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User Manual

Tektronix

VX4780
16-Channel Signal Conditioner

070-9488-00

This document supports firmware version 1.00 and above.

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

CE

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

Only qualified personnel should perform service procedures.

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

Injury Precautions

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

Avoid Electric Shock. To avoid injury or loss of life, do not connect or disconnect probes or test leads while they are connected to a voltage source.

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

Do Not Operate Without Covers. To avoid electric shock or fire hazard, do not operate this product with covers or panels removed.

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

Do Not Operate in Wet/Damp Conditions. To avoid electric shock, do not operate this product in wet or damp conditions.

Do Not Operate in an Explosive Atmosphere. To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

Product Damage Precautions

Provide Proper Ventilation. To prevent product overheating, provide proper ventilation.

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

Symbols and Terms

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



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

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

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

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

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

CAUTION indicates a hazard to property including the product.

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



DANGER
High Voltage



Protective Ground
(Earth) Terminal



ATTENTION
Refer to Manual



Double
Insulated

Certifications and Compliances

Refer to the specifications section for a listing of certifications and compliances that apply to this product.

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Service Safety Summary

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

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

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

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

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Preface

This manual assumes you are familiar with VXIbus instruments and operation and with the purpose and function of this instrument.

Please read and follow all instructions for installation and configuration. Use the Installation Checklist to ensure proper installation and to record your initial settings.

The *Operating Basics* section gives a summary of VXIbus operation and presents an overview of the operation of this instrument.

The *Syntax and Commands* section provides a summary of all the commands followed by detailed descriptions of each command.

The *Status and Events* section contains an explanation of the Status and Event Reporting System and lists the system messages. *Appendix C: Examples* contains example programs that demonstrate the programmable features of this instrument.

Conventions

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

Specific conventions for programming are given in the sections *Syntax and Commands* and *Appendix C: Examples*.

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Getting Started

This section begins with a brief description of the VX4780 16-Channel Signal Conditioner, and explains how to configure and install the module in a VXIbus mainframe. The quick functional check, also included in this section, assures that the instrument operates properly.

Product Description

The VX4780 16-Channel Signal Conditioner is a printed circuit board assembly for use in a mainframe conforming to the VXIbus Specification. Figure 1–1 shows a functional block diagram of the VX4780. The VX4780 is a single slot, C-size VXI module with the following features:

Input Characteristics

- Differential inputs
- Input isolation relays
- 2 MΩ Differential input impedance
- Command selectable input attenuation of 10 and 100 V/V.
- Command selectable input attenuator bypass
- Command selectable gain of 1, 2, 5, 10, 20, 50 and 100 V/V.
- Command selectable AC or DC input coupling
- 250 V overvoltage protection

Low Pass Filtering

- 4 Pole Bessel Response
- Command selectable cutoff frequencies from 468 Hz to 107 kHz

Output Characteristics

- Differential outputs
- Output isolation relays
- 50 Ω output impedance
- ±10 V output voltage

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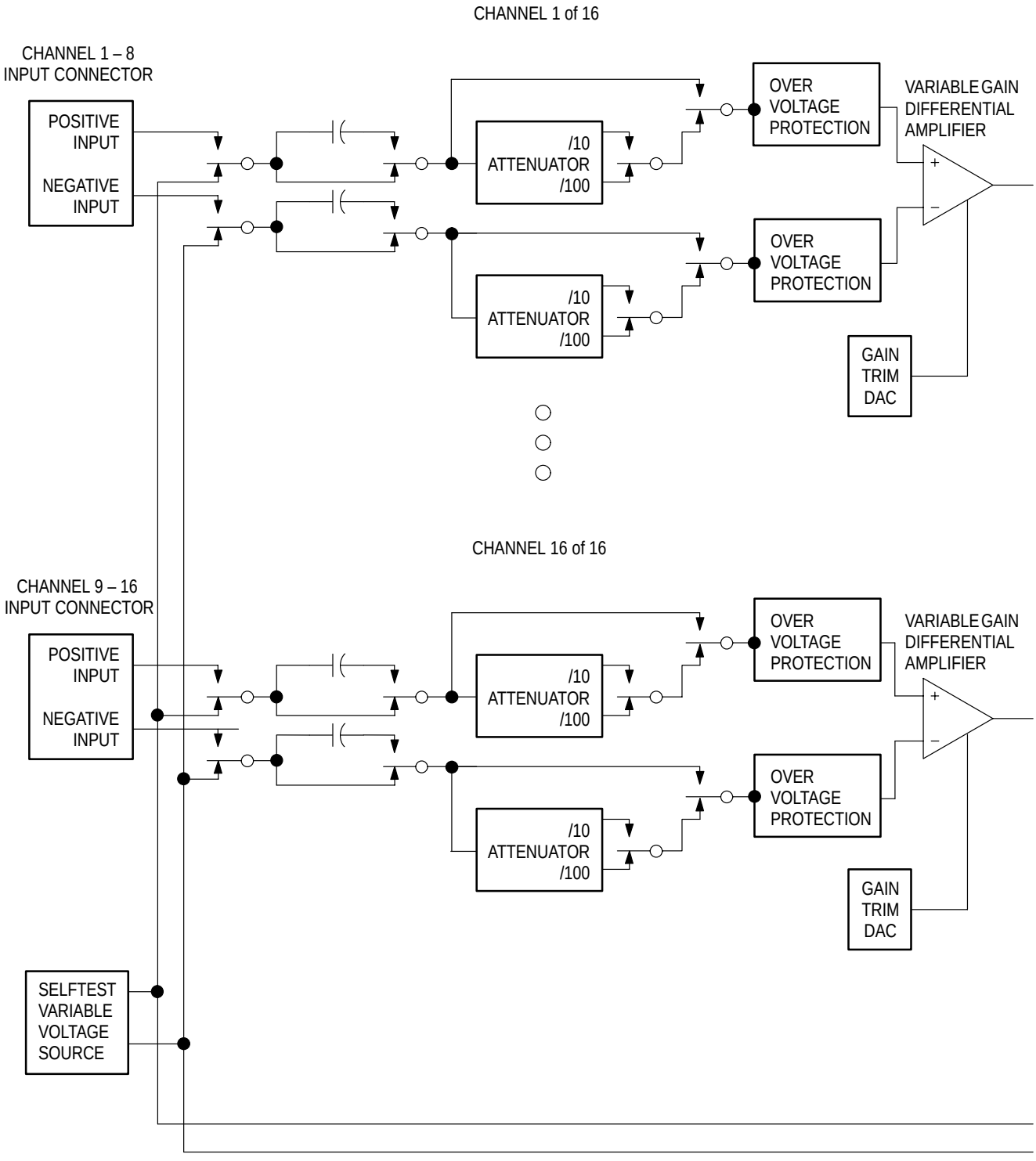


Figure 1–1: VX4780 Functional Block Diagram

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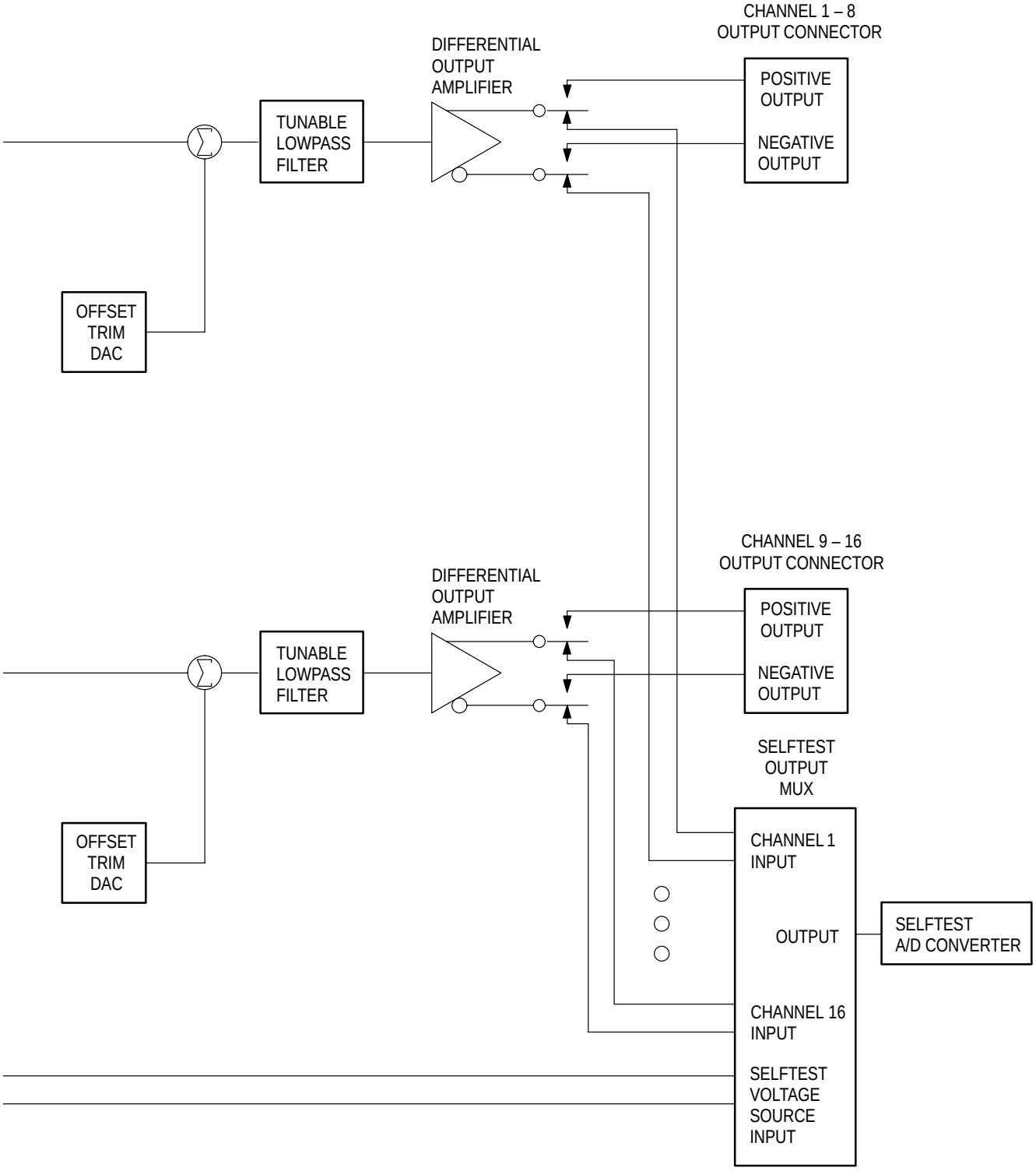


Figure 1–1: VX4780 Functional Block Diagram (cont.)

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- DC coupled
- Short circuit protected

Additional Features

- Extensive self test/diagnostics
- SCPI 1994 / IEEE-488.2 compatible command set
- Command selectable DC offset trim and gain trim for system level calibration

The VX4780 VXI Interface includes the following features:

- CPU:

  Zilog Z88C00 microcontroller with 20 MHz clock

  64 Kbyte of EPROM and 32 Kbyte of RAM

- VXI Interface:

  VXI Rev 1.4 message based device

  Supports Fast Handshake word serial protocol data transfers

  IEEE-488.2 device

  Logical address selectable with two rotary hexadecimal switches

  Interrupter level selectable with a rotary hexadecimal switch. Selects one of seven levels or disables interrupt generation

Fuses

The VX4780 has three 2 amp fast-acting fuses: one for +5 V power (F1181), one for +24 V power (F1481), and one for –24 V power (F1581).

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

If a +5 V fuse opens, remove the fault before replacing the fuse. Replacement fuse information is given in the *Appendix F:Replaceable Parts List.*

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LEDs

The following LEDs are visible at the top of the VX4780 Module front panel to indicate the status of the module operation.

LED	When lighted, indicates
Power	power is applied to the module
Failed	the module is in the FAILED state
Message	the VX4780 is communicating with its commander on the VXI bus
Error	the VX4780 has detected a syntax error in a command sent by its commander or has detected a parameter in a command that is out of range or has failed self test. When one of these conditions is detected, the Error LED is lighted and an error message describing the error is placed in the module Error/Event queue. The Error LED remains lighted until the entire Error/Event queue is read. Use the SYSTem:ERRor? query to access the Error/Event queue.

BITE (Built-in Test Equipment)

Built-in Test Equipment (BITE) is provided by extensive self tests that are automatically invoked on power-on and can also be invoked on command.

An abbreviated self test is performed at power-on. At power-on, only the CPU and RAM are tested. When self test is initiated with the *TST? query, the tests listed below are performed. Self test can test all channels or selected channels. Pass/Fail messages that indicate the results of the self test are placed in the Error/Event queue. These messages can be read with the SYStem:ERRor? query.

Test	Performs
NOVRAM Checksum	The checksums of gain and offset calibration constants stored in NOVRAM are calculated and checked against the stored checksums. A gain constant checksum and an offset constant checksum are stored for each channel.
Offset calibration circuitry	The DC offset trim DAC and associated circuitry is tested.
Test source	The self test variable voltage source is tested.
Input attenuator	The performance of the input attenuator is verified at attenuation settings of /10 and /100 and with the attenuator bypassed. This test is performed with nominal attenuation calibration factors, then repeated with stored calibration factors.
Gain calibration circuitry	The gain trim DAC and associated circuitry is tested.
Lowpass filter	The cutoff frequency of the lowpass filter is checked at cutoff frequencies of 468 Hz, 936 Hz, 1872 Hz, 3744 Hz, and 7133 Hz. This test verifies that the cutoff frequency tuning circuitry is functioning properly.

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Test	Performs
AC coupling capacitors	The positive input and negative input AC coupling capacitors are checked.
Variable gain amplifiers	The variable gain amplifier is checked at gains of 1, 2, 5, 10, 20, 50, and 100 V/V. This test is performed with nominal gain calibration factors, then repeated with stored calibration factors.

Accessories

Table 1–1 lists the standard accessories included with the VX4780.

Table 1–1: Standard Accessories

Accessory	Part Number
VX4780 User Manual	070-9488-XX
VX4780 Reference	070-9489-XX

Table 1–2 lists the options available for the VX4780.

Table 1–2: Options

Option	Part Number
Input Cable Channels 1 through 8	174-3543-00
Input Cable Channels 9 through 16	174-3553-00
Output Cable VX4780 to VX4244	174-3542-00

Controls and Indicators

The following controls are provided to select the functions of the VX4780 operating environment. Figures 1–2 and 1–3 illustrate the physical location of these controls and indicators.

Switches

The Logical Address switches, VMEbus Interrupt Level Select switch, and Halt switch must be correctly set to insure proper operation. See *Configuration* for details on how to set the switches.

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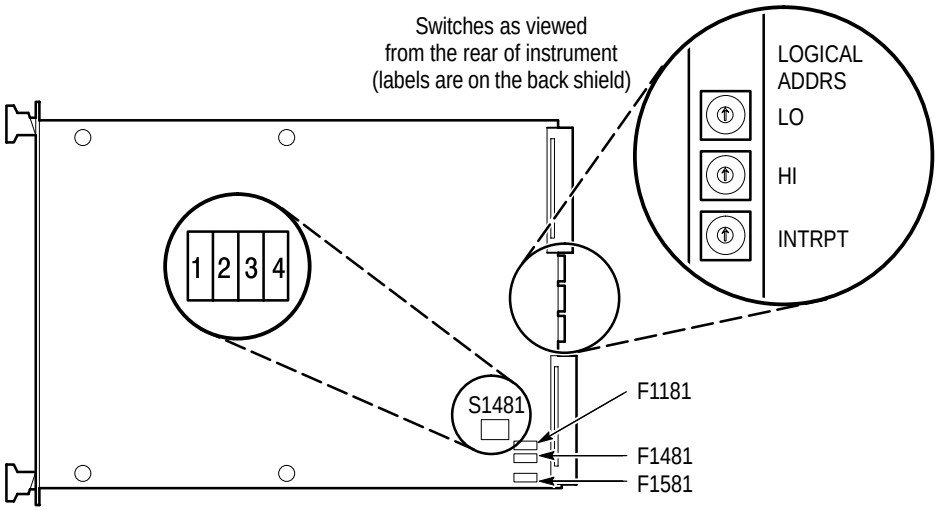


Figure 1–2: VX4780 Connectors, Indicators, and Switch Locations

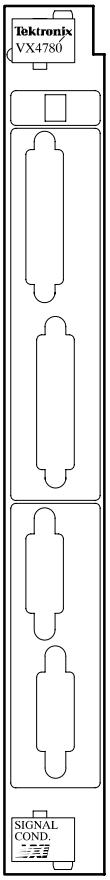


Figure 1–3: VX4780 Front Panel

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Configuration

The following switches must be correctly set to ensure proper operation. Refer to Figure 1–2 for their physical locations.

Logical Address Switches

Each functional module in a VXIbus System must be assigned a unique logical address, from 1 to decimal 255 (hexadecimal FF). The base VMEbus address of the VX4780 is set to a value between 1 and hexadecimal FF (FF_{16}) by two hexadecimal rotary switches. Align the desired switch position with the arrow on the module shield.

The physical address of the instrument is on a 64 byte boundary. If the Logical Address switch representing the most significant digit (LA-HI) of the logical address is set to position X and the switch representing the least significant digit (LA-LO) of the logical address is set to position Y, then the base physical address of the VX4780 will be $[(40_{16} \times XY_{16}) + C000_{16}]$. For example:

L.A.	HI	LO	Base Physical Address	
			decimal	hexadecimal
A_{16}	0_{16}	A_{16}	(64 * 10) + 49152 = 49792	$(40_{16} * A_{16}) + C000_{16} = C280_{16}$
15_{16}	1_{16}	5_{16}	(64 * 21) + 49152 = 50496	$(40_{16} * 15_{16}) + C000_{16} = C540_{16}$

LA. is the Logical Address

IEEE-488 Address

In order to use and program the VX4780 Signal Conditioner in an IEEE-488 environment you must know the IEEE-488 address of the module. Different manufacturers of IEEE-488 interface devices might have different algorithms for equating a logical address with an IEEE-488 address. Consult the operating manual of the IEEE-488 Interface Module being used.

VMEbus Interrupt Level Select Switch

Each function module in a VXIbus System can generate an interrupt at a specified level on the VMEbus to request service from the interrupt handler located on its commander. Set the interrupt level to the same level as the interrupt handler on that commander. The VMEbus interrupt level on which the VX4780 Signal Conditioner generates interrupts is set by a rotary switch. Align the desired switch position with the arrow on the module shield.

Valid VMEbus Interrupt Level Select switch settings are one through seven, with setting one equivalent to level one, and so on. The level chosen should be the same as the level set on the VX4780 interrupt handler, typically the module commander. Setting the switch to zero or eight will disable the module interrupts. Do not use switch settings nine through f.

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Interrupts are used by the module to return VXIbus Protocol Events to the module commander. Refer to the *Operating Basics* section for more information on interrupts. The VXIbus Protocol Events supported by the module are listed in *Appendix A: Specifications*.

Halt Switch

Switch S1481 contains four rockers. Rocker number 1 serves as a Halt Switch. The setting of this switch selects the response of the VX4780 Module when the Reset bit in the module VXIbus Control register is set. If the Halt switch is in the closed position, the VX4780 is reset to its power-on state and all programmed module parameters are set to their default values. If the Halt switch is set to the open position, the module will ignore the Reset bit and no action will take place.

Rockers 2 through 4 on switch S1481 are reserved for future use and should be placed in the closed position.

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

Installation

This section describes how to install the VX4780.

Tools Required

A slotted screwdriver set is required for proper installation.

Requirements and Notes

The VX4780 Signal Conditioner 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. To install the module in a D-size mainframe, consult the operating manual for the mainframe. Refer to *Configuration* for information on selecting and setting the Logical Address switch of the module. This switch defines the programming address of your module. To avoid confusion, it is recommended that the slot number and the logical address be the same.

***NOTE**. Note that there are two printed ejector handles on the card. To avoid installing the card incorrectly, make sure the ejector marked "VX4780" is at the top.*

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

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If the VX4780 is used in a Tektronix mainframe, all VX4780 cooling requirements are met.

***NOTE**. If the VX4780 is inserted in a slot with any empty slots to the left of the module, the VME daisy-chain jumpers must be installed on the backplane in order for the VXI Module to operate properly. Check the manual of the mainframe being used for jumpering instructions. Jumpers are not necessary for autoconfiguring backplane designs.*

Installation Procedure

Follow these steps to install the VX4780.



***CAUTION.** The VX4780 Signal Conditioner is a piece of electronic equipment and therefore has some susceptibility to electrostatic damage (ESD).To avoid (ESD), use precautions when handling the module.*

1. Record the revision level, serial number (located on the label on the shield of the VX4780), and switch settings on the *Installation Checklist*.
2. Verify that the switches are set to the correct values. Refer to *Configuration* for more information on setting switches.
3. Make sure that the mainframe power is off.
4. Insert the module into one of the instrument slots of the mainframe (see Figure 1–4).
5. Cable Installation: Use the correct cable to interface between the module I/O connector and the Unit Under Test (UUT). The recommended cable is listed in *Appendix F: Replaceable Parts List.*

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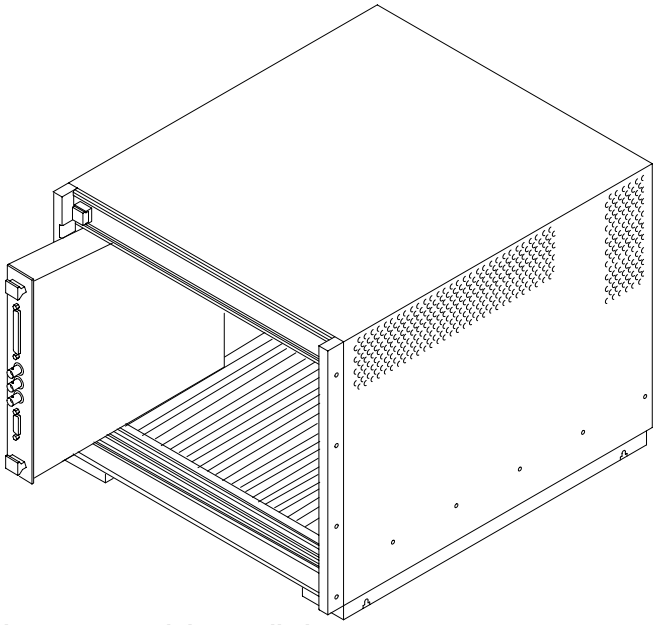


Figure 1–4: Module Installation

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Installation Checklist

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

Revision Level:

Serial No.: _____

Mainframe Slot Number:

Switch Settings:

VXIbus Logical Address Switch: _____

Interrupt Level Select Switch: _____

Halt Switch: _____

Cable Installed (if any):

Performed by: _____ Date: _____

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Functional Check

In addition to the self tests, you can also perform an operational check of the VX4780.

Self Test

The VX4780 16-Channel Signal Conditioner executes a self test at power-on, on direction of a VXIbus hard or soft reset condition or on command. The power-on self test consists of an interface self test. The self test requested by command performs an instrument self test. A VXIbus hard reset occurs when another device, such as the VXIbus Resource Manager, asserts the backplane line SYSRESET*. A VXIbus soft reset occurs when another device, such as the VX4780 commander, sets the Reset bit in the VX4780 Control register.

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

1. The SYSFAIL* (VME system-failure) line is set active, indicating that the module is executing a self test, and the Failed LED is lighted. For a soft reset, SYSFAIL* is set. All Tektronix commanders will simultaneously set SYSFAIL INHIBIT to prevent the resource manager from prematurely reporting the failure of a card.
2. On completion of the interface self test, SYSFAIL* is deasserted. If the test fails, the SYSFAIL* line remains active. If the interface self test passed, the SYSFAIL* line is released, and the module enters the VXIbus PASSED state (ready for normal operation). If it failed, the module enters the VXIbus FAILED state.

The default condition of the VX4780 after the completion of the power-on self test is as follows:

Input Isolation Relays: Open

Input Coupling: AC

Input Attenuator Setting: /10

Input Attenuator State: Inserted

Gain: 1 V/V

Lowpass Filter Cutoff Frequency: 468 Hz

Output Isolation Relays: Open

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

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During a commanded self test:

1. SYSFAIL* is not asserted.
2. All settings of all channels are restored to their pretest state.

Operational Check

Send a *CLS command to the VX4780 to clear the Error/Event queue. Send a *TST? query to the VX4780 to initiate a self test of all channels. Wait one minute, then read the module response. A response of 0 indicates that all channels passed passed self test. A response of 1 indicates that one or more channels failed self test. Read the results of self test from the Error/Event queue by sending SYSTem:ERRor? queries and reading the module response until the Error queue is empty.

Set all channels to the configuration listed below by sending the listed commands:

Configuration	Command
Input Isolation Relays: Open	input:state off,(@1:16)
Input Coupling: DC	input:coupling dc,(@1:16)
Input Attenuator Setting: /10	input:att 10,(@1:16)
Input Attenuator State: Inserted	input:att:State on,(@1:16)
Gain: 10	input:gain 10,(@1:16)
Lowpass Filter Cutoff Frequency: 20 kHz	input:filter:lpass:Freq 20e3,(@1:16)
Output Isolation Relays: Closed	output:state on,(@1:16)

Note that the overall channel gain for all channels is set to 1 (channel gain / channel attenuation = 10/10 = 1). Also note that the self test voltage source is applied to the input of all channels that have their input isolation relays set to the open position. Apply a 5 V_{p-p} 1 kHz square wave to all channel inputs by sending the command:

```
diag:sqr 225
```

Use a 2-channel oscilloscope to observe a 5 V_{p-p} 1 kHz square wave at each of the channel outputs. Connect one channel of the oscilloscope to a VX4780 channel positive output. Connect the other oscilloscope channel to the VX4780 channel negative output. Display the difference of the oscilloscope channel inputs. Send a VXI Clear command to the VX4780 to halt the square wave generation and to allow additional commands to be sent to the VX4780.

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Close all input isolation relays by sending the command:

```
input:state on,(@1:16)
```

Use a function generator to apply a 20 V_{p-p} 1 kHz sine waveform to all channel inputs. Observe a 20 V_{p-p} 1 kHz sine waveform at all channel outputs. Set the frequency of the function generator waveform to 20 kHz (the current cutoff frequency of the lowpass filter). Note that the amplitude at all channel outputs has dropped to .7071 * 20 V_{p-p} = 14 $V_{p-p.}$ This verifies that the lowpass filters are functioning properly.

SYSFAIL* Operation

SYSFAIL* becomes active during power-on, hard or soft reset, or 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 causes the VX4780 16-Channel Signal Conditioner to deactivate SYSFAIL* except when +5 V power is lost.

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Operating Basics

The VX4780 16-Channel Signal Conditioner is a VXIbus message-based instrument and communicates using the VXIbus Word Serial Protocol. The module is programmed by issuing ASCII characters from the system controller to the VX4780 via the module VXIbus commander and the VXIbus mainframe backplane. Refer to the manual for the VXIbus device that will be the VX4780 Signal Conditioner commander for details on the operation of that device.

If the module commander is a Tektronix IEEE-488 Interface Module, refer to the operating manual for the module and *Appendix C: Examples* in this manual for information on how the system controller communicates with the commander being used.

Functional Overview

The VX4780 contains sixteen signal conditioning channels. The high channel input impedance minimizes the loading of signal sources that are connected to the module inputs. Under program control, the input signal can be AC or DC coupled to the channel input. The overall channel gain (channel gain divided by channel attenuation) can be programmed in 1/2/5 steps from 0.01 V/V to 100 V/V. This capability enables the VX4780 to scale a wide range of input voltages to a normalized output voltage of ±10 V.

A differential input configuration enables the VX4780 to reject common mode interference that may be coupled onto the input signal from nearby sources of EMI. Overvoltage protection circuitry that follows the input attenuator protects the channel's input circuitry from voltages of up to 250 V.

After the input signal is scaled by the input attenuator and variable gain amplifier, it is lowpass filtered. This filter serves as an antialiasing filter for a digitizer (typically a VX4244 16-Channel Digitizer) connected to the channel output. The cutoff frequency of the low pass filter is command programmable over the frequency range of 468 Hz to 107 kHz. The filter cutoff frequency is typically programmed to a value less than or equal to one half of the sampling frequency of the digitizer. The lowpass filter is designed to have a Bessel response. The linear phase response of this type of filter preserves the phase relationship of the frequency components of the input signal. This gives the VX4780 an excellent pulse response.

Each channel contains input and output isolation relays which are used to connect or disconnect the VX4780 from external devices under program control.

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Power-On

The instrument runs its self test and is ready for programming five seconds after power-on. The VXIbus Resource Manager can add an additional delay. The default condition of the module after power-on is listed in the *RST command description. Self-test failures are described in the SYSTem:ERRor command description.

At power-on, the front panel LEDs will be in the following states:

Power LED	On
Failed LED	Off
Error LED	Off
Message LED	On when the module is addressed by its commander, otherwise this LED is off.

The format and syntax for the command strings are described in the *Command Syntax* section. A complete description of each command in alphabetical order is in the *Command Descriptions* section.

Instrument I/O: VXIbus Basics

NOTE. *If the user's mainframe has other manufacturers' 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 VX4780 Module installed on a switching 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 VX4780 is neither a VXIbus commander nor a VMEbus master; therefore it does not have a VXIbus Signal register. The VX4780 is a VXIbus message-based servant.

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

A Normal Transfer Mode read of the VX4780 proceeds as follows:

1. The commander reads the VX4780 Response register and checks if the Write Ready and DOR bits are true. If they are, the commander proceeds to the

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next step. If not, the commander continues to poll these bits until they become true.

2. The commander writes the Byte Request command (hexadecimal 0DEFF) to the Data Low register of the VX4780.

3. The commander reads the VX4780 Response register and checks if the Read Ready and DOR bits are true. If they are, the commander proceeds to the next step. If not, the commander continues to poll these bits until they become true.

4. The commander reads the VX4780 Data Low register.

A Normal Transfer Mode write to the VX4780 proceeds as follows:

1. The commander reads the VX4780 Response register and checks if the Write Ready and DIR bits are true. If they are, the commander proceeds to the next step. If not, the commander continues to poll the Write Ready and DIR bits until they are true.

2. The commander writes the Byte Available command which contains the data (hexadecimal 0BCXX or 0BDXX, depending on the End bit) to the Data Low register of the VX4780.

The module also supports the Fast Handshake Mode during readback. In this mode, the module is capable of transferring data at optimal backplane speed without needing the commander to test any of the handshake bits. The VX4780 asserts BERR* to switch from Fast Handshake Mode to Normal Transfer Mode, per VXI Specification. The VX4780 Read Ready, Write Ready, DIR and DOR bits react properly, in case the commander does not support the Fast Handshake Mode.

A Fast Handshake Transfer Mode read of the VX4780 proceeds as follows:

1. The commander writes the Byte Request command (hexadecimal 0DEFF) to the VX4780 Data Low register.

2. The commander reads the VX4780 Data Low register.

A Fast Handshake Transfer Mode write of the VX4780 proceeds as follows:

The commander writes the Byte Available command which contains the data (hexadecimal 0BCXX or 0BDXX, depending on the End bit) to the Data Low register of the VX4780. The commander may immediately write another Byte Available command without having to check the Response register.

The module has no registers beyond those defined for VXIbus message based devices. All communications with the module are through the Data Low register, the Response register, or the VXIbus interrupt cycle. Any attempt by another

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module to read or write to any undefined location of the VX4780 address space may cause incorrect operation of the module.

As with all VXIbus devices, the VX4780 has registers located within a 64 byte block in the A16 address space. The base address of the VX4780 device registers is determined by the device unique logical address and can be calculated as follows:

$$\text{Base Address} = V_{16} * 40_{16} + C000_{16}$$

where V is the device logical address as set by the Logical Address switches.

Configuration Registers

Table 2–1 contains a list of the Configuration registers and a complete description of each register. The offset is relative to the module base address.

Table 2–1: Register Definitions

Register	Address (hexa-decimal)	Type	Value (Bits 15–0)
ID Register	0000	RO	1011 1111 1111 1100 (hexadecimal BFFD)
Device Type	0002	RO	See Device Type definition below
Status	0004	R	Defined by state of interface
Control	0004	W	Defined by state of interface
Offset	0006	WO	Not used
Protocol	0008	RO	1111 0111 1111 1111 (hexadecimal F7FF)
Response	000A	RO	Defined by state of the interface
Data High	000C		Not used
Data Low	000E	W	Not fixed; command-dependent
Data Low	000E	R	Not fixed; command-dependent

RO is Read Only

WO is Write Only

R is Read

W is Write

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The Register Bit definitions are listed in Table 2–2:

Table 2–2: Register Bit Definitions

Register	Bit Definition
ID	hexadecimal BFFD
Protocol	hexadecimal F7FF
Device	hexadecimal F4F3

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Command Syntax

Command protocol and syntax for the VX4780 Signal Conditioner are as follows:

- A command string consists of a string of ASCII-encoded characters terminated by a <program message terminator>. The <program message terminator> is optional white space, followed by any one of the following command terminations:

  a line feed <LF> or new line <NL> character (hexadecimal 0A, decimal 10)

  the END bit set

  the END bit with a line feed <LF> or new line <NL>

The command string is buffered until the terminator is encountered, at which time the entire string is processed.

- In addition to terminating a command, the semi-colon character directs the SCPI command parser to interpret the next command with the assumption that all characters up to and including the last colon in the previous command have just been parsed.

This does not apply to semicolon characters specified in a SCPI <channel_list>. The following example illustrates the use of the semi-colon as a command terminator.

The commands:

```
input:state on,(@1,2)<LF>

input:gain 1,(@1:10)<LF>

input:att:state off,(@1,2)<LF>
```

are equivalent to the following command:

```
input:state on,(@1,2); gain 1,(@1:10); att:state
off,(@1,2)<LF>
```

After a line feed or END bit is used to terminate a command, the parser no longer makes the assumption described above. Thus, after the command

```
input:coupling DC,(@1); filter:lpass:Freq 100e3,(@1)<LF>
```

is parsed, the command

```
gain 1,(@1:10)<LF>
```


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is no longer valid. Note that <LF> in these examples represents a single line feed character.

- White space characters can be used to make a command string more readable. These characters are ASCII-encoded bytes in the range hexadecimal 00–09 and 0B–20 (decimal 0–9 and 11–32). This range includes the ASCII control characters and the space, but excludes the line feed <NL>. White space characters are ignored when legally encountered in a command string. White space is allowed anywhere in a command string, except for the following:

  Within a program mnemonic (for example IN PUT)

  Around a colon (:) mnemonic separator (for example INPUT: STATE)

  Between a mnemonic and a (?) (for example *TST ?)

  Following an asterisk (for example * TST?)

  Within a number (for example 12 34)

At least one white space character is required between a command/query header and its associated arguments. For example in the command

```
input:filter:lpass:freq 10e3,(@1:10)
```

the command header is the string “input:filter:lpass:freq”. The arguments associated with this command header are the number “10e3” and the channel list “(@1:10)”. At least one white space character must be sent before the first argument.

- All characters in a command can be sent in either upper or lower case form.
- Multiple data parameters passed by a command are separated by a comma (,).
- A question mark (?) following a command indicates that a response will be returned. All responses from the module are terminated with a carriage return <CR> and a line feed <LF> (hexadecimal 0A) character.
- In the command descriptions, the following special characters are used. Except for the colon (:), these characters are not part of the command and should not be sent. If an optional field is omitted, the default for the command is applied.

  [ ] Brackets indicate an optional field

  | A bar indicates a logical OR choice

  : A colon is used to separate command fields

  < > Field indicator

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Syntax Example

Capital letters indicate the minimum required characters which need to be sent. Lower case letters are optional.

For example, the syntax of the lowpass filter cutoff frequency selection command is given as:

```
INPut:FILTer:LPASs:FREQuency
<cutoff_frequency>,<channel_list>
```

where <cutoff_frequency> is a <nrf> field that specifies the filter cutoff frequency, and <channel_list> specifies the channels to be affected.

Each of the following is a valid form of this command:

```
input:filter:lpass:frequency 1e3,(@1:5)

inp:filt:lpas:freq 1e3,(@1:5)

INPUT:FILT:LPASS:FREQ 1e3,(@1:5)

Input:Filter:Lpass:Frequency maximum,(@1:5)

Input:Filter:Lpass:Frequency max,(@1:5)
```

SCPI/IEEE 488.2 Command Elements

The definition of elements used in SCPI/IEEE-488.2 commands and command descriptions is as follows:

<NR1>

ASCII integer representation of a decimal number.

<NRf>

ASCII integer, fixed point or floating point representation of a decimal number.

The ASCII strings MAXimum, MINimum, and DEFault may also be specified in a <NRf> field. If MAXimum is specified for a command parameter, the parameter is set to the maximum allowed value. If MINimum is specified for a command parameter, the parameter is set to the minimum allowed value. If DEFault is specified for a command parameter, the parameter is set to the value assigned at power-on.

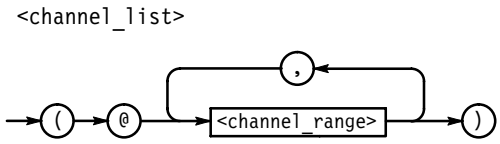
The following are example commands that use the MAXimum, MINimum and DEFault ASCII strings.

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Command	Description
input:filter:lpass:Freq min,(@1:10)	Set the lowpass filter cutoff frequency of channels 1 through 10 to the minimum allowed value, 468 Hz.
input:gain maximum,(@16)	Set the gain of channel 16 to the maximum allowed value, 100 V/V.
input:gain def,(@1:16)	Set the gain of all channels to the gain setting used at power-on, 1 V/V.

<channel_list>

A <channel_list> is a list of channel numbers on a VX4780 Module. When used in a command, the <channel_list> specifies which channels the command applies to. When used in a query, the <channel_list> specifies which channels' status to report. The channel numbers in the channel list must be in the range of 1 through 16. The syntax of a <channel_list> is described by the following diagram:



A channel_range may consist of a single channel number or a range of channel numbers. A range of channel numbers is indicated by two channel numbers separated by a colon (:) character.

The following are examples of valid <channel_list>s for the VX4780.

<channel_list>	Channels Specified
(@1)	Channel number 1
(@1,2,16)	Channels 1, 2 and 16
(@1:8)	Channels 1 through 8
(@3,9:16)	Channels 3 and 9 through 16

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output queue

The Output queue of the VX4780 is used to return replies to queries. Bit 4 (the MAV bit) of the Status Byte register is set to indicate that this queue is not empty. The DOR bit in the VXI Response register is also set to indicate that this queue is not empty. The commander of the VX4780 monitors the DOR bit to determine when it may read a message from the Output queue.

error/event queue

When the command parser detects a syntax error or data range error, it places an error message describing the error in the Error/Event queue. Bit 2 of the Status Byte Register is set to indicate that this queue is not empty. Bit 5 of the Standard Event Status Register (the Command Error bit) is set if the parser detects a syntax error. Bit 4 of the Standard Event Status register (the Execution Error bit) is set if the parser detects a numeric argument that is out of range. When a SYSTem:ERRor? query is received, an error message is dequeued from the Error/Event queue and placed in the Output queue.

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Functional Command Groups

This section lists the VX4780 system and module commands.

System Commands

The following low-level commands are typically sent by the module's commander, and are transparent to the user of the module. Exceptions are the Read STB command and the Clear command. These commands are typically sent by commanders that serve as an IEEE-488-to-VXIbus word serial interface. This type of commander maps IEEE-488 addresses to VXIbus logical addresses. When a IEEE-488 Serial Poll is issued on the IEEE-488 bus, the commander typically sends a VXI Read STB command to the corresponding VXI logical address. When a IEEE-488 Selected Device Clear command is sent on the IEEE-488 bus, the commander typically sends a VXIbus Clear command to the corresponding VXI logical address.

Most commanders or Slot 0 devices have specific ASCII commands that cause the commander 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
Begin Normal Operation	The module begins operation if it has not already done so.
Byte Available	Transfers module commands to this module.
Byte Request	Requests the module to return a byte of data from the output queue.
Clear	The module clears its VXIbus interface and any pending commands. Current module operations are unaffected.
Clear Lock	Clears the Lock bit of the Response register.
Read Protocol	The module returns its protocol to its commander.
Read STB	The module returns its VXI status byte to its commander.
Set Lock	Set the Lock bit of the Response register.
Trigger	Accepted, but has no effect on the VX4780 Module.

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Module Commands

A summary of the VX4780-specific and IEEE-488.2 Common Commands is listed in Tables 3–1 and 3–2 below. The next section, *Command Descriptions*, includes detailed descriptions of each command. *Appendix C: Examples* shows examples of command usage.

Table 3–1: Summary of VX4780–Specific SCPI Commands

Subsystem Command	Functions Controlled
DIAGnostic	Diagnostic commands.
INPut	Control input isolation relays, input coupling, attenuators, variable gain amplifier, and lowpass filter.
OUTPut	Control output isolation relays.
STATus	Status register functions: OPERation, QUESstionable.
SYSTem	System-level functions: ERRor?, PRESet, VERSion?

Table 3–2: Summary of IEEE-488.2 Common Commands

Command/Syntax	Description
Clear Status *CLS	Clears the SCPI and IEEE 488.2 event registers and the SCPI Error/Event queue, and the Output queue.
Standard Event Status Enable *ESE <NRf>	Sets the contents of the Standard Event Status Enable register.
Standard Event Status Enable Query *ESE?	Returns the current value of the Standard Event Status Enable register in <nr1> format.
Standard Event Status Register Query *ESR?	Returns the current value of the Standard Event Status register in <nr1> format, then set the contents of this register to 0.
Identification Query *IDN?	Returns an ASCII string in the Output queue which identifies the board.
Operation Complete *OPC	Sets bit 0 (the Operation Complete bit) of the Standard Event Status register when all pending device operations have been completed.
Operation Complete Query *OPC?	Places the ASCII character 1 in the Output queue when all pending device operations have been completed.
Reset* *RST	The VX4780 is placed in its power-on state with some exceptions.

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Table 3–2: Summary of IEEE-488.2 Common Commands (Cont.)

Command/Syntax	Description
Service Request Enable *SRE <NRf>	Sets the contents of the Service Request Enable register.
Service Request Enable Query *SRE?	Returns the current value of the Service Request Enable register in <nr1> format.
Read Status Byte Query *STB?	Returns the current value of the Status Byte register in <nr1> format.
Self Test Query *TST?[<channel_list>]	Performs a self test of the VX4780. Place a “0” or “1” into the output queue to indicate whether the self test passed or failed.
Wait-to-Continue *WAI	Does not execute any further commands or queries until all pending operations have been completed.

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Command Descriptions

This section lists the VX4780-specific SCPI commands and queries in alphabetic order. The IEEE-488.2 Common Commands are listed in the next section. A summary listing of the SCPI command set for the VX4780 is as follows:

INPut:ATTenuation <attenuation>,<channel_list>,
INPut:COUPling DC | AC | GROund, <channel_list>,
INPut:FILTer:LPASs:FREQuency <cutoff_frequency>,<channel_list>
INPut:GAIN <gain>,<channel_list>,
INPut:GAIN:TRIM <gainadj>,<channel_list>,
INPut:STATe <state>,<channel_list>

OUTPut:STATe <state>,<channel_list>,
OUTPut:OFFSet:TRIM <offsetadj>,<channel_list>

STATus:OPERation:CONDition?
STATus:OPERation:ENABle
STATus:OPERation[:EVENt?]
STATus:QUEStionable:CONDition?
STATus:QUEStionable:ENABle
STATus:QUEStionable[:EVENt?]

SYSTem:ERRor?
SYSTem:PRESet
SYSTem:VERSion?

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INPut

Command Syntax

```
INPut:
   ATTenuation <attenuation>,<channel_list>
```

Query Syntax

```
INPut:ATTenuation? <channel_list>
or
INPut:ATTenuation? MAXimum | MINimum | DEFault [,<channel_list>]
```

Query Response

The query returns the attenuation setting in units of volt/volt (v/v) for each channel specified.

***RST Value**

The attenuation of all channels is set to 10.

Limits

N/A

Related Commands

INPut:GAIN <channel_list>
INPut:GAIN:TRIM <channel_list>
INPut:ATTenuation:STATe <channel_list>

Description

Each channel contains an input attenuator followed by a variable gain amplifier followed by a low pass filter with programmable cutoff frequency.

The INPut:ATTenuation command is used to set the input attenuator of each channel to divide the input signal by 10 or 100. The INPut:ATTenuation:STATe command is used to either insert the attenuator into the signal path or bypass it.

The attenuation is specified in units of volt/volt, and must be 10 or 100. An error is placed in the Error/Event queue if any other value is specified. An attenuation of 100 is only permitted when the low pass filter is programmed for a cutoff frequency of 7.02 kHz or less. An error is placed in the Error/Event queue if an attenuation of 100 is specified for a channel that has been programmed with a low pass filter cutoff frequency greater than 7.02 kHz.

The <attenuation> parameter consists of a decimal ASCII number or one of the ASCII strings MAXimum, MINimum, or DEFault. The ASCII string MAXimum specifies an attenuation of 100. The ASCII strings MINimum and DEFault specify an attenuation of 10. If the input attenuator is bypassed, the overall channel gain is equal to the gain of the variable gain amplifier. If the input attenuator is inserted into the signal path, the overall channel gain is equal to the gain of the variable gain amplifier divided by the attenuator attenuation setting. For example, if the attenuator of channel 1 is inserted into the signal path and set

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to divide the signal by 10 and the gain of the variable gain amplifier is set to 50, the overall channel gain is equal to 50/10 = 5.

Examples

Command	Response
input:Att 100,(@1:16)	Set the attenuators of channels 1 through 16 to divide by 100.
input:Attenuation max,(@1:16)	Set the attenuators of channels 1 through 16 to divide by 100.
inp:att min,(@1,2,3)	Set the attenuators of channels 1 through 3 to divide by 10.

Command Syntax

```
INPut:COUPling DC | AC | GROund, <channel_list>
```

Query Syntax

```
INPut:COUPling? <channel_list>
```

Query Response

"DC", "AC", or "GRO" is returned for each channel specified in the query, indicating the state of the input coupling relay for each channel.

***RST Value**

All inputs are AC coupled.

Limits

N/A

Related Commands

INPut:STATe

Description

If DC coupling is specified in this command, the inputs of the specified channel(s) are connected through the input isolation relays directly to the input attenuator(s). If AC coupling is specified, the inputs of the specified channel(s) are switched through the input isolation relays, then through coupling capacitors to the input attenuators(s). The INPut:STATe command is used to control the state of the input isolation relays.

If GROund is specified in the INPut:COUPling command, the input isolation relays are opened and the amplifier inputs of the specified channel(s) are switched to ground.

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Examples

Command	Response
`input:coupling dc,(@1:16); state on,(@1:16)`	DC couple the inputs of all 16 channels.
`input:coupling ac,(@1:16); state on,(@1:16)`	AC couple the inputs of all 16 channels.
`input:coupling ground, (@1:6,10)`	Open the isolation relays of channels 1 through 6 and 10 and connect the inputs of these channels to ground.

Command Syntax

```
INPut:FILTer:LPASs:FREQuency <cutoff_frequency>,<channel_list>
```

Query Syntax

```
INPut:FILTer:LPASs:FREQuency? <channel_list>
```

or

```
INPut:FILTer:LPASs:FREQuency? MAXimum | MINimum | DEFault
[,<channel_list>]
```

Query Response

The response to the first query listed above is the frequency setting of the lowpass filter cutoff in Hz for each channel specified in the query.

The response to the second query listed above is the maximum, minimum, or default frequency setting of the lowpass filter cutoff of the specified channels. If no <channel_list> is specified, the value associated with the ASCII strings MAXimum, MINimum or DEFault when specified in the INPut:FILTer:LPASs:FREQuency command is returned.

***RST Value**

The cutoff frequency of the lowpass filter of all channels is set to 468 Hz.

Limits

N/A

Related Commands

N/A

Description

Each channel contains a 4th order Bessel low pass filter. The cutoff frequency of each filter is command selectable from 468 Hz to 7.02 kHz in 468 Hz steps, and from 7.13 kHz to 107 kHz in 7.13 kHz steps. Cutoff frequencies greater than 468 Hz and less than 107 kHz are rounded to the closest realizable value. This value is returned in the response to an INPut:FILTer:LPASs:FREQuency? query. An error is placed in the Error/Event queue if a frequency of less than 468 Hz or greater than 107 kHz is specified. The <cutoff_frequency> argument consists of a decimal ASCII number (followed by optional units of “Hz” or “kHz”), or one of the ASCII strings MAXimum, MINimum, or DEFault. MAXimum specifies a

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cutoff frequency of 107 kHz. The ASCII strings MINimum and DEFault specify a cutoff frequency of 468 Hz.

Examples

The following four commands are equivalent and set the cutoff frequencies of all 16 channels to 107 kHz.

```
input:filter:lpass:Freq 107e3,(@1:16)
input:filter:lpass:Freq maximum,(@1:16)
input:filter:lpass:Freq 107kHz,(@1:16)
input:filter:lpass:Freq 107000Hz,(@1:16)
```

The next five commands are equivalent and set the cutoff frequencies of all 16 channels to 468 Hz.

```
input:filter:lpass:Freq 468Hz,(@1:16)
input:filter:lpass:Freq min,(@1:16)
input:filter:lpass:Freq minimum,(@1:16)
input:filter:lpass:Freq default,(@1:16)
input:filter:lpass:Freq 468,(@1:16)
```

The next example sets the cutoff frequency of the filters of channels 1, 5, and 10 to 7.02 kHz, then verifies it.

Command	Response
input:filter:lpass:Freq 7e3, (@1,5,10)	no response
input:filter:lpass:freq? (@1)	7020<cr><lf>

Command Syntax

```
INPut:GAIN <gain>,<channel_list>
```

Query Syntax

```
INPut:GAIN? <channel_list>
```

or

```
INPut:GAIN? MAXimum | MINimum | DEFault [,<channel_list>]
```

Query Response

The response to the INPut:GAIN? <channel_list> query is the gain setting in volt/volt for each channel specified in the query.

The response to the Maximum/Minimum/Default query is the maximum, minimum, or default gain setting(s) of the specified channel(s). If no <channel_list> is specified, the value associated with ASCII strings MAXimum, MINimum, or DEFault (when specified in the INPut:GAIN command) is returned.

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***RST Value** The gain of all channels is set to 1.

Limits N/A

Related Commands INPut:ATTenuation <channel_list>,
INPut:ATTenuation:STATe <channel_list>,
INPut:GAIN:TRIM <channel_list>

Description Each channel consists of an input attenuator followed by a variable gain amplifier and low pass filter. The input attenuator of each channel may be set to divide the input signal by 10 or 100 with the INPut:ATTenuation command. The input attenuator of each channel may be inserted into the signal path or bypassed with the INPut:ATTenuation:STATe command. The gain of the variable gain amplifier in units of volt/volt is set to the <gain> parameter of the INPut:GAIN command. The gain specified in this command must be one of the following values: 1.0, 2.0, 5.0, 10.0, 20.0, 50.0 or 100.0. An error is placed in the Error/Event queue if any other gain value is specified.

The <gain> parameter consists of a decimal ASCII number or one of the ASCII strings MAXimum, MINimum, or DEFault. The ASCII string MAXimum specifies a gain of 100. The ASCII strings MINimum and DEFault specify a gain of 1.

If the input attenuator is bypassed, the overall channel gain is equal to the gain of the variable gain amplifier. If the input attenuator is inserted into the signal path, the overall channel gain is equal to the gain of the variable gain amplifier divided by the attenuator attenuation setting. For example, if the attenuator of channel 1 is inserted into the signal path and set to divide the signal by 10 and the gain of the variable gain amplifier is set to 50, the overall channel gain is equal to 50/10 = 5.

Examples The following three examples are equivalent and set the gain of all 16 variable gain amplifiers to 100. The attenuators of all 16 channels are bypassed, so the overall gain of all 16 channels is set to 100.

Command	Response
input:att:State off,(@1:16)	Bypass the input attenuators of channels 1 through 16.
input:gain 100,(@1:16)	Set the gain of all 16 variable gain amplifiers to 100.
input:gain maximum,(@1:16)	Set the gain of all 16 variable gain amplifiers to 100.
input:gain 1e2,(@1:16)	Set the gain of all 16 variable gain amplifiers to 100.

The following are all valid examples of the input:gain command.

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Command	Response
input:gain 100,(@1:16)	Set the gain of channels 1 through 16 to 100 V/V.
input:gain max,(@1:16)	Set the gain of channels 1 through 16 to 100 V/V.
inp:gain 1,(@1,2,3)	Set the gain channels 1 through 3 to 1 V/V.
input:gain 5,(@1:16)	Set the gain of channels 1 through 16 to 5 V/V.
input:gain? (@1:8)	5, 5, 5, 5, 5, 5, 5, 5<cr>,<lf>

Command Syntax

```
INPut:GAIN:TRIM <gainadj>,<channel_list>
```

Query Syntax

```
INPut:GAIN:TRIM? <channel_list>
```

or

```
INPut:GAIN:TRIM? MAXimum | MINimum | DEFault [,<channel_list>]
```

Query Response

The response to the first query listed above is the gain trim setting in parts per million (ppm) for each channel specified in the query.

The response to the second query listed above is the maximum, minimum or default gain trim settings of the specified channels. If no <channel_list> is specified, the value associated with the ASCII strings MAXimum, MINimum or DEFault when specified in the INPut:GAIN:TRIM command is returned.

***RST Value**

The input gain trim of all channels is set to 0 ppm.

Limits

N/A

Related Commands

INPut:GAIN <channel_list>,
INPut:ATTenuation <channel_list>,
INPut:ATTenuation:STATe <channel_list>

Description

Each channel contains a digital-to-analog converter (DAC) used to calibrate the overall channel gain. The INPut:GAIN:TRIM command provides access to these DACs. A value corresponding to the <gainadj> parameter is added to the value from NOVRAM that is normally loaded into the converter. The result is loaded into the gain trim DAC(s) of the channel(s) specified in the <channel_list>.

This feature is useful for performing a system level calibration of gain. For example if the gain of a sensor connected to a VX4780 input is 0.5% low, the INPut:GAIN:TRIM command can be used to compensate for this error by increasing the VX4780 gain by 0.5%. The resolution of the gain correction can

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be determined for a particular channel can be determined by reading NOVRAM address (chan-1)*12 and dividing by 100. The result is the gain trim resolution in ppm. Nominally the gain trim resolution is 16.89 ppm. The range of the correction factors that can be specified in the INPut:GAIN:TRIM command is ±10000 ppm = ±1%. Values specified outside of this range will cause an error condition.

Examples

The gain of a sensor connected to VX4780 channel 1 input is determined to be 0.567% low. The following example increases the gain VX4780 channel 1 by 0.567% to compensate for the sensor gain error.

Command	Response
input:gain:trim 5670ppm,(@1)	Increase the gain of VX4780 channel 1 by 0.567%.

Command Syntax

```
INPut:STATe  <state>,<channel_list>
```

Query Syntax

```
INPut:STATe? <channel_list>
```

Query Response

This query returns the state of the input isolation relay for each channel specified in the query. A 1 in the query response indicates that an isolation relay is closed, and that the signal conditioning channel input is connected to the front panel input connector. A 0 in the query response indicates that the input isolation relay is opened, and the signal conditioning channel input is disconnected from the front panel input connector.

***RST Value**

The input isolation relays for all channels are opened.

Limits

N/A

Related Commands

INPut:COUPling

Description

Each channel contains an input isolation relay. When closed, this relay connects the positive and negative channel inputs on one of the front panel input connectors to the input of the signal conditioning circuitry for that channel. When this relay is opened, the front panel inputs are disconnected from the input of the signal conditioning circuitry.

The <state> argument in this command can consist of a decimal ASCII number or the ASCII strings ON or OFF. The ASCII string ON or non zero ASCII number specify that the input isolation relay(s) of the channel(s) specified in the channel list are to be closed. The ASCII string OFF or the number zero specify

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that the input isolation relay(s) of the channel(s) specified in the channel list are to be opened.

The input isolation relays are also opened when a INPut:COUPling GROund,<channel_list> command is received.

When power is removed from the VXIbus chassis containing the VX4780, VMEbus signal ACFAIL* is asserted. In response to this signal, the VX4780 opens all input and output isolation relays.

Examples

The following two examples open the input isolation relays of all channels.

Command	Response
`input:state off,(@1:16)`	no response
`input:State 0.0,(@1:16)`	no response

The next two examples are equivalent and close the input isolation relays of all channels.

Command	Response
`input:state 1,(@1:16)`	no response
`input:state on,(@1:16)`	no response

The next example queries the state of the input isolation relays of channels 3, 4, and 15. The query response indicates that the input isolation relays for these channels are closed.

Command	Response
`input:state? (@3:4,15)`	1, 1, 1<cr><lf>

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OUTPut

Command Syntax

```
OUTPut:STATe  <state>,<channel_list>
```

Query Syntax

OUTPut:STATe? <channel_list>

Query Response

This query returns the state of the output isolation relay for each channel specified in the query. A 1 in the query response indicates that an output isolation relay is closed, and that the signal conditioning channel output is connected to the front panel output connector. A 0 in the query response indicates that the output isolation relay is open, and the signal conditioning channel output is disconnected from the front panel output connector.

***RST Value**

The output isolation relays for all channels are opened.

Limits

N/A

Related Commands

N/A

Description

Each channel contains an output isolation relay. When closed, this relay connects the output of the signal condition circuitry for that channel to a front panel output connector. When this relay is opened, the channel output is disconnected from the front panel output connector. The <state> argument in this command can consist of a decimal ASCII number or the ASCII strings ON or OFF. The ASCII string ON or non-zero ASCII number specify that the output isolation relay(s) of the channel(s) specified in the channel list are to be closed. The ASCII string OFF or the number zero specify that the output isolation relay(s) of the channel(s) specified in the channel list are to be opened.

When power is removed from the VXIbus chassis containing the VX4780, VMEbus signal ACFAIL* is asserted. In response to this signal, the VX4780 opens all input and output isolation relays.

Examples

The following two examples open the output isolation relays of all channels.

Command	Response
`output:state off, (@1:16)`	no response
`output:State 0.0, (@1:16)`	no response

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The next two examples are equivalent and close the output isolation relays of all channels.

Command	Response
`output:state 1,(@1:16)`	no response
`output:state on,(@1:16)`	no response

The next example queries the state of the output isolation relays of channels 3, 4, and 15. The query response indicates that the output isolation relays for these channels are closed.

Command	Response
`output:state? (@3:4,15)`	1, 1, 1<cr><lf>

Command Syntax

```
OUTPut:OFFSet:TRIM <offsetadj>,<channel_list>
```

Query Syntax

```
OUTPut:OFFSet:TRIM? <channel_list>
```

or

```
OUTPut:OFFSet:TRIM? MAXimum | MINimum | DEFault [,<channel_list>]
```

Query Response

The response to the first query listed above is the output DC offset trim setting in volts for each channel specified in the query.

The response to the second query listed above is the maximum, minimum or default output DC offset trim settings of the specified channels. If no <channel_list> is specified, the value associated with the ASCII strings MAXimum, MINimum or DEFault when specified in the OUTPut:OFFSet:TRIM command is returned.

***RST Value**

The output offset trim of all channels is set to 0 volts.

Limits

N/A

Related Commands

N/A

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Description

Each channel contains a DAC used to null DC offset errors at the channel output. The OUTPut:OFFSet:TRIM command provides access to these DACs. A value corresponding to the <offsetadj> parameter is added to the offset error value from NOVRAM corresponding to the current gain setting. The result is used to calculate a load value for the offset trim DAC(s) of the channel(s) specified in the <channel_list>.

This feature is useful for performing a system level calibration of DC offset. For example if a sensor connected to a VX4780 input produces an offset error of +10 mV at the VX4780 channel output, the OUTPut:OFFSet:TRIM command can be used to compensate for this error by adding a –10 m VDC correction to the channel output signal. The resolution of the offset correction that the VX4780 can apply increases as the magnitude of the correction increases according to the following formula:

R = (128 - x) * ref / 16320

where

x = –1 + round down (128 * (1 – |correction| / ref))

correction = the correction to apply in volts.

ref = the contents of NOVRAM location 192 + (channel-1)*12 divided by 100000. This value is nominally 0.395 volts.

R = resolution of the DC correction in volts.

For example, for ref = 0.395 and a desired correction of 0.01 volts, x = 123 => R = 121 µV

The range of the correction factors that can be specified in the INPut:OFFSet:TRIM command is ±0.2 V. Values specified outside of this range will cause an error condition.

Examples

In the following example 0V is input to channel 1 of the VX4780 and a voltmeter measures 300 µV at the channel 1 output.

Command	Response
`output:offset:trim -300e-6,(@1)`	Subtracts 300 µV from the DC offset at the output of channel 1, nulling this offset error.

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STATus

Command Syntax

```
STATus
    :OPERation
        :CONDition?
```

***RST Value** 0

Limits N/A

Related Commands N/A

Description This query returns the contents of the SCPI Status Operation Condition register. For the VX4780, the value of this register is always equal to 0.

Examples

Command	Response
`status:operation:condition?`	00000

Command Syntax

```
STATus
    :OPERation
        :ENABle
```

Query Syntax

```
STATus:
    OPERation
        :ENABle?
```

***RST Value** 0

Limits N/A

Related Commands N/A

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Description This command sets the contents of the SCPI Status Operation Event Enable register.

Examples

Command	Response
status:operation: enable 1	no response
stat:oper:enab?	00001

Command Syntax

```
STATus
    :OPERation
        [:EVENt?]
```

***RST Value** 0

Limits N/A

Related Commands N/A

Description This query returns the contents of the SCPI Status Operation Event register. For the VX4780, the value of this register is always equal to 0.

Examples

Command	Response
status:operation: event?	00000

Command Syntax

```
STATus
    :QUEStionable
        :CONDition?
```

***RST Value** 0

Limits N/A

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Related Commands N/A

Description This query returns the contents of the SCPI Status Questionable Condition register. For the VX4780, the value of this register is always equal to 0.

Examples

Command	Response
`status:questionable: condition?`	`00000`

Command Syntax

```
STATus
    :QUEStionable
        :ENABle
```

Query Syntax

```
STATus
    :QUEStionable
        :ENABle?
```

Query Response Indicates whether the Status Operation Event is enabled.

***RST Value** 0

Limits N/A

Related Commands N/A

Description This command sets the contents of the SCPI Status Operation Event Enable register.

Examples

Command	Response
`status:questionable: enable 1`	`No response`
`stat:ques:enab?`	`00001`

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Command Syntax

```
STATus
    :QUEStionable
          [:EVENt?]
```

***RST Value** 0

Limits N/A

Related Commands N/A

Description This query returns the contents of the SCPI Status Questionable Event register. For the VX4780, the value of this register is always equal to 0.

Examples

Command	Response
`status:questionable:event?`	00000

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SYSTem

Command Syntax

```
SYSTem
    :ERRor?
```

Query Response

0,“No error”

Number 10 messages are placed in the Error/Event queue during self test to indicate which channels passed self test. See the description of the “*TST?” query for more information on these error messages.

10,“Test passed; Novram checksum, Constant type/Channel mask: Gain/x, Offset/x

10,“Test passed; Offset trim dac(s), Channel mask: x”

10, “Test passed; Input test voltage, Input/Channel mask: Neg/x, Pos/x

10,“Test passed; Attenuator bypass with nominal cal, Input/Channel mask: Neg/x, Pos/x”

10,“Test passed; Attenuator bypass with stored cal, Input/Channel mask: Neg/x, Pos/x”

10,“Test passed; /10 Attenuator(s) with nominal cal, Input/Channel mask: Neg/x, Pos/x”

10,“Test passed; /10 Attenuator(s) with stored cal, Input/Channel mask: Neg/x, Pos/x”

10,“Test passed; /100 Attenuator(s) with nominal cal, Input/Channel mask: Neg/x, Pos/x”

10,“Test passed; /100 Attenuator(s) with stored cal, Input/Channel mask: Neg/x, Pos/x”

10,“Test passed; Gain trim dac(s), Channel mask: x”

10,“Test passed; Low pass filter(s), Tuning bit/Channel mask: 0/x, 1/x, 2/x, 3/x, 4/x”

10,“Test passed; AC coupling capacitors, Input/Channel mask: Neg/x, Pos/x”

10,“Test passed; Variable gain amplifier with nominal cal, Channel mask: 2/x, 5/x, 10/x, 20/x, 50/x, 100/x”

10,“Test passed; Variable gain amplifier with stored cal, Gain/Channel mask: 2/x, 5/x, 10/x, 20/x, 50/x, 100/x”

-102,“Syntax error; Unexpected x detected while ...”

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–108,“Parameter count exceeded for xxxx command”

–109,“Missing parameter for xxxx command”

–121,“Invalid character in number”

–123,“Exponent too large

–221,“Settings conflict; /100 attenuator setting conflict with upper range filter cutoff frequency, Channel mask x”

–222,“Data out of range; Minimum cutoff frequency is 468 Hz”

–222,“Data out of range; Maximum cutoff frequency is 107 KHz”

–222,“Data out of range; Maximum gain is 100”

–222,“Data out of range; Minimum gain is 1”

–222,“Data out of range”

–222,“Data out of range; Illegal channel number: x”

–224,“Illegal parameter value; Allowed gains are 1 and 10”

–224,“Illegal parameter value; Allowed gains are 1,2,5 and 10”

–224,“Illegal parameter value; Allowed gains are 1 to 100 in 1/2/5 steps”

–224,“Illegal parameter value; Allowed attenuations are 10 and 100”

Number -330 messages are placed in the Error/Event queue during self test to indicate which channels failed self test. See the description of the *TST? query for more information on these error messages.

–330,“Self-test failed; self test a/d converter failure”

–330,“Self-test failed; Novram checksum, Constant type/Channel mask: Gain/x, Offset/x

–330,“Self-test failed; Offset trim dac(s), Channel mask: x”

–330, “Self-test failed; Input test voltage, Input/Channel mask: Neg/x, Pos/x

–330,“Self-test failed; Attenuator bypass with nominal cal, Input/Channel mask: Neg/x, Pos/x”

–330,“Self-test failed; Attenuator bypass with stored cal, Input/Channel mask: Neg/x, Pos/x”

–330,“Self-test failed; /10 Attenuator(s) with nominal cal, Input/Channel mask: Neg/x, Pos/x”

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–330,“Self-test failed; /10 Attenuator(s) with stored cal, Input/Channel mask: Neg/x, Pos/x”

–330,“Self-test failed; /100 Attenuator(s) with nominal cal, Input/Channel mask: Neg/x, Pos/x”

–330,“Self-test failed; /100 Attenuator(s) with stored cal, Input/Channel mask: Neg/x, Pos/x”

–330,“Self-test failed; Gain trim dac(s) , Channel mask: x”

–330,“Self-test failed; Low pass filter(s), Tuning bit/Channel mask: 0/x, 1/x, 2/x, 3/x, 4/x”

–330,“Self-test failed; AC coupling capacitors, Input/Channel mask: Neg/x, Pos/x”

–330,“Self-test failed; Variable gain amplifier(s) with nominal cal, Gain/Channel mask: 2/x, 5/x, 10/x, 20/x, 50/x, 100/x”

–330,“Self-test failed; Variable gain amplifier(s) with stored cal, Gain/Channel mask: 2/x, 5/x, 10/x, 20/x, 50/x, 100/x”

–350,“Queue overflow; Error/event queue”

–350,“Queue overflow; Output queue”

***RST Value**

The Error/Event queue is empty.

Limits

N/A

Related Commands

*ESR?,
*STB?

Description

If an error condition is detected by the VX4780, it places an error message describing the condition in the Error/Event queue. The SYSTem:ERRor? query requests the VX4780 to remove the oldest message in the Error/Event queue and place it into the Output queue. If the Error/Event queue is empty, a “No error” message is placed in the Output queue.

Examples

Command	Response
`SYSTEM:ERROR?`	0, “No error”
`syst:err?`	-222,“Data out of range”

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Command Syntax

```
SYSTem:
    PRESet
```

Query Syntax N/A

***RST Value** N/A

Limits N/A

Related Commands *RST

Description This command places the VX4780 in the power-on state. This command has the same effect as the *RST command, with the following exceptions: the SYSTem:PRESet command clears

the Output queue,

the Error/Event queue,

the Standard Event Status Enable register,

the SCPI Status Operational Enable register, and

the SCPI Status Questionable Enable register.

Examples

Command	Response
`system:preset`	No response
`syst:pres`	No response

Command Syntax

```
SYSTem
    :VERSion?
```

***RST Value** N/A

Limits N/A

Related Commands None

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Description This query returns the following ASCII string in the output queue:

”1994.0”

Examples

Command	Response
system:version?	"1994.0"
syst:vers?	"1994.0"

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IEEE-488.2 Common Commands

This section lists the IEEE-488.2 common commands and queries recognized by the VX4780.

*CLS

Clear Status. This commands clears the following:

Event Status register (ESR)
Error/Event queue
Output queue

*ESE <NRf>

Event Status Enable (ESE) command. This command defines the mask for setting the Event Status Summary bit (bit 5) in the Status Byte register (*STB?). The mask is logically ANDed with the Event Status register (*ESR?) to determine whether or not to set the Event Status Summary bit. The mask can be any numeric value from 0 to 255, corresponding to the encoded bits of the ESR register. A “1” in a bit position enables reporting of the function. A “0” disables it. The *ESE register is cleared at power-on, or by writing an *ESE 0 command only. If <mask> is not specified, it defaults to 0.

For example, the command *ESE 37 (hexadecimal 25, binary 00010101) enables setting the Event Status Summary bit whenever an operation is complete, a query error is detected, or an execution error is detected.

*ESE?

Event Status Enable (ESE) query. This command returns the value of the Event Status Enable register as a numeric value from 0 to 255. For example, a value of 32 (hexadecimal 40, binary 00100000) indicates that command error reporting is enabled.

*ESR?

Event Status Register (ESR) query. This command returns the value of the Event Status register. The *ESR command is destructively read (that is, read and cleared). The Event Status Summary bit in the Status Byte (*STB?) is also cleared by a read of the ESR. The ESR is set to 128 on power-on (bit 7) set. It is

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cleared by an *ESR? or *CLS command only. When converted to a binary number, the bits of the ESR correspond to:

bit	0 (LSB)	Operation Complete
	1	Request Control
	2	Query error
	3	Device Dependent error
	4	Execution error
	5	Command error
	6	User Request
	7 (MSB)	Power On

The Error bits are set whenever the module detects an error. The error values from –100 to –199 are Command errors. Error values from –200 to –299 are Execution errors. Error values from –300 to –399 are Device Dependent errors. Error values from –400 to –499 are Query errors (see the SYSTem:ERRor command description).

The Request Control and User Request bits are unused, and are always reported as zeroes.

The Operation Complete bit is set in response to an *OPC command. A 1 indicates that the module has completed all pending commands and queries.

*IDN?

Identification query; This returns a 4-field response. Field 1 is the manufacturer, field 2 the model, field 3 the serial number, and field 4 contains both the SCPI and the firmware version levels. For the VX4780, the serial number field is always a 0. The response syntax is:

```
TEKTRONIX,VX4780,0,SCPI:94.0 FV1.0<LF>
```

*OPC

Operation Complete. This command causes the module to set the Operation Complete bit in the Event Status register (ESR) when all pending commands and queries are complete.

*OPC?

Operation Complete query. This command causes the module to place a “1” in the Output queue when all pending commands and queries are complete. All commands following *OPC are suspended until the pending operations are

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complete. The *OPC? command does not affect the OPC bit in the Event Status register.

*RST

Reset. This command places the VX4780 in the following state:

Input Isolation Relays: Open

Input Coupling: AC

Input Attenuator Setting: /10

Input Attenuator State: Inserted

Gain: 1 V/V

Lowpass Filter Cutoff Frequency: 468 Hz

Output Isolation Relays: Open

This command does not clear the Error/Event queue, the Output queue or the Standard Event Status Enable register.

*SRE <mask>

Service Request Enable (SRE) register. This command defines a mask that is ANDed with the contents of the Status Byte register. If the result of this operation is non-zero, the VX4780 generates a VXI Request True interrupt. Bits 0, 1, 3, 6, and 7 of the SRE register are not used. Bits 2, 4, and 5 are set to enable VXI Request True interrupts to be generated under the conditions listed in the following table.

Bit No.	Meaning
bit0 (LSB)	Not used.
1	Not used.
2	The Error/Event queue contains one or more error messages.
3	Not used.
4	The Output queue contains one or more query responses.
5	The contents of the Standard Event Status register ANDed with the contents of the Standard Event Status Enable register produces a non–zero result.
6	Not used.
7	Not used.

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*SRE?

Service Request Enable (SRE) query. This command returns the value of the Service Request Enable register as a numeric value from 0 to 255. Bit 6 is unused, and is reported as zero.

*STB?

Status Byte Query. This query returns the value of the Status Byte register as a numeric value between 0 and 255. The Status Byte register contents (with the exception of bit 6) are also returned in response to a VXI Read STB command. Bit 6 is read destructively in response to a VXI Read STB command. Bit 6 is not read destructively in response to a *STB? query. The Status Byte register is encoded as follows:

Bit No.	Meaning
bit 0 (lsb)	Not used.
bit 1	Not used.
bit 2	Set when the Error/Event queue contains one or more error messages.
bit 3	Not used.
bit 4	Set when the Output buffer contains one or more query responses.
bit 5	Set when the contents of the Standard Event Status register ANDed with the contents of the Standard Event Status Enable register produces a non zero result.
bit 6	Set when the contents of bits 0 through 5 and bit 7 of the Status Byte register ANDed with the contents of the Service Request Enable register produce a non zero result. If bit 6 becomes set, the VX4780 will generate a VXI Request True interrupt on the VME interrupt level selected by its interrupt level select switch. If bit 6 becomes set and the Status Byte register is read using a VXI Read STB command, bit 6 will be reported as being set. In response to subsequent VXI Read STB commands, bit 6 will be reported as being cleared. If bit 6 becomes set and the Status Byte register is read using a *STB? query, bit 6 will be reported as being set. Bit 6 will continue to be reported as set in response to *STB queries until the contents of bits 0 through 5 and bit 7 of the Status Byte register ANDed with the contents of the Service Request Enable register is equal to 0.
bit 7	Not used.

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*TST?

*TST? [<channel_list>] Self Test Query.

In response to this query, the VX4780 performs a self test of the channels specified in the <channel_list> argument. If no <channel_list> is specified, all sixteen channels are tested. If the channel(s) pass self test, an ASCII “0” is placed in the Output buffer and user defined messages describing the tests performed are placed in the Error/Event queue. These error messages may be read by issuing a SYSTem:ERRor? query or cleared with the *CLS command. If one or more channels fail self test, an ASCII “1” is placed in the output buffer and error message(s) describing the failure(s) are queued in the Error/Event queue. These error messages may be read by issuing a SYSTem:ERRor? query. When a *TST? command is issued to the VX4780, it opens the input and output isolation relays of the channel(s) to be tested, then performs the following tests:

1. NOVRAM contains a set of DC offset calibration factors and gain calibration factors for each channel of the VX4780. Two calibration factor checksums are stored for each channel, one for the DC offset calibration factors and one for the gain calibration factors. This test calculates the checksum of the DC offset and gain calibration factors and verifies that they are equal to the stored checksums.

2. Each channel contains a d/a converter that is used to null the DC offset error at the channel output for each setting of the variable gain amplifier. This test verifies that these d/a converters are functioning properly.

3. During self test, a variable voltage source is applied to the inputs of each channel being tested. This test verifies that the variable voltage source is functioning properly.

4. The channel gain is measured and checked to be equal to 1 after setting the channel to the following state: DC coupled, Attenuator bypassed, variable gain amplifier gain set to 1, low pass filter cutoff frequency set to 107 kHz.

5. The channel gain is measured and checked to be equal to 0.1 after setting the channel to the following state: DC coupled, Attenuator inserted and set to divide by 10, variable gain amplifier gain set to 1, low pass filter cutoff frequency set to 107 kHz.

6. The channel gain is measured and checked to be equal to 0.01 after setting the channel to the following state: DC coupled, Attenuator inserted and set to divide by 100, variable gain amplifier gain set to 1, low pass filter cutoff frequency set to 107 kHz.

Tests 4, 5, and 6 are performed with nominal calibration factors loaded, then repeated using stored calibration factors. If a test passes with nominal calibration factors and fails with stored calibration factors, this indicates that an incorrect

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calibration factor has been stored in NOVRAM. Self test is terminated if a failure is detected by tests 4, 5, or 6 with nominal calibration factors loaded.

7. Each channel contains a DAC that is used to trim the channel gain for each attenuator setting and variable gain amplifier setting. This test verifies that these DACs are functioning properly.

8. The cutoff frequency of each lowpass filter is controlled by a 5-bit tuning word. The VX4780 verifies that each bit in the tuning word produces the correct cutoff frequency. The cutoff frequency is checked indirectly by measuring the group delay of the filter.

9. The AC coupling capacitors for the positive and negative inputs of each channel are tested. This test also tests the 1 M Ω input resistor of each channel input by measuring the RC time constant of the network formed by the AC coupling capacitor and the 1 MΩ input resistor of each input.

10. The gain of the variable gain amplifier is checked at gains of 2, 5, 10, 20, 50, and 100. This test is performed with nominal calibration factors, then repeated with stored calibration factors. If this test passes with nominal calibration factors and fails with stored calibration factors, this indicates that an incorrect calibration factor has been stored in NOVRAM. Note that the variable gain amplifier has already been tested at a gain of 1 in test 4.

The following is a description of the messages placed in the Error/Event queue during self test. Each message contains one or more hexadecimal masks that indicate the channel(s) that the message applies to. The least significant bit (bit 0) of the mask is set if the message applies to channel 1, bit 1 is set if the message applies to channel 2, ..., bit 15 is set if the message applies to channel 16. For example a mask value of hexadecimal 8007 indicates that the message applies to channels 1, 2, 3, and 16.

–330,“Self-test failed; self test a/d converter failure”

The VX4780 uses a 14 bit a/d converter to measure channel input and output voltages in tests 2 through 10. If an a/d converter time-out occurs during any of these tests, this error message is placed in the Error/Event queue and self test is terminated.

–330,“Self-test failed; Novram checksum, Constant type/Channel mask: Gain/x, Offset/x

One or more channels failed test number 1. The first hexadecimal mask indicates which channel(s) have an incorrect gain calibration constant checksum. The second hexadecimal mask indicates which channel(s) have an incorrect offset calibration constant checksum.

–330,“Self-test failed; Offset trim dac(s), Channel mask: x”

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One or more channels failed test number 2. The hexadecimal mask at the end of this error message indicates which channel(s) failed.

–330, “Self-test failed; Input test voltage, Input/Channel mask: Neg/x, Pos/x

One of more channels failed test number 3. The first hexadecimal mask indicates which channel(s) had a failure on the negative input. The second hexadecimal mask indicates which channel(s) had a failure on the positive input.

–330,“Self-test failed; Attenuator bypass with nominal cal, Input/Channel mask: Neg/x, Pos/x”

One or more channels failed test number 4 with nominal calibration factors loaded. The first hexadecimal mask at the end of this error message indicates which channel(s) failed the test of the negative channel input. The second hexadecimal mask indicates which channel(s) failed the test of the positive channel input.

–330,“Self-test failed; Attenuator bypass with stored cal, Input/Channel mask: Neg/x, Pos/x”

One or more channels failed test number 4 with stored calibration factors loaded. The first hexadecimal mask at the end of this error message indicates which channel(s) failed the test of the negative channel input. The second hexadecimal mask indicates which channel(s) failed the test of the positive channel input.

–330,“Self-test failed; /10 Attenuator(s) with nominal cal, Input/Channel mask: Neg/x, Pos/x”

One or more channels failed test number 5 with nominal calibration factors loaded. The first hexadecimal mask at the end of this error message indicates which channel(s) failed the test of the negative channel input. The second hexadecimal mask indicates which channel(s) failed the test of the positive channel input.

–330,“Self-test failed; /10 Attenuator(s) with stored cal, Input/Channel mask: Neg/x, Pos/x”

One or more channels failed test number 5 with stored calibration factors loaded. The first hexadecimal mask at the end of this error message indicates which channel(s) failed the test of the negative channel input. The second hexadecimal mask indicates which channel(s) failed the test of the positive channel input.

–330,“Self-test failed; /100 Attenuator(s) with nominal cal, Input/Channel mask: Neg/x, Pos/x”

One or more channels failed test number 6 with nominal calibration factors loaded. The first hexadecimal mask at the end of this error message indicates

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which channel(s) failed the test of the negative channel input. The second hexadecimal mask indicates which channel(s) failed the test of the positive channel input.

–330,“Self-test failed; /100 Attenuator(s) with stored cal, Input/Channel mask: Neg/x, Pos/x”

One or more channels failed test number 6 with stored calibration factors loaded. The first hexadecimal mask at the end of this error message indicates which channel(s) failed the test of the negative channel input. The second hexadecimal mask indicates which channel(s) failed the test of the positive channel input.

–330,“Self-test failed; Gain trim dac(s) , Channel mask: x”

One or more channels failed test number 7. The hexadecimal mask at the end of this error message indicates which channel(s) failed.

–330,“Self-test failed; Low pass filter(s), Tuning bit/Channel mask: 0/x, 1/x, 2/x, 3/x, 4/x”

One or more channels failed test number 8. The hexadecimal masks at the end of this error message indicates which tuning bit(s) of which channel(s) failed. The first mask indicates which channels(s) failed the test of least significant cutoff frequency tuning bit. The last mask indicates which channel(s) failed the test of the most significant cutoff frequency tuning bit.

–330,“Self-test failed; AC coupling capacitors, Input/Channel mask: Neg/x, Pos/x”

One or more channels failed test number 9. The first hexadecimal mask indicates which channels failed the test of the negative input ac coupling capacitor. The second hexadecimal mask indicates which channels failed the test of the positive input ac coupling capacitor.

–330,“Self-test failed; Variable gain amplifier(s) with nominal cal, Gain/Channel mask: 2/x, 5/x, 10/x, 20/x, 50/x, 100/x”

One or more channels failed test number 10 with nominal calibration factors loaded. The six hexadecimal masks at the end of this error message correspond to gains of 2, 5, 10, 20, 50, and 100. The first mask indicates which channels failed at a gain of 2, the second indicates which channels failed at a gain of 5, and so on.

–330,“Self-test failed; Variable gain amplifier(s) with stored cal, Gain/Channel mask: 2/x, 5/x, 10/x, 20/x, 50/x, 100/x”

One or more channels failed test number 10 with stored calibration factors loaded. The six hexadecimal masks at the end of this error message correspond to gains of 2, 5, 10, 20, 50, and 100. The first mask indicates

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which channels failed at a gain of 2, the second indicates which channels failed at a gain of 5, and so on.

10,“Test passed; Novram checksum, Constant type/Channel mask: Gain/x, Offset/x

All channels tested passed test number 1. The first hexadecimal mask indicates which channel(s) have a correct gain calibration constant checksum. The second hexadecimal mask indicates which channel(s) have a correct offset calibration constant checksum.

10,“Test passed; Offset trim dac(s), Channel mask: x”

All channels tested passed test number 2. The hexadecimal mask at the end of this message indicates which channels were tested.

10, “Test passed; Input test voltage, Input/Channel mask: Neg/x, Pos/x

All channels tested passed 3. The first hexadecimal mask indicates which channel(s) passed the negative input test. The second hexadecimal mask indicates which channel(s) passed the positive input test.

10,“Test passed; Attenuator bypass with nominal cal, Input/Channel mask: Neg/x, Pos/x”

All channels tested passed test number 4 with nominal calibration factors loaded. The first hexadecimal mask at the end of this message indicates which channel(s) passed the test of the negative channel input. The second hexadecimal mask indicates which channel(s) passed the test of the positive channel input.

10,“Test passed; Attenuator bypass with stored cal, Input/Channel mask: Neg/x, Pos/x”

All channels tested passed test number 4 with stored calibration factors loaded. The first hexadecimal mask at the end of this message indicates which channel(s) passed the test of the negative channel input. The second hexadecimal mask indicates which channel(s) passed the test of the positive channel input.

10,“Test passed; /10 Attenuator(s) with nominal cal, Input/Channel mask: Neg/x, Pos/x”

All channels tested passed test number 5 with nominal calibration factors loaded. The first hexadecimal mask at the end of this message indicates which channel(s) passed the test of the negative channel input. The second hexadecimal mask indicates which channel(s) passed the test of the positive channel input.

10,“Test passed; /10 Attenuator(s) with stored cal, Input/Channel mask: Neg/x, Pos/x”

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All channels tested passed test number 5 with stored calibration factors loaded. The first hexadecimal mask at the end of this message indicates which channel(s) passed the test of the negative channel input. The second hexadecimal mask indicates which channel(s) passed the test of the positive channel input.

10,“Test passed; /100 Attenuator(s) with nominal cal, Input/Channel mask: Neg/x, Pos/x”

All channels tested passed test number 6 with nominal calibration factors loaded. The first hexadecimal mask at the end of this message indicates which channel(s) passed the test of the negative channel input. The second hexadecimal mask indicates which channel(s) passed the test of the positive channel input.

10,“Test passed; /100 Attenuator(s) with stored cal, Input/Channel mask: Neg/x, Pos/x”

All channels tested passed test number 6 with stored calibration factors loaded. The first hexadecimal mask at the end of this message indicates which channel(s) passed the test of the negative channel input. The second hexadecimal mask indicates which channel(s) passed the test of the positive channel input.

10,“Test passed; Gain trim dac(s), Channel mask: x”

All channels tested passed test number 7. The hexadecimal mask at the end of this message indicates which channels were tested.

10,“Test passed; Low pass filter(s), Tuning bit/Channel mask: 0/x, 1/x, 2/x, 3/x, 4/x”

All channels tested passed test number 8. The hexadecimal masks at the end of this message indicate which channels were tested.

10,“Test passed; AC coupling capacitors, Input/Channel mask: Neg/x, Pos/x”

All channels tested passed test number 9. The first hexadecimal mask indicates which channels passed the test of the negative input ac coupling capacitor. The second hexadecimal mask indicates which channels passed the test of the positive input AC coupling capacitor.

10,“Test passed; Variable gain amplifier with nominal cal, Channel mask: 2/x, 5/x, 10/x, 20/x, 50/x, 100/x”

All channels tested passed test number 10 with nominal calibration factors loaded. The six hexadecimal masks at the end of this message correspond to gains of 2, 5, 10, 20, 50, and 100. The first mask indicates which channels passed at a gain of 2, the second indicates which channels passed at a gain of 5, and so on.

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10,“Test passed; Variable gain amplifier with stored cal, Gain/Channel mask: 2/x, 5/x, 10/x, 20/x, 50/x, 100/x”

All channels tested passed test number 10 with stored calibration factors loaded. The six hexadecimal masks at the end of this message correspond to gains of 2, 5, 10, 20, 50, and 100. The first mask indicates which channels passed at a gain of 2, the second indicates which channels passed at a gain of 5, and so on.

*WAI

Wait to Continue. This command causes the module to wait until all pending commands and queries are complete. All commands following *WAI are suspended until the pending operations are complete.

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Status and Events

The Status and Event Reporting System reports asynchronous events and errors that occur in the VX4780 16-Channel Signal Conditioner. This system consists of four 8-bit registers and two queues that you access through the command language. You can use these registers and queues to query the instrument status and control the interrupts that report events.

In general, after an interrupt occurs, first conduct a serial poll, query the registers to see why the interrupt occurred, and then send the SYSTem:ERRor? query to see a descriptive error message.

This section describes the four registers and two queues of the Status and Event Reporting system. For each register, you are given a description, a table describing all of the bits, and an example of how to use the register.

The Status and Event Reporting process, synchronizing programming commands, and the system messages are also described in this section.

Status and Event Reporting System

The Status and Event Reporting system monitors and reports such events as an error occurring or the availability of a response to a query. This system includes descriptions of the following registers and queues:

- Status Byte Register
- Service Request Enable Register
- Standard Event Status Register
- Event Status Enable Register
- Output queue
- System Error and Event queue

Status Byte Register

The Status Byte Register, shown in Table 4–1, summarizes information from other registers. Use a serial poll or a *STB? query to read the contents of the Status Byte Register. The response is the sum of the decimal values for all bits set. When you use a serial poll, bit 6 shows Request Service information. When you use the *STB? query, bit 6, the Master Status Summary bit, indicates that bits 5, 4, or 2 may be set.

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Table 4–1: The Status Byte Register

Bit	Decimal Value	Function
0–1	–	Not used.
2	4	Error/Event Queue Not Empty indicates that information is contained in the Error/Event queue and is waiting to be read.
3	–	Not used.
4	16	Message Available shows that output is available in the Output queue.
5	32	Event Status Bit indicates that one or more events have occurred and the corresponding bits in the Standard Event Status Register have been set.
6	64	Request Service (obtained from a serial poll) shows that the VX4780 has requested service from the GPIB controller. Master Status Summary (obtained from *STB? query) summarizes the Event Status bit, Message Available bits, and Error/Event queue Not Empty bits in the Status Byte Register.
7	–	Not used.

A common example of using the Status Byte register is to enable the Message Available bit. This is done by sending an *SRE 16 command to the VX4780 VXI Interface Module. If the *STB? query returns a value of 80, bit 4 (decimal value of 16) and bit 6 (decimal value of 64) have been set (giving a decimal sum of 80). Bit 4 indicates that a message is available in the output queue. Bit 6 indicates that a bit in the Status Byte register that has been enabled by setting the corresponding bit in the Service Request Enable register (in this case bit 4) has been set.

Service Request Enable Register

The Service Request Enable Register, shown in Table 4–2, controls which bits in the Status Byte Register will generate a service request. Use the *SRE command to set bits in the Service Request Enable Register. Use the *SRE? query to see which bits in this register are enabled. The response from this query is the sum of the decimal values for all bits set.

Table 4–2: The Service Request Enable Register

Bit	Decimal Value	Function
0–1	–	Not used.
2	4	Error/Event queue Bit indicates that a service request will be generated when a message is placed in the Error/Event queue.

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Table 4–2: The Service Request Enable Register (Cont.)

Bit	Decimal Value	Function
3	8	Not used.
4	16	Message Available Bit indicates that a service request will be generated when a message is placed in the Output queue.
5	32	Event Status Bit indicates that events summarized in bit 5 of the Status Byte Register will generate a service request.
6–7	–	Not used.

If, for example, the *SRE? query returns a value of 48, bits 4 and 5 are set in the Service Request Enable Register. Any event that causes the Message Available bit (bit 4) or Event Status bit (bit 5) to be set in the Status Byte Register now generates an interrupt. If you want an interrupt to be generated only when the Event Status bit (bit 5) is set, use the *SRE 32 command.

Standard Event Status Register

The Standard Event Status Register, shown in Table 4–3, records many types of events that can occur in the VX4780. Use the *ESR? query to read the contents of this register. The response is the sum of the decimal values for all bits set. Reading this register clears all bits so the register can accumulate information about new events.

Table 4–3: The Standard Event Status Register

Bit	Decimal Value	Function
0	1	Operation Complete shows that the operation is complete. This bit is set when all pending operations complete following a *OPC command.
1	–	Not used.
2	4	Query Error shows that data in the Output queue was lost.
3	8	Device Dependent Error shows that an overflow condition exists in either the Error/Event Queue or the Output Queue. This bit is also set if the VX4780 fails selftest. Table 4–7 on pages 4–7 and 4–8 lists the device dependent error messages.
4	16	Execution Error shows that an error occurred while the VX4780 was executing a command or query. Table 4–6 on page 4–8 lists the execution error messages.
5	32	Command Error shows that an error occurred while the VX4780 was parsing a command or query. Table 4–5 on page 4–7 lists the command error messages.

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Table 4–3: The Standard Event Status Register (Cont.)

Bit	Decimal Value	Function
6	–	Not used.
7	128	Power On shows that the VX4780 was powered on.

The following example assumes that all bits have been enabled using the Event Status Enable Register (see the next section for information about this register). If a *ESR? query returns a value of 128, bit 7 (decimal value of 128) is set indicating that the instrument is in the initial power-on state.

Event Status Enable Register

The Event Status Enable Register, shown in Table 4–4, controls which events are summarized in the Event Status bit (bit 5) of the Status Byte Register. Use the *ESE command to set bits in the Event Status Enable Register. Use the *ESE? query to see what bits in the Event Status Enable Register are set. The response from this query is the sum of the decimal values for all bits summarized in the event status bit of the Status Byte Register.

Table 4–4: The Event Status Enable Register

Bit	Decimal Value	Function
0	1	Set bit 5 of the Status Byte register when bit 1 (the Operation Complete bit) of the Standard Event Status register is set.
1	2	Not used.
2	4	Set bit 5 of the Status Byte register when bit 2 (the Query Error bit) of the Standard Event Status register is set.
3	8	Not used.
4	16	Set bit 5 of the Status Byte register when bit 4 (the Execution Error bit) of the Standard Event Status register is set.
5	32	Set bit 5 of the Status Byte register when bit 5 (the Command Error bit) of the Standard Event Status register is set.
6	64	Not used.
7	128	Set bit 5 of the Status Byte register when bit 7 (the Power On bit) of the Standard Event Status register is set.

If, for example, the *ESE? query returns a value of 255, all bits are set, indicating that all events will set the event status bit (bit 5) of the Status Byte Register.

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The Output Queue

The VX4780 stores query responses in the Output queue.

The System Error and Event Queue

The VX4780 error and event messages are stored in the System Error and Event queue. Use the SYSTem:ERRor? query to get the event number and a text description of the event. Reading an event removes it from the queue. The Event queue stores detailed information for up to 20 events; the events are stored in first-in first-out order.

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Status and Event Reporting Process

Figure 4–1 shows how to use the Status and Event Reporting system. In the explanation that follows, numbers in parentheses refer to the circled numbers in Figure 4–1.

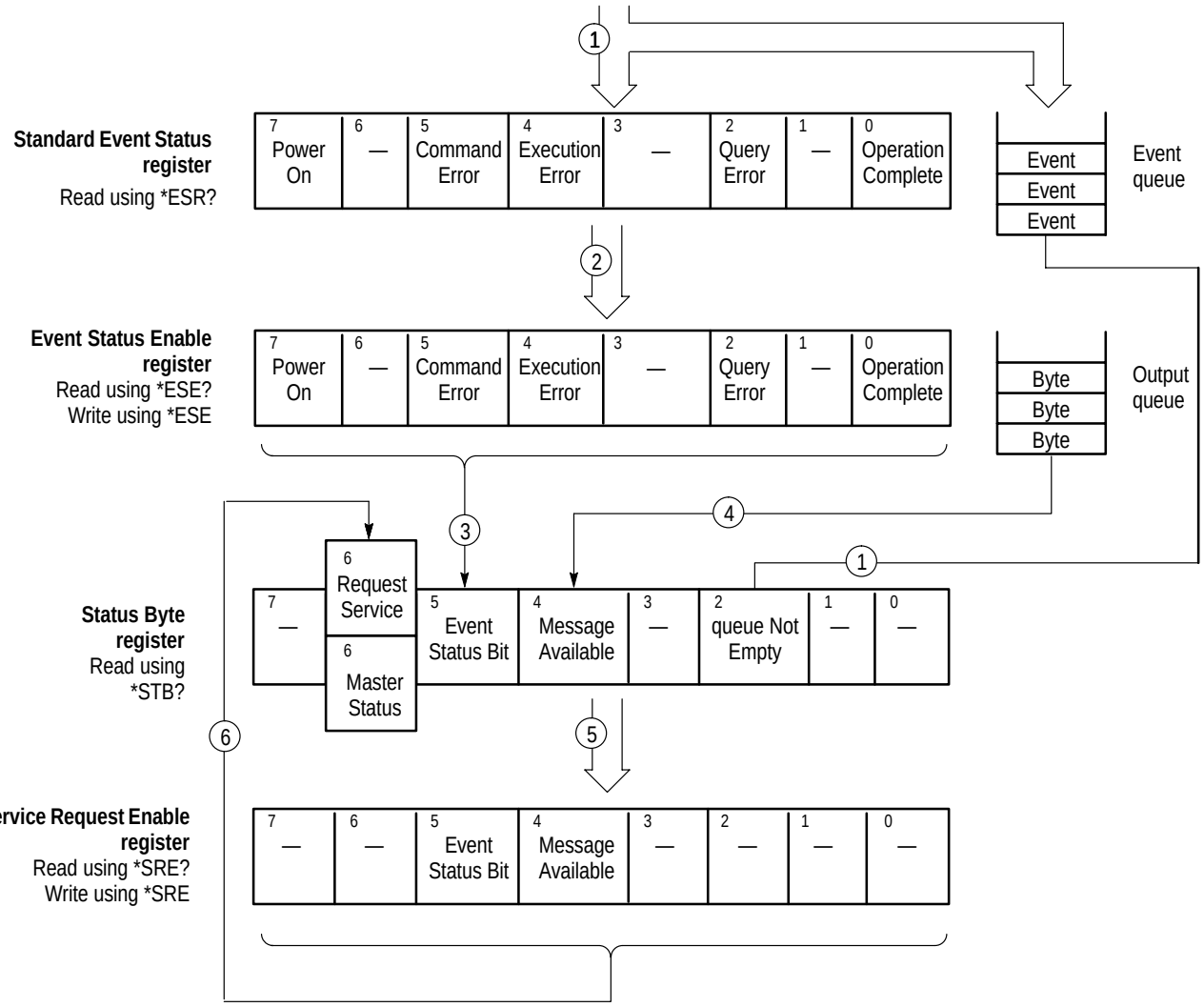


Figure 4–1: Status and Event Reporting Process

When an event occurs the appropriate bit in the Standard Event Status Register is set to one and the event is recorded in the Event queue (1). If the corresponding bit in the Event Status Enable Register is also enabled (2), then the event status bit in the Status Byte Register is set to one (3).

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When output is sent to the Output queue (for example, a response to a query), the message available bit in the Status Byte Register is set to one (bit 4).

When a bit in the Status Byte Register is set to one and the corresponding bit in the Service Request Enable Register is enabled (5), the Master Status Summary bit in the Status Byte Register is set to one and a service request is generated (bit 6).

Messages

The VX4780 generates error messages in response to events caused by commands or queries. Each type of event sets a specific bit in the Standard Event Status Register. Thus, each message is associated with a specific Standard Event Status Register bit. In the message tables that follow, the associated Standard Event Status Register bit is specified in the table title. Not shown in the tables are secondary messages giving more detail about the cause of the error or the meaning of the message. These secondary messages are shown for each command and query in *Syntax and Commands*.

Table 4–5 shows the error messages generated by improper command syntax. Check to see that the command is properly formatted and that it follows the rules in *Syntax and Commands*.

Table 4–5: Command Error Messages (Bit 5 in Standard Event Status Register)

Code	Message
0	“No error”
–102	“Syntax error;Unexpected x detected while ...”
–108	“Parameter count exceeded for xxxx command”
–109	“Missing parameter for xxxx command”
–121	“Invalid character in number”
–123	“Exponent too large”

Table 4–6 lists the execution error messages that can occur during execution of a command.

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Table 4–6: Execution Error Messages (Bit 4 in Standard Event Status Register)

Code	Message
–221	"Settings conflict; /100 attenuator setting conflict with upper range filter cutoff frequency, Channel mask x"
–222	"Data out of range; Minimum cutoff frequency is 468 Hz"
–222	"Data out of range; Maximum cutoff frequency is 107 KHz"
–222	"Data out of range; Maximum gain is 100"
–222	"Data out of range; Minimum gain is 1"
–222	"Data out of range"
–222	"Data out of range; Illegal channel number: x"
–224	"Illegal parameter value; Allowed gains are 1 and 10"
–224	"Illegal parameter value; Allowed gains are 1,2,5 and 10"
–224	"Illegal parameter value; Allowed gains are 1 to 100 in 1/2/5 steps"
–224	"Illegal parameter value; Allowed attenuations are 10 and 100"

Table 4–7 lists the device dependent error messages that can occur during VX4780 operation. Number –330 error messages are placed in the Error/Event queue to indicate which channels failed self test. See the description of the *TST? query for more information on these error messages.

Table 4–7: Device Dependent Error Messages (Bit 3 in Standard Event Status Register)

Code	Message
–330	"Self-test failed; self test ADC failure"
–300	"Self-test failed; Novram checksum, Constant type/Channel mask: Gain/x, Offset/x
–330	"Self-test failed; Offset trim dac(s), Channel mask: x"
–330	"Self-test failed; Input test voltage, Input/Channel mask: Neg/x, Pos/x
–330	"Self-test failed; Attenuator bypass with nominal cal, Input/Channel mask: Neg/x, Pos/x"
–330	"Self-test failed; Attenuator bypass with stored cal, Input/Channel mask: Neg/x, Pos/x"
–330	"Self-test failed; /10 Attenuator(s) with nominal cal, Input/Channel mask: Neg/x, Pos/x"
–330	"Self-test failed; /10 Attenuator(s) with stored cal, Input/Channel mask: Neg/x, Pos/x"

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Table 4–7: Device Dependent Error Messages (Bit 3 in Standard Event Status Register) (Cont.)

Code	Message
–330	"Self-test failed; /100 Attenuator(s) with nominal cal, Input/Channel mask: Neg/x, Pos/x"
–330	"Self-test failed; /100 Attenuator(s) with stored cal, Input/Channel mask: Neg/x, Pos/x"
–330	"Self-test failed; Gain trim dac(s) , Channel mask: x"
–330	"Self-test failed; Low pass filter(s), Tuning bit/Channel mask: 0/x, 1/x, 2/x, 3/x, 4/x
–330	"Self-test failed; AC coupling capacitors, Channel masks: x x"
–330	"Self-test failed; Variable gain amplifier(s) with nominal cal, Gain/Channel mask: 2/x, 5/x, 10/x, 20/x, 50/x, 100/x"
–330	"Self-test failed; Variable gain amplifier(s) with stored cal, Gain/Channel mask: 2/x, 5/x, 10/x, 20/x, 50/x, 100/x"
–350	"Queue overflow; Error/event queue"
–350	"Queue overflow; Output queue"

Table 4–8 lists the user event messages that can occur during VX4780 operation. Number 10 messages are placed in the Error/Event queue during self test to indicate which channels passed self test. See the description of the *TST? query for more information on these error messages.

Table 4–8: User Event Messages

Code	Message
10	"Test passed; Novram checksum, Constant type/Channel mask: Gain/x, Offset/x
10	"Test passed; Offset trim dac(s), Channel mask: x"
10	"Test passed; Input test voltage, Input/Channel mask: Neg/x, Pos/x
10	"Test passed; Attenuator bypass with nominal cal, Input/Channel mask: Neg/x, Pos/x"
10	"Test passed; Attenuator bypass with stored cal, Input/Channel mask: Neg/x, Pos/x"
10	"Test passed; /10 Attenuator(s) with nominal cal, Input/Channel mask: Neg/x, Pos/x"
10	"Test passed; /10 Attenuator(s) with stored cal, Input/Channel mask: Neg/x, Pos/x"
10	"Test passed; /100 Attenuator(s) with nominal cal, Input/Channel mask: Neg/x, Pos/x"

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Table 4–8: User Event Messages (Cont.)

Code	Message
10	“Test passed; /100 Attenuator(s) with stored cal, Input/Channel mask: Neg/x, Pos/x”
10	“Test passed; Gain trim dac(s), Channel mask: x”
10	“Test passed; Low pass filter(s), Tuning bit/Channel mask: 0/x, 1/x, 2/x, 3/x, 4/x”
10	“Test passed; AC coupling capacitors, Input/Channel mask: Neg/x, Pos/x”
10	“Test passed; Variable gain amplifier with nominal cal, Channel mask: 2/x, 5/x, 10/x, 20/x, 50/x, 100/x”
10	“Test passed; Variable gain amplifier with stored cal, Gain/Channel mask: 2/x, 5/x, 10/x, 20/x, 50/x, 100/x”

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Appendix A: Specifications

Table A–1: VXI Instrument Characteristics

Characteristics	Description
VXI General Characteristics	The instrument provides a VXI interface that complies with Revision 1.4. The VXI interface is defined by the VXI Consortium, Inc.
Interface Type	Message Based (1.4)
Protocols	Word Serial (WSP)

Table A–2: Environmental/Reliability Characteristics

Characteristics	Description
Temperature	Operating: Meets or exceeds MIL-T-28800E for Type III, 0 to 50°C external ambient, when operated in a mainframe providing Class 3 equipment. Nonoperating: –40°C to +71°C
	Airflow of at least 4.432 liters/sec at 0.09 mm H_2O air pressure, –10°C/55°C for 10°C (or less) temperature rise of internal air, as measured at the cooling air exit points, and with no heat transfer either to or from any adjacent VXI modules.
Humidity	Relative Humidity: Nonoper: Up to 95%, at up to 50°C. Operating: Up to 95% at up to 30°C, and up to 45%, at up to 50°C.
Altitude (1)	Operating: 6,000 ft. altitude.
Altitude (2)	*Meets or exceeds MIL-T-28800E for Type III, (operating to 10,000 ft., nonoperating to 15,000 ft.).*

Table A–3: VX4780–Specific Characteristics

Characteristics	Description
Number of signal conditioning channels	16
Number of VXI slots	1
Input Configuration	Differential inputs
Differential Input Impedance	2 MΩ +0.2% –0.0%
Input AC coupling capacitors	18 nF ±1%
Input capacitance to ground	75 pF typical with input attenuator bypassed. 55 pF typical with input attenuator inserted.

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Table A–3: VX4780–Specific Characteristics (Cont.)

Characteristics	Description
Channel to Channel crosstalk referenced to input	<–80 dB at 20 kHz. Crosstalk decreases by 6 dB/octave as frequency is decreased. Crosstalk increases by 6 dB/octave as frequency is increased.
Input Coupling	AC, DC, or ground. Command selectable.
Maximum Input Voltage	150 V AC $_{RMS,}$ ±212 V peak in CAT I environment.
Input Common Mode Range	Input Attenuator Gain volt/volt — Input Common Mode Range 1 — ±10V 0.1 — ±100V 0.01 — ±200V
Input Slew Rate	Gain Setting (V/V) — Maximum Input Slew Rate (V/µsec) 1 — 10.0 2 — 5.0 5 — 2.0 10 — 1.0 20 — 0.5 50 — 0.2 100 — 0.1 The slew rates listed assume that the input attenuator is bypassed. Multiply the slew rates by 10 if the /10 attenuator is inserted. Multiply the slew rates by 100 if the /100 attenuator is inserted.
Output Configuration	Differential outputs
Differential Output Impedance	50 Ω ± 5 Ω
Differential Load Impedance	The load connected to the output of each channel must be greater than or equal to 600 Ω.
Gain Accuracy	Overall channel gain must be accurate to within ± 0.5% for all gain/attenuation settings listed below, with a 200 k Ω load across the channel differential outputs. Gain = 1,2,5,10,20,50,100 with attenuator bypassed Gain = 10 with /10 attenuator inserted Gain = 100 with /100 attenuator inserted
Output Coupling	DC
Output Short Circuit Protection	Outputs are short circuit protected.
Low Pass Filter Response	Each signal conditioning channel contains a 4th order low pass filter with a Bessel response.
Low Pass Filter Attenuation at Programmed Cutoff Frequency	Low pass filter attenuation should be between –3.0 dB ±0.5 dB (±0.2 dB, typical) at the programmed cutoff frequency.

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Table A–3: VX4780–Specific Characteristics (Cont.)

Characteristics	Description
Common Mode Rejection Ratio	Common Mode Rejection Ratio at 60 Hz CMRR / Input Coupling / Attenuator Setting / Gain Setting ≥90dB / DC / bypassed / gain ≥ 10 ≥70dB / DC / bypassed / gain ≤ 5 ≥55dB / DC / inserted / 1 ≤ gain ≤100 ≥55dB / AC / bypassed / 1 ≤ gain ≤100 ≥50dB / AC / inserted / 1 ≤ gain ≤100
Signal to Noise and Distortion Ratio (SINAD)	Minimum / (Typical) SINAD in dB vs. Gain and Signal Frequency Signal frequency (Hz) Gain (V/V) / 1k / 10k / 20k / 100k 1* / 80/(96) / 70/(85) / 65/(80) / 60/(75) 1** / 80/(96) / 75/(90) / 70/(85) / 65/(80) 1*** / 80/(90) / n/a / n/a / n/a 2* / 80/(96) / 70/(85) / 65/(80) / 55/(70) 5* / 80/(93) / 70/(85) / 65/(80) / 45/(60) 10* / 80/(95) / 70/(85) / 65/(80) / 60/(75) 20* / 80/(93) / 70/(85) / 65/(80) / 55/(70) 50* / 70/(88) / 65/(80) / 60/(75) / 45/(60) 100* / 65/(80) / 60/(75) / 55/(70) / 45/(60) * VX4780 input attenuator bypassed ** VX4780 /10 input attenuator inserted, gain set to 10 *** VX4780 /100 input attenuator inserted, gain set to 100 SINAD measured with the following lowpass filter settings Signal Frequency (Hz) / Lowpass Filter Cutoff Frequency 1k / 1.872k 10k / 21.4k 20k / 42.8k 100k / 107k
DC Offset at Output with Inputs Grounded	DC Offset at channel output should be 0 V ± 5 millivolts
Isolation Relays	Inputs and outputs are switched through isolation relays. These relays are opened during self test and when power is removed from the module.
Input Connectors	Two connectors are used as input connectors. The Tektronix part number for this connector is 131–3395–00. The Amp Inc. part number is 747842–4.
Output Connectors	Two connectors are used as input connectors. The Tektronix part number for this connector is 131–5713–00. The Amp Inc. part number is 748481–5.

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EC Declaration of Conformity	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility and Low Voltage Directive 73/23/ECC for Product Safety. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities: EMC Directive 89/336/EEC: EN 55011 — Class A Radiated and Conducted Emissions EN 50081-1 Emissions: EN 60555-2 — AC Power Line Harmonic Emissions EN 50082-1 Immunity: IEC 801-2 — Electrostatic Discharge Immunity IEC 801-3 — RF Electromagnetic Field Immunity IEC 801-4 — Electrical Fast Transient/Burst Immunity IEC 801-5 — Power Line Surge Immunity Low Voltage Directive 73/23/EEC: EN 61010-1 — Safety requirements for electrical equipment for measurement, control and laboratory use To ensure compliance with EMC requirements this module must be installed in a mainframe which has backplane shields installed which comply with Rule B.7.45 of the VXIbus Specification. Only high quality shielded cables having a reliable, continuous outer shield (braid and foil) which has low impedance connections to shielded connector housings at both ends should be connected to this product.
EMC Compliance	Meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility when it is used with the product(s) stated in the specifications table. Refer to the EMC specification published for the stated products. May not meet the intent of the Directive if used with other products.
Certifications	Underwriters Laboratories Listed to CAN/CSA–C22.2 No. 1010.1–92, Electrical Equipment for Measurement, Control and Laboratory Use. Underwriters Laboratories Listed to Standard UL3111-1 for Electrical Measuring and Test Equipment.
Safety Certification of Plug-in or VXI Modules	For modules (plug-in or VXI) that are safety certified by Underwriters Laboratories, UL Listing applies only when the module is installed in a UL Listed product. For modules (plug-in or VXI) that have cUL or CSA approval, the approval applies only when the module is installed in a cUL or CSA approved product.
Overvoltage Category	Category: — Examples of Products in this Category: CAT III — Distribution-level mains, fixed installation CAT II — Local-level mains, appliances, portable equipment CAT I — Signal levels in special equipment or parts of equipment, telecommunications, electronics
Pollution Degree 2	Do not operate in environments where conductive pollutants may be present.

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Appendix B: Input/Output Connections

Pinout for VX4780 input connectors:

channel	+input pin	–input pin
1,9	1	14
2,10	15	3
3,11	4	17
4,12	18	6
5,13	7	20
6,14	21	9
7,15	10	23
8,16	24	12
ground pins 2, 5, 8, 11, 16, 19, 22, 25		
Pin 13 is not used		

Pinout for VX4780 output connectors:

channel	+input pin	–input pin
1,9	9	18
2,10	8	17
3,11	7	16
4,12	6	15
5,13	5	14
6,14	4	13
7,15	3	12
8,16	2	11
ground pins 19, 20, 21, 22, 23, 24, 25, 26		
Pins 1 and 10 are not used		

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Appendix C: Examples

These examples demonstrate how some of the programmable features of the VX4780 are used. It is assumed the module has completed its power-on self test. For information on specific commands or syntax, please review the *Syntax and Commands* section.

Example 1

In this example, self test is performed on channels 1 through 8. The response to the *tst? query is an ASCII “0” indicating that all channels passed all elements of the self test. SYSTem:ERRor? queries are issued in order to read the results of each element of self test. These messages are placed in the Error/Event queue at the end of each test.

Note that all channel masks are set to hexadecimal 00FF. The lower eight bits of the channel masks are set indicating that the messages apply to channels 1 through 8. If after reading back a “0” following the *TST? query, the user does not wish to read the results of each element of the self test, a *CLS command can be sent to the module. This clears the Error/Event queue containing the error messages, but does not change the settings of the module.

Command	Response
*tst? (@1:8)	0
system:error?	“Test passed; Novram checksum, Constant type/Channel mask: Gain/00FF, Offset/00FF”
system:error?	“Test passed; Offset trim dac(s), Channel mask: 00FF”
system:error?	“Test passed; Input test voltage, Input/Channel mask: Neg/00FF, Pos/00FF”
system:error?	“Test passed; Attenuator bypass with nominal cal, Input/Channel mask: Neg/00FF, Pos/00FF”
system:error?	“Test passed; /10 Attenuator(s) with nominal cal, Input/Channel mask: Neg/00FF, Pos/00FF”
system:error?	“Test passed; /100 Attenuator(s) with nominal cal, Input/Channel mask: Neg/00FF, Pos/00FF”
system:error?	“Test passed; Attenuator bypass with stored cal, Input/Channel mask: Neg/00FF, Pos/00FF”
system:error?	“Test passed; /10 Attenuator(s) with stored cal, Input/Channel mask: Neg/00FF, Pos/00FF”
system:error?	“Test passed; /100 Attenuator(s) with stored cal, Input/Channel mask: Neg/00FF, Pos/00FF”

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Command	Response
system:error?	“Test passed; Gain trim dac(s), Channel mask: 00FF”
system:error?	“Test passed; Low pass filter(s), Tuning bit/Channel mask: 0/00FF, 1/00FF, 2/00FF, 3/00FF, 4/00FF”
system:error?	“Test passed; AC coupling capacitors, Input/Channel mask: Neg/00FF, Pos/00FF”
system:error?	“Test passed; Variable gain amplifier with nominal cal, Gain/Channel mask: 2/00FF, 5/00FF, 10/00FF, 20/00FF, 50/00FF, 100/00FF”
system:error?	“Test passed; Variable gain amplifier with stored cal, Gain/Channel mask: 2/00FF, 5/00FF, 10/00FF, 20/00FF, 50/00FF, 100/00FF”
system:error?	0, “No error”

Example 2

In this example, all channels of the VX4780 are set to the following configuration:

Input isolation relay: Closed

Input coupling: DC

Input attenuator: Bypassed

Gain: 1V/V

Lowpass filter cutoff frequency: 20 kHz

Output isolation relays: Closed

Command	Response
input:state on,(@1:16)	no response
input:coupling dc,(@1:16)	no response
input:Att:state off,(@1:16)	no response
input:gain 1,(@1:16)	no response
input:filter:lpass:Freq 20khz,(@1:16)	no response
output:state on,(@1:16)	no response
system:Error?	0,“No error”

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Example 3

In this example, the VX4780 is used to generate a 7.13 kHz sine waveform at the output of each channel for use as a test signal into the digitizer connected to these outputs. This is accomplished by setting the lowpass filter cutoff frequency to 7.13 kHz, then using the self test variable voltage source to apply a 7.13 kHz 5 V_{p-p} square waveform to all channel inputs. The lowpass filters attenuate the harmonics of the square waveform, creating a sine waveform at the channel outputs. The overall channel gain is set to 2 V/V for each channel. The overall channel gain is equal to the channel gain divided by the channel attenuation. Note that it is necessary to send a VXI Clear command after the DIAGnostic:SQRwave command before the VX4780 will accept any additional commands.

Command	Response
input:state off,(@1:16)	no response
input:coupling ac,(@1:16)	no response
input:att (@1:16)	no response
input:Att:State on,(@1:16)	no response
input:gain 20,(@1:16)	no response
input:filter:lpass:Freq 7.13khz,(@1:16)	no response
input:filter:lpass:Freq? (@1:16)	7133, 7133, 7133, 7133, 7133, 7133, 7133, 7133, 7133, 7133, 7133, 7133, 7133, 7133, 7133, 7133
output:State on,(@1:16)	no response
diag:sqr 30	no response

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Appendix D: Diagnostics

The following commands are intended for calibration and for diagnosing problems on the module and should not be used for any other purpose. An exception is the “DIAGnostic:SQRwave” command, which can be used to generate a test source waveform at the module output.

DIAGnostic:AD? <channel_list>,
DIAGnostic:CAL <caladr>,<caldata>,
DIAGnostic:CAL? <caladr>,
DIAGnostic:DC <input_voltage>,
DIAGnostic:GAIN <gaindac>,<channel_list>,
DIAGnostic:IAgain <iagain>,<channel_list>,
DIAGnostic:INPut:FILTer:LPASS <channel_list>
DIAGnostic:OFFSet <msoffset>,<lsoffset>,<channel_list>,
DIAGnostic:SQRwave <loopcount>,
DIAGnostic:STgain <stgain>,<channel_list>

NOTE. *When the “DIAGostic:OFFSet” command is sent to the VX4780 and the VXI end bit is asserted on the closing parenthesis character of the <Channel_list> argument, the VX4780 ignores the command. A white space character (with the VXI end bit asserted) or a line feed character (with or without the VXI end bit asserted) must be sent after the closing paren of the channel list in order for the VX4780 to parse and act on the command.*

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DIAGnostic:AD

Command Syntax

```
DIAGnostic
    :AD? <channel_list>
```

***RST Value** N/A

Related Commands N/A

Description After an OUTPut:STATe off, <channel_list> command has been issued, the specified channels are disconnected from the output connector and connected to the input of an analog mux. The output of this mux is connected to the input of the module's self test analog-to-digital converter (ADC). The DIAGnostic:AD? command routes the first channel specified in the channel list to the input of the self test ADC, triggers the ADC, and returns the converted data in hexadecimal format.

Examples Full input range of the self test ADC is +3V to -3V which results in returned hexadecimal values of 1fff to E000.

Command	Response
diag:ad? (@1)	1AA5

In the above example the voltage at the ADC input is:

3V * 1AA5/1FFF = 3V * 6821.0/8191 = 2.5 volts

DIAGnostic:CAL

Command Syntax

```
DIAGnostic
    :CAL <caladr>,<caldata>
```

Query Syntax

```
DIAGnostic:CAL? <caladr>
```

***RST Value** N/A

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Related Commands N/A

Description This command writes data to NOVRAM. <caladr> is a value from 0 to 1023 equal to the NOVRAM address to write to. <caldata> is a value from 0 to 65535 to write to the specified NOVRAM location.

Gain and offset correction calibration factors for each channel are stored in NOVRAM. The format for the gain calibration factors is listed in the following table.

This command is used during factory calibration of the VX4780 Module. It is described here for reference only and it is not recommended for use by the customer.

The base address for the gain calibration factors for a channel is given by the equation: (channel – 1) * 12.

NOVRAM address	Calibration Factor Response
base address + 0	Gain trim DAC calibration factor. This factor represents the gain change produced when the contents of the gain trim DAC is changed by 1 count. The units of this factor are ppm*100 / DAC count. The nominal value for this factor is 1689. This indicates that a change of 1 DAC count produces a gain change of 16.89 ppm. The values written to the gain trim DAC range from 0 to 4095. As this value is increased, the channel gain decreases.
base address + 1	Gain error in ppm when the channel gain is set to 1 and the input attenuator is bypassed. For example, a value of 5500 indicates that when the nominal value of 2048 is written to the gain trim DAC, the gain is 5500 ppm (0.55%) too high. Signed integer format.
base address + 2	Gain error in ppm when the channel gain is set to 2 relative to the gain error when the gain is set to 1. Signed integer format. For example if the gain error with the gain set to 1 is 5500 ppm and the gain error with the gain set to 5 is 6000 ppm, a value of 500 ppm will be stored in this location.
base address + 3	Gain error in ppm when the channel gain is set to 5 relative to the gain error when the gain is set to 1. Signed integer format.
base address + 4	Gain error in ppm when the channel gain is set to 10 relative to the gain error when the gain is set to 1. Signed integer format.
base address + 5	Gain error in ppm when the channel gain is set to 20 relative to the gain error when the gain is set to 1. Signed integer format.
base address + 6	Gain error in ppm when the channel gain is set to 50 relative to the gain error when the gain is set to 1. Signed integer format.

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NOVRAM address	Calibration Factor Response
base address + 7	Gain error in ppm when the channel gain is set to 100 relative to the gain error when the gain is set to 1. Signed integer format.
base address + 8	Gain error in ppm when the input attenuator is enabled and set to divide the input signal by 10, relative to the gain error when the attenuator is bypassed. Signed integer format. For example, with the gain of the variable gain amplifier set to 1, if the gain error with the attenuator bypassed is 5500 ppm and the gain error with the attenuator enabled is 6000 ppm, a value of 500 will be stored in this location.
base address + 9	Gain error in ppm when the input attenuator is enabled and set to divide the input signal by 100, relative to the gain error when the attenuator is bypassed. Signed integer format. For example, with the gain of the variable gain amplifier set to 1, if the gain error with the attenuator bypassed is 5500 ppm and the gain error with the attenuator enabled is 6000 ppm, a value of 500 will be stored in this location.
base address + 10	Reserved. Set to 0.
base address + 11	Checksum of constants stored in locations from base address to base address + 11.

The format for the DC offset calibration factors is listed in the following table.

The base address for the gain calibration factors for a channel is given by the equation: 192 + (channel – 1) * 12.

NOVRAM address	Calibration Factor Response
base address + 0	Offset trim DAC calibration factor. This factor represents the full scale adjust range of the offset trim DAC. It is stored as an unsigned integer in units of volts * 100000. The nominal value for this constant is 39500. This indicates that the full scale adjust range of the offset trim DAC is ±0.39500 volts.
base address + 1	Offset error at a gain setting of 1 with the channel inputs shorted to ground. Stored as a signed integer in units of volts * 100000. For example, if the channel gain is set to 1 with an INPUT:GAIN 1,(@channel_number> command and the offset trim DAC is programmed to output 0 volts with a DIAG:OFF-SET 0,128,(@channel_number) command and a voltage of 5.7 millivolts DC is measured at the output, a value of 570 will be stored in this location when the module is calibrated.
base address + 2	Offset error at a gain setting of 2 with the channel inputs shorted to ground. Stored as a signed integer in units of volts * 100000.

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NOVRAM address	Calibration Factor Response
base address + 3	Offset error at a gain setting of 5 with the channel inputs shorted to ground. Stored as a signed integer in units of volts * 100000.
base address + 4	Offset error at a gain setting of 10 with the channel inputs shorted to ground. Stored as a signed integer in units of volts * 100000.
base address + 5	Offset error at a gain setting of 20 with the channel inputs shorted to ground. Stored as a signed integer in units of volts * 100000.
base address + 6	Offset error at a gain setting of 50 with the channel inputs shorted to ground. Stored as a signed integer in units of volts * 100000.
base address + 7	Offset error at a gain setting of 100 with the channel inputs shorted to ground. Stored as a signed integer in units of volts * 100000.
base address + 8 to base address + 10	Reserved. Set to 0
base address + 11	Checksum of constants stored in locations from base address to base address + 11.

DIAGnostic:DC

Command Syntax

```
DIAGnostic:DC <input_voltage>
```

***RST Value**

The voltage applied to the inputs of all channels is set to 0 V.

Related Commands

INput:STATe

Description

This command applies a DC voltage to the inputs of all channels that have their input isolation relays set to the open position. The voltage applied can be set to +2.5 V, 0 V, or –2.5 V. If a positive value is specified for `<input_voltage>`, the applied voltage is set to +2.5 V. If a negative value is specified, the applied voltage is set to –2.5 V. If a value of 0.0 is specified, the applied voltage is set to 0.0 V.

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Examples

Command	Response
input:state off, (@1:8)	Open the input isolation relays of channels 1 through 8.
input:state on, (@9:16)	Close the input isolation relays of channels 9 through 16.
diag:dc 2.5	Apply +2.5 volts to the inputs of channels 1 through 8. This voltage is not applied to the inputs of channels 9 through 16 because the input isolation relays of these channels are in the closed position.
diag:dc 0.0	Apply 0.0 volts to the inputs of channels 1 through 8. This voltage is not applied to the inputs of channels 9 through 16 because the input isolation relays of these channels are in the closed position.
diag:dc –2.5	Apply –2.5 volts to the inputs of channels 1 through 8. This voltage is not applied to the inputs of channels 9 through 16 because the input isolation relays of these channels are in the closed position.

DIAGnostic:GAIN

Command Syntax

`DIAGnostic:GAIN <gaindac>,<channel_list>`

*RST Value

N/A

Related Commands

N/A

Description

This command loads data into the gain trim DACs of the channel(s) specified in the <channel_list>. <gaindac> is a decimal number between 0 and 4095. The nominal value for <gaindac> is 2048.

The gain of the channel is given by the equation:

Gt = G (1 + ((2048 – <gaindac>) * 16.89/1000000))

where G is the channel gain when <gaindac> = 2048.

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Examples

Command	Response
diag:gain 2048,(@1)	Load the gain trim DAC of channel 1 with 2048, the nominal value for the gain trim DAC
diag:cal? 0	1689 Read the gain trim in parts per 10000 per dac count for channel 1.
diag:gain 2049,(@1)	Decrease the gain of channel 1 by–16.89 ppm. (2048 -–2049) *16.89ppm = -16.89ppm

DIAGnostic:IAgain

Command Syntax

```
DIAGnostic
   :IAgain <iagain>,<channel_list>
```

***RST Value** N/A

Related Commands N/A

Description Each channel of the VX4780 contains a variable gain amplifier. This amplifier consists of an instrumentation amplifier with programmable gains of 1 or 10 followed by an amplifier with programmable gains of 1, 2, 5, or 10. This command sets the gain of the instrumentation amplifier of the specified channels to either 1 or 10. It does not change the gain of the amplifier that follows the instrumentation amplifier.

Examples

Command	Response
diag:iagain 1,(@10)	Set the gain of the instrumentation amplifier of channel 10 to 1.
diag:iagain 10,(@11)	Set the gain of the instrumentation amplifier of channel 11 to 10.

DIAGnostic:INPut:FILTer:LPASS

Command Syntax

```
DIAGnostic:INPut:FILTer:LPASS <channel_list>
```

***RST Value** N/A

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Limits N/A

Related Commands N/A

Description This command opens the analog switches in the lowpass filter portion of the channels specified in the <channel_list>. You can then use an ohmmeter to measure the resistors that determine the filter cutoff frequency to check for correct component values.

Examples

Command	Response
diag:inp:filt:lpas (@9)	Open the analog switches used to set the cutoff frequency of the lowpass filter of channel 9.

DIAGnostic:OFFset

Command Syntax `DIAGnostic:OFFSet <msoffset>,<lsoffset>,<channel_list>`

***RST Value** N/A

Limits N/A

Related Commands N/A

Description This command loads data into the offset trim DACs of the channels specified in the <channel_list>. <msoffset> is an ASCII decimal number from 0 to 128 that is loaded into the ms offset DAC. <lsoffset> is an ASCII decimal number between 0 and 255 that is loaded into the ls offset DAC. The resulting offset at the output of the channel(s) specified is given by the equation:

Vo = [k * (128 – <msoffset>) / 128 * (128 – <lsoffset>) / 128] + m

where k is equal to 0.00001 multiplied by the contents of NOVRAM address equal to:

192 + ((channel –1)*12)

and m is equal to the DC offset when <msoffset> and <lsoffset> are set to 128.

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Examples

Command	Response
diag:offset 128,128,(@1:6)	Set the DC correction introduced by the offset trim DACs of channels 1 through 16 to 0 V.

DIAGnostic:SQRwave

Command Syntax `DIAGnostic:SQRwave <loopcount>`

***RST Value** N/A

Limits N/A

Related Commands N/A

Description This command generates a 5 V_{p-p} square wave at the input of all channels that have their input isolation relays set to the open position. The frequency of the square wave is controlled by the <loopcount> parameter. <loopcount> must be between 0 and 65535. A VXI CLEAR command must be sent to the module after this command is issued before it will accept new commands.

The period of the squarewave in microseconds is given by the equation:P = 10.4 + (4.4* <loopcount>)

Examples

Command	Response
diag:sqr 225	Apply a 5 V_{p-p} 1 kHz square wave to the inputs of all channels that have their input isolation relays in the open position. Note that a loopcount of 225 is arrived at by solving the above equation given a waveform period of 1000 µsec. 225 = (1000 - 10.4) / 4.4

DIAGnostic:STgain

Command Syntax `DIAGnostic:STgain <stgain>,<channel_list>`

***RST Value** N/A

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Limits N/A

Related Commands N/A

Description Each channel of the VX4780 contains a variable gain amplifier. This amplifier consists of an instrumentation amplifier with programmable gains of 1 or 10 followed by an amplifier with programmable gains of 1, 2, 5, or 10. This command sets the gain of the amplifier that follows the instrumentation amplifier to 1, 2, 5, or 10. This command does not change the gain of the instrumentation amplifier.

Examples

Command	Response
diag:stgain 2,(@10)	Set the gain of the amplifier that follows the instrumentation amplifier of channel 10 to 2.
diag:stgain 5,(@11)	Set the gain of the amplifier that follows the instrumentation amplifier of channel 11 to 5.

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Appendix E: User Service

This appendix contains service-related information for the VX4780 that covers the following topics:

- Performance Verification
- Preventive maintenance
- Troubleshooting

Performance Verification

You may use the Operational Check procedure listed in *Getting Started* to verify that the module is operating correctly. The instrument has been fully tested and calibrated before leaving the factory.

If the self test or diagnostic commands indicate a failure, contact your Tektronix field office or representative for assistance.

Preventive Maintenance

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

1. Turn off power and remove the VX4780 from the VXIbus mainframe.
2. Remove loose dust on the outside of the instrument with a lint-free cloth.
3. Remove any remaining dirt with a lint-free cloth dampened with water or a 75% isopropyl alcohol solution. Do not use abrasive cleaners.

Troubleshooting

If you suspect a malfunction, first double check connections to and from the instrument. If the trouble persists, perform the *Functional Check*.

If the self test indicates a failure, contact your Tektronix field office or representative for assistance.

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Appendix F: Replaceable Parts List

This section contains a list of the replaceable modules for the <VX4780>. Use this list to identify and order replacement parts.

Parts Ordering Information

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

Changes to Tektronix products are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest improvements. Therefore, when ordering parts, it is important to include the following information in your order.

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

If you order a part that has been replaced with a different or improved part, your local Tektronix field office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

Module Servicing

Modules can be serviced by selecting one of the following three options. Contact your local Tektronix service center or representative for repair assistance.

Module Exchange. In some cases you may exchange your module for a reman-ufactured module. These modules cost significantly less than new modules and meet the same factory specifications. For more information about the module exchange program, call 1-800-TEK-WIDE, extension 6630.

Module Repair and Return. You may ship your module to us for repair, after which we will return it to you.

New Modules. You may purchase replacement modules in the same way as other replacement parts.

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Using the Replaceable Parts List

This section contains a list of the mechanical and/or electrical components that are replaceable for the <VX4780>. Use this list to identify and order replacement parts. The following table describes each column in the parts list.

Parts List Column Descriptions

Column	Column Name	Description
1	Figure & Index Number	Items in this section are referenced by figure and index numbers to the exploded view illustrations that follow.
2	Tektronix Part Number	Use this part number when ordering replacement parts from Tektronix.
3 and 4	Serial Number	Column three indicates the serial number at which the part was first effective. Column four indicates the serial number at which the part was discontinued. No entries indicates the part is good for all serial numbers.
5	Qty	This indicates the quantity of parts used.
6	Name & Description	An item name is separated from the description by a colon (:). Because of space limitations, an item name may sometimes appear as incomplete. Use the U.S. Federal Catalog handbook H6-1 for further item name identification.
7	Mfr. Code	This indicates the code of the actual manufacturer of the part.
8	Mfr. Part Number	This indicates the actual manufacturer's or vendor's part number.

Abbreviations

Abbreviations conform to American National Standard ANSI Y1.1–1972.

Mfr. Code to Manufacturer Cross Index

The table titled Manufacturers Cross Index shows codes, names, and addresses of manufacturers or vendors of components listed in the parts list.

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Manufacturers Cross Index

Mfr. Code	Manufacturer	Address	City, State, Zip Code
00779	AMP INC.	CUSTOMER SERVICE DEPT PO BOX 3608	HARRISBURG, PA 17105–3608
0KB01	STAUFFER SUPPLY CO	810 SE SHERMAN	PORTLAND, OR 97214–4657
62559	SCHROFF INC	170 COMMERCE DRIVE	WARWICK, RI 02886–2430
75915	LITTELFUSE INC	800 E NORTHWEST HWY	DES PLAINES, IL 60016–3049
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON, OR 97077–0001
56708	ZILOG	5360 MANHATTAN CIRCLE SUITE 203	BOULDER, CO 80303
TK2647	INSTRUMENT SPECIALTIES CO INC.	C/O TEMCO NW 1336 SE 51ST STREET	HILLSBORO, OR 97123
30817	INSTRUMENT SPECIALTIES CO INC	EXIT 53, RT 80 BOX A	DELAWARE WATER GAP, PA 18327

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Replaceable Parts List

Fig. & Index Number	Tektronix Part Number	Serial No. Effective	Serial No. Discont'd	Qty	Name & Description	Mfr. Code	Mfr. Part Number
	063–1939–XX			1	SOFTWARE PKG:SOFTWARE PKG. VER. 1.0 PLUG AND PLAY FOR SOFT FRONT PANEL 3.5 INCH DISKETTE	80009	063–1939–00
	070–9488–XX			1	MANUAL TECH:USERS	80009	070–9488–00
1	950–1678–00			1	SHIELD,ELEC:BACK VXI C SIZE	80009	950–1678–00
2	211–0867–00			16	SCREW PHIL M2.5X 4,FLHD	0KB01	211–0867–00
3	950–8663–00			8	REAR SHIELD STANDOFF	80009	950–8663–00
4	342–1017–00			1	INSULATOR MYLAR VXI BACKSHIELD	80009	348–1434–00
5	348–1434–00			4	GASKET,EMI	30817	
6	950–4051–00			4	STANDOFF ROUND M2 9 X 19MM	80009	950–4051–00
7	950–5688–00			4	STANDOFF HEX M2.5 THRU X .538L	80009	950–5688–00
8	160–9794–00			1	IC,DIGITAL:STTL,PLD,PAL,PRGM (U372, REF DESIG PRINTED ON CKT BRD)	80009	160–9794–00
9	160–9790–00			1	IC,DIGITAL:STTL,PLD,PAL,PRGM (U373, REF DESIG PRINTED ON CKT BRD)	80009	160–9790–00
10	160–9793–00			1	IC,DIGITAL:STTL,PLD,PAL,PRGM (U482, REF DESIG PRINTED ON CKT BRD)	80009	160–9793–00
11	156–6652–00			1	IC,PROCESSOR:CMOS,MICROCONTROLLER (U47, REF DESIG PRINTED ON CKT BRD)	56708	Z88C0020VSC
12	163–0664–00			1	IC,MEMORY:CMOS,EPROM,PRGM (U681, REF DESIG PRINTED ON CKT BRD)	80009	163–0664–00
13	160–9792–00			1	IC,DIGITAL:CMOSPRGM (U77, REF DESIG PRINTED ON CKT BRD)	80009	160–9792–00
14	160–9791–00			1	IC,DIGITAL:STTL,PLD,PAL,PRGM (U982, REF DESIG PRINTED ON CKT BRD)	80009	160–9791–00
15	211–0409–00			11	SCR,ASSEM WSHR:4–40 X 0.312,PNH	0KB01	211–0409–00
16	210–0586–00			5	NUT,PL,ASSEM WA:4–40 X 0.25	0KB01	ORDER BY DESCRIPTION
17	214–4715–00			4	HEAT SINK,SEMIC:TRANSISTOR	80009	214–4715–00
18	337–4074–00			1	SHIELD,ELEC:TOP	80009	337–4074–00
19	337–4094–00			2	SHIELD:DIVIDER EDGE SHIELD	80009	337–4094–00
20	159–5014–00			3	FUSE,SMD:2.0A,125V,FAST BLOW, UL REG,CSA CERT, (F1181, F1481, F1581 REF DESIG PRINTED ON CKT BRD)	75915	R451 002
21	160–9789–00			1	IC,DIGITAL:CMOS,PLD,PRGM (U1273, REF DESIG PRINTED ON CKT BRD)	80009	160–9789–00
22	129–1483–00			1	SPACER POST:SPACER,0.45 L	80009	129–1483–00
23	950–4448–00			2	SCREW M2.5X10 CHEESEHEAD	80009	950–4448–00
24	950–3794–00			2	WASHER WAVY 2.7MM	80009	950–3794–00
25	367–0410–00			1	HANDLE,EJECTOR:BOTTOM,SINGLE WIDE	62559	20817–327
26	333–4184–00			1	FRONT PANEL FACE PLATE	80009	333–4184–00
27	950–4827–00			2	SCREW PHIL M 2.5 X 8	0KB01	950–4827–00
28	334–9099–00			1	MARKER IDENT:LOWER LABEL,MKD SIGNAL COND	80009	334–9099–00

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Replaceable Parts List (Cont.)

Fig. & Index Number	Tektronix Part Number	Serial No. Effective	Serial No. Discont'd	Qty	Name & Description	Mfr. Code	Mfr. Part Number
29	131–0890–01			8	CONN,HARDWARE:DSUB,JACK SCREW,4–40 X 0.312 L HEX HD,L,W/2 FLAT WASHERS,1 LOCK WASHER	00779	205818–2
30	367–0411–00			1	HANDLE,EJECTOR:TOP,SINGLE WIDE	62559	20817–328
31	334–9100–00			1	MARKER IDENT:UPPER LABEL,MKD TEKTRONIX VX4780	80009	334–9100–00
32	348–1365–01			1	SHLD GSKT,ELEC:SYMETRICAL SLOTTED FINGER	TK2647	348–1365–01
	174–3553–00			1	CA ASSY SP ELEC:SHLD TWPR,VX4780 INPUT 8 SHIELDED TWISTED PAIRS CHANNELS 9–16,CRC,8,22 AWG,TWPR,	80009	174–3553–00
	174–3542–00			1	CA ASSY SP ELEC:CABLE VX4780 TO VX4244 16 SHIELDED TWISTED PAIRS	80009	174–3542–00
	174–3543–00			1	CA ASSY SP ELEC:CABLE VX4780 INPUT 8 SHIELDED TWISTED PAIRS DB25S,CHANNELS 1–8	80009	174–3543–00
					OPTIONAL ACCESSORIES		
	VX1744			1	CA ASSY SP ELEC:CABLE	80009	ORDER BY PRODUCT
	VX1745			1	CA ASSY SP ELEC:CABLE	80009	ORDER BY PRODUCT

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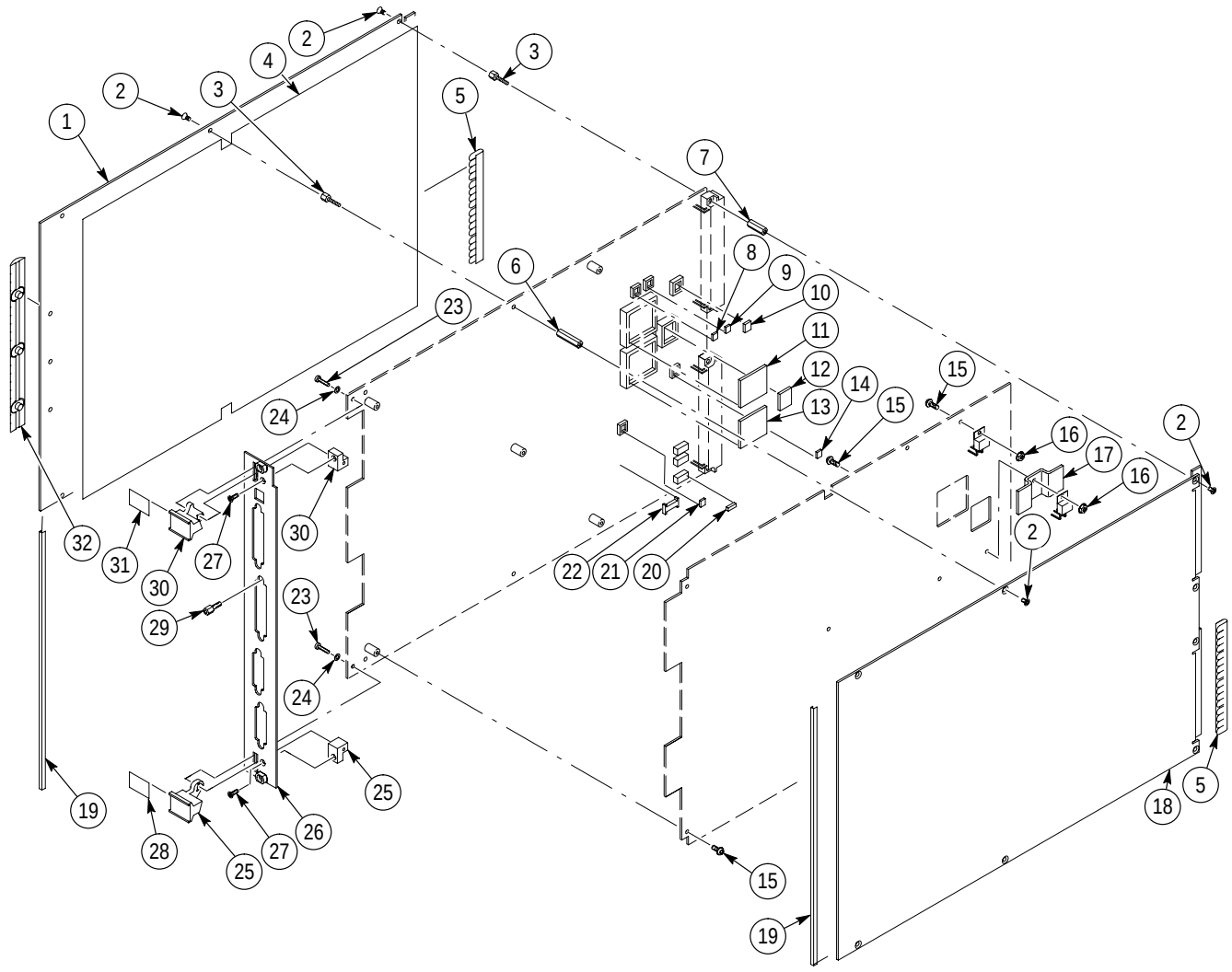


Figure F–1: VX4780 Exploded View

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Glossary

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

Accessed Indicator
A green 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.

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.

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

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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.

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 mm × 233.4 mm × 30.48 mm (13.4 in. × 9.2 in × 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.

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D-Size Card
A VXIbus instrument module that is 340.0 × 366.7 mm × 30.48 mm (13.4 × 14.4 in × 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 Ω; 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-on 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

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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 VX1410 Intelliframe, an operable housing that includes 13 C-size VXIbus instrument module slots.

Memory Device
A storage element (such as bubble memory, RAM, and ROM) that has configuration registers and memory attributes (such as type and access time).

Message
A series of data bytes that are treated as a single communication, with a well defined terminator and message body.

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

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MODID Lines
Module/system identity lines.

Physical Address
The address assigned to a backplane slot during an access.

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

P1
The top-most backplane connector for a given module slot in a vertical mainframe. 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; or the middle backplane connector for a given module slot in a vertical D-size mainframe such as the VX1500.

Query
A form of command that allows for inquiry to obtain status or data.

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

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perform according to a given set of standards. A self test routine is performed upon power-on.

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

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) bidirectional, 50 Ω, differential ECL lines that provide for intermodule 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 ns, and the lines are well matched for timing skew.

STARY
Two (2) bidirectional, 50 Ω, differential ECL lines that provide for intermodule 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 ns, 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 2 ns of skew.

Synchronous Communications
A communications system that follows the “command-response” cycle

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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, bidirectional, 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.

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488-To-VXIbus Interface

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

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