commands.

Description: This command will cause the VX4332 to wait until the VXIbus trigger line selected by the SET TRIGGER IN command is pulsed, or until a VXIbus TRIGGER command is sent to the VX4332 before it will process another VX4332 command.

The VXIbus TRIGGER command is a VXIbus system command (different from the VX4332 TRIGGER command) and is sent by the VX4332's commander. In an IEEE-488-controlled system, this TRIGGER is typically sent to the VX4332 in response to a Group Execute Trigger (GET) command being received by the VX4332's commander while the VX4332 is addressed to listen on the IEEE-488 bus.

If the VX4332 is in program mode and waiting on a VXIbus TTLTRG, sending any other command to the VX4332 will cancel the wait and stop the program. Whether or not a program is being executed, the following events will cancel this command:

- a VXIbus system reset
- a VXIbus Abort Normal Operation command
- a VXIbus End Normal Operation command

The front panel display will show "trgw" while the module is waiting for a trigger.

Using this command when not in program mode before a SET TRIGGER IN command or after a SET TRIGGER IN DISABLE command will result in a syntax error.

Example: TW — This command will cause the VX4332 to wait until the VXIbus trigger line selected by the SET TRIGGER IN command is pulsed, or until a VXIbus TRIGGER command is sent to the VX4332.

Command: USER_INTERRUPT

Syntax: USER_INTERRUPT [n]<tm>
U [n]<tm>

Purpose: This command causes a Request True Interrupt to occur on the VXIbus.

Description: n specifies the number of the interrupt. The value of n may be 1 or 2.

This command is typically included as part of a user program loaded into the VX4332, where it is used to notify the VX4332's commander that a given point in the program has been reached.

When the VX4332 is used in an IEEE-488 bus system with a Tektronix/CDS Slot 0 module, the occurrence of a Request True Interrupt on the VXIbus will generate an SRQ condition on the IEEE-488 bus. If a serial poll of the VX4332 is then conducted on the IEEE-488 bus, the status byte returned will be:

Status Byte		
Decimal Value	ASCII Value	Description
65	A	User interrupt 1
66	B	User interrupt 2

The availability of two different user interrupts allows interrupts to be generated for different user-selected events, with indication of the interrupt type being passed to the serial poll byte in an IEEE-488 based system. This allows the system controller to determine the type of interrupt without also having to query the VX4332 Module.

NOTE: Other bits may be set in the Status byte from other causes. See the INTERRUPT command.

Example: U 2 Causes a Request True interrupt.

Command: WAIT

Syntax: WAIT [n]<tm>
W [n]<tm>

Purpose: The WAIT or W command causes the module to wait n milliseconds before accepting another command.

Description: n is a number in the range 0 to 32767. This command is useful when a delay is needed other than the delays associated with the OPEN and CLOSE commands.

The front panel display will show "wait" while this command executes.

This command is most useful when the command following it is also sent to the VX4332. The WAIT command assumes that the system controller (or commander) for the VX4332 waits for the VX4332 to finish processing a command before sending commands to another instrument.

Most resource managers and system controllers buffer commands to multiple instruments, and will send commands to a second instrument without waiting for the first instrument to fully process its command. To ensure a proper wait time in this case, either a) issue the WAIT command to the VX4332 and then read the status before communicating with another instrument, or b) send a second WAIT statement to the module following the first WAIT statement sent to the VX4332.

The second WAIT 1 statement is effective because the VX4332 buffers the internal WAIT statement, including the terminator, and holds off the system controller prior to accepting the first character of the following command. (This is true of all commands to the VX4332.)

Example: W 1000 Waits one second before accepting another command.

SYSFAIL, Self Test, and Initialization

The VX4332 Module will execute a self test at power-up, or upon direction of a VXIbus hard or soft reset condition. 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 VX4332's commander, sets the Reset bit in the VX4332's Control register.

The VX4332 executes a power-up self test that includes a PROM checksum, a RAM test, and a test that the third contact of all relays indicates that they are open.

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. In the case of a soft reset, SYSFAIL* is set. However, all Tektronix/CDS commanders will simultaneously set SYSFAIL INHIBIT. This is done to prevent the resource manager from prematurely reporting the failure of a card.

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 2 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 VX4332 Module after the completion of power-up self test is as follows:

All relays are open.
Joining relays are open.
The front panel display will show "open".
Relay name assignments are cleared.
Program memory is cleared.
The Trigger Wait function is disabled.
Open and close delay times are set to the default values.
Interrupts are disabled (except error interrupt).
The error list is cleared.

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 VX4332 Module to deactivate SYSFAIL* in all cases except when +5 volt power is lost.

Section 4
Programming Examples

This section contains example programs which demonstrate how the various programmable features of the VX4332 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 VX4332.
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 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 or '	All characters following the REM or ' 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 Example In BASIC

The following sample BASIC program shows how commands for the VX4332 might be used. This example assumes that the VX4332 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 VX4332 Module's logical address to an IEEE-488 primary address of decimal 24.

Following the example, the data sent to and returned from the module is shown, with data returned by the module shown underlined.

Example:

The following program demonstrates closing relays and the resulting default readback messages from the VX4332 when it is configured as two 1-of-20 scanners and as a 1-of-40 scanner. An error is created and an error message is read back. Also, a small program is loaded and executed.

```
10 GOSUB 1000
```

Go to a sub-routine which identifies the memory location of CEC IEEE-488 Interface Card ROM.

```
20 ENTER = 21:SEND = 9:INIT = 0
30 PC.ADDRESS% = 21:CONTROL% = 0
40 CALL INIT(PC.ADDRESS%,CONTROL%)
50 ADDR332% = 24
```

Line 50 assigns the decimal IEEE-488 address of the VX4332 to the variable ADDR332%.

```
60 CL$ = CHR$(13) + CHR$(10)
```
Carriage return and linefeed characters.

```
100 WRT$ = "RESET" + CL$ : GOSUB 10000
```
Line 100 sends the RESET command to put the VX4332 in its power-up state.

```
110 GOSUB 10100 : PRINT RD$
```
Line 110 reads and prints the current relay status "OPEN OPEN".

```
120 WRT$ = "C 5" + CL$ : GOSUB 10000
```
Line 120 sends the command to close relay 5.

```
130 GOSUB 10100 : PRINT RD$
```
Line 130 reads and prints the current relay status "0005 OPEN".

```
140 WRT$ = "C 35" + CL$ : GOSUB 10000
```
Line 140 sends the command to close relay 35.

```
150 GOSUB 10100 : PRINT RD$
```
Line 150 reads and prints the current relay status "0005 0035".

```
160 WRT$ = "C 8" + CL$ : GOSUB 10000
```
Line 160 sends the command to close relay 8.

```
170 GOSUB 10100 : PRINT RD$
```
Line 170 reads and prints the current relay status "0008 0035".

```
180 WRT$ = "J 0" + CL$ : GOSUB 10000
```
Line 180 sends the command to join the module as a 1 of 40 scanner.

```
190 GOSUB 10100 : PRINT RD$
```
Line 190 reads and prints the current relay status "OPEN".

```
200 WRT$ = "C 5" + CL$ : GOSUB 10000
```
Line 200 sends the command to close relay 5.

```
210 GOSUB 10100 : PRINT RD$
```
Line 210 reads and prints the current relay status "0005".

```
220 WRT$ = "C 35" + CL$ : GOSUB 10000
```
Line 220 sends the command to close relay 35.

```
230 GOSUB 10100 : PRINT RD$
```
Line 230 reads and prints the current relay status "0035".

```
240 WRT$ = "C 99" + CL$ : GOSUB 10000
```
Line 240 sends the command to close a non-existent relay.

```
250 WRT$ = "LIST? ERRORS" + CL$ : GOSUB 10000
```
Line 250 sends the command to queue up error messages.

```
260 GOSUB 10100 : PRINT RD$
```
Line 260 reads back error message "Y,RELAY FAILED TO CLOSE"

```
270 GOSUB 10100 : PRINT RD$
```
Line 270 reads back terminating line of <space><cr><lf>.

```
280 GOSUB 10100 : PRINT RD$
```
Line 280 reads back default message "OPEN".

```
290 WRT$ = "SCA 300;A ONE 1;A TWO 2;A THRE 3" + CL$ : GOSUB 10000
```
Line 290 sets a close delay time of 300ms and assigns names to relay channels 1, 2, and 3.

```
300 WRT$ = "PI;C ONE;C TWO;C THRE;PE;PG 10" + CL$ : GOSUB 10000
```
Line 300 sends a scan list program to the VX4332, and starts the program for 10 loops.

```
310 GOSUB 10100 : PRINT RD$
```
Line 310 reads back "LOOP 1, STEP 2, PROGRAM RUNNING" indicating program status. The loop and step numbers may be different, depending on the processing speed of the system controller.

```
320 END
```

```
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


10000 REM - SUBROUTINE TO SEND THE STRING WRT$ TO THE VX4332
10010 REM   AND CHECK FOR TIMEOUT ERROR
10020 CALL SEND (ADDR332%,WRT$,STATUS%)
10030 IF STATUS% < > 0 THEN PRINT "error-ieee-488 timeout":STOP
10040 RETURN

10100 REM - SUBROUTINE TO READ DATA FROM THE VX4332 AND CHECK FOR A TIMEOUT
      ERROR
10110 REM   STRING IS RETURNED IN RD$.
10120 RD$ = SPACE$(250) : REM MAKE A PLACE TO RECEIVE STRING
10130 CALL ENTER(RD$,LENGTH%,ADDR332%,STATUS%)
10140 IF STATUS% < > 0 THEN PRINT "error-ieee-488 timeout":STOP
10150 RD$ = LEFT$(RD$,LENGTH%)
10160 RETURN
```

Data Sent	Data Received
RESET<cr><lf>	OPEN OPEN<cr><lf>
C 5<cr><lf>	0005 OPEN<cr><lf>
C 35<cr><lf>	0005 0035<cr><lf>
C 8<cr><lf>	0008 0035<cr><lf>
J 0<cr><lf>	OPEN<cr><lf>
C 5<cr><lf>	0005<cr><lf>
C 35<cr><lf>	0035<cr><lf>
C 99<cr><lf>	
LIST? ERRORS<cr><lf>	Y,RELAY FAILED TO CLOSE<cr><lf>
	<sp><cr><lf>
	OPEN<cr><lf>
SCA 300;A ONE 1;A TWO 2;A THRE 3<cr><lf>	
PI;C ONE;C TWO;C THRE;PE;PG 10<cr><lf>	
	LOOP 1, STEP 2, PROGRAM RUNNING<cr><lf>

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 VX4332 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 VX4332 Module is neither a VXIbus commander nor a VMEbus master, and therefore it does not have a VXIbus signal register. The VX4332 is a VXIbus message based servant.

A Normal Transfer Mode Read of the VX4332 Module proceeds as follows:

1. The commander reads the VX4332'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 VX4332's Data Low register.

3. The commander reads the VX4332'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 VX4332's Data Low register.

A Normal Transfer Mode Write to the VX4332 Module proceeds as follows:

1. The commander reads the VX4332'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 Available command which contains the data (0BCXX or 0BDXX depending on the state of the End bit) to the VX4332's Data Low register.

As with all VXIbus devices, the VX4332 Module has registers located within a 64 byte block in the A16 address space.

The base address of the VX4332 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.

VX4332 Configuration Registers

Below is a list of the VX4332 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

REGISTER BIT DEFINITIONS

ID: BFFCh

Device: F6B3

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

Appendix B
Input/Output Connections

Signal Connectors. P4 and P7 are DD-50P connectors.

Channel		Pin #	User Description
0	High	P4-1	
	Low	P4-18	
1	High	P4-2	
	Low	P4-19	
2	High	P4-3	
	Low	P4-20	
3	High	P4-4	
	Low	P4-21	
4	High	P4-5	
	Low	P4-22	
5	High	P4-6	
	Low	P4-23	
6	High	P4-7	
	Low	P4-24	
17	High	P4-8	
	Low	P4-25	
8	High	P4-9	
	Low	P4-26	
9	High	P4-10	
	Low	P4-27	
10	High	P4-11	
	Low	P4-28	
11	High	P4-12	
	Low	P4-29	

Channel		Pin #	User Description
12	High	P4-13	
	Low	P4-30	
13	High	P4-14	
	Low	P4-31	
14	High	P4-15	
	Low	P4-32	
15	High	P4-16	
	Low	P4-33	
16	High	P4-34	
	Low	P4-35	
17	High	P4-36	
	Low	P4-37	
18	High	P4-38	
	Low	P4-39	
19	High	P4-40	
	Low	P4-41	
Ground		P4-17	
		P4-50	
		P7-17	
		P7-50	
20	High	P7-1	
	Low	P7-18	
21	High	P7-2	
	Low	P7-19	

Channel		Pin #	User Description
22	High	P7-3	
	Low	P7-20	
23	High	P7-4	
	Low	P7-21	
24	High	P7-5	
	Low	P7-22	
25	High	P7-6	
	Low	P7-23	
26	High	P7-7	
	Low	P7-24	
27	High	P7-8	
	Low	P7-25	
28	High	P7-9	
	Low	P7-26	
29	High	P7-10	
	Low	P7-27	
30	High	P7-11	
	Low	P7-28	
31	High	P7-12	
	Low	P7-29	
32	High	P7-13	
	Low	P7-30	
33	High	P7-14	
	Low	P7-31	
34	High	P7-15	
	Low	P7-32	
35	High	P7-16	
	Low	P7-33	
36	High	P7-34	
	Low	P7-35	

Channel		Pin #	User Description
37	High	P7-36	
	Low	P7-37	
38	High	P7-38	
	Low	P7-39	
39	High	P7-40	
	Low	P7-41	

Common Connectors

Section A or common - P5.
P5 is a 10-pin male circular connector.

Pin	Signal
P5-A	Scan Clear*
P5-B	Encode*
P5-C	Join*
P5-D	Relay Closed Out*
P5-E	No Connection
P5-F	Ground
P5-H	Analog Bus Shield
P5-J	Analog Bus Guard
P5-K	Analog Bus High
P5-L	Analog Bus Low

Section B or Slave - S6.
S6 is a 10-pin female circular connector.

Pin	Signal
S6-A	Scan Clear*
S6-B	Encode*
S6-C	Join Sense*
S6-D	Relay Closed In*
S6-E	No Connection
S6-F	Ground
S6-H	Analog Bus Shield
S6-J	Analog Bus Guard
S6-K	Analog Bus High
S6-L	Analog Bus Low

* Low True signal.

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 appear 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-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).

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.

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.

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.

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.

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.

Appendix D
Error Messages

Use the LIST? ERRORS command to read back any error messages that have been generated since the last LIST? ERRORS command. The error message buffer is limited to 10 messages. If an overflow occurs, new messages will be lost, but a buffer overflow error will be added to the buffer. One error message is returned per read and is terminated by a <cr><lf>. The list of errors is terminated by a <sp><cr><lf>. The front panel ERR light is lit whenever an error message is generated, and is off after they have all been read.

The following errors will also generate a Syntax Error interrupt if that interrupt has been enabled.

A,SYNTAX ERROR
A syntax error occurred in a command.

B,OUT OF RANGE
A command parameter is out of range.

C,NAME TOO LONG IN ASSIGN COMMAND
Names are limited to 4 characters.

D,RELAY NAME STARTS WITH NUMERIC
Relay names must start with an alphabetic character.

E,ASSIGNMENT TABLE FULL
The number of name assignments is limited to 850.

F,NAME TOO LONG IN CLOSE COMMAND
Relay names are limited to 4 characters.

G,NAME NOT FOUND IN ASSIGNMENT TABLE

H,NON-NUMERIC IN RELAY NUMBER

I,PROGRAM IN OVERFLOW
Program memory was exceeded during a PROGRAM IN command.

J,GO WITH NO PROGRAM

K,PROGRAM ABORTED STEP xxxxx OF LOOP xxxxx
An error condition stopped the program.

L,ILLEGAL COMMAND OR SYNTAX ERROR STEP xxxxx
A command not allowed in a program is executed in a program.

M,ILLEGAL COMMAND IN NON-PROGRAM MODE

This message results from executing a command reserved for execution in a program.

N,TRIGGER OUT DISABLED ON TRIGGER COMMAND.

A TRIGGER command was sent when the trigger channel is undefined or disabled.

O,TOO MANY ERRORS

If the error queue overflows, this message is tacked on the end of the queue and no further messages are saved until the messages are read.

The following errors will generate a Hardware Error interrupt if that interrupt has been enabled.

V,RAM ERROR

Power-up RAM test failed.

W,ROM ERROR

Power-up ROM test failed.

X,JOIN RELAY FAILURE MODULE mm

The relays that implement the join function have contacts to verify their position. If this verify fails after a join or disjoin command this error is generated.

Y,RELAY FAILED TO CLOSE

Z,RELAY FAILED TO OPEN