VX4281
RF Power Meter Module
Operating Manual

Tektronix

12/23/91 9104-01-A
through
9112-01-B

Operators Safety Summary

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

TERMS

In This Manual

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

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

Marked on the Module

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

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

SYMBOLS

In This Manual

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

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

Marked on the Module

DANGER — High Voltage.

Protective ground (earth) terminal.

ATTENTION — Refer to the manual.

Refer to manual before using.

Power Source

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

Grounding the Module

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

Danger Arising from Loss of Ground

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

Use the Proper Fuse

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

Do Not Operate in Explosive Atmosphere

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

Do Not Remove Covers or Panels

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

WARRANTY

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

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PROGRAMMING

The programming examples in the manual are written in Microsoft GW BASIC. For programming examples, see page 4 - 2.

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

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

END Terminates the program.

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

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

GOTO n Program branches to line n.

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

REM All characters following the REM command are not executed.

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

<CR> Carriage Return character, decimal 13.

<LF> Line Feed character, decimal 10.

VX4281 RF Power Meter Module
QUICK REFERENCE GUIDE

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

SETUP

Be sure all switches are correctly set. (p. 1 - 4)
Follow Installation guidelines. (p. 2 - 1)

The default condition of the VX4281 Module after the completion of power-up self test is as follows:

Service Request Mask	set to zero
Status byte	set to zero
Measurement Filter	reset

All other conditions are retained by the non-volatile memory as they were before powering down the last time.

LEDs

When lit, the LEDs indicate the following:

Power	power supplies functioning
Failed	module failure
ERR	an error has been found in self test or programming
MSG	module is processing a VMEbus cycle

SYSTEM COMMANDS

These low-level commands are typically sent by the module's commander, transparent to the user, except for the Read Status command. See p. 3 - 4 for details.

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

COMMAND SYNTAX

Command protocol and syntax for the VX4281 Module is as follows: (3 - 4)

1) Commands consist of two letter characters followed, in some cases, by a numeric parameter, which may be a single digit number, a 2-digit hexadecimal number, or signed decimal number. Leading zeros and trailing zeroes following a decimal point may be omitted from numeric parameters. Lower or upper case characters are accepted for all letter characters.

2) A command is terminated by entering any character that is not a valid part of the parameters, such as another valid command, a <CR>, and/or <LF>.

3) More than one command may be entered on a single line simply by stringing them together. For proper operation, commands ending in 'S' must be delimited from a following command beginning with a 'B'.

4) Spaces, null characters, colons, and semi-colons may be inserted as delimiters.

MODULE COMMANDS

This summary lists the commands in the order they would typically be programmed.

A. Command Type: Calibration and Setup

ZE automatically zeroes all ranges on the active entry channel. (3 - 8)
CLz<TM> adjust the gain of the Power Meter to read 1 mW when the sensor on the active entry channel is attached to a 1.00 mW reference oscillator. (3 - 9)
STz stores the present configuration for later recall in storage register z. (3 - 9)
RC sets the Power Meter to the configuration stored in register z. (3 - 10)
$SSz_1,...,z_n$ allows the frequency calibration factors supplied with a sensor to be entered into non-volatile memory. (3 - 10)
RSz recalls the frequency calibration data for sensor number z. (3 - 11)
DS identical to the RS command, except that it returns the frequency calibration data for all twenty sensors. (3 - 12)
ROz turns on or off the open collector relay driver specified by z. (3 - 13)
OCz turns power on or off to any of the calibration reference power outputs. (3 - 13)
PR sets the Power Meter to a known state. (3 - 14)
FRz<TM> enters the input frequency for sensors previously entered with the SS command. (3 - 15)
OSsz<TM> / OSDO set an offset value for the active entry channel. (3 - 15)
KB(z)<TM> enters a calibration factor for the active entry channel. (3 - 16)

B. Command Type: Measurement Mode

LG / LN change the data returned to the system controller to either logarithmic or linear measurement units. (3 - 17)
zP specifies single sensor measurements for sensor z. The specified channel then becomes the active entry channel. (3 - 17)
z_1Rz_2 changes the active entry channel and specifies dual sensor ratio measurements. (3 - 18)
z_1Dz_2 changes the active entry channel and specifies dual sensor difference measurements. (3 - 18)
RLz enter or exit relative mode. (3 - 19)

C. Command Type: Trigger Mode

TRz selects one of the trigger modes. (3 - 20)

D. Command Type: Active Entry Channel

zE selects the channel for which the parameters are to be changed. (3 - 21)

E. Command Type: Operational Mode

RA / RMz / RH control the range selection for the active entry channel. (3 - 22)
FA / FMz / FH control the on-card digital filter selection for the active entry channel. (3 - 22)
LMz enables or disables the limits checking function. (3 - 23)
LHsz<TM> / LLsz<TM> set the active entry channel power limit values to be used for monitoring the power limit on the attached sensor. (3 - 24)

F. Command Type: Format

EN indicates the end of a numeric entry. (3 - 25)
EXz specifies the format for the exponent. (3 - 25)

G. Command Type: System Status

LP1 sends an ASCII string of up to 240 characters to the controller containing information about the Power Meter configurations. (3 - 26)
CS clears the status byte of the Power Meter to zero. (3 - 27)
SB returns the status byte on a subsequent input request as two hexadecimal ASCII digits followed by a <CR><LF>. (3 - 28)
SR sets the bits in the service request mask. (3 - 28)
RV reads the Service Request Mask value. (3 - 29)
?ID reads back the model number and the version number. (3 - 29)
SM reads the status of the Power Meter. (3 - 30)

H. Command Type: Error Messages

SM1 / SM2 used to read the error code number and a short ASCII error message. (3 - 32)

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RF Power Meter Module

Section 1
General Information and Specifications

Introduction

The VX4281 RF Power Meter Module is a printed circuit board assembly for use in a C size or larger mainframe conforming to the VXIbus Specification. Depending on the sensor chosen, the VX4281 can measure RF levels from 1 nW (-60 dBm) to 100 mW (+20 dBm). A variety of low noise, low VSWR accessory sensors are available, including thermocouple and diode coaxial models operating in the 0.1 Mhz to 26.5 GHz range. Power levels to one Watt and waveguide models operating from 18 to 110 GHz may be special ordered.

This manual describes the installation and operation of the VX4281 RF Power Meter Module, the VX1813 Calibration Reference Source, the VX1811 and VX1812 Diode Detector RF Sensors, the VX1814 Thermocouple Detector RF Sensor, and the associated adapters and cables.

The VX4281 supports an exceptionally wide dynamic range of 70 dB with a single sensor, eliminating the need to switch between multiple sensors when measuring a wide range of power levels. At the same time, it provides a 240 picowatt total instrument accuracy and 100 picowatt per hour typical instrument drift rate at -60 dB (1 nW).

The VX4281 Module accepts simultaneous measurements from up to four power sensors (the standard module has two channels, and two additional channels are available as Option 01), allowing automatic tests to be conducted without the errors and uncertainties associated with microwave switching schemes. It has the capability of making a number of calculations in addition to the basic ratio and difference measurements provided by dual channel power meters.

The flexibility gained by having up to four heads on a single instrument makes the VX4281 invaluable for a wide range of applications, including:

- transmitter, signal generator and oscillator measurements;
- VSWR and return-loss measurements with directional couplers and slotted lines;
- gain and insertion loss measurements;
- RF attenuation measurements; and
- antenna measurements.

The VX4281 includes a programmable averaging filter with ten different settings to provide, on a case by case basis, automatic control of the speed vs. accuracy trade-off that is inherent in power measurements. The module also has an auto filter mode that filters an input on a continuous basis, but has the capability to reset the filter automatically when a substantial change in input signal occurs.

Calibration data for twenty sensors at seven different power ranges and at up to 20 frequencies may be stored in non-volatile memory on the VX4281. The calibration data for any of the twenty sensors may be assigned to any of the four channels, allowing more flexible use of power sources and channels.

A significant improvement in the logistics of Power Meter calibration is provided by the VX4281 and its remotely locateable 50 MHz reference source and external relay driver outputs. The remotely controlled reference source can be mounted with the Power Meter sensors at the Unit Under Test (UUT) source, with a user-selected microwave transfer switch.

The transfer switch can then be controlled by the Power Meter relay driver outputs, and used to switch either the reference source or the signal to be measured into the power sensor(s) for automatic calibration and zeroing of individual Power Meter channels. This eliminates the requirement to manually move the power sensor to a reference source located on the front panel of the instrument each time a calibration is performed.

The time savings represented by this automatic calibration capability can be significant, especially in test systems where calibration is performed as often as once a day.

Additional features designed to enhance the use of a power meter in a test system include:

- a delayed trigger mode,
- auto range, and
- a range hold feature which permits switching from auto to manual range without changing ranges.

Tektronix/CDS offers both diode and thermocouple type heads for the VX4281. Diode RF sensors operate by detecting the voltage developed across a precision non-inductive resistor with selected and matched microwave diodes. This gives much higher sensitivity, faster response, better temperature stability, and other important advantages over thermocouple or bolometer sensors. Diode sensors measure true RMS in the lower 40 dB of their dynamic range. This allows the instrument to accurately measure the average power of pulsed and amplitude modulated signals within the sensor's specified range. Above the true RMS range, the sensor shifts from RMS response to peak response. The VX4281 Module compensates for this, and provides a true average power reading of CW (continuous wave) signals in this higher range.

The VX4281 also provides a frequency entry capability. Historically, power meter measurements have required reading a calibration factor printed on the sensor head and manually entering it as a correction factor. Since the VX4281 has up to 20 points of frequency data for up to twenty heads stored on the module, the module provides

program entry of a frequency, and interpolation between the frequency points, to automatically supply the calibration factor.

The current VX4281 operational settings may be saved for future use through a LEARN mode. Using this mode, complete set-up information can be read, stored in non-volatile memory in one of the twenty storage register sets, and restored at any time.

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

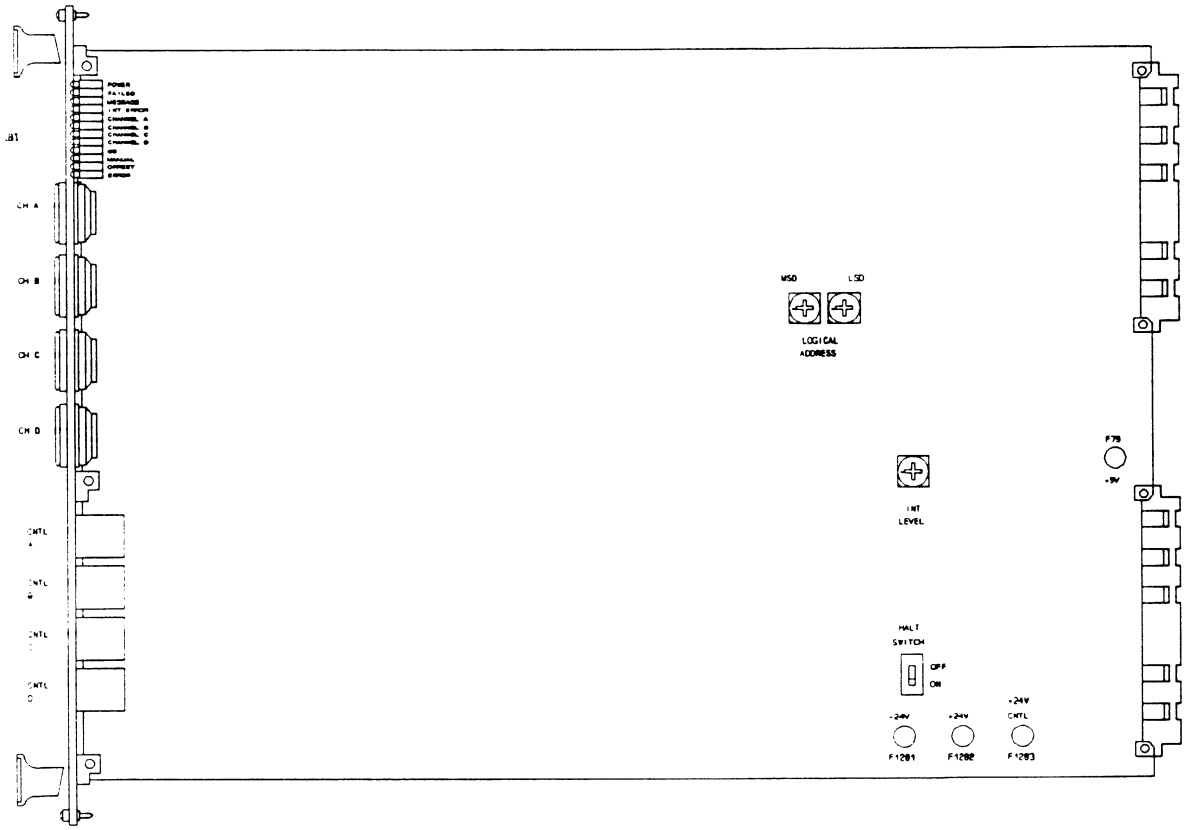
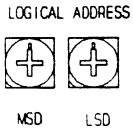


Figure 1: VX4281 Controls and Indicators

Controls And Indicators

The following controls and indicators are provided to select and display the functions of the VX4281 Module's operating environment. See Figures 1 and 2 for their physical locations.

Switches



Logical Address Switches

Each function module in a VXIbus System must be assigned a unique logical address, from 1 to 255 decimal. The base VMEbus address of the VX4281 is set to a value between 1 and FFh (255d) by two hexadecimal rotary switches. Align the desired switch position with the arrow on the module shield.

The actual physical address of the VX4281 Module is on a 64 byte boundary. If the switch representing the most significant digit (MSD) of the logical address is set to position X and the switch representing the least significant digit (LSD) of the logical address is set to position Y, then the base physical address of the VX4281 will be [(64d * Xyh) + 49152d]. For example:

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

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

IEEE-488 Address

Using the VX4281 Module in an IEEE-488 environment requires knowing the module's IEEE-488 address in order to program it. Different manufacturers of IEEE-488 interface devices may have different algorithms for equating a logical address with an IEEE-488 address.

If the VX4281 is being used in a Tektronix/CDS IEEE-488 IAC system, consult the operating manual of the VX4520 Slot 0 Device/Resource Manager.

If the VX4281 is being used in a MATE system, VXIbus logical addresses are converted to IEEE-488 addresses using the algorithm specified in the MATE IAC standard (MATE-STD-IAC). This algorithm is described in detail in the Tektronix/CDS 73A-156 Operating Manual.

If the VX4281 is not being used in a Tektronix/CDS IAC System, consult the operating manual of the IEEE-488 interface device being used for recommendations on setting the logical address.

INT LEVEL

VMEbus Interrupt Level Select Switch

Each function module in a VXIbus System can generate an interrupt on the VMEbus to request service from the interrupt handler located on its commander (for example, a Tektronix/CDS VX4521 Enhanced Slot 0/Resource Manager/IEEE-488 Module or VX4544 embedded PC-386 compatible system controller). The VMEbus interrupt level on which the VX4281 Module generates interrupts is set by a BCD rotary switch. Align the desired switch position with the arrow on the module shield.

Valid Interrupt Level Select switch settings are 1 through 7, with setting 1 equivalent to level 1, etc. The level chosen should be the same as the level set on the VX4281's interrupt handler, typically the module's commander. Setting the switch to 0 or 8 will disable the module's interrupts. Switch setting 9 should not be used.

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

HALT SWITCH

Halt Switch

This two-position slide switch selects the response of the VX4281 Module when the Reset bit in the module's VXIbus Control register is set. Control of the Reset bit depends on the capabilities of the VX4281's commander.

If the Halt switch is in the ON position, the VX4281 Module is reset to its power-up state and all programmed module parameters are reset to their default values.

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

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

LEDs

The following LEDs are visible at the top of the VX4281 Module's front panel to indicate the status of the module's operation:

POWER

This green LED is normally lit and is extinguished if the +5V or ±24V power supplies fail, or if the +5V or ±24V fuses blow.

FAILED

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

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

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

INT ERROR
When lit, this green LED indicates a VXI interface error.

CHANNEL A — This green LED is lit when Channel A is being measured.

CHANNEL B — This green LED is lit when Channel B is being measured.

CHANNEL C — This green LED is lit when Channel C is being measured.

CHANNEL D — This green LED is lit when Channel D is being measured.

dB
This green LED is lit when measurement results are expressed in logarithmic units (dBm or dB). When this LED is not lit, measurement results are in linear units (watts or %).

MANUAL
When lit, this green LED indicates that the measurements are being taken with either Manual Range or Manual Filter selected. This LED is not lit only when both Auto Range and Auto Filter are in effect.

OFFSET
When lit, this green LED indicates that returned measurements are not absolute, but are being returned with Offset Mode or Relative Mode in effect.

ERROR
This green LED is lit to indicate that an error has occurred in a command entry or in making a measurement.

Fuses

The VX4281 Module has four fuses, one for +5 Volts dc, one for -24 Volts dc, one for +24 Volts dc, and an additional, separate fuse to supply +24 Volts dc to the transfer switch control outputs. The fuses protect the module in case of an accidental shorting of the power bus or any other situation where excessive current might be drawn.

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

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

Front Panel

In addition to the LEDs, the front panel also has four Power Sensor inputs (7-pin screw-lock DIN circular connectors) labeled CH A, CH B, CH C, and CH D. There are four open collector, 1 A, +40 V relay drive outputs with four +24V 0.25A relay power sources; and four switched +15 V outputs for powering four reference oscillators, labeled CNTL A, CNTL B, CNTL C, and CNTL D. These are configured as one Relay Drive and one Oscillator Drive output in each of four modular 4-pin telephone type connectors.

BITE (Built-In Test Equipment)

Built-in Test Equipment is provided on the VX4281 by front panel LEDs which indicate operational status, and

- programmable interrupts,
- a programmable service request mask including upper, lower, and window limit checking, and
- error reporting by either error number or a fully described ASCII error message.

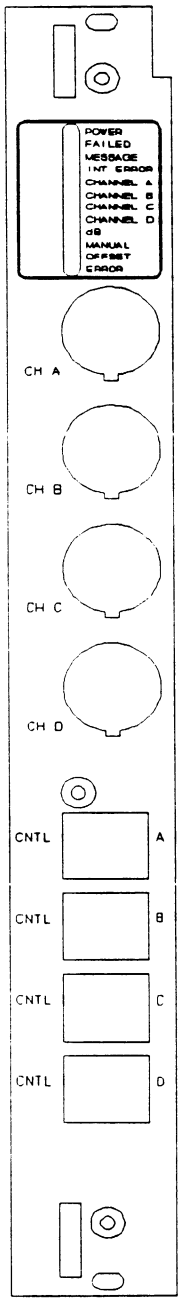


Figure 2: Front Panel

Specifications

Frequency Range: 0.1 MHz to 110 GHz depending on sensor (see table below).

Power Range: 70 dB dynamic range with diode detector sensors, 40 dB with thermocouple sensors. Absolute ranges are shown below:

Tektronix/CDS Model (Nominal Impedance) (RF Connector)	Frequency Range	PWR range (Watts) (dBm)	Overload Rating (Watts) (dBm)	Max. SWR Frequency	Max. SWR	Drift (typical) 1 hr.	Noise (typical) RMS	Noise (typical) 2σ
DIODE TYPE SENSORS								
VX1811 50 ohms N(m)	100kHz to 18GHz	1nW to 10mW -60 to +10dBm	300mW +25dBm	100kHz to 12.4GHz 12.4GHz to 18GHz	1.28 1.37	100 pW	30 pW	60 pW
VX1812 50 ohms APC3.5(m)	100KHz to 26.5GHz	1nW to 10mW -60 to +10dBm	300mW +25dBm	100KHz to 12.4GHz 12.4GHz to 18GHz 18GHz to 26.5GHz	1.28 1.37 1.92	100 pW	30 pW	60 pW
THERMOCOUPLE TYPE SENSORS								
VX1814 50 ohms N(m)	10MHz to 18GHz	1uW to 10mW -30 to +10dBm	30mW +15dBm	10MHz to 15MHz 15MHz to 10GHz 10GHz to 18GHz	1.5 1.35 1.6	450 nW	150 nW	300 nW

Ranging: Full Auto-ranging or programmable ranging.

Full Scale Power Ranges*

Range Number	5811/5812 Sensor	5814 Sensor
7	+10 dBm (+10 mW)	--
6	+ 6 dBm (+ 4 mW)	--
5	-10 dBm (100 µW)	--
4	-20 dBm (10 µW)	+10 dBm (10 mW)
3	-30 dBm (1 µW)	+ 2 dBm (1.6 mW)
2	-40 dBm (100 nW)	- 8 dBm (160 µW)
1	-48 dBm (15 nW)	-15 dBm (30 µW)

* ±3dB due to sensor sensitivity variations

Basic Instrument Accuracy: Accuracy, including the sensor, is the sum of basic uncertainty and calibration uncertainty. For maximum uncertainty, add the two factors. For probable uncertainty, take the square root of the sum of the squares of the factors.

Temperature Uncertainty:	21°C to 25°C - 0 dB for instrument and sensor. 18°C to 30°C - 0 dB for instrument and ±0.1 dB for all sensors. 10°C to 40°C - ±0.2 dB for instrument and ±0.2 dB for all sensors.
VX1813 Calibration Power Reference Source:	50 MHz oscillator with type N female connector and detachable cable.
Power Output:	1.00 mW factory set to ±0.03 dB, traceable to NIST.
Accuracy:	±0.05 dB worst case for one year, 0°C to 55°C.
Calibration Factors:	1.25 dB to -1.25 dB range in 0.01 dB steps, downloaded through the system interface. Stored calibration factors interpolated linearly and applied automatically when frequency is entered through the system interface. Twenty calibration points for up to twenty sensors can be stored in non-volatile memory and can be recalled by sensor number.
Waveform Response:	Detector type sensors: True RMS power over the lowest 40 dB of the sensor's dynamic range. Average power of CW signals in the upper 30 dB of the sensor's range. Thermocouple type sensors: True RMS power.
VXIbus Compatibility:	Fully compatible with the VXIbus Specification for message-based instruments with the Halt switch in the ON position.
VXI Device Type:	VXI message based instrument, revision 1.3.
VXI Protocol:	Word serial.
VXI Card Size:	C size, one slot wide.
Module-Specific Commands:	All module-specific commands and data are sent via the VXIbus Byte Available command. All module-specific commands are made up of ASCII characters. Module-specific data may be in either ASCII or binary format.
VMEbus Interface:	Data transfer bus (DTB) slave - A16, D16 only.
Interrupt Level:	Switch selectable, levels 1 (highest priority) through 7 (lowest).
Interrupt Acknowledge:	D16; lower 8 bits returned are the logical address of the module.

Temperature Uncertainty:	21°C to 25°C - 0 dB for instrument and sensor. 18°C to 30°C - 0 dB for instrument and ±0.1 dB for all sensors. 10°C to 40°C - ±0.2 dB for instrument and ±0.2 dB for all sensors.
Power Reference Source:	50 MHz oscillator with type N female connector and detachable cable.
Power Output:	1.00 mW factory set to ±0.03 dB, traceable to NIST.
Accuracy:	±0.05 dB worst case for one year, 0°C to 55°C.
Calibration Factors:	1.25 dB to -1.25 dB range in 0.01 dB steps, downloaded through the system interface. Stored calibration factors interpolated linearly and applied automatically when frequency is entered through the system interface. Twenty calibration points for up to twenty sensors can be stored in non-volatile memory and can be recalled by sensor number.
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Interrupt Acknowledge:	D16; lower 8 bits returned are the logical address of the module.

VXIbus Data Rate:	Buffered mode write: 200K bytes/sec maximum. Nonbuffered mode write: 20K bytes/sec maximum.
VXIbus Commands Supported:	All VXIbus commands are accepted (e.g. DTACK* will be returned). The following commands have effect on this module; all other commands will cause an Unrecognized Command error: ABORT NORMAL OPERATION ASYNCHRONOUS MODE CONTROL BEGIN NORMAL OPERATION BYTE AVAILABLE (with or without END bit set) BYTE REQUEST CLEAR CLEAR LOCK CONTROL EVENT END NORMAL OPERATION ERROR QUERY GRANT DEVICE IDENTIFY COMMANDER READ INTERRUPTER LINE READ INTERRUPTERS READ PROTOCOL READ STATUS RESPONSE ENABLE SET LOCK TRIGGER
VXIbus Protocol Events Supported:	VXIbus events are returned via VME interrupts. The following events are supported and returned to the VX4281 Module's commander: REQUEST TRUE (In IEEE-488 systems such as the 73A-IBX, this interrupt will cause a Service Request (SRQ) to be generated on the IEEE-488 bus.)
VXIbus Registers:	ID Device Type Status Control Protocol Response Data Low See Appendix A for definition of register contents.
Device Type Register Contents:	F6E6 (1s complement of binary value of model number).
Power Requirements:	All required dc power is provided by the Power Supply in the VXIbus mainframe.

Front Panel Signal Connectors:	4 Power Sensor inputs (7-pin screw-lock DIN circular connectors), 4 Open Collector, 1 A, +40 V relay drive outputs with four +24V 0.25A relay power sources, and 4 Switched +15 V Outputs for powering four Reference Oscillators (one Relay Drive and one Oscillator Drive output in each of four modular 4-pin telephone type connectors).
Equipment Supplied:	1 - VX4281 RF Power Meter Module. 1 - VX1813 Calibration reference source with 7-meter cable. 2 - T-Adapter (Part # 45002-75641). 1 - Operating Manual (Part # 00000-34281). 1 - Service Manual (Part # 00000-44281).
Equipment Required:	One or more VX1811, VX1812, or VX1814 Power Sensors. One or more VX1681 Power Sensor cables.
Available Options and Accessories:	VX4281 Option 01: Additional two sensor ports, for a total of four. VX1681: 5 meter Power Sensor Cable Extension. VX1681 Option 14: 14 meter Power Sensor Cable. VX1681 Option 28: 28 meter Power Sensor Cable. VX1682: 7 meter Transfer Switch Cable. VX1683: 7 meter Transfer-Cal Switch Cable Extension. VX1811 Power Sensor 100 KHz to 18 GHz. VX1812 Power Sensor 100 KHz to 26.5 GHz. VX1813 Remote Calibrator for VX4281. VX1814 Power Sensor 10 MHz to 18 GHz.
Software Revision:	V1.02.

Front Panel Signal Connectors:	4 Power Sensor inputs (7-pin screw-lock DIN circular connectors), 4 Open Collector, 1 A, +40 V relay drive outputs with four +24V 0.25A relay power sources, and 4 Switched +15 V Outputs for powering four Reference Oscillators (one Relay Drive and one Oscillator Drive output in each of four modular 4-pin telephone type connectors).
Equipment Supplied:	1 - VX4281 RF Power Meter Module. 1 - VX1813 Calibration reference source with 7-meter cable. 2 - T-Adapter (Part # 45002-75641). 1 - Operating Manual (Part # 00000-34281). 1 - Service Manual (Part # 00000-44281).
Equipment Required:	One or more VX1811, VX1812, or VX1814 Power Sensors. One or more VX1681 Power Sensor cables.
Available Options and Accessories:	VX4281 Option 01: Additional two sensor ports, for a total of four. VX1681: 5 meter Power Sensor Cable Extension. VX1681 Option 14: 14 meter Power Sensor Cable. VX1681 Option 28: 28 meter Power Sensor Cable. VX1682: 7 meter Transfer Switch Cable. VX1683: 7 meter Transfer-Cal Switch Cable Extension. VX1811 Power Sensor 100 KHz to 18 GHz. VX1812 Power Sensor 100 KHz to 26.5 GHz. VX1813 Remote Calibrator for VX4281. VX1814 Power Sensor 10 MHz to 18 GHz.

Section 2
Preparation For Use

Installation Requirements And Cautions

The VX4281 Module is a C size VXIbus instrument module and therefore may be installed in any C or D size VXIbus mainframe slot other than slot 0. If the module is being installed in a D size mainframe, consult the operating manual for the mainframe to determine how to install the module in that particular mainframe. Setting the module's logical address switch defines the module's programming address. Refer to the Controls and Indicators subsection for information on selecting and setting the VX4281 Module's logical address. To avoid confusion, it is recommended that the slot number and the logical address be the same.

Tools Required

The following tools are required for proper installation:

Slotted screwdriver set.

CAUTION

Note that there are two ejector handles on the card. To avoid installing the card incorrectly, make sure the ejector labeled "VX4281" is at the top.

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

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

CAUTION

Verify that the mainframe is able to provide adequate cooling and power for the VX4281 Module. Refer to the mainframe Operating Manual for instructions on determining cooling and power compatibility.

CAUTION

If the VX4281 Module is inserted in a slot with any empty slots to the left of the module, the VME daisy-chain jumpers must be installed on the backplane in order for the VX4281 Module to operate properly. Check the manual of the mainframe being used for jumpering instructions.

If a VX1400 or VX1401 mainframe is being used, the jumper points may be reached through the front of the mainframe. There are five (5) jumpers that must be installed for each empty slot. The five jumpers are the pins to the left of the empty slot.

Installation Procedure

CAUTION

The VX4281 Module is a piece of electronic equipment and therefore has some susceptibility to electrostatic damage (ESD). ESD precautions must be taken whenever the module is handled.

Use the following procedure to install the VX4281. Refer to Figures 4 and 5.

1) Record the module's Revision Level, Serial Number (located on the label on the top shield of the VX4281), and switch settings on the Installation Checklist. Only qualified personnel should install the VX4281 Module.

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

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

3. Connect the RF sensor to be used on Channel A to the upper 7-pin DIN connector. Use a VX1681 Power Sensor Extension Cable if necessary.

   a. Select Channel A as the active entry channel with the 'AE' command, and select the sensor number of the RF Power sensor (as shown on the calibration sheet) with the 'SSx' command.

b. Record the sensor number (the 'x' from the 'SSx' command) on the label of the sensor.

4. Repeat step 1 for each of the sensors to be used on each of the channels of the VX4281.

5. Connect the VX1813 Power Reference to the CNTL A connector on the VX4281, using a VX1683 Extension Cable and 45002-75641 T-Adapter if necessary.

   Additional Power References may be added using the CNTL B, C, and D connectors.

6. A VX1682 Cable can be used to control external transfer switches with the VX4281.
   a. Connect the positive coil terminal of the transfer switch to the green +24V dc lead of the VX1682 Cable.

   b. Connect the yellow open-collector drive lead from the cable to the other transfer switch coil terminal.

   Additional transfer switches may be added to the remaining CNTL connectors of the VX1683 using additional VX1682 Cables and VX1683 Extension Cables as needed.

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

8. **Installation of Cables -**
   Use a VX1681 Cable to interface between the module I/O connector and the Unit Under Test (UUT). If the module is being installed in a mainframe with a cable tray, route the cable from the front panel of the module down through the cable tray at the bottom of the mainframe and out the rear of the mainframe.

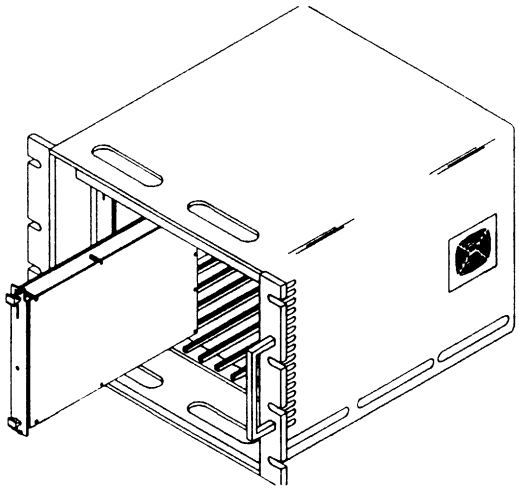

Figure 3: Module Installation

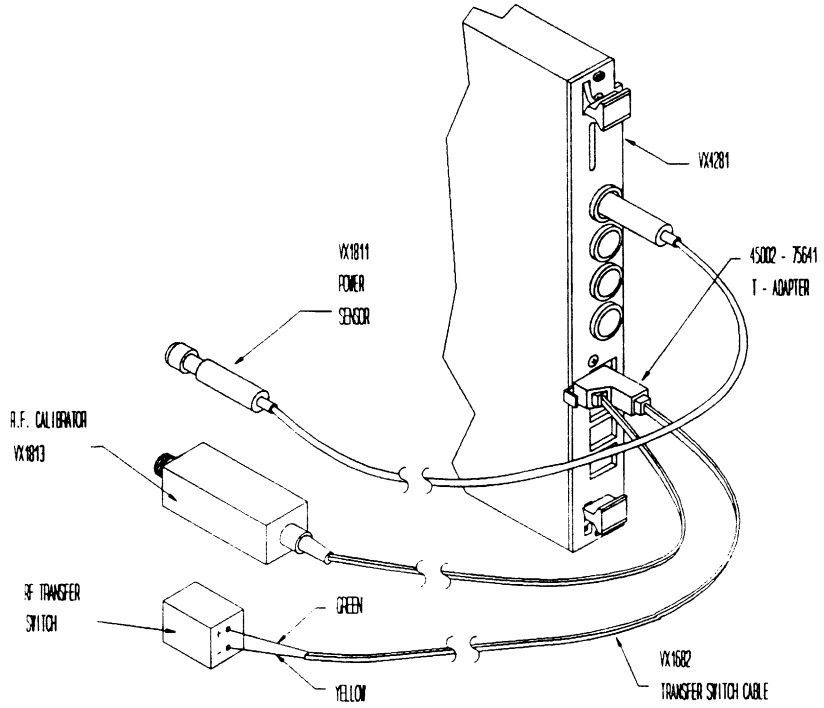

Figure 4: Cabling Example

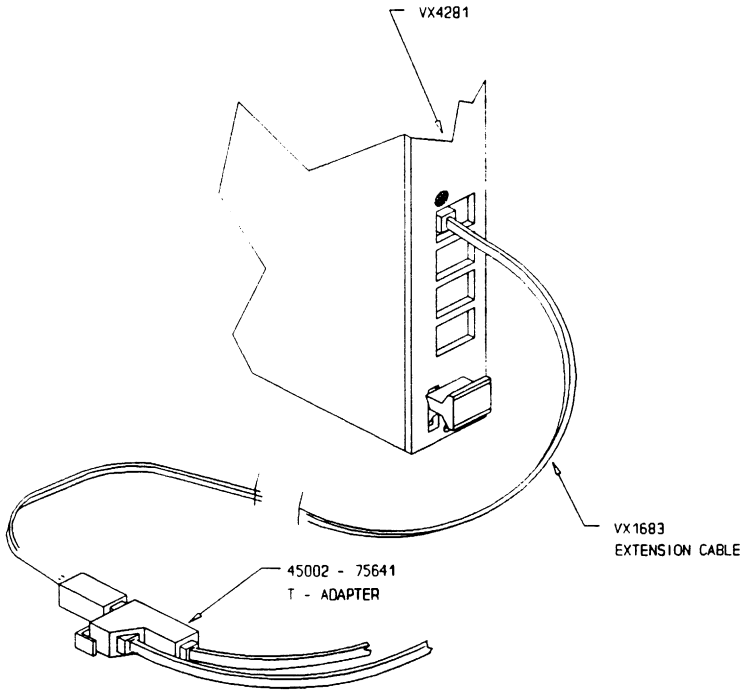

Figure 5: Extension Cables

Installation Checklist

Installation parameters may vary depending on the mainframe being used. Be sure to consult the mainframe Operating Manual before installing and operating the VX4281 Module.

Revision Level: _____

Serial No.: _____

Mainframe Slot Number: _____

Switch Settings:

VXIbus Logical Address Switch: _____

Interrupt Level Switch: _____

Halt Switch: _____

Cables Installed: _____

Power Sensors Installed (if any): _____

Options Installed (if any): _____

Performed by: _____ Date: _____

Section 3
Operation

Overview

Depending on the sensor chosen, the VX4281 Module can measure RF levels from 1 nW (-60 dBm) to 100 mW (+20 dBm). The VX4281 supports an exceptionally wide dynamic range of 70 dB with a single sensor, eliminating the need to switch between multiple sensors when measuring a wide range of power levels. At the same time, it provides a 240 picowatt total instrument accuracy and 100 picowatt per hour typical instrument drift rate at -60 dB (1 nW).

The VX4281 Module accepts simultaneous measurements from up to four power sensors (the standard module has two channels, and two additional channels are available as Option 01), allowing automatic tests to be conducted without the errors and uncertainties associated with microwave switching schemes. It has the capability of making a number of calculations in addition to the basic ratio and difference measurements provided by dual channel power meters.

The VX4281 includes a programmable averaging filter with ten different settings to provide, on a case by case basis, automatic control of the speed vs. accuracy trade-off that is inherent in power measurements. The module also has an auto filter mode that filters an input on a continuous basis, but has the capability to reset the filter automatically when a substantial change in input signal occurs.

Calibration data for twenty sensors at seven different power ranges and at up to 20 frequencies may be stored in non-volatile memory on the VX4281. The calibration data for any of the twenty sensors may be assigned to any of the four channels, allowing more flexible use of power sources and channels.

The VX4281 Module is programmed by ASCII characters issued from the system controller to the VX4281 Module via the module's VXIbus commander and the VXIbus mainframe backplane. The module is a VXIbus Message Based instrument and communicates using the VXIbus Word Serial Protocol. Refer to the manual for the VXIbus device that will be the VX4281 Module's commander for details on the operation of that device.

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

The VX4281 also provides a frequency entry capability. Historically, power meter measurements have required reading a calibration factor printed on the sensor head and manually entering it as a correction factor. Since the VX4281 has up to 20 points of frequency data for up to twenty heads stored on the module, the module provides program entry of a frequency, and interpolation between the frequency points, to automatically supply the calibration factor.

The current VX4281 operational settings may be saved for future use through a LEARN mode. Using this mode, complete set-up information can be read, stored in non-volatile memory in one of the twenty storage register sets, and restored at any time.

Calibration Command Overview

An extensive automated calibration capability is provided for the VX4281 Power Meter. This is fully described in the Calibration section of the Service Manual. Three levels of calibration are provided:

a) each of the four channels is calibrated for offset and gain errors;

b) calibration factors are provided for multiple sensors;

c) calibration is provided at measurement time to compensate for gains or losses in the test setup.

Channel calibration is performed using the ZE (zero) command for offset calibration and the CL (Cal Adjust) command for gain. The gain calibration is performed with a 1 mW reference source supplied with the VX4281, which can be remotely located and remotely controlled for automatic calibration.

Additional channel calibration at each power range is performed on a 12-month calibration cycle, using an adjustable reference source and the ZE and CL commands. This calibration data may be read from the VX4281 for backup on the system controller, if desired.

The SS (Store Sensor) command allows storage of calibration factors for up to twenty sensors at up to 20 frequencies each. These calibration factors are typically supplied on a label attached to the sensor.

Calibration factors for each of the sensors at each of the seven power ranges may be obtained by using the ZE and CL commands, with the sensor attached (using the calibration procedure specified in the Service Manual). This range calibration data may be read with the RS or DS command, stored by the system controller for future use, and restored to the VX4281 with the SS command. Calibration factors for any single sensor may be recalled with the RS (Recall Sensor) command, and for all twenty sensors with the DS (Dump Setup) command.

At operation time, any sensor may be assigned to a channel with a variation of the SS (Store Setup) command, and that sensor's calibration data will then be used. A

frequency may be specified prior to a measurement using the FR (Frequency Range) command and the VX4281 will interpolate to determine a calibration factor based on frequency calibration data previously saved for the sensor. If frequency calibration for a sensor has not been previously stored, a KB (Cal Factor) command may be used at measurement time to program the calibration factor. An offset compensation factor may also be programmed at measurement time with the OS (Offset) command to compensate for gain or loss in the UUT-to-power sensor cabling.

Once the Power Meter has been programmed, the total configuration for the module may be stored in one of twenty storage registers using the ST command. The total configuration may be recalled from any of the twenty pre-stored setups with the RC (Recall Configuration) command.

Typical Operation Sequence

The PR (Preset) command presets the VX4281 to a known state. Measurement time calibration factors programmed by the OS (Offset) or KB (Calibration Factor) commands are reset. Basic gain and offset calibration factors for each channel, sensor calibration data, and configuration data, all of which are stored in non-volatile memory, are unaffected by the Preset command.

The measurement mode is first defined by a set of commands. The measurement may be returned as dBm or dB by using the LG command, or watts or percent ratio using the LN command. The AP, BP, CP, and DP commands provide direct measurement for the four channels. The AR, BR, CR, and DR commands provide a ratio measurement between any two channels. The AD, BD, CD, and DD commands provide a difference measurement between any two channels. The RL (Relative Mode) command returns measurements relative to the first measurement obtained on entering the mode.

A set of TR (Trigger Mode) commands is provided to program trigger immediate, trigger with delay, or free run operation.

The Active Entry Channel commands - AE, BE, CE, and DE - select the channel for which any following commands will apply. Measurement Mode commands can also be used for Active Entry Channel selection.

A set of Range commands - RA, RM and RH - program autorange, a selected range, or range hold. The Filter commands - FA, FM, and FH - program an automatic filtering algorithm, a manual filter selection, or a filter hold.

LH (High Limit) and LL (Low Limit) commands monitor power limit values for a sensor. An LM (Limit Checking) command enables or disables these limits.

A DO (Calculate Offset) command is used with the OS (Offset) command to calculate the offset necessary to make the present power level read zero.

A set of status byte and service request commands clear and read the status byte, and enable and disable a set of service request masks. An ID command returns the model number and version number of the module.

Power-up

The VX4281 Module will complete its self test and be ready for programming five seconds after power-up. The VXIbus Resource Manager may add an additional one or two second delay. The Power LED will be on, and all other LEDs off. The MSG LED will blink during the power-up sequence as the VXIbus Resource Manager addresses all modules in the mainframe. The default condition of the module after power-up is described in the SYSFAIL, Self Test and Initialization subsection.

System Commands

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

Command	Effect
Clear	The module clears its VXIbus interface and any pending commands. Current module operations are unaffected.
Trigger	The Trigger command is accepted, but it has no effect on the card.
Begin Normal Operation	The module will begin operation if it has not already done so.
Read Protocol	The module will return its protocol to its commander.
Read Status	The module will return its status to its commander.

Module Commands

A summary of the VX4281's Module's commands is listed below. This is followed by detailed descriptions of each of the commands. A sample BASIC program using these commands is shown in Section 4.

Command Syntax

Command protocol and syntax for the VX4281 Module are as follows:

1) Commands consist of two letter characters (A-Z) followed, in some cases, by a numeric parameter, indicated in the command description by a lower-case 'z'. The numeric parameter may be a single digit number for some commands, a two-

digit hexadecimal number, or a signed decimal number for others. Leading zeros and trailing zeroes following a decimal point may be omitted from numeric parameters.

2) A command is terminated by entering any character that is not a valid part of the alpha-numeric parameters, such as an EN (ENTER) command, another valid command, or by a carriage return <CR> and/or line feed <LF>. <TM> is used in the command description to indicate that one of these terminators must be used. Examples of correct syntax for each command are given in the detailed explanations of the commands.

3) More than one command may be entered on a single line simply by stringing them together. They are scanned and acted upon in a left-to-right order, except for the status commands: SB, SM, SM1, and SM2. These commands are executed as they are received. For proper operation, commands ending in 'S', such as CS, must be delimited from a following command beginning with a 'B', such as 'BP' or 'BE'.

4) Spaces, null characters, colons, and semi-colons may be inserted as delimiters wherever desired without affecting operation. Lower case (a-z) or upper case (A-Z) characters are accepted for all letter characters.

Summary

This summary lists the commands in the order they would typically be programmed. The detailed descriptions of each command that follow are presented in the same order.

Command Description (Page)

A. Command Type: Calibration and Setup

B. Command Type: Measurement Mode

LG LOG (dB or dBm) (3 - 17)
LN LINEAR (Watts or %) (3 - 17)
P SINGLE SENSOR MEASUREMENT (3 - 17)
R RATIO MEASUREMENT (3 - 18)
D DIFFERENCE MEASUREMENT (3 - 18)
RL RELATIVE MODE SWITCH (3 - 19)

C. Command Type: Trigger Mode

TR TRIGGER MODE (3 - 20)

D. Command Type: Active Entry Channel

E SET ACTIVE ENTRY CHANNEL (3 - 21)

E. Command Type: Operational Mode

RA AUTO RANGE (3 - 22)
RM MANUAL RANGE (3 - 22)
RH RANGE HOLD (3 - 22)
FA AUTO FILTER (3 - 22)
FM MANUAL FILTER (3 - 22)
FH FILTER HOLD (3 - 22)
LM LIMITS CHECKING (3 - 23)
LH HIGH LIMIT (3 - 24)
LL LOW LIMIT (3 - 24)

F. Command Type: Format

EN ENTER (3 - 25)
EX EXPONENT (3 - 25)

G. Command Type: System Status

LP1 LEARN (3 - 26)
CS CLEAR STATUS BYTE (3 - 27)
SB READ STATUS BYTE (3 - 28)
SR SET SERVICE REQUEST MASK (3 - 28)
RV READ SERVICE REQUEST MASK (3 - 29)
?ID IDENTIFICATION (3 - 29)
SM STATUS MESSAGE (3 - 30)

H. Command Type: Error Messages

SM1 SENT MEASUREMENT ERROR MESSAGE (3 - 32)
SM2 SEND ENTRY ERROR MESSAGE (3 - 32)

Detailed descriptions of the VX4281 Module's commands, in the same order as listed above, are given on the following pages. Note that the actual calibration procedures

are described in the Calibration section of the Service Manual. A summary of the calibration and setup commands is also included in that section.

A. Calibration and Setup Commands

Command: ZE ZERO

Syntax: ZE

Purpose: The ZE command automatically zeroes all of the Power Meter's ranges on the active entry channel (see AE command). The internal circuitry is adjusted for a 0 power indication when no power is applied to the sensor. Each channel of the Power Meter must be zeroed separately.

Description: Automatic zeroing takes about 10 seconds total time to read, average, and store zero corrections for all seven measurement ranges. The four Channel LEDs - CHANNEL A, CHANNEL B, CHANNEL C, and CHANNEL D - reverse their normal state to indicate that zeroing is occurring. Commands may be sent while zeroing, but the commands (other than SB and SM commands) will not be acted upon until zeroing is completed.

CAUTION

Make sure that all power is removed from the sensor input during zeroing. If any RF power is present, it will introduce an offset into all subsequent readings.

The Power Meter needs to be calibrated when it does not read zero power within specification with all power removed from the sensor input. These residual non-zero readings may be insignificant when added to high power measurements, but they can be unacceptable when added to low power measurements.

The power output to the VX1813 reference oscillator is automatically turned off during zeroing. It is returned to its original state after the cycle is completed.

CAUTION

Do not power down the Power Meter during zeroing, or an error 57 (recall failure) may occur when power is reapplied because information was not stored properly.

Example: To select Channel A as the active entry channel and to zero its source, enter the command

AEZE

Command: CL CALIBRATION ADJUSTMENT

Syntax: CLz<TM>

Purpose: The CL command for calibration with a reference is used after the ZE (ZERO) command to adjust the gain of the Power Meter to read 1 mW when the sensor on the active entry channel is attached to a 1.00 mW reference oscillator.

Description: z is 1e-3, except for Calibration. Values other than 1 mW (1e-3) should not be used in the CL command except for maintenance (see Calibration). If the VX42813 Reference Power Oscillator is used, use the OC command to turn on the Reference Oscillator before calibration. Use the RO command to operate any transfer switches, if they are used.

<TM> is a required terminator. Any of the terminators specified in the Command Syntax subsection may be used.

Each channel must be zeroed and calibrated separately. Zero and recalibrate when changing sensors or when the ambient temperature changes by 5°C or more.

Auto-ranging is temporarily enabled during calibration (to accommodate various sensors) and then restored to its previous setting. OS (OFFSET) settings are disregarded during calibration, as are the calibration factors entered with the KB (CAL FACTOR) command, which is used only for measurements.

Commands may be sent while calibrating, but commands other than SB and SM will not be acted upon until calibration is completed.

Example: To calibrate a sensor to the 1 mW reference, enter the command CL1e-3EN

****

Command: ST STORE CONFIGURATION

Syntax: STz

Purpose: The ST command stores the present configuration for later recall in storage register z.

Description: z can be register number 1 through 19.

Register 0 always contains the previous configuration of the Power Meter. RECALL CONFIGURATION 0 can therefore be used to recover from a setup entry error.

The following information is stored by the ST command:

- measurement mode
- active entry channel
- CAL FACTOR for each channel
- OFFSET for each channel
- RANGE for each channel
- FILTER for each channel
- REFERENCE OSCILLATOR on/off status for each channel
- measurement units (linear or logarithmic)
- on/off status of REL mode
- reference value, if in REL mode

Example: To store the present configuration in Register 2, enter the command ST2

****

Command: RC RECALL CONFIGURATION

Syntax: RCz

Purpose: The RC command sets the Power Meter to the configuration stored in register z.

Description: z can be register number 0 through 19. Register 0 always contains the previous configuration, so the RC0 command can be used to recover from an entry error. Registers 1 through 19 contain the last configuration stored by the ST command in that location.

Example: To recall the configuration that was stored in Register 2, enter the command RC2

****

Command: SS STORE CALIBRATION FACTORS

Syntax: $SSz_1,\ldots,z_n$

Purpose: The SS command allows the frequency calibration factors supplied with a sensor, for up to twenty sensors, to be entered into non-volatile memory for future use. The SS command is also used to assign the calibration factors for a particular sensor to a channel when that sensor is attached to a particular Power Meter channel.

Description: z_1 is the sensor number 0 through 19.

z_2 is the serial number of the sensor and can contain up to 10 alphanumeric characters.

z_3 is the calibration factor frequency in GHz for the first calibration factor from the calibration chart for the sensor. Frequency values from 0.01 to 0.99 with a decimal point and values from 1 to 127 without a decimal point are valid.

Frequencies must be entered in ascending order starting from the lowest and proceeding in order through the highest.

z_4 is the calibration factor in dB corresponding to the preceding frequency value. Values of -1.25 to 1.25 are valid.

$z_5, z_6, \ldots, z_{n-1}, z_n$ are additional pairs of ascending frequency/calibration factor parameters for the sensor. If the number of calibration points for a particular sensor exceeds 20, simply assign another sensor number and enter the continuing series of calibration points as if the next point was the first point for that sensor.

If z_2 through z_n are not specified, then already stored calibration factors for sensor number z_1 will be assigned to the active entry channel specified by the last AE, BE, CE, or DE command. The SS command may also be used to assign sensor numbers to all channels with a single command. For this capability, z_1 is the value 99, z_2 is the module serial number, and z_3 through z_6 are the sensor numbers to be assigned to channels A through D respectively.

Example: The command string

SS5,11975,1,.04,2,.12,3,.01,4,-.23,5,-.38,6,-.48,7,-.44,8,-.43,9,-.42,10,-.31, 11,-.26,12,-.16,13,-.03,14,.32,15,-.16,16,-.26,17,-.46, 18,.19

stores as sensor number 5 the calibration data for a sensor with serial number 11975. The calibration factors in dB are stored for 1 GHz intervals from 1 through 18 GHz.

NOTE: The SS command is also used to restore voltage calibration data for each of the seven power ranges for either the VX4281 Module itself or for a particular sensor to the VX4281. z_1 will have a value of -99, or -0 through -19 for these functions. The definition of z_1 and the additional arguments following z_1 for these functions are described in the Calibration section of the Service Manual.

****

Command: RS RECALL CALIBRATION FACTORS

Syntax: RSz

Purpose: The RS command recalls the frequency calibration data for sensor number z.

Description: z is a number from 0 through 19.

An input request immediately following the RS command will return a string with the format of the SS command (including the SS at the beginning of the command) for the requested sensor. This response may be stored by the system

controller to permit storage of data for an unlimited number of sensors in a host controller.

The serial number of the module and sensor numbers assigned to each channel may be obtained with an RS99 command. The format of the response is as defined by the SS99 command. (Gain and offset calibration data at each of the seven power ranges may also be recalled for either the VX4281 Module itself, or for up to six sensors.) z has a value of -99, or -0 to -19 for these functions. See the Calibration section of the Service Manual for a detailed description.)

Example: If the command string "RS5" is sent and the last SS command sent for sensor 5 was the one in the previous example, the returned string would be

SS5,11975,1,.04,2,.12,3,.01,4,-.23,5,-.38,6,-.48,7,-.44,8,-.43,9,-.42,10,-.31,11,-.26, 12,-.16, 13,-.03,14,.32,15,-.16,16,-.26,17,-.46,18,.19

****

Command: DS DUMP SETUPS OF CALIBRATION FACTORS

Syntax: DS

Purpose: The DS command is identical to the RS command, except that it returns the frequency calibration data for all twenty sensors.

Description: The frequency calibration data is formatted into up to 42 SS command strings, each terminated with a carriage return <CR> and line feed <LF>. If more than twenty sensors need to be stored, the set of 42 SS setup strings returned by the DS command can be stored by the system controller and sent back to the Power Meter when this set of sensors is used.

The order of returned data is as follows:

SS0..... <CR><LF>
SS-0.... <CR><LF>
SS1..... <CR><LF>
SS-1.... <CR><LF>
.
.
.
SS99.... <CR><LF>
SS-99... <CR><LF>

The format for the SS0, ...SS19, and SS99 responses is described in the SS (Store Sensor) command description. The SS-0, ...SS19, and SS-99 responses are described in the Calibration section of the Service Manual.

If all twenty sensors have not been assigned, then fewer than 42 responses will be returned. For example, if sensor information for only sensors 0 and 1 has been stored, only six response lines will be returned:

SS0, SS-0, SS1, SS-1, SS99, and SS-99.

****

Command: RO RELAY OPERATE

Syntax: ROz

Purpose: The RO command turns on or off the open collector relay driver specified by z.

Description: Valid values for z are:

z	Channel	Relay Status
0	A	OFF
1	A	ON
2	B	OFF
3	B	ON
4	C	OFF
5	C	ON
6	D	OFF
7	D	ON

Relay drivers are typically used to control a remote transfer switch to select either the Unit Under Test measurement point or a VX42813 calibration reference oscillator source for input to the VX4281. It is recommended that the signal input be wired to the OFF contact of the transfer relay, and the reference source to the ON contact. The calibrator is selected prior to using the CL command for calibrating the gain of a VX4281 channel.

Use of this command assumes the use of a VX1682 Cable containing wiring from the relay driver to the transfer switch. This command is not required if the calibrator is manually connected to the VX4281 signal input.

Example: To operate the Channel A relay, enter the command
RO1

****

Command: OC REFERENCE OSCILLATOR POWER SWITCH

Syntax: OCz

Purpose: The OC command turns power on or off to any of the calibration reference power outputs.

z is a number from 0 to 7, which switches the power as indicated:

z	Channel	Power
0	A	OFF
1	A	ON
2	B	OFF
3	B	ON
4	C	OFF
5	C	ON
6	D	OFF
7	D	ON

A command to turn power on is required for using a VX41813 calibration source for calibrating the VX4281 with the CL command. It is recommended that the calibrator be powered off even if switched off by a transfer switch, to minimize power leakage through the transfer switch.

Example: To operate the Channel A calibration source, enter the command

OC1

****

Command: PR PRESET

Syntax: PR

Purpose: The PR command sets the Power Meter to a known state.

Description: On receipt of the PR command, the VX4281 is set to the following known state:

Reference Oscillators	Off
Remote Relay Drivers	Off
Channels A, B, C, and D	
CAL FACTOR	100%
OFFSET	0.00 dB
Filter	Auto
Range	Auto
Measurement Mode	Channel A
Active Entry Channel	Channel A
Measurement Units	Watts
Relative Mode	Off
Channels A, B, C, and D	
Low Limit	0.000 dBm
High Limit	0.000 dBm
Limits Checking	Disabled
Trigger Mode	Free Run
LEDs Channel A	ON
Channel B	OFF
Channel C	OFF

Channel D	OFF
dB	OFF
MNL	OFF
OFS	OFF
ERR	OFF

The PR command resets the calibration factor as programmed by the KB command to a value of 100%. It does not affect the zero and calibration information stored for each channel, or any of the calibration data stored for sensors in non-volatile memory.

If a data error is detected in the non-volatile memory due to battery failure or powering down during a calibration or zero cycle, storage register 0 (see ST command) will be set to the PRESET state.

****

Command: FR FREQUENCY RANGE

Syntax: FRz<TM>

Purpose: The FR command can be used to enter the input frequency for automatic reading and interpolation of calibration chart information for sensors that have previously been entered with the SS (STORE SENSOR) command.

Description: The FR command is a simple, less tedious alternative to the KB command.

z is the frequency value for the FR command, entered in GHz, with the format xxx.xx. Leading and trailing zeros may be omitted.

<TM> is a required terminator. Any of the terminators specified in the Command Syntax subsection may be used.

Example: To enter the calibration factor at 1.5 GHz, enter the command
FR1.50EN

****

Command: OS OFFSET
OSDO CALCULATE OFFSET

Syntax: OSsz<TM> OSDO

Purpose: The OS and OSDO commands are used to set an offset value for the active entry channel. Offset values are added to the measured power to compensate for gain or loss.

Description: s indicates that this is a signed value. s must be - for negative values; the + is optional for positive values.

z is the offset value in dB, with values from -99.99 to +99.99 dB in 0.01 dB increments. Leading and trailing zeros are optional.

<TM> is a required terminator. Any of the terminators specified in the Command Syntax subsection may be used.

To enter the offset necessary to cause the measurement value to read 0.00 dB or dBm for logarithmic units, or 100% or 1.00 mW for linear units send "OSDO". The OSDO command ignores the REL mode when calculating the offset value. If the calculated offset value is not in the allowable range, an offset entry error (Error 51) will result.

Example: To enter an offset of 1.5 dB, enter the command OS1.5EN

****

Command: KB CALIBRATION FACTOR

Syntax: KB(z)<TM>

Purpose: The KB command enters a calibration factor to compensate for the effective sensitivity of the sensor on the active entry channel and for mismatch losses.

Description: z is the optional calibration factor value. Values of 1.0 to 150.0% are accepted. If no data value is entered, the calibration factor is set to 100%.

<TM> is a required terminator. Any of the terminators specified in the Command Syntax subsection may be used.

The appropriate calibration factor can be read from the calibration factor vs. frequency chart on the side of the sensor. If the sensor data has been entered previously with the SS command, the FR command can be used instead of the KB command to enter the calibration factor.

The calibration factor set with the KB command is used only during measurements, not during calibration.

Example: To enter a calibration factor of 102.4%, enter the command KB102.4EN

B. Measurement Mode Commands

Command: LG LOG (dB or dBm)
LN LINEAR (Watts or %)

Syntax: LG LN

Purpose: The LG and LN commands change the data returned to the system controller to either logarithmic (dB or dBm) or linear (Watts or %) measurement units.

Description: Logarithmic units are not valid for values that are negative or zero. A negative or zero value will result in an Error 27 (illegal logarithmic operation). Logarithmic measurements cannot, therefore, be used for difference measurements where the measurement value is negative.

The measurement value for single sensor measurements drifts both positive and negative around zero. This results in log error (Error 27) when the value is negative. This is normal and requires no corrective action.

The measurement units with REL mode off are watts and dBm for single sensor and difference measurements. For ratio measurements and all measurements with REL mode on the units are % and dB. The LG command causes the dB LED to light.

Example: LN Measurements after receipt of this command will be in linear units. If REL is off, the units will be watts; if REL is on, they will be %.

****

Command: P SINGLE SENSOR MEASUREMENT

Syntax: zP

Purpose: The P command specifies single sensor measurements for sensor z. The specified channel then becomes the active entry channel.

Description: z specifies the sensor, and may be A, B, C, or D.

The digital filter, as defined by the most recent filter command, is reset whenever the measurement mode is changed. All subsequent measurements reflect the power level on the specified channel in measurement units of dBm or watts.

If REL mode is selected after the single sensor measurement command, all readings will be in dB or % relative to the first reading after the REL mode was selected.

Example: If the command string "BPRL1" is entered, the system will set channel B to the active entry channel, and the first reading will be retained as the reference value for all subsequent readings, since the REL mode was also selected.

****

Command: R RATIO MEASUREMENT

Syntax: z_1Rz_2

Purpose: The RATIO MEASUREMENT command changes the active entry channel and specifies dual sensor ratio measurements.

Description: z_1 specifies the new active entry channel, and may be either A, B, C, or D.

z_2 (possible sensor combinations) may have the values shown in the following table:

AR		BR		CR		DR	
AR	A/B	BR	B/A	CR	C/A	DR	D/A
AR2	A/B	BR1	B/A	CR1	C/A	DR1	D/A
AR3	A/C	BR3	B/C	CR2	C/B	DR2	D/B
AR4	A/D	BR4	B/D	CR4	C/D	DR3	D/C

The digital filter, as defined in the most recent filter command, is reset whenever the measurement mode is changed. Measurements will be returned with measurement units of dB or %. The power value used for each sensor in making the ratio measurements includes offsets and cal factors for that sensor.

A log error (Error 27) will result if the denominator of the ratio is zero or if the ratio is negative.

If REL mode is selected after the RATIO MEASUREMENT command, all readings will be returned relative to the first reading after REL was selected.

Example: To enter D/C ratio measurement mode, enter the command DR3

****

Command: D DIFFERENCE MEASUREMENT

Syntax: z_1Dz_2

Purpose: The Difference Measurement command changes the active entry channel and specifies dual sensor difference measurements.

z_1 specifies the new active entry channel, and may be either A, B, C, or D.

z_2 (possible sensor combinations) may have the values shown in the following table:

AD		BD		CD		DD	
AD	A-B	BD	B-A	CD	C-A		
AD2	A-B	BD1	B-A	CD1	C-A	DD1	D-A
AD3	A-C	BD3	B-C	CD2	C-B	DD2	D-B
AD4	A-D	BD4	B-D	CD4	C-D	DD3	D-C

The digital filter, as defined by the most recent filter command, is reset when the measurement mode is changed. Measurements will be returned in units of dBm or watts. The difference measurements must be greater than zero or a log error (Error 27) will result in LOG mode.

If Relative mode is selected after the D command, all readings will be in dB or % relative to the first reading after REL was selected.

Example: To enter B-D measurement mode, enter the command BD4

****

Command: RL RELATIVE MODE SWITCH

Syntax: RLz

Purpose: The RL command is used to enter or exit relative mode.

Description: z has the following effect:

z	Function
0	Exit REL Mode
1	Enter REL Mode

The first reading on entering relative mode is saved and subsequent readings are returned in units of dB or % relative to this reference value. Changing the measurement mode will disable relative mode and the reference value will be lost.

The reference can be a negative power value, but the measured power must have the same sign or a log error (Error 27) will occur. In WATT mode the absolute value of negative ratios will be displayed.

If an RL1 command is sent and the Power Meter is already in Relative Mode, the reference value will be replaced with the first reading taken after the RL1 command is processed.

When the internal configuration is saved, the reference value will be saved also if the Power Meter is in Relative Mode. The RL1 command causes the OFFSET LED to light.

Example: To enter Relative Mode, enter the command RL1

C. Trigger Mode Commands

Command: TR TRIGGER MODE

Syntax: TRz

Purpose: The TR command selects one of the trigger modes.

Description: The value of z specifies the trigger mode:

z	Selects
0	Trigger Hold
1	Trigger Immediate
2	Trigger With Delay
3	Trigger Free Run

In Trigger Hold mode the Power Meter is inhibited from returning power measurements until one of the other trigger commands is received.

The Trigger Immediate command causes one measurement to be taken as fast as possible. For the reading to be valid, the Power Meter should be settled on a steady input. Subsequent input requests without a TR command will cause an immediate measurement to be taken.

The Trigger With Delay command is identical to the Trigger Immediate command, except that a settling time delay is inserted according to the range and filter setting to produce an accurate, settled reading. In this mode, measurements are returned only when the digital filter is fully settled. Subsequent input requests without a TR command may be delayed if the filter is reset by auto-ranging.

In the Trigger Free Run mode the measurements are continuously updated and the last measurement will be returned on subsequent input requests unless it has already been read. If the last measurement has already been read, the next reading will be returned when a new measurement is available. About 24 measurements per second can be returned to the system controller in this mode.

Example: To enter Trigger With Delay Mode, enter the command TR2

D. Active Entry Channel

Command: E SET ACTIVE ENTRY CHANNEL

Syntax: zE

Purpose: The E command selects the channel for which the parameters are to be changed.

Description: z specifies the sensor, and may be A, B, C, or D. The parameters which are to be changed are:

Zero
Reference Calibration Factor
Calibration Factor
Limits
Offset
Range
Filters

The active entry channel is also changed whenever a measurement mode is specified, but in either case, the parameters listed above can only be changed through the appropriate command.

Example: To set Channel B as the active entry channel, enter the command BE

E. Operational Mode Commands

Command:
RA AUTO RANGE
RM MANUAL RANGE
RH RANGE HOLD

Syntax: RA RMz RH

Purpose: The RA, RM, and RH commands control the range selection for the active entry channel.

Description: The Power Meter has seven ranges, with range 1 being the most sensitive (for low power levels) and range 7 being the least sensitive (for high power levels).

Auto Range automatically selects the correct range for the power level present at the sensor. Repeating the RA command when already in Auto Range mode causes the Power Meter to go down one range, if possible, for increased resolution. (The ranges overlap by about 20%.)

The RM (Manual Range) command allows manual range selection. Valid values for z (range number) are 1 through 7. Selecting manual range causes the MNL LED to light. The full scale power value for any given range depends on the power sensor used. Full scale power values by range for VX42811/5812 and 5814 are shown in the Specifications section.

The RH (Range Hold) command permits switching from Auto Range to Manual Range without changing ranges. For example, if the power meter is in Auto Range, range 5, and an RH command is sent, the power meter will switch to Manual Range 5 and no longer autorange.

Example: To manually select range 5, enter the command RM5

The MANUAL LED will light.

****

Command:
FA AUTO FILTER
FM MNL FILTER
FH FILTER HOLD

Syntax: FA FMz FH

Purpose: The FA, FM, and FH commands control the on-card digital filter selection for the active entry channel.

Description: The filter reduces jitter in individual measurement values by averaging each new value with previous values. The number of previous values averaged with each new reading depends on the filter length, as shown in the following table:

Auto Filter Power Range	Manual Filter Number (x)	Filter length*
4-7	0	1
3	1	2
-	2	4
2	3	8
-	4	16
-	5	32
-	6	64
1	7	128
-	8	256
-	9	512

* number of readings averaged

When Auto Filter is selected, and the Power Meter's configuration is changed, then the filter is automatically reset. Subsequent readings will reflect the new average of the measurements.

For most applications, Auto Filter works best. Manual Filter selection is available for those applications that require either higher resolution or faster settling times than provided by the automatic selection. The filter number, x, is a single digit number from 0 to 9, where 2^x is the number of readings to average [range = from 1 (2^0) to 512 (2^9)]. Selecting manual mode causes the MANUAL LED to light.

The Filter Hold command retains the filter setting when switching from auto to manual filter mode.

To improve settling times in the Auto Filter mode, the average of the last 4 readings is compared to the filtered average. If the averages differ by more than 12.5% of full scale, the filter is reset and filtering proceeds from the new value.

Example: To set the filter length to 256, enter the command FM8

****

Command: LM LIMITS CHECKING

Syntax: LMz

Purpose: The LM command enables or disables the limits checking function.

Description: z must be either 1 or 0:

z	Limits Checking Function
0	disabled
1	enabled

When the limits checking function is enabled, the most recent high and low limit values programmed for each of the sensors used in the present measurement mode are compared with the measured levels plus offsets.

An out-of-limits condition is indicated by a flashing LED for the corresponding channel and by an interrupt if the Service Request Mask is set for the out-of-limits condition. The Service Request Mask is programmed using the SR command described in the Status Commands subsection.

Example: To enable limits checking, enter the command LM1

****

Command: LH HIGH LIMIT
LL LOW LIMIT

Syntax: LHsz<TM> LLsz<TM>

Purpose: The LH and LL commands are used to set the active entry channel power limit values to be used for monitoring the power limit on the attached sensor.

Description: s indicates that this is a signed value. s must be - for negative values; the + is optional for positive values.

z specifies the limit value. Values are entered in dB and can have values from -299.999 to +299.999 dBm.

<TM> is a required terminator. Any of the terminators specified in the Command Syntax subsection may be used.

The limit value is compared to the measured power plus offsets when limits checking is enabled (see the LM command).

If the measured value is higher than the High Limits value or lower than the Low Limits value, an out-of-limits condition exists. To program the module to generate an out-of-limits condition within a certain range, set the Low Limits value higher than the High Limits value. An out-of-limits condition will then exist for a measurement between these two values.

Example: To set limits for sensor D to -15 dBm (low limit) and +5 dBm (high limit) and enable limits checking, enter the command DELL-15LH5LM1EN

"DE" sets channel D as the active entry channel, "LL-15" sets -15 as the lower limit, "LH5" sets 5 as the high limit, "LM1" enables limit checking, and "EN" is the required terminator.

F. Format Commands

Command: EN ENTER

Syntax: EN

Purpose: The EN command indicates the end of a numeric entry.

Description: Numeric entries can also be terminated with a carriage return <CR> and/or line feed <LF>, or by entering the maximum number of digits allowed for the parameter. Entering any character which is not valid for the parameter also ends the numeric entry and will be interpreted as beginning a new command.

Example: To terminate the numeric parameter that follows a command to set the lower limit to -15 dBm, enter the command LL-15EN

****

Command: EX EXPONENT

Syntax: EXz

Purpose: The EX command specifies the format for the exponent.

Description: z sets either upper or lower case "E" to be used in the output format of data to be returned to the system controller:

z	Function
0	Use lower case e
1	Use upper case E

Example: To set upper case E to be used in the output format, enter the command EX1

G. Status Commands

Command: LP1 LEARN MODE

Syntax: LP1

Purpose: The LP1 command sends an ASCII string of up to 240 characters to the controller containing information about the Power Meter configurations.

Description: The following table shows the format of the string.

Parameter	Output from Power Meter
Trigger Mode	TRx
Measurement Mode	AP, BP, ARx, BRx, ADx, or BDx
Sensor A Parameters	AE
Cal Factor	KBxxx.x EN
Offset	OSsxx.xx EN
Range	RA, or RMx EN
Filter	FA, or FMx EN
Low Limit	LL sxxx.xxx EN
High Limit	LH sxxx.xxx EN
Sensor B Parameters	BE
Cal Factor	KBxxx.x EN
Offset	OSsxx.xx EN
Range	RA, or RMx EN
Filter	FA, or FMx EN
Low Limit	LL sxxx.xxx EN
High Limit	LH sxxx.xxx EN
Sensor C Parameters	CE
Cal Factor	KBxxx.x EN
Offset	OSsxx.xx EN
Range	RA, or RMx EN
Filter	FA, or FMx EN
Low Limit	LL sxxx.xxx EN
High Limit	LH sxxx.xxx EN
Sensor D Parameters	DE
Cal Factor	KBxxx.x EN
Offset	OSsxx.xx EN
Range	RA, or RMx EN
Filter	FA, or FMx EN
Low Limit	LL sxxx.xxx EN
High Limit	LH sxxx.xxx EN

Active Entry Channel	AE, BE, CE, or DE
Measurement Units	LG or LN
Reference Oscillator Status	OC0 or OC1, OC2 or OC3, OC4 or OC5, and OC6 or OC7. For example: OC0OC2OC4OC7
Limits Checking Status	"LM0 or LM1
Termination	<Carriage Return> <Line Feed>

Example: Assume the response following an "LP1" command returns

TR3BPAEKB100.ENOS+00.00ENRAFALL+000.000ENLH+000.000ENBEKB100.0ENOS+00.00ENRAFALL+000.000ENLH+000.000ENCEKB100.0ENOS+00.00ENRAFALL+000.000ENLH+000.000ENDEKB100.0ENOS+00.00ENRAFALL+000.000ENLH+000.000ENLGOC0OC2OC4OC6LM0<CR><LF>

The above response indicates:

TR3	Trigger Mode, Free Run
BP	Sensor B measurement mode
AE	Following parameters for channel A
KB100.0EN	Calibration factor of 100%
OS+00.00EN	Offset of 0 dB
RAFA	Auto range and auto filter
LL+000.000EN	Lower limit of 0 dB
LH+000.000EN	Upper limit of 0 dB
BE	Following parameters for channel B
	Items KB through LH are repeated for channel B.
CE	Following parameters for channel C
	Items KB through LH are repeated for channel C.
DE	Following parameters for channel D
	Items KB through LH are repeated for channel BD
LG	Logarithmic measurement mode
OC0OC2OC4OC6	Cal power off for all 4 channels
LM0	Limit checking disabled

****

Command: CS CLEAR STATUS BYTE

Syntax: CS

Purpose: The CS command clears the status byte of the Power Meter to zero.

Description: The 8-bit status byte contains 5 bits which are used to report the condition of the Power Meter. When set (1), these bits indicate Data Ready, Cal/Zero Complete, Entry Error, Measurement Error and Over/Under Limit. (See the SM and SR commands.)

Bit	7	6	5	4	3	2	1	0
Weight	128	64	32	16	8	4	2	1
Condition	0	Request for Interrupt	0	Over/ Under Limit	Measurement Error	Entry Error	Cal/ Zero Complete	Data Ready

Status Byte and Service Request Mask

****

Command: SB READ STATUS BYTE

Syntax: SB

Purpose: The SB command returns the status byte on a subsequent input request as two hexadecimal ASCII digits followed by a <CR><LF>.

Example: Send the command "SB". When the module is read, the two characters "50" followed by <CR><LF> are returned, indicating a hexadecimal status value of 50. The status byte indicates a Request For Interrupt (bit 6) and Over/Under Limit condition (bit 4).

****

Command: SR SET SERVICE REQUEST MASK VALUE

Syntax: SRz

Purpose: The SR command sets the bits in the service request mask.

Description: The service request mask shown in the table above determines which conditions will generate a request for interrupt.

z is the mask value, which is sent as a string of two hexadecimal digits, high weighted byte first.

When one of these five conditions occurs, the corresponding bit in the status byte is set. If the same bit is set in the Service Request Mask, then the Request for Interrupt bit (bit 6) is set and a request for interrupt is generated. The five bits and the conditions they encode which can be enabled by the Service Request Mask to generate a Request for Interrupt are:

Bit 0 - Data Ready: The measurement data is ready that was requested by the trigger command.

Bit 1 - Cal/Zero Completed: The calibration or zeroing cycle has finished.

Bit 2 - Entry Error: An invalid or out of range number was entered for the selected parameter.

Bit 3 - Measurement Error: The power applied to the sensors is not correct for the present configuration.

Bit 4 - Over/Under Limits: The power is above the high limit or below the low limit and the limits checking function is enabled.

Example: To enable interrupts for only measurement errors (bit 3) and data ready (bit 0) enter the command SR09EN

****

Command: RV READ SERVICE REQUEST MASK VALUE

Syntax: RV

Purpose: The RV command reads the Service Request Mask value.

Description: An input request immediately following the RV command will return an ASCII string of two hexadecimal digits.

Example: Enter the command "RV". When the module is read, the ASCII string "09" is returned, indicating that interrupts are enabled for measurement errors (bit 3) and data ready (bit 0).

****

Command: ?ID IDENTIFICATION

Syntax: ?ID

Purpose: The ?ID command is used to read back the model number and the version number of the Power Meter.

Description: For example, if the ID command is followed by an input request, the Power Meter sends the string "VX4281Vx.xx" where VX4281 is the instrument model number and Vx.xx is the instrument internal software version number.

****

Command: SM STATUS MESSAGE

Syntax: SM

Purpose: The SM command reads the status of the Power Meter.

Description: If the SM command is followed by an input request, the Power Meter sends a string of 23 ASCII characters followed by a carriage-return <CR> and a line-feed <LF>. The string has the following format:

"AAaaBbCCccDDddEFGHIJKLMNO<CR><LF>", where:

Status Message Output Format

AAaaBbCCccDDddEFGHIJKLMNO<CR><LF>

AA	Measurement Error Code	H	REL Mode Status
aa	Entry Error Code	I	Trigger Mode
Bb	Operating Mode	J	Group Trigger Mode
CC	Sensor A Range	K	Limits Checking Status
cc	Sensor B Range	L	Sensor A Limits Status
DD	Sensor A Filter	M	Sensor B Limits Status
dd	Sensor B Filter	N	Sensor C Limits Status
E	Measurement Units	O	Sensor D Limits Status
F	Active Entry Channel	<CR>	Carriage Return
G	Osc Status	<LF>	Line Feed

Codes Used in Status Message

Bb	CCcc	DDdd	E	F	G	H	I	J	K	LMNO
Operating Mode	Range	Filter	Measure-ment Units	Active Entry Channel	OSC Status	REL Mode Status	Trigger Mode	Group Trigger Mode	Limits Checking Status	Sensor A,B, C,D Limits Status
B 0=power on b 1=diff. b 2=ratio b 3=zeroing b 4=calibrat-ing b b 0=A 8=C&A 1=A&B 9=C&B 2=A&C A=C 3=A&B B=C&D 4=B&A C=D&A 5=B D=D&B 6=B&C E=D&C 7=B&D F=D	Manual Range 01=1 02=2 03=3 04=4 05=5 06=6 07=7 Auto Range 11=1 12=2 13=3 14=4 15=5 16=6 17=7	Manual Filter 00=0 01=1 02=2 03=3 04=4 05=5 06=6 07=7 08=8 09=9 Auto Filter 10=0 11=1 12=2 13=3 14=4 15=5 16=6 17=7 18=8 19=9	0=Watts 1=dBm 2=% 3=dB	A=A B=B C=C D=D	0=Off 1=On	0=Off 1=On	0=Free Run 1=Hold	0=GTO	0=Disabled 1=Enabled	0=In limits 1=Over high limit 2=Under low limit 3=Over high limit and under low limit

H. Error Messages

Command: SM1 SEND MEASUREMENT ERROR MESSAGE
SM2 SEND ENTRY ERROR MESSAGE

Syntax: SM1 SM2

Purpose: When the ERR LED is lit, indicating an error, use the SB (Read Status Byte) command to check on whether there are both measurement and entry errors, since they can interact. The Status Message SM1 or SM2 command can then be used to read the error code number and a short ASCII error message (see below).

Description: The most recent error will be displayed.

Measurement errors are cleared automatically when a valid measurement is returned or when read by the SM1 command. Entry errors are cleared when read by the SM2 command. The SM command can be used to read and then clear both the entry and measurement error numbers.

A measurement error results in a measurement value of +9.0000E+40. Measurement errors are coded 01 through 49; entry errors are coded 50 through 99. A full explanation of each code is given below to supplement the displayed message.

Example: The ERR LED is lit, indicating an error occurred. The SB command reveals that both an entry error and a measurement error have occurred. The SM2 command returns the most recent error, with a message of "52, RG ERROR", and the SM1 command returns "27, LOG ERR".

Measurement Errors

Error Code	Message	Action
01 - CAN'T 0 A or CAN'T 0 C	Power Meter cannot zero sensor A or C	Ensure that no RF power is being applied to sensor A or C.
02 - CAN'T 0 B or CAN'T 0 D	Power Meter cannot zero sensor B or D	Ensure that no RF power is being applied to sensor B or D.
05 - CAL-ERR A or CAL-ERR C	Power Meter cannot calibrate sensor A or C	Check sensor A or C connection to reference oscillator. Reference must be 1.00 mW.
06 - CAL-ERR B or CAL-ERR D	Power Meter cannot calibrate sensor B or D	Check sensor B or D connection to reference

		oscillator. Reference must be 1.00 mW.
11 - INPUT-OL	Input overload on sensor A or C[1]	Reduce input power to sensor A or C.
12 - INPUT-OL	Input overload on sensor B or D[1]	Reduce input power to sensor B or D.
15 - PLEASE 0 A or PLEASE 0 C	Sensor A or C's zero reference has drifted negative	Zero sensor A or C. If error persists, check input power.
16 - PLEASE 0 B or PLEASE 0 D	Sensor B or D's zero reference has drifted negative	Zero sensor B or D. If error persists, check input power.
17 - UP RNG A or UP RNG C	Input power on sensor A or C is too high for current range[2]	Select a higher range or reduce input power to sensor range A or C.
18 - UP RNG B or UP RNG D	Input power on sensor B or D is too high for current range[2]	Select a higher range or reduce input power to sensor B or D.
25 - CALC OF	Overflow error[3]	Change either the input power, offset, cal factor or measurement mode.
26 - CALC UF	Underflow error[4]	Change either the input power, offset, cal factor or measurement mode.
27 - LOG ERR	Illegal logarithmic operation	Change to linear measurement units, zero the Power Meter with no RF input power, or increase input power to greater than 0 Watts.

Entry Errors

50 - CF ERROR	Entered cal factor is out of range	Re-enter value between 1.0 and 150.0.
51 - OS ERROR	Entered offset is out of range	Re-enter value between -99.99 and +99.99.

52 - RG ERROR	Entered range number is out of range	Re-enter range number between 1 and 7.
53 - FL ERROR	Entered filter number is out of range	Re-enter filter number between 0 and 9.
54 - RC ERROR	Entered recall register number is out of range	Re-enter register number between 0 and 19.
55 - ST ERROR	Entered storage register number is out of range	Re-enter number between 1 and 19.
57 - RCL FAIL	Continuous memory failure[5]	Refer to Notes below.

NOTES:

1. This error occurs when the input power exceeds the full-scale power for range 7 and only when the Power Meter is on range 7.

2. This error occurs when the Power Meter is on manual range and the input power exceeds full-scale for ranges 1 through 6.

3. Power calculations result in a value that is too large to calculate or display. The combination of input power, offset, calibration factor and measurement mode results in a value whose absolute value is greater than 3.4028E+38.

4. Power calculations result in a value that is too small to calculate or display. The combination of input power, offset, calibration factor and measurement mode results in a value whose absolute value is less than 1.1755E-38.

5. Error 57 occurs when the instrument is turned on and the internal RAM contents have been lost. This is generally due to battery failure, but may also occur when the Power Meter is powered down during the end of a zero or calibration sequence. The Power Meter is then configured in the PRESET state and sensor data is set to a default state. Sensor data and all calibration data must be re-entered, as all calibration data is contained in the non-volatile RAM.

SYSFAIL, Self Test, And Initialization

The VX4281 Module will execute a self test at power-up, or upon direction of a VXIbus hard or soft reset condition, or upon command. A VXIbus hard reset occurs when another device, such as the VXIbus Resource Manager, asserts the backplane line SYSRST*. A VXIbus soft reset occurs when another device, such as the VX4281's commander, sets the Reset bit in the VX4281's Control register.

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

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

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

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

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

The default condition of the VX4281 Module after the completion of power-up self test is as follows:

Service Request Mask	set to zero
Status byte	set to zero
Measurement Filter	reset

All other conditions are retained by the non-volatile memory as they were before powering down the last time.

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

During a commanded self test:

1) SYSFAIL* is not asserted.

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

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

SYSFAIL* Operation

SYSFAIL* becomes active during power-up, hard or soft reset, self test, or if the module loses any of its power voltages. When the mainframe Resource Manager detects SYSFAIL* set, it will attempt to inhibit the line. This will cause the VX4281 Module to deactivate SYSFAIL* in all cases except when +5 volt power is lost.

Section 4

Programming Examples

This section contains example programs which demonstrate how the various programmable features of the VX4281 are used. The examples are written in BASIC using an IBM PC or equivalent computer as the system controller.

Definition of BASIC Commands

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

Command — Result

CALL ENTER (R$, LENGTH%, ADDRESS%, STATUS%)
The CALL ENTER statement inputs data into the string R$ from the IEEE-488 instrument whose decimal primary address is contained in the variable ADDRESS%. Following the input, the variable LENGTH% contains the number of bytes read from the instrument. The variable STATUS% contains the number '0' if the transfer was successful or an '8' if an operating system timeout occurred in the PC. Prior to using the CALL ENTER statement, the string R$ must be set to a string of spaces whose length is greater than or equal to the maximum number of bytes expected from the VX4281.

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

END — Terminates the program.

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

GOSUB n — Runs the subroutine beginning with line n. EX: GOSUB 750 - runs the subroutine beginning on line 750. The end of the subroutine is delineated with a RETURN statement. When the subroutine reaches the RETURN

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

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

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

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

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

<CR> — Carriage return character, decimal 13.

<LF> — Line feed character, decimal 10.

Programming Examples In BASIC

The following sample BASIC programs show how commands for the VX4281 might be used. These examples assume that the VX4281 has logical address 24 and is installed in a VXIbus mainframe that is controlled through an IEEE-488 interface from an external system controller, such as an IBM PC or equivalent using a Capital Equipment Corp. IEEE-488 interface. The VXIbus IEEE-488 interface is assumed to have an IEEE-488 primary address of decimal 21 and to have converted the VX4281 Module's logical address to an IEEE-488 primary address of decimal 24.

The command sequence terminator character <TM> used in the example programs is a line feed character which is appended to output data strings using the BASIC command CHR$(10). That is, DATA# = "....." + CHR$(10).

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

Example 1:

Lines 10 through 40 initialize the PC's IEEE-488 interface card as a system controller with an IEEE-488 address of decimal 21. Line 50 assigns the decimal IEEE-488 address of the VX4281 to the variable ADDR4281%.

```
10   GOSUB 1000
```
Go to a sub-routine which identifies the memory location of CEC IEEE-488 Interface Card ROM.
```
20   SEND = 9 : INIT = 0 : ENTER = 21
```
Initialize PROM offsets for IBM PC IEEE-488 Interface Module.
```
30   PC.ADDRESS% = 0 : CONTROL% = 0
```
Define IEEE-488 Interface Module's IEEE-488 address, and define it to be a controller.
```
40   CALL INIT (PC.ADDRESS%, CONTROL%)
50   ADDR4281% = 24
```
Define VX4281's IEEE-488 address.

.
.
.

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

Example 2:

```
60  O$ = "SS0 PR" : CALL SEND(ADDR4281%,O$,STATUS%)
```
Set up sensor number 0, and preset the card to the default conditions.
```
70  IF STATUS% <> 0 THEN PRINT "ERROR - IEEE-488 TIMEOUT" : STOP
80  PRINT "Connect Sensor 0 to the CHA VX1813 calibrator and press the SPACE BAR."
90  IF INKEY$<> " " THEN GOTO 90
100 O$ = "ZE" : CALL SEND(ADDR4281%,O$,STATUS%)
110 PRINT "Zeroing and calibrating sensor 0."
120 O$ = "SB" : CALL SEND(ADDR4281%,O$,STATUS%)
```
Read the Status byte until it is finished.
```
130 R$ = SPACE$(40) : CALL ENTER (R$,LENGTH%,ADDR4281%,STATUS%)
140 IF INSTR("2367ABEF",MID$(R$,2,1)) = 0 THEN GOTO 120
150 O$ = "FM5 OC1 TR2" : CALL SEND(ADDR4281%,O$,STATUS%)
```
Turn on the VX1813 Calibrator and trigger a settled reading.
```
160 O$ = "SB" : CALL SEND(ADDR4281%,O$,STATUS%)
```
Read the Status byte until it is finished.
```
170 R$ = SPACE$(40) : CALL ENTER (R$,LENGTH%,ADDR4281%,STATUS%)
180 IF INSTR("13579BDF",MID$(R$,2,1)) = 0 THEN GOTO 160
190 CALL ENTER (R$,LENGTH%,ADDR4281%,STATUS%)
```
Take the reading that was triggered.

```
200 O$ = "CL1E-3 FA TR3" : CALL SEND(ADDR4281%,O$,STATUS%)
210 O$ = "SB" : CALL SEND(ADDR4281%,O$,STATUS%)
    Read the Status byte until the calibration is finished.
220 R$ = SPACE$(40) : CALL ENTER (R$,LENGTH%,ADDR4281%,STATUS%)
230 IF INSTR("2367ABEF",MID$(R$,2,1)) = 0 THEN GOTO 210
240 CALL ENTER (R$,LENGTH%,ADDR4281%,STATUS%)
    Take a reading.
250 LOCATE 5,1 : PRINT "The power level on sensor 0 is ";R$
    Print the power level continuously until a key is pressed.
260 IF INKEY$ = "" THEN GOTO 240
270 O$ = "OC0" : CALL SEND(ADDR4281%,O$,STATUS%)
280 END
```

Appendix A
VXIbus Operation

The VX4281 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 VX4281 Module is neither a VXIbus commander nor a VMEbus master, and therefore it does not have a VXIbus signal register. The VX4281 is a VXIbus message based servant.

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

A Normal Transfer Mode Read of the VX4281 Module proceeds as follows:

1. The commander reads the VX4281's Response register and checks if the Write Ready bit is true. If it is, the commander proceeds to the next step. If not, the commander continues to poll the Write Ready bit until it becomes true.

2. The commander writes the Byte Request command (0DEFFh) to the VX4281's Data Low register.

3. The commander reads the VX4281's Response register and checks if the Read Ready bit is true. If it is, the commander proceeds to the next step. If not, the commander continues to poll the Read Ready bit until it becomes true.

4. The commander reads the VX4281's Data Low register.

A Normal Transfer Mode Write to the VX4281 Module proceeds as follows:

1. The commander reads the VX4281's Response register and checks if the Write Ready bit is true. If it is, the commander proceeds to the next step. If not, the commander continues to poll the Write Ready bit until it becomes true.

2. The commander writes the Byte Available command which contains the data (0BCXX or 0BDXX depending on the state of the End bit) to the VX4281's Data Low register.

The VX4281 Module has no registers beyond those defined for VXIbus message based devices. All communications with the module are through the Data Low register, the Response register, or the VXIbus interrupt cycle. Any attempt by another module to read or write to any undefined location of the VX4281's address space may cause incorrect operation of the module.

CAUTION

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

As with all VXIbus devices, the VX4281 module has registers located within a 64 byte block in the A16 address space.

The base address of the VX4281 device's registers is determined by the device's unique logical address and can be calculated as follows:

Base Address = V * 40H + C000H

where V is the device's logical address as set in the logical address switches.

VX4281 Configuration Registers.

Below is a list of the VX4281 Configuration registers with a complete description of each. In this list, RO = Read Only, WO = Write Only, R = Read, and W = Write. The offset is relative to the module's base address.

REGISTER DEFINITIONS

Register	Address	Type	Value (Bits 15-0)
ID Register	0000H	RO	1011 1111 1111 1100 (BFFCh)
Device Type	0002H	RO	See Device Type definition below
Status	0004H	R	1X11 1111 1111 1111 (BFFFh or FFFFh)
Control	0004H	W	0111 1111 1111 110X (7FFCh or 7FFDh)
Offset	0006H	WO	Not used
Protocol	0008H	RO	1111 1111 1111 1111 (FFFFh)
Response	000AH	RO	Defined by state of the interface
Data High	000CH		Not used
Data Low	000EH	W	See Data Low definition below
Data Low	000EH	R	See Data Low definition below

REGISTER BIT DEFINITIONS

ID:	BFFCh
Device:	F6E6h
Protocol:	F7FFh

Word Serial Commands

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

Read Protocol command response: FE6Bh

Appendix B
Input/Output Connections

S1 - Channel A — A seven pin locking DIN connector for POWER SENSOR A.

S2 - Channel B — A seven pin locking DIN connector for POWER SENSOR B.

S3 - Channel C — A seven pin locking DIN connector for POWER SENSOR C.

S4 - Channel D — A seven pin locking DIN connector for POWER SENSOR D.

S5 - CNTL A — A 4-pin 6-position modular telephone-type jack for Channel A Calibrator power, and Transfer switch control. The pins are numbered 2 through 5 starting from the top.

Pin 5 - Channel A Open Collector Relay Drive (40 V dc max., 1 Amp max.). (Yellow wire in phone plug.
Pin 4 - +24 V dc for transfer switch (1 A total for all four channels). (Green wire in phone plug.)
Pin 3 - Channel A Calibrator Power Output (+15 V dc). (Red wire in phone plug.)
Pin 2 - Ground return for above. (Black wire in phone plug.)

S6 - CNTL B — A 4-pin 6-position modular telephone-type jack for Channel B Calibrator power, and Transfer switch control. The pins are numbered 2 through 5 starting from the top.

Pin 5 - Channel B Open Collector Relay Drive (40 V dc max., 1 Amp max.). (Yellow wire in phone plug.)
Pin 4 - +24 V dc for transfer switch (1 A total for all four channels). (Green wire in phone plug.)
Pin 3 - Channel B Calibrator Power Output (+15 V dc). (Red wire in phone plug.)
Pin 2 - Ground return for above. (Black wire in phone plug.)

S7 - CNTL C — A 4-pin 6-position modular telephone-type jack for Channel C Calibrator power, and Transfer switch control. The pins are numbered 2 through 5 starting from the top.

Pin 5 - Channel C Open Collector Relay Drive (40 V dc max., 1 Amp max.). (Yellow wire in phone plug.)
Pin 4 - +24 V dc for transfer switch (1 A total for all four channels). (Green wire in phone plug.)

Pin 3 - Channel C Calibrator Power Output (+15 V dc). (Red wire in phone plug.)
Pin 2 - Ground return for above. (Black wire in phone plug.)

S8 - CNTL D

A 4-pin 6-position modular telephone-type jack for Channel D Calibrator power, and Transfer switch control. The pins are numbered 2 through 5 starting from the top.

Pin 5 - Channel D Open Collector Relay Drive (40 V dc max., 1 Amp max.). (Yellow wire in phone plug.)
Pin 4 - +24 V dc for transfer switch (1 A total for all four channels). (Green wire in phone plug.)
Pin 3 - Channel D Calibrator Power Output (+15 V dc). (Red wire in phone plug.)
Pin 2 - Ground return for above. (Black wire in phone plug.)

Appendix C
VXIbus Glossary

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

Term	Definition
Accessed Indicator	An amber LED indicator that lights when the module identity is selected by the Resource Manager module, and flashes during any I/O operation for the module.
ACFAIL*	A VMEbus backplane line that is asserted under these conditions: 1) by the card cage Power Supply when a power failure has occurred (either ac line source or power supply malfunction), or 2) by the front panel ON/STANDBY switch when switched to STANDBY.
A-Size Card	A VXIbus instrument module that is 100.0 by 160 mm by 20.32 mm (3.9 by 6.3 in by 0.8 in), the same size as a VMEbus single-height short module.
Asynchronous Communication	Communications that occur outside the normal "command-response" cycle. Such communications have higher priority than synchronous communication.
Backplane	The printed circuit board that is mounted in a VXIbus card cage to provide the interface between VXIbus modules and between those modules and the external system.
B-Size Card	A VXIbus instrument module that is 233.4 by 160 mm by 20.32 mm (9.2 by 6.3 in by 0.8 in), the same size as a VMEbus double-height short module.
Bus Arbitration	In the VMEbus interface, a system for resolving contention for service among VMEbus Master devices on the VMEbus.
Bus Timer	A functional module that measures the duration of each data transfer on the Data Transfer Bus (DTB) and terminates the DTB cycle if the duration is excessive. Without the termination capability of this module, a Bus Master attempt to transfer data to or from a non-

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

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

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

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

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

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

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

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

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

Communication Registers — In word serial protocol, a set of device registers that are accessible to the commander of the device. Such registers are used for inter-device communications, and are required on all VXIbus message-based devices.

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

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

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

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

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

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

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

DTB See Data Transfer Bus.

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

DUT Device Under Test.

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

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

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

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

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

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

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

ID-ROM An NVRAM storage area that provides for non-volatile storage of diagnostic data.

Instrument Module A plug-in printed circuit board, with associated components and shields, that may be installed in a VXIbus card cage. 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 card cage or several card cages. See Resource Manager.

Local Processor The processor on an instrument module.

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

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

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

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

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

MODID Lines Module/system identity lines.

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

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

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

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

P3 The bottom backplane connector for a given module slot in a vertical D-size card cage such as the Tektronix VX1500.

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

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

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

Requester A functional module that resides on the same module as a Master or Interrupt Handler and requests use of the DTB whenever its Master or Interrupt Handler requires it.

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

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

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

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

Server A shared memory device that controls the shared memory buffers used in a given Shared Memory Protocol channel.

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

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

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

SMP See Shared Memory Protocol.

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

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

STST STart/STop protocol; used to synchronize modules.

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

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

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

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

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

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

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

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

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

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

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

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

WSP See Word Serial Protocol.

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

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

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