User Manual

Tektronix

VX4750
Function Generator Module

070-9151-05

This document applies for firmware version 2.60
and above.

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

WARRANTY

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of three (3) years from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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EC Declaration of Conformity

We

Tektronix Holland N.V.
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The Netherlands

declare under sole responsibility that the

VX4750 Option 04

meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EN 55011	Class A Radiated and Conducted Emissions

EN 50081-1 Emissions:

EN 60555-2	AC Power Line Harmonic Emissions

EN 50082-1 Immunity:

IEC 801-2	Electrostatic Discharge Immunity
IEC 801-3	RF Electromagnetic Field Immunity
IEC 801-4	Electrical Fast Transient/Burst Immunity
IEC 801-5	Power Line Surge Immunity

To ensure compliance with EMC requirements this module must be installed in a mainframe that has backplane shields installed that comply with Rule B.7.45 of the VXIbus Specification. Only high quality shielded cables having a reliable, continuous outer shield (braid & foil) that has low impedance connections to shielded connector housings at both ends should be connected to this product. Additionally, any cable attached to the S3 or S4 connector must pass through a ferrite block while making at least one complete turn. Use a Steward PN 28B1531-000 ferrite block or equivalent. The ferrite blocks should be mounted as close as possible to the connectors on the VX4750.

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General Safety Summary

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

To avoid potenital hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

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

Injury Precautions

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

Avoid Overvoltage. To avoid electric shock or fire hazard, do not apply potential to any terminal, including the common terminal, that varies from ground by more than the maximum rating for that terminal.

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

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

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

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

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

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

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

Product Damage Precautions

Use Proper Power Source. Do not operate this product from a power source that applies more than the voltage specified.

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

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

Symbols and Terms

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

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

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

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

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

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

CAUTION indicates a hazard to property including the product.

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

DANGER High Voltage | Protective Ground (Earth) Terminal | ATTENTION Refer to Manual | Double Insulated

Certifications and Compliances

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

Service Safety Summary

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

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

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

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

To avoid electric shock, do not touch exposed connections.

VX4750
Function Generator Module

Section 1
General Information and Specifications

Introduction

The VX4750 Function Generator Module is a printed circuit board assembly for use in a mainframe conforming to the VXIbus Specification, such as the **VX1410 or VX1411 C size** mainframe used in the **Tektronix** IAC System. The VX4750 Module is a single channel function generator capable of generating sine, triangle, ramp, dc, square, pulse and arbitrary waveforms. The function output is capable of driving 11 V p-p into a 50 ohm load. The maximum output frequency is 25 MHz. The selected waveform may be output continuously or gated on for a programmable number of cycles.

The module has extensive internal and external modulation capabilities. These include FM, PM, AM, PSK, FSK and PWM. These forms of modulation may be applied to any of the waveforms that the VX4750 is capable of generating (with the exception of PWM, which applies only to the pulse waveform). The module may be programmed to sweep the frequency of the output waveform over its entire frequency range. The module outputs a TTL compatible SWEEP SYNC signal at the end of each sweep and a TTL compatible MARKER FREQ signal at a specified frequency within the sweep. The polarity of each of these TTL signals is programmable.

The module may be programmed to sweep continuously or for a specified number of times. Alternatively, the sweep frequency may be controlled by an external signal applied to the module's modulation input.

The module can be triggered from any of several sources. These include: the front panel Trigger input, any of the VXI TTL trigger signals, a VXI Word Serial Protocol TRIGGER command, a module TRIG command. Any of the above trigger sources generates a TRIG OUT signal which is output to the front panel TRIG OUT connector and optionally to any one of the VXI TTL trigger signals.

The module can be programmed to accept a frequency reference from one of several sources. These include an internal 10 MHz reference (standard accuracy 1 ppm,) **the VXI CLK10 clock and an external reference applied to the front panel REF IN connector. The front panel REF IN signal may also be programmed to act as a module clock rather than a frequency reference. This feature is useful in synchronizing two or more VX4750 modules to produce waveforms with a programmable phase relationship. The front panel REF OUT may be programmed to output a buffered version of the selected 10 MHz reference or the 33 MHz module clock.**

The VX4750 incorporates additional features which improve its speed and operational efficiency when installed in an ATE system. The Buffered Mode automatically enables Fast Handshake protocol, a special provision of the VXIbus Specification that allows commands and/or data to be sent from the system controller to a module with minimum VXIbus protocol overhead. In this mode, the VX4750 stores incoming data/commands in an internal buffer that is sequentially processed. Module data processing and buffer loading occur simultaneously.

In non-buffered normal transfer mode, information is processed by the VX4750 on a byte-by-byte basis as it is received. This feature supports applications where it is important that the VX4750's operation remain synchronous with another event in the ATE system.

A combination of the benefits of both non-buffered mode and Fast Handshake mode can be obtained by sending binary data while in the non-buffered mode. In this case, information is processed a byte at a time, but the VX4750 automatically switches into Fast Handshake mode during the binary transfer. This mode is useful when downloading data for the generation of arbitrary waveforms.

All outputs of the VX4750 are short circuit protected. The modulation input is over-voltage protected.

On-board LEDs display the address status of the VX4750, monitor the presence of proper power on the power buses, indicate on-board failures, show syntax and other programming errors.

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).

In addition, the following acronyms are used in this manual:

ARB	Arbitrary Waveform Generator
ATLAS	Abbreviated Test Language for All Systems
IAC	Instrument on A Card
ICM	IAC Control Module
PSK	Phase Shift Keying modulation
UUT	Unit Under Test

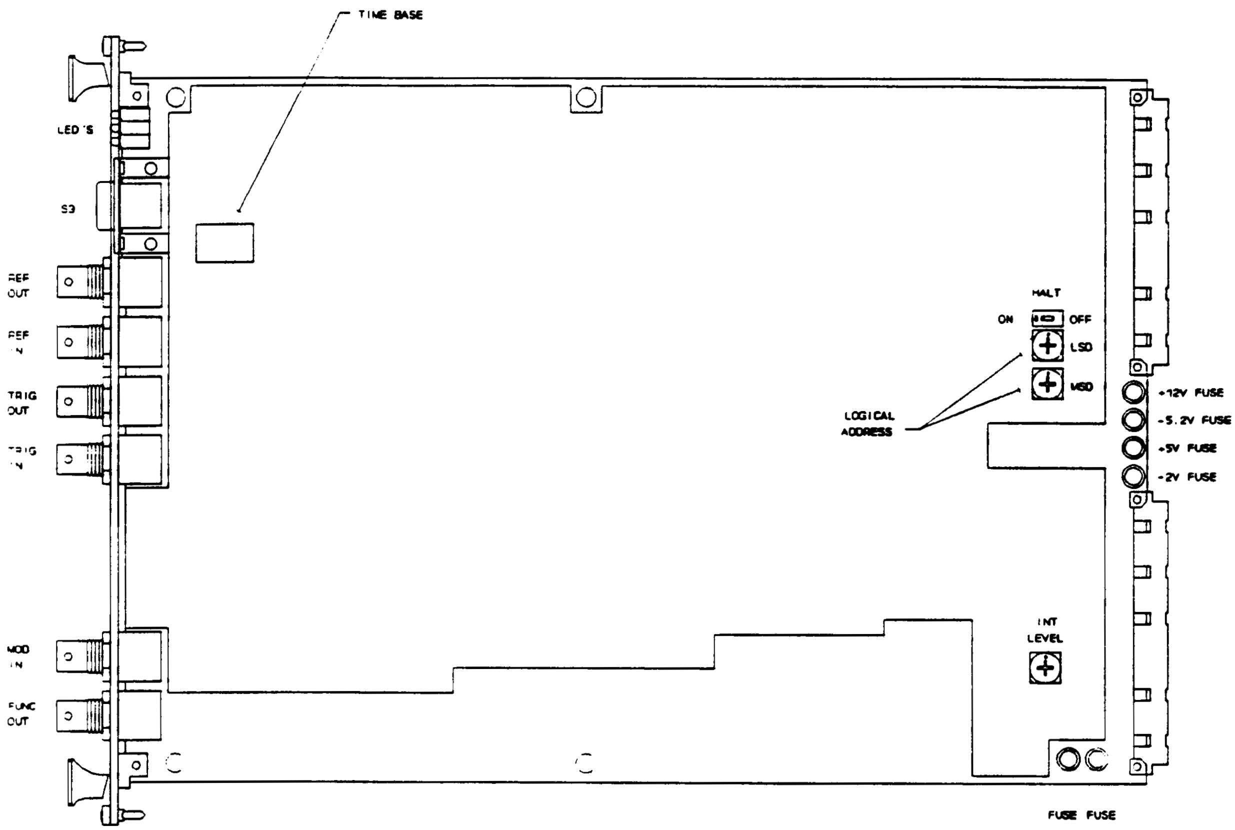


Figure 1: VX4750 Controls and Indicators

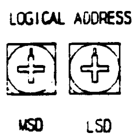
Refer to *Appendix D* for Option 04 information.

Controls And Indicators

The following controls and indicators are provided to select and display the functions of the VX4750 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 254 decimal. The base VMEbus address of the VX4750 is set to a value between 1 and FEh (254d) by two hexadecimal rotary switches. Align the desired switch position with the arrow on the module shield.

The actual physical address of the VX4750 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 VX4750 will be [(64d * XYh) + 49152d]. For example:

L. A.	M S D	L S D	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

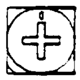
IEEE-488 Address
Using the VX4750 Module in an IEEE-488 environment requires knowing the module's IEEE-488 address in order to program it. Different manufacturers of IEEE-488 interface devices may have different algorithms for equating a logical address with an IEEE-488 address.

If the VX4750 is being used with a Tektronix IEEE-488 interface module, consult the operating manual of the Tektronix Resource Manager/IEEE-488 Interface Module being used.

If the VX4750 is not being used with a Tektronix Resource Manager/IEEE-488 Interface Module, consult the operating manual of the IEEE-488 interface device being used for recommendations on setting the logical address.

VMEbus Interrupt Level Select Switch

INT LEVEL



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 Tek/CDS VX4521 Enhanced Slot 0/Resource Manager/IEEE-488 Module or VX4544 embedded PC-386 compatible system controller). When using the VX4750 with a Tek/CDS commander module, set the interrupt level to the same level as the interrupt handler on that commander. The VMEbus interrupt level on which the VX4750 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 VX4750's interrupt handler, typically the module's commander. Setting the switch to an invalid interrupt level (0, 8, or 9) will disable the module's interrupts.

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 VX4750 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 VX4750's commander.

If the Halt switch is in the ON position, the VX4750 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 VX4750 Module's front panel to indicate the status of the module's operation:

Power LED

This green LED is normally lit and is extinguished if one or more of the module fuses opens or if the +5V, +12V, +24V, -24V, -5.2V or -2V power supplies fail.

Failed LED

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

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

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

Error LED
This green LED indicates that an error was found while attempting to execute a command sent to the VX4750. This includes out of range and syntax errors. The error that caused this LED to light can be determined by the ERR? (error query) command. The LED is cleared when the ERR? command is executed and all errors have been read.

Gate LED
This green LED is lit when the FUNCTION output of the VX4750 is enabled. It is cleared when the FUNCTION output is gated off.

Lock LED
This green LED indicates the state of the phase locked loop used to generated sine waves with a frequency greater than 10 MHz. This LED is lit when the high frequency phase locked loop is locked.

Fuses

The VX4750 Module has six fuses, for +5V, +12V, +24V, -24V, -5.2V and -2V. These 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.

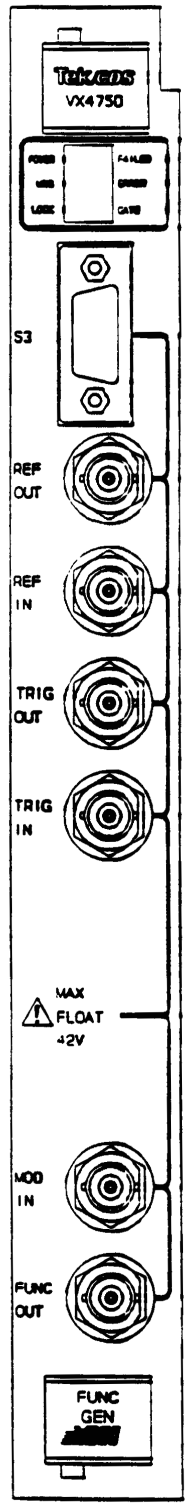


Figure 2: VX4750 Front Panel

Refer to *Appendix D* for Option 04 information.

Specifications

Waveforms:		Sine, Square, Triangle, Positive Ramp, Negative Ramp, Pulse, Arbitrary.
Frequency:	Range:	Sine: 1 milliHz - 25 MHz Square: 1 milliHz - 10 MHz Triangle: 1 milliHz - 500 KHz Pulse: 1 milliHz - 500 KHz Ramp: 1 milliHz - 50 KHz
		Resolution: 1 milliHz for frequency range 1 milliHz to 10 MHz; 4 milliHz for frequency range 10 MHz to 25 MHz. Accuracy: 1 ppm **(0 degrees – 50 degrees C)** Stability: **Ageing Rate** ± 1 ppm/year.
Phase Offset:		Range: ± 180.0 degrees. Resolution: 0.1 degrees. Accuracy: ± 3° or ± 5 nsec (whichever is greater).

Amplitude:	Range:	0.000 Vp to 11 Vp into high impedance load. (≥65.535 kΩ) 0.000 Vp to 5.5 Vp into 50 Ω load
	Resolution: (typical)	Resolution — Amplitude in Vp + |D.C. Offset in Volts| 2 mVp — 1.001 V to 5.500 V into 50 Ω load 1 mVp — 0.000 V to 1.000 V into 50 Ω load
	Accuracy:	+−0.2 dB (+−0.1 dB typical) or the absolute accuracy listed in the table below (whichever is greater) for the frequency range 0.001 Hz ≤ f ≤ 3 MHz with 50 Ω load, D.C. offset set to 0 V, at ambient temperature of 25° C.

Amplitude Range	Absolute Accuracy
5.500 Vp ≤ A ≤ 1.000 Vp	±40 mVp (±20 mVp typical)
1.000 Vp < A ≤ 0.200 Vp	±8 mVp (±4 mVp typical)
0.200 Vp < A ≤ 0.000 Vp	±4 mVp (±2 mVp typical)

±0.5 dB into 50 Ω load for the frequency range
3 MHz < f ≤25 MHz with D.C. offset set to 0.000 V.

	Flatness:	±0.1 dB (±0.05 dB typical) into 50 Ω load for frequency range 0.001 Hz < f ≤ 3 MHz. ±0.5 dB into 50 Ohm load for frequency range 3 MHz < f ≤ 25 MHz
D.C. Offset	Range	−11.000 V to + 11.000 V into high impedance load (≥65.535 kΩ) −5.500 V to +5.500 V into 50 Ω load
	Resolution: (typical)	Resolution — Amplitude in Vp + |D.C. Offset in Volts| 4 mV — 1.001 V to 5.500 V into 50 Ω load 1 mV — 0.000 V to 1.000 V into 50 Ω load
	Accuracy:	+−2.5% or 20 mV whichever is greater into 50 Ω load with amplitude set to 0.000 Vp.

Modulation:	FM:	External only.
	Source:	Modulation input.
	Modulating signal amplitude:	±1.414 V.
	Bandwidth:	20 kHz.
	Frequency Deviation:	
	Range:	2 Hz to 5 MHz.
	Resolution:	2 Hz.
	AM:	External only.
	Source:	Modulation input.
	Modulating signal amplitude:	±1.414 V.
	Bandwidth:	20 kHz.
	Modulation Index:	
	Range:	0 to 99%.
	Resolution:	2.4%
	PM:	External only.
	Source:	Modulation input.

Modulating signal amplitude: ±1.414V.
Bandwidth: 20 kHz.
Phase Deviation:
Range: 0 to 350°.
Resolution: 0.1°.

FSK: External only.
Source: Trigger Input or selected VXI TTL trigger
Modulating signal level: TTL.
Mark Frequency Range: 1 milliHz to 10 MHz.
Space Frequency Range: 1 milliHz to 10 MHz.
Maximum bit rate: 3.5 Mbps.
Phase-continuous frequency switching.

PWM: External only.
Source: Modulation input.
Modulating signal amplitude: ±1.414V.
Bandwidth: 20 kHz.
Duty Cycle deviation (from 50%).
Range: 0 to 45%.
Resolution: 1%.

PSK: Internal only.
Type: BPSK, QPSK, 8PSK, or 16PSK.
Maximum data rate:
BPSK: 50 Kbps.
QPSK: 100 Kbps.
8PSK: 150 Kbps.
16PSK: 200 Kbps.

Frequency Sweep:

Internal (linear or log): Continuous sweep or counted (1 to 65535) sweeps.
Lower Range Sweep: Phase continuous
Minimum start frequency: linear sweep: DC. log sweep: 1 Hz.
Maximum stop frequency: 10 MHz.
Sweep rate: 21 Hz/sec to 7.45 MHz/sec.
Resolution: 0.125 Hz/Sec for sweep rates of 25 Hz/sec to 475 KHz/Sec.
2 Hz/Sec for sweep rates of 475 KHz/sec to 7.5 MHz/Sec.

Upper Range Sweep: Phase continuous.
Minimum start frequency: 7 MHz.
Maximum stop frequency: 25 MHz.
Sweep rate: 84 Hz/sec to 29.8 MHz/sec.
Resolution: 0.5 Hz/Sec for sweep rates of 84 Hz/sec to 1.9 MHz/Sec; 8 Hz/Sec for sweep rates of 1.9 MHz/sec to 29.8 MHz/Sec.

External:
Source: Modulation Input.
Modulating signal level: 0V to 10V.

Lower Range Sweep: Phase continuous.
Minimum start frequency: 500 Hz.
Maximum stop frequency: 10 MHz.

Upper Range Sweep: Phase continuous.
Minimum start frequency: 7 MHz.
Maximum stop frequency: 25 MHz.

Waveform Specifications:

Sine: Measurement at an output amplitude of 10dBm into 50 Ohms.
Harmonic Distortion: no harmonic greater than:
- 1 milliHertz to 1 MHz: -45 dBc.
- 1 MHz to 10 MHz: -35 dBc.
- 10 MHz to 25 MHz: -25 dBc.

Square: rise/fall time: less than or equal to 25 nsec.
Maximum overshoot: less than or equal to 5%.

Triangle: Linearity: **0.625%.**

Pulse: Duty Cycle:
Range: 5% to 95%
Resolution: 1%

Ramp: Linearity: **0.625%.**
Slope: positive or negative.

Arbitrary: Memory Size: 4096 words.
Word Size: 12 bits.
Sample period:
Range: 29.8 nsec to 429.4 sec.
Resolution: 29.8 nsec.

Burst Mode: Output may be gated on for 1 to 65535 waveform cycles.

Outputs: Isolation: Maximum float voltage: **42 V_p.**
Leakage Current: Maximum 15 μA.

Function Output: Impedance: 50 Ohm.
Connector: BNC.

Marker Frequency Output: Signal level: Positive or Negative TTL pulse.
Connector: signal: DEM-9S pin 3.
return: DEM-9S pin 4.

Arb Marker Output: Signal level: TTL
Connector: signal: DEM-9S pin 7.
return: DEM-9S pin 6.

Internal Frequency Sweep Sync: Signal level: Positive or Negative TTL pulse.
Connector: signal: DEM-9S pin 5.
return: DEM-9S pin 9.

TTL Output:	Signal level: TTL Connector: signal: DEM-9S pin 1. return: DEM-9S pin 2.
Frequency Reference Output:	Frequency: 10 MHz or 33 MHz. Signal level: TTL. Duty cycle: 50% ±20%. Accuracy: 1 ppm Connector: BNC.
Trigger Output to Front Panel:	Signal Level: Positive or negative TTL pulse. Connector: BNC.
Trigger Output to VXI TTL Trigger Bus:	VXI Trigger Protocol: Asynchronous.
Inputs:	
Frequency Reference Input:	Frequency: 10 MHz or 33 MHz. Signal level: TTL. Duty cycle: 50% ±10%. Coupling: AC. Connector: BNC.
Trigger/Gate Input:	Signal level: TTL active polarity programmable to high or low. Connector: front panel BNC. Modulation input for FSK modulation.
External Modulation Input:	Mode: FM, PM, AM, PWM, Frequency Sweep; command selectable. Input Impedance: 10 K Ohm. Nominal Signal level: ±1.414V for FM, PM, AM, PWM. 0V to 10V for frequency sweep. Coupling: DC. Connector: BNC.
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.
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 through 7.

Interrupt Acknowledge: D16; lower 8 bits returned are the logical address of the module.

VXIbus Data Rate: Buffered mode write: 200K bytes/sec maximum.
Nonbuffered mode write: 20K bytes/sec maximum.

VXIbus Commands Supported: All VXIbus commands are accepted (e.g. DTACK* will be returned). The following commands have effect on this module; all other commands will cause an Unrecognized Command Event:

ABORT NORMAL OPERATION
ASYNCHRONOUS MODE CONTROL
BEGIN NORMAL OPERATION
BYTE AVAILABLE (with or without END bit set)
BYTE REQUEST
CLEAR
CLEAR LOCK
CONTROL EVENT
END NORMAL OPERATION
READ INTERRUPTER LINE
READ INTERRUPTERS
READ PROTOCOL
READ PROTOCOL ERROR
READ STATUS BYTE
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 VX4750 Module's commander:

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

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

ID Register Contents: BFFC

Device Type Register Contents: F511

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

Voltage:	+5 volt supply: 4.75 V dc to 5.25 V dc. +12 volt supply: +11.5 V to +12.5 V +24 volt supply: +23.5 V dc to +24.5 V dc. -24 volt supply: -23.5 V dc to -24.5 V dc. -5.2 volt supply: -5.0 V to -5.4 V -2 volt supply: -1.9 V to -2.1 V
Current (Peak Module, I_{PM}):	+5 volt supply: 3.25A +12 volt supply: 35mA +24 volt supply: 500mA -24 volt supply: 500mA -5.2 volt supply: 40mA -2.0 volt supply: 40mA
Fuses:	+5 volt replacement fusı Littelfuse P/N 273004 +12, +24, -24, -5.2, -2 volt replacement fuse: Littelfuse P/N 273001
Cooling:	Provided by the fan in the VXIbus mainframe. Less than 10°C temperature rise with 2.24 liters/sec of air at a pressure drop of 0.16 mm of H_2O.
Temperature:	0°C to +50°C, operating. -40°C to +85°C, storage.
Humidity:	Less than 95% R.H. non-condensing, 0°C to +30°C. Less than 75% R.H. non-condensing, +31°C to +40°C. Less than 45% R.H. non-condensing, +41°C to +50°C.
Radiated Emissions:	Complies with VXIbus Specification.
Conducted Emissions:	Complies with VXIbus Specification.
Module Envelope Dimensions:	VXI C size. 262 mm x 353 mm x 30.5 mm (10.3 in x 13.9 in x 1.2 in)
Dimensions, Shipping:	When ordered with a Tektronix mainframe, the module will be installed and secured in one of the instrument module slots (slots 1 - 12). When ordered alone, the module's shipping dimensions are: 406 mm x 305 mm x 102 mm. (16 in x 12 in x 4 in).
Weight:	1.92 kg. (4.25 lb).
Weight, Shipping:	When ordered with a Tektronix mainframe, the module will be installed and secured in one of the instrument module slots (slots 1-12). When ordered alone, the module's shipping weight is: 2.38 kg. (5.25 lb).

Mounting Position:	Any orientation.
Mounting Location:	Installs in an instrument module slot (slots 1-12) of a C or D size VXIbus mainframe. (Refer to D size mainframe manual for information on required adapters.)
Front Panel Signal Connectors:	6 BNC connectors, 1 DE9S.
Equipment Supplied:	1 - VX4750 Module.
Options:	**30 – (Custom Mod AA) – Increase maximum frequency of sine waveform to 32 MHz.**

Mounting Position:	Any orientation.
Mounting Location:	Installs in an instrument module slot (slots 1-12) of a C or D size VXIbus mainframe. (Refer to D size mainframe manual for information on required adapters.)
Front Panel Signal Connectors:	6 BNC connectors, 1 DE9S.
Equipment Supplied:	1 - VX4750 Module.

Section 2
Preparation For Use

Installation Requirements And Cautions

The VX4750 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 <u>Controls and Indicators</u> subsection for information on selecting and setting the VX4750 Module's logical address. To avoid confusion, it is recommended that the slot number and the logical address be the same.

Tools Required

The following tools are required for proper installation:

Slotted screwdriver set.

CAUTION

Note that there are two printed ejector handles on the card. To avoid installing the card incorrectly, make sure the ejector marked "VX4750" is at the <u>top</u>.

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

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

CAUTION

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

If the VX4750 is used in a VX1X Series Mainframe, all VX4750 cooling requirements will be met.

CAUTION

If the VX4750 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 VX4750 Module to operate properly. Check the manual of the mainframe being used for jumpering instructions.

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

Installation Procedure

CAUTION

The VX4750 Module is a piece of electronic equipment and therefore has some susceptibility to electrostatic damage (ESD). ESD precautions must be taken whenever the module is handled.

1) Record the revision level, serial number (located on the label on the top shield of the VX4750), and switch settings on the Installation Checklist. Only qualified personnel should perform this installation.

2) Verify that the switches are switched to the correct values. 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-up and when SYSRST* is set true on the VXIbus backplane. If the module's commander is a Tek/CDS Resource Manager/IEEE-488 Interface Module, SYSRST* will be set true whenever the Reset switch on the front panel of that module is depressed. Also note that when the Halt switch is in the OFF position, the operation of this module is not VXIbus compatible.

3) Make sure power is off in the mainframe.

4) The module can now be inserted into one of the instrument slots of the mainframe.

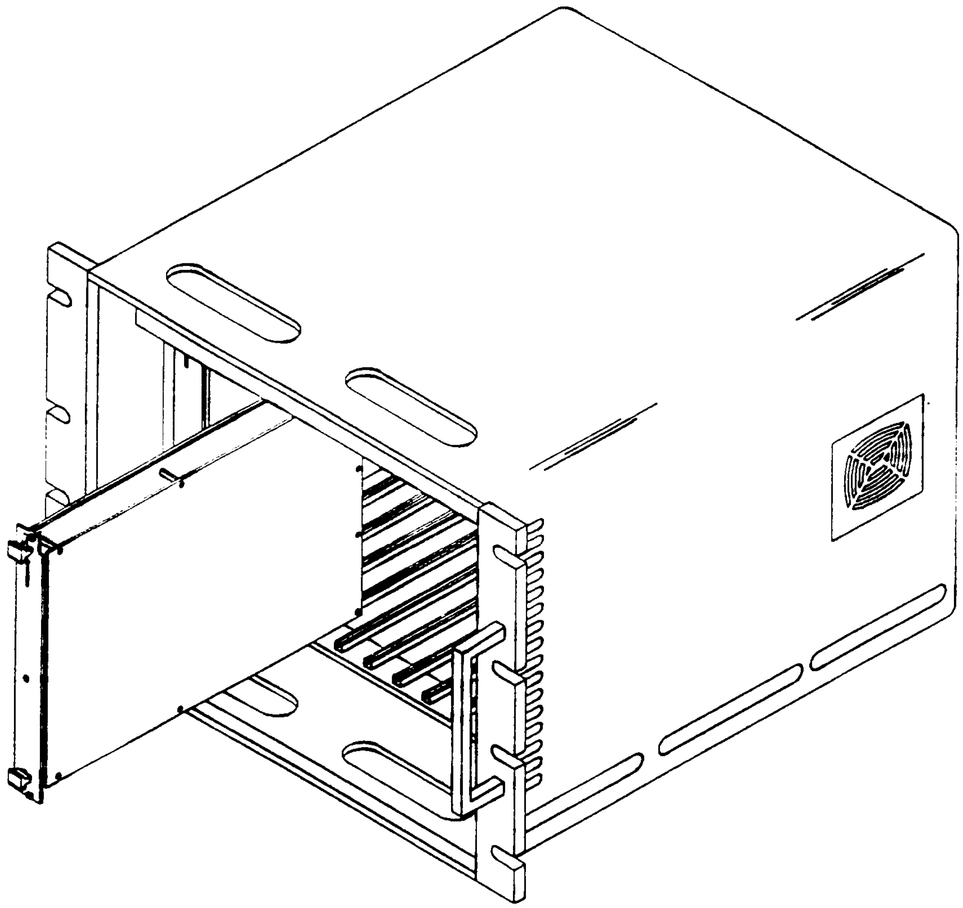


Figure 3: Module Installation

5) Cable Installation -

Use the appropriate cable to interface between the module I/O connector and the Unit Under Test (UUT). If the module is being installed in a Tek/CDS VX1400 or VX1401 Mainframe, route the cable from the front panel of the module down through the cable tray at the bottom of the mainframe and out the rear of the mainframe.

The mainframe is interfaced to the system controller using a standard IEEE-488 cable to connect the IEEE-488 connector on the rear panel of the VX1400 or VX1401 Mainframe to the IEEE-488 interface connector at the system controller.

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 VX4750 Module.

Revision Level: ____________________

Serial No.: ______________________

Mainframe Slot Number: ______________

Switch Settings:

VXIbus Logical Address Switch: ____________________

Interrupt Level Switch: ________________________

Halt Switch: _______________________________

Cable / Hooded Connector Installed:

____

Performed by: ________________________ Date: _____________

Section 3
Operation

Overview

The VX4750 Module is a single channel function generator capable of generating sine, triangle, ramp, dc, square, pulse and arbitrary waveforms. The function output is capable of driving 11 V p-p into a 50 ohm load. The maximum output frequency is 25 MHz. The selected waveform may be output continuously or gated on for a programmable number of cycles.

The module has extensive internal and external modulation capabilities. These include FM, PM, AM, PSK, FSK and PWM. These forms of modulation may be applied to any of the waveforms that the VX4750 is capable of generating (with the exception of PWM, which applies only to the pulse waveform). The module may be programmed to sweep the frequency of the output waveform over its entire frequency range. The module outputs a TTL compatible SWEEP SYNC signal at the end of each sweep and a TTL compatible MARKER FREQ signal at a specified frequency within the sweep. The polarity of each of these TTL signals is programmable.

The module may be programmed to sweep continuously or for a specified number of times. Alternatively, the sweep frequency may be controlled by an external signal applied to the module's modulation input.

The module can be triggered from any of several sources. These include: the front panel Trigger input, any of the VXI TTL trigger signals, a VXI Word Serial Protocol TRIGGER command, a module TRIG command. Any of the above trigger sources generates a TRIG OUT signal which is output to the front panel TRIG OUT connector and optionally to any one of the VXI TTL trigger signals.

The module can be programmed to accept a frequency reference from one of several sources. These include an internal 10 MHz reference (standard accuracy 1 ppm), the VXI CLK10 clock and an external reference applied to the front panel REF IN connector. The front panel REF IN signal may also be programmed to act as a module clock rather than a frequency reference. This feature is useful in synchronizing two or more VX4750 modules to produce waveforms with a programmable phase relationship. The front panel REF OUT may be programmed to output a buffered version of the selected 10 MHz reference or the 33 MHz module clock. The VX4570 module is programmed by ASCII characters issued from the system controller to the VX4570 module via the module's VXIbus commander and the VXIbus mainframe backplane. The module is a VXIbus Message Based Device and communicates using the VXIbus Word Serial Protocp;/ Refer to the manual for the

VXIbus device that will be the VX4750 Module's commander for details on the operation of that device.

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

Power-up

The VX4750 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 and Gate LEDs 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 of the module. An exception is the Read Status command, which is sent whenever a Serial Poll on an IEEE-488 system is performed. Most commanders or Slot 0 devices have specific ASCII commands which will cause them to send one of these low-level commands to a specified instrument. Refer to the Operating Manual of the commander or Slot 0 device for information on these commands.

Command	Effect
Asynchronous Mode Control	The module responds to the Event Enable and Event Mode bits in this command. The Response enable and Response mode bits are ignored.
Begin Normal Operation	After receiving this command, the VX4750 may generate VXI events using interrupts.
Clear	The module clears its VXIbus interface and any pending commands. Current module operations are unaffected.
Read Protocol	The module will return its protocol to its commander.
Read Status Byte	The module will return its status to its commander.
Trigger	The module outputs a programmed number of cycles or frequency sweeps of the selected waveform.

Module Commands

A summary of the VX4750's Module's commands is listed below. The summary also shows any required order of programming needed for commands. This is followed by detailed descriptions of each of the commands. A sample BASIC program using these commands is shown in the Programming Examples section.

Command protocol and syntax for the VX4750 Module are as follows:

1) Every command must end with a terminator: line feed <LF> or semicolon ; . Carriage returns <CR> are optional before line feeds or semicolons.

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

[ ]	encloses the symbol for the actual argument to be sent. These argument symbols are defined under each command heading.
( )	optional parameters or characters
<CR>	carriage return.
<LF>	line feed.
<SP>	space character.
<TM>	terminator: indicates a line feed or a semicolon.

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

4) Any of the following white space characters:

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

   are allowed in any of the following places:

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

   Any number of white space characters may be used together.

5) Any binary argument must be formatted as follows: #0[B1][B2]...

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

Summary

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

Command	Action
AM	Set the mode of the external modulation input to amplitude modulation and set the AM modulation index.
AMPL	Specify the amplitude of the function output.
AMPL?	Returns the current amplitude of the function output.
BRST	Sets the burst count (the number of cycles of the selected waveform to output.
BRST?	Return the current burst count.
BUF	Place the module in buffered mode.
DAT	Load data into the module for use in generating arbitrary waveforms.
DFREQ	Change the output frequency by a specified amount in a phase continuous manner.
DINT	Disable VXI event generation from the module.
DPHAS	Change the phase of the output waveform by a specified number of degrees in a phase continuous manner.
ERR?	Report any error conditions
FILT	Enable or disable a low pass filter to the output waveform.
FM	Set the mode of the external modulation input to frequency modulation. Specify the peak frequency deviation.
FREQ	Specify the frequency of the output waveform.
FREQ?	Return the frequency specified in the most recent valid FREQ command.
FSK	Set the mode of the front panel trigger input or selected VXI TTL trigger to FSK modulation. Specify the upper and lower FSK frequencies.
FSK?	Return the upper and lower frequencies selected by the front panel trigger input or selected VXI TTL trigger when it is programmed for external FSK modulation.

IMP	Specify the load impedance to be driven by the function output.
INT	Enable VXI event generation from the module.
IST	Initiate a self test.
ISWP	Specify parameters to be used in generating an internal linear frequency sweep of the output waveform.
LSWP	Specify parameters to be used in generating an internal log frequency sweep of the output waveform.
NBUF	Places the module in nonbuffered mode.
OFST	Specifies the dc offset of the output waveform.
OFST?	Returns the current dc offset of the output waveform.
PHAS	Specifies the phase of the output waveform.
PHAS?	Returns the phase specified in the most recent valid PHAS command.
PM	Set the mode of the external modulation input to phase modulation. Specify the maximum phase deviation.
PSK	Encode data on the output waveform using phase shift keying modulation.
PWM	Set the mode of the external modulation input to pulse width modulation. Specify the maximum duty cycle deviation from 50 percent.
REFI	Selects a frequency reference source.
REFO	Selects a 10 MHz or 33 MHz reference to be output to the front panel reference output connector.
REV?	Return the revision level of the VX4750 firmware.
RST	Reset the VX4750 to its power-up state.
SPER	Specify the sample period to use when generating an arbitrary waveform.
SPER?	return the current arbitrary waveform sample period setting.
SWP OFF	Disable a frequency sweep initiated by the ISWP, LSWP, or XSWP commands.
TRGI	Select a VXI TTL trigger as an input trigger source. Set the polarity of the front panel trigger input.

TRGO	Select a VXI TTL trigger signal to drive. Set the polarity of the front panel trigger output.
TRIG	Trigger the VX4750 to output a previously defined waveform.
XSWP	Set the mode of the external modulation input to frequency sweep. Define the start and stop frequencies of the sweep.
XSWP?	Return the start and stop frequencies used in the generation of an external frequency sweep.
WAVE	Specify the type of waveform the output to the function output.

Command Descriptions

Command: AM (Set to amplitude modulation)

Syntax: AM z<TM>

Purpose: Set the mode of the external modulation input to amplitude modulation. Also specify the desired modulation index, assuming that the applied modulating signal is a 1 volt rms sine wave.

Description: After an AM command is issued to the VX4750, the amplitude of the output signal is controlled by the signal applied to the front panel MOD IN connector. The signal applied to the MOD IN connector may be varied from -1.414 volts to +1.414 volts. If 'A' is equal to the amplitude in volts peak specified in the most recent AMPL command, 'V' is the voltage applied to the MOD IN connector, and 'z' is the modulation index specified in the AM command, then the amplitude of the output signal is given by the equation:

$$Amod = A (1 + ((V / 1.414) * (z / 100))$$

Amod is expressed in volts peak.

The modulation index z, specified in the AM command, must be greater than or equal to 0 and less than or equal to 100. If z is set to 0, AM modulation is disabled.

Example: ampl 2.0vp; am 50;

In this example, as the voltage applied to the MOD IN connector is varied from −1.414 volts to +1.414 volts, the amplitude of the output signal varies from 1 volt peak to 3 volts peak.

This example specifies an amplitude modulation index of 50 percent.

Errors: If the command contains syntax errors, such as Am 120<TM> (invalid argument), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: AMPL (Select the Amplitude of the Output Waveform)

Syntax: AMPL z_1 (z_2) <TM>

Purpose: The AMPL command selects the amplitude of the waveform to be output to the VX4750 "Function" output.

Description:

z_1 a decimal number in integer or real format that indicates the magnitude of the amplitude.

z_2 an optional ASCII string that indicates the units of argument z_1. If it is not specified, the units of z_1 are assumed to be Volts peak. Valid values for z_2 are:

z_2	Unit
mV	millivolts peak
mVP	millivolts peak
mVPP	millivolts peak-to-peak
V	Volts peak (default)
VP	Volts peak
VPP	Volts peak-to-peak
VRMS	Volts RMS (valid for all waveforms except for an arbitrary waveform).
DBM	DBM into the impedance specified by the IMP command. 50 Ohms is assumed if no IMP command is issued. (Valid for all waveforms except for an arbitrary waveform.)

Examples:

AMPL 5<TM>

Imp 50<TM>
Ampl 3 dBm<TM>

The first example selects an amplitude of 5 volts peak. The second selects an amplitude of 3 dBm into 50 ohms.

Errors: If the command contains syntax errors, such as AMPL 1.2E3<TM> (specified amplitude is too large), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: AMPL? (Amplitude)

Syntax: AMPL?<TM>

Purpose: The AMPL? command instructs the VX4750 to return the current amplitude setting.

Description: This command returns the amplitude specified by the latest valid AMPL command. The response is always expressed in Volts peak regardless of the units specified in the AMPL command.

Example: AMPL?<TM>

Response Syntax: An example of a typical response is:

AMPLITUDE = 3.0 VOLTS PEAK<CR><LF>

Command: BRST (Burst Count)

Syntax: BRST z<TM>

Purpose: The BRST command selects the number of cycles of the selected waveform to output or the number of times to sweep the frequency of the output waveform.

Description:

z a decimal number in integer or real format that indicates the number of cycles to output after receiving a trigger event.

If the BRST command is not issued, the default operation of the VX4750 is to continuously output the selected waveform. After a BRST command is issued, the function output is gated off. A trigger must be received (see the TRGI command) before the VX4750 will output the specified number of cycles. The range of z is 1 to 65535. If an internal frequency sweep has been specified by the ISWP or LSWP commanos, then the burst count is equal to the number of frequency sweeps to output when an input trigger is received.

Examples:

```
TRGI VXI 4;<tm>
BRST 100;<tm>
WAVE SINE;<tm>
AMPL 5.33;<tm>
```

This example specifies a burst count of 100. The function output is gated on for 100 waveform cycles when the VX4750 is triggered.

```
wave sine;ampl 4;brst 2;lswp 1e3,10e6,10e6,10;trig;<tm>
```

This example sweeps the frequency of the output waveform from 1 kHz to 10 MHz two times when the VX4750 is triggered.

Errors: If the command contains syntax errors, such as BRST -1<TM> (invalid burst count specification), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: BRST? (Burst Count Query)

Syntax: BRST?<TM>

Purpose: The BRST? command instructs the VX4750 to return the current burst count setting.

Description: This command returns the count specified by the latest valid BRST command.

Example: BRST?<TM>

Response Syntax: An example of a typical response is:

BURST COUNT = 100<CR><LF>

Command: BUF (Buffered input)

Syntax: BUF<TM>

Purpose: The BUF command allows the system controller to send data and commands to the VX4750 over the VXIbus at optimum speed, independent of the parsing and execution speed of this module.

Description: In the buffered mode, all data sent to the module is buffered before being parsed, allowing much faster transfer rates. This module operates using the VXIbus Fast Handshake mode while in buffered mode. The module can take in up to 4000 characters at the 400 Kbyte rate before it has to temporarily hold off the VXIbus.

If you plan on sending 4000 bytes of data in under 200 milliseconds (which roughly corresponds to 50 µs/character, or 1000 changes in voltage per second) in buffered mode, the data will be received faster than the module's parser is able to process the characters, and eventually the module's 4096 byte buffer will fill up. This will cause a temporary VXIbus hold off condition, which is transparent except for the effect it has on data transfer speed. If the IEEE-488 controller is slower than the module's parser rate, as many are, this hold off condition would never be encountered.

When the hold off situation occurs, the VX4750 will not allow the VXIbus system controller to send any additional data until the parser has emptied half of its input buffer.

As an example, the first time the 4096-byte buffer is filled, the system controller will be held off until the first 2048 bytes are parsed. From this point on, every time the module releases the hold off condition, the controller may send another 2048 bytes, at which time it has to wait for the parser again.

Each character sent takes up one byte in the module's input buffer unless the END bit is set (EOI for IEEE-488), in which case it takes up three bytes. All buffered VXIbus commands (Trigger, Set Lock, Clear Lock) take up three bytes. (The VXIbus commands Clear and Read Status are not buffered.) Refer to the VX4750's commander manual for information on generation of VXIbus commands. If the module is being used in a CDS 73A-IBX System, the 73A-151 is its commander.

Example: BUF<TM>

Command: DAT (Load Data)

Syntax: DAT z<TM> (ASCII data format)
or
DAT #0z<TM> (binary data format)

Purpose: The DAT command loads data into the VX4750 waveform map RAM.

Description: The DAT command is used to specify data used in the generation of an arbitrary waveform. When a WAVE ARB command is received by the VX4750, these values are retrieved and presented to the VX4750 output DAC at a rate specified by the SPER command.

z a list of numbers in ASCII or binary format. The number of values in the list must be a power of two between two and 4096. If the number of values specified is not a power of two, the VX4750 appends values to the list to make the number of values in the list equal to a power of two. The values appended to the list are equal to -1V. For example, if five values are specified in the DAT command, the VX4750 appends three more values of -1V to the list to make the total equal to eight (the next highest power of two).

If ASCII format is used, then each value in the list must be separated from the next value by one or more white space characters.

Values expressed in ASCII format must be between -1 volt and +1 volt.

If binary format is used, two bytes must be sent for each 12 bit waveform RAM location. The lower four bits of the first byte represent the four most significant bits of a RAM location. The second byte of a pair represents the least significant 8 bits of a RAM location. The format of each pair of data bytes is shown below. The complement of the ARB marker data bit in the upper half of the first data byte is output to the ARB marker output (pin 7 of front panel connector S3). To specify the state of the ARB marker bit, arbitrary waveform data must be specified in binary format. The state of the ARB Marker output leads the arbitrary waveform sample point by 29.8 nsec. Values specified in binary mode range from 000 hex to fff hex. A value of 000 hex corresponds to a voltage of -1 volt. A value of fff hex corresponds to a voltage of +1 volt.

```
        First data byte                  Second data  byte
(msb)                      (lsb)       (msb)                 (lsb)
  7 6       5  4  3  2  1  0            7  6  5  4  3  2  1  0

  0  ARB     0  0  <----------Waveform Ram Data------------->
     marker
```

The amplitude and dc offset of the loaded arbitrary waveform may be varied with the AMPL and OFST commands. The resulting output voltage given an AMPL setting of "a" volts peak, an offset setting of "o" volts and a DAT voltage of "p" volts is:

output voltage = (p * a) + o

For the AMPL command to produce an accurate amplitude, the largest value in the DAT command must be equal to 1V and the smallest value must be equal to -1V.

Example:

ASCII data format:

SPER 1 SEC;
BRST 0;
AMPL 2 VP;
OFST 0 V;
DAT -1.0,0.0,1.0,0.0<TM>
WAVE ARB;

This example specifies the sequence of voltages:

-2V, 0V, +2V, 0V

Each voltage in the sequence is output for 1 second. The sequence is repeated indefinitely.

Binary data format:

SPER 1 uSEC;
BRST 100;
AMPL 2V;
OFST 0;
DAT #0<0fh><ffh><08h><00h><00h><00h><04h><00h>
WAVE ARB;
TRIG;

In the above example, the following sequence of voltages is generated: +2V, 0V, -2V, -2V. A high TTL level will be output to the ARB Marker output for the first three samples. The ARB marker output will be driven low during the last sample. Each voltage in the sequence is output for 1 microsecond. The sequence is repeated 100 times.

Errors:

If a value specified in the DAT command is greater than 1V, the module's Error LED will be lit and a VXIbus Request True event will be generated (if interrupts have been enabled with the INT command). Refer to the INT command for a complete description of VX4750 interrupts and to the ERR? command for the syntax of the error message.

Command: DFREQ (Change the output frequency)

Syntax: DFREQ z_1 (z_2)<tm>

Purpose: Change the output frequency by a specified amount in a phase continuous manner.

Description: z_1 and z_2 specify a change in the frequency of the output waveform. This change in frequency is added to the frequency specified in the FREQ command.

z_1 a positive or negative decimal number in integer or real format.

z_2 an optional ASCII string that specifies the units of frequency associated with z_1. Valid values for z_2 are:

z_2	Unit
Hz	Hertz
KHz	KiloHertz
MHz	MegaHertz

The maximum frequency that may be specified in a DFREQ command depends on the selected waveform and the frequency specified in the FREQ command. The sum of the frequencies specified in the FREQ and DFREQ commands must be less than the maximum frequency of the selected waveform. The maximum frequency for each waveform is listed below.

Waveform	Maximum frequency
Sine	25 MHz
Square	10 MHz
Triangle	500 KHz
Pulse	500 KHz
Ramp	50 KHz
Arbitrary	1 MHz

The DFREQ command may be used for arbitrary waveforms only for 4096-point waveforms.

NOTE: if the FREQ and DFREQ commands are used for an arbitrary waveform, the sample time for each point may vary and/or points in the waveform may be skipped in order to produce the specified frequency.

Example: FREQ 1MHz; DFREQ 10KHZ; DFREQ -10KHZ;

The first example selects a base frequency of 1 MHz using a FREQ command. DFREQ commands are then used to change the frequency to 1.01 MHz and then to 990 KHz.

Errors: If the command contains syntax errors, such as FREQ 10e6;DFREQ 5MHz<TM> (sum of FREQ, DFREQ frequencies crosses frequency ranges), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command:	DINT (Disable Interrupts)
Syntax:	DINT<TM>
Purpose:	This command disables generation of the VXIbus Request True event when an error condition is detected by this module.
Description:	The DINT command stops the VX4750 from generating any external interrupts on the VXIbus that could be caused by a module error condition. If interrupts are not disabled and the VX4750 detects a programming error or self test error, it has the capability to generate a VXIbus Request True event to its interrupt handler (typically its commander). For further information on VX4750 programming errors, refer to the ERR? command.
Example:	DINT<TM>

Command: DPHAS (Change the phase of the output waveform)

Syntax: DPHAS z_1 (z_2)<tm>

Purpose: Change the phase of the output waveform by a specified number of degrees in a phase continuous manner.

Description:

z_1 a positive or negative decimal number in integer or real format that indicates the magnitude of the change in phase to be applied to the output waveform. This change in phase is added to the phase specified in the PHAS command.

z_2 an optional ASCII string that specifies the units associated with z_1. If it is not specified, z_1 is assumed to be expressed in degrees. Valid values for z_2 are:

z_2	Unit
DEG	Degrees (default)
RAD	Radians

This command is useful only if two or more VX4750 Modules are being used together. The front panel reference and trigger outputs of one module are connected to the front panel reference and trigger inputs of each of the other modules. Under these conditions, PHAS and DPHAS commands can be used to program the relative phase of the output of each module. This command produces meaningful results only if the output frequency of each module is programmed to the same value.

Example: The "REF OUT" output of VX4750 #1 is connected to the "REF IN" input of VX4750 #2 and the "TRIG OUT" output of VX4750 #1 is connected to the "TRIG IN" input of VX4750 #2.

Send to VX4750 #1: refo fp33m;wave sine;ampl 1;freq 1e6;

Send to VX4750 #2: refi fp33m;wave sine;ampl 1;freq 1e6;

Send to VX4750 #2: phas 0.0;

Send to VX4750 #1: phas 90.0;

After this sequence of commands is given, both VX4750 Modules are generating a 1 MHz sine wave with an amplitude of 1 volt peak. The output of VX4750 #1 leads the output of VX4750 #2 by 90 degrees. The "phase 90.0;" command sent to VX4750 #1 generates a TTL pulse on its "TRIG OUT" output which synchronizes its output with that of VX4750 #2.

Send to VX4750 #2: dphas 90.0;

This command advances the phase of the output of VX4750 #2 so that it is in phase with the output of VX4750 #1. The phase change is done in a phase continuous manner.

Errors: If the command contains syntax errors, such as DPHAS 3000<TM> (phase out of range), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: ERR? (Report errors)

Syntax: ERR?<TM>

Purpose: The ERR? command instructs this module to return its error status the next time input is requested from the module.

Description: This command is typically issued to the module in response to a VXIbus Request True event (in an IEEE-488 system, the Request True event generates an SRQ on the IEEE-488 bus). Errors reported by this command include programming errors and those detected during self test.

All errors listed in this section cause a Request True interrupt to be generated if interrupts are enabled via the INT command.

All errors occurring since the last ERR? command or reset condition will be returned, beginning with the first error that occurred. After issuing the ERR? command to the module, the system controller should continue to request input from the module until the "00,NO ADDITIONAL ERRORS TO REPORT" message is returned from the module.

The ERR? command is compatible with the standard "send query command/read response data" method as defined in the 488.2 specification for querying an instrument. Sending the ERR? command before reading the response is entirely optional. Whenever a response is read, error data will be returned.

Response Syntax: The format of data returned by the ERR? command is:

[error],[ASCII message]<CR><LF>
[error],[ASCII message]<CR><LF>
.
.
.
00, NO ADDITIONAL ERRORS TO REPORT <CR><LF>

where:

[error] is a 2-digit error code.

[ASCII message] is an English message describing the error.

All possible values for [error] and [ASCII message] are listed below. [error] is listed first, with [ASCII message] below it, and below this the description of the error.

Error # = 0
NO ADDITIONAL ERRORS TO REPORT

There are no more errors to report.

Error # = 6
TOO MANY DIGITS IN EXPONENT

Error # = 1
RECEIVED UNEXPECTED [CHR] WHILE [REASON]

Where:
[CHR] = [single quote][character][single quote] for printable characters (20 hex through 7F hex), for example, 'G'.
or
[CHR] = [sp][ASCII hex digit][ASCII hex digit] for nonprintable characters (00 hex through 19 hex and 80 hex through FF hex), for example, 0A .

[REASON] = one of the following:
- EXPECTING A LINE FEED, SEMICOLON OR COMMA.
- EXPECTING A VOLTAGE.
- PARSING MANTISSA.
- PARSING EXPONENT.
- EXPECTING A CHANNEL CHARACTER.

Error # = 2
UNRECOGNIZED COMMAND

This error occurs if a command that is not listed in this document is received by the module.

Error # = 10
PHASE OUT OF RANGE

Error # = 11
AM MODULATION INDEX OUT OF RANGE

Error # = 12
AMPLITUDE, D.C. OFFSET, AM MODULATION INDEX EXCEED
MAXIMUM OUTPUT LEVEL

Error # = 13
MAXIMUM AMPLITUDE EXCEEDED

Error # = 14
BURST COUNT OUT OF RANGE

Error # = 15
MAXIMUM FREQUENCY EXCEEDED FOR SELECTED WAVEFORM

Error # = 16
FREQUENCY, FREQUENCY DEVIATION CROSS RANGES

Error # = 17
MAXIMUM PHASE DEVIATION EXCEEDED

Error # = 18
INVALID VXI TTL TRIGGER LEVEL SPECIFIED

Error # = 19
MAXIMUM D.C. OFFSET EXCEEDED

Error # = 20
INVALID EXTERNAL FSK FREQUENCY SPECIFIED

Error # = 21
EXTERNAL FSK FREQUENCIES CROSS RANGES

Error # = 22
INVALID EXTERNAL SWEEP FREQUENCY SPECIFIED

Error # = 23
EXTERNAL SWEEP FREQUENCIES CROSS RANGES

Error # = 24
INVALID INTERNAL SWEEP FREQUENCY SPECIFIED

Error # = 25
FREQUENCY SWEEP RATE OUT OF RANGE < 21Hz/SEC

Error # = 26
FREQUENCY SWEEP RATE OUT OF RANGE > 7.5MHz/SEC

Error # = 27
INTERNAL SWEEP FREQUENCIES CROSS RANGES

Error # = 28
ARB DATA OUT OF RANGE

Error # = 29
MAXIMUM DUTY CYCLE DEVIATION EXCEEDED

Error # = 30
INVALID DUTY CYCLE SPECIFIED IN WAVE PULS COMMAND

Error # = 31
ARB MODE SAMPLE PERIOD OUT OF RANGE

Error # = 32
INVALID FM MODE SPECIFIED

Error # = 33
MISSING PARAMETER FOR xxx COMMAND

Error # = 34
PARAMETER COUNT EXCEEDED FOR xxx COMMAND

Error # = 35
FILT COMMAND VALID IN ARB MODE ONLY

Error # = 36
BURST COUNT MUST BE 0 FOR XXX COMMAND

Error # = 37
HEX ERROR

Error # = 38
FREQUENCY SWEEP VALID ONLY FOR 4096 POINT ARB WAVEFORM

Error # = 39
INVALID INTERNAL SWEEP TIME SPECIFIED

Error # = 40
MAXIMUM START FREQ TO STOP FREQ RATIO EXCEEDED

Error # = 41
MAXIMUM PSK FREQUENCY EXCEEDED

Error # = 42
RESERVED

Error # = 43
NOVRAM CHECKSUM ERROR, STORED C.S. = XXXX, CALCULATED C.S. = XXXX

Error # = 44
RESERVED

Error # = 45
RATIO OF START FREQUENCY TO STOP FREQUENCY MUST BE < = 10.0

Error # = 46
RESERVED

Error # = 47
XSWP START FREQUENCY MUST BE > = 500HZ

Error # = 98
RESERVED

Examples: ERR?<TM>

Example Responses:

no errors:

<u>00,NO ADDITIONAL ERRORS TO REPORT<CR><LF></u>

multiple errors:

<u>01,RECEIVED UNEXPECTED 'C' WHILE PARSING EXPONENT<CR><LF></u>
<u>00,NO ADDITIONAL ERRORS TO REPORT<CR><LF></u>

Command: FILT (Enable or disable low pass filtering of an arbitrary waveform)

Syntax: FILT z<TM>

Purpose: The FILT command enables or disables low pass filtering of an arbitrary waveform

Description: The FILT command is valid only if the selected waveform is an arbitrary waveform. z may be set to ON or OFF.

z	Action taken
ON	A 12 MHz low pass filter is applied to the arbitrary waveform.
OFF	No filter is applied to the arbitrary waveform.

Example:

rst;wave arb;ampl 3;freq 1e6;<tm>
filt on;<tm>

This example outputs the default arbitrary waveform at a frequency of 1MHz and amplitude of 3 volts peak. The 12 MHz low pass filter is applied to the waveform.

Errors: If the command contains any errors, such as WAVE SINE;FILT OFF; (FILT command not valid for sine wave output), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: FM (Set the mode of the external modulation input to frequency modulation)

Syntax: FM z_1 (z_2)<TM>

Purpose: The FM command sets the mode of the external modulation input to frequency modulation. It also specifies the peak frequency deviation assuming that the signal applied to the external modulation input is a 1 volt RMS sine wave.

Description: Arguments z_1 and z_2 determine the maximum frequency deviation from the frequency specified in the FREQ command assuming that a 1 volt RMS sine wave is applied to the external modulation input. FM modulation may be disabled by setting z_1 to 0.

z_1 a decimal number in integer or real format.

z_2 an optional ASCII string that represents the units of frequency associated with z_1. If it is not specified, the unit of frequency associated with z_1 is assumed to be Hertz. Valid strings for z_2 are:

z2	Unit
Hz	Hertz (default)
KHz	KiloHertz
MHz	MegaHertz

Example: FM 10 kHz<TM>

This example sets the peak frequency deviation to 10 kHz. This peak frequency deviation results from the application of a 1V RMS sine wave to the external modulation input.

Errors: If the command contains syntax errors, such as FM 32MHz<TM> (argument range error), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command:	FREQ (Select the Frequency of the Output Waveform)
Syntax:	FREQ z_1 (z_2)<TM>
Purpose:	The FREQ command selects the frequency of the waveform to be output to the VX4750 "Function" output.
Description:	z_1 and z_2 specify the frequency of the waveform to be output to the function output.

z_1 a decimal number in integer or real format.

z_2 an optional ASCII string that indicates the units of frequency associated with z_1. Valid values for z_2 are:

z_2	Unit
Hz	Hertz (default)
KHz	KiloHertz
MHz	MegaHertz

The maximum frequency that may be specified in a FREQ command depends on the selected waveform:

Waveform	Maximum frequency
Sine	25 MHz
Square	10 MHz
Triangle	500 KHz
Pulse	500 KHz
Ramp	50 KHz
Arbitrary	1 MHz

The FREQ command may be used for arbitrary waveforms only for 4096 point waveforms.

NOTE: if the FREQ command is used for an arbitrary waveform, the sample time for each point may vary and/or points in the waveform may be skipped in order to produce the specified frequency.

Examples:

FREQ 1 Hz<TM>

freq 2.00000e6<TM>

Freq 2.0 MHz<TM>

The first example selects a frequency of 1 Hertz. The second and third examples select a frequency of 2 megaHertz.

Errors: If the command contains syntax errors, such as FREQ 100e6 MHz<TM> (specify a frequency that the VX4750 is incapable of generating), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: FREQ? (Frequency)

Syntax: FREQ?<TM>

Purpose: The FREQ? command instructs the VX4750 to return the current frequency setting.

Description: This command returns the frequency specified by the latest valid FREQ command.

Example: FREQ?<TM>

Response Syntax: An example of a typical response is:

FREQUENCY = 10.000 Hz<CR><LF>

Command: FSK (Command the trigger input or selected VXI TTL trigger to act as a frequency shift keying (FSK) modulation source)

Syntax: FSK z_1 (z_2), z_3 (z_4)<tm>

Purpose: Set the mode of the front panel trigger input or selected VXI TTL trigger to FSK modulation. Specify the upper and lower FSK frequencies.

Description: Arguments z_1 and z_2 specify the lower FSK frequency. This frequency is generated when the modulating signal is in its inactive state. Arguments z_3 and z_4 specify the upper FSK frequency. This frequency is generated when the modulating signal is in its active state.

z_1 ,z_3 decimal numbers in integer or real format.

z_2 ,z_4 optional ASCII strings that indicate the units of frequency associated with z_1 and z_3 respectively. Valid values for z_2 and z_4 are:

z_2,z_4	Unit
Hz	Hertz
KHz	KiloHertz
MHz	MegaHertz

Examples: wave sine;ampl 1;fsk 1MHz, 2MHz;trgi neg;

Application of a high TTL signal to the front panel TRIG IN connector produces a frequency of 1 MHz. A TTL low applied to the front panel TRIG IN connector produces a frequency of 2 MHz. (Opt 04 TRIG IN at connector S4.)

wave sine;ampl 1;fsk 550e3,560e3;trgi vxi 2;

When a device in the VXI chassis drives VXI TTL trigger signal 2 low, a frequency of 560 KHz is produced by the VX4750. When no device in the VXI chassis is driving VXI TTL trigger signal 2, a frequency of 550 KHz is produced by the VX4750.

Command:	FSK? (Return the upper and lower frequencies)
Syntax:	FSK?<tm>
Purpose:	Return the upper and lower frequencies.
Description:	Return the upper and lower frequencies selected by the front panel trigger input or selected VXI TTL trigger when it is programmed for external FSK modulation.
Examples:	FSK?<tm>
Response Syntax:	An example of a typical response is: <u>LOW FREQ.: 1000000.000HZ, HIGH FREQ.: 1100000.000HZ<CR><LF></u>

Command: IMP (Specify the impedance of the load connected to the function output)

Syntax: IMP z_1 (z_2)<TM>

Purpose: The IMP command specifies the impedance of the load connected to the function output.

Description: z_1 and z_2 specify the impedance of the load connected to the function output. The default load impedance is 50 ohms.

z_1 a decimal number in integer or real format.

z_2 an optional ASCII string that indicates the units of resistance associated with z_1. The only valid value for z_2 is ohms.

The impedance specified in the IMP command determines the maximum voltage that the VX4750 can drive into the load connected to the function output. If the impedance is equal to 'R' ohms, then the maximum output voltage is given by the equation:

$$V_{max} = 11.0 \text{ Volts} * R / (50 \text{ Ohms} + R)$$

If the amplitude specified in the AMPL command is 'A' volts peak, the d.c. offset specified in the OFST command is 'O' volts and the modulation index in the AM command is equal to 'k', then the peak voltage of the output waveform is given by the equation:

$$V_{peak} = O + A * (1 + (k/100))$$

If V_{peak} is greater than V_{max}, an error condition is reported by the VX4750.

Examples: IMP 100 Ohm<TM>

This example specifies a load impedance of 100 Ohms.

Errors: If the command contains syntax errors, such as IMP 0<TM> (specify a short on the function output), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: INT (Interrupt enable)

Syntax: INT<TM>

Purpose: The INT command enables generation of the VXIbus Request True event when an error condition is detected by this module.

Description: The INT command enables the module to generate a VXIbus Request True event whenever any of the error conditions listed under the ERR? command occur. If the module is installed in an IEEE-488 system, the occurrence of a VXIbus Request True event condition will cause a Service Request (SRQ) to be generated on the IEEE-488 bus.

Example: INT<TM>

Command: IST (Internal Self Test)

Syntax: IST<TM>

Purpose: The IST command initiates an internal self test of this module.

Description: The self test initiated by the IST command is the same as the power-up self test described in the SYSFAIL, Self test and Initialization subsection. Following completion of the self test, the VX4750 is in the following state:

Waveform	Sine
Frequency	1 kHz
Amplitude	150 mV
Phase	0 deg
Offset	0V
Burst count	0 (continuous operation)
External modulation	Off
Internal modulation	Off
Internal sweep	Off
VXI TTL triggers	Disabled
Assumed load on function output	50 Ohms
Frequency reference input	Internal 10 MHz reference
Reference applied to REF OUT conn.	Internal 33 MHz clock
Polarity of signal applied to TRIG IN connector Opt. 04 at connector S4	Active low (Module is triggered on the trailing edge of a negative TTL pulse applied to the TRIG IN connector.) (Opt 04 at connector S4)

If a failure occurs, the VXIbus ERR LED will be lit and the reason for the failure will be stored for later interrogation by the ERR? command. If interrupts have been enabled by the INT command, a VXIbus Request True event will be generated.

Example: IST<TM>

Command: ISWP (Linear sweep the frequency of the Output Waveform)

Syntax: ISWP z_1 z_2, z_3 z_4, z_5 z_6, z_7<TM>

Purpose: Sweep the frequency of the output waveform from a specified start frequency to a specified stop frequency.

Description: The ISWP command specifies the start frequency, marker frequency, stop frequency, and sweep time to be used. The frequency of the output waveform varies linearly with time:

$$f(t) = f1 + (f2 - f1) * (t / T)$$

where f1 is the start frequency, f2 is the stop frequency, and T is the sweep time.

z_1, z_3, and z_5 are decimal numbers in integer or real format that specify the start, marker, and stop frequencies respectively.

z_7 is a positive decimal number in integer or real format that specifies the sweep time in seconds.

z_2, z_4, and z_6 are ASCII strings that specify the units of frequency associated with arguments z_1, z_3, and z_5 respectively. Valid values for z_2, z_4, and z_6 are:

z	Unit
Hz	Hertz (default)
KHz	KiloHertz
MHz	MegaHertz

If z_2, z_4, or z_6 are not specified, a value of Hz is assumed.

The sweep rate is given by the equation:

$$f' = (f2 - f1) / T$$

Where f1 = start frequency, f2 = stop frequency, and T = sweep time.

For sweeps in the frequency range 1 milliHz to 10 MHz, the sweep rate must be greater than 21 Hz/sec and less than 7.45 MHz/sec. For sweeps in the frequency range 10 MHz to 25 MHz, the sweep rate must be greater than 84 Hz/sec and less than 29.8 MHz/sec. If an ISWP command specifies a sweep rate that is not within these limits, an error condition is reported.

The marker frequency must be greater than or equal to the start frequency and less than or equal to the stop frequency. The stop frequency must be greater than the start frequency.

The number of frequency sweeps performed is determined by the BRST command. If no BRST command is issued, or a "BRST 0" command is issued, a continuous frequency sweep is performed.

The marker output is pulsed low when the frequency of the selected waveform is equal to the marker frequency.

A frequency sweep initiated by the ISWP command may be disabled by sending a SWP OFF command to the VX4750.

Example: ISWP 2e3, 50 kHz, 1 MHz, 20<TM>

This example initiates a continuous linear frequency sweep from 2KHz to 1MHz. The marker output is active when the output waveform passes through 50 KHz. It takes 20 seconds to sweep the frequency from 2 KHz to 1 MHz.

Errors: If the command contains syntax errors, such as ISWP 100Hz, 2Hz, 24Hz, 3<TM> (the stop frequency is less than the start frequency), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: LSWP (Log sweep the frequency of the Output Waveform)

Syntax: LSWP z_1 z_2, z_3 z_4, z_5 z_6, z_7<TM>

Purpose: Sweep the frequency of the output waveform from a specified start frequency to a specified stop frequency.

Description: The LSWP command specifies the start frequency, marker frequency, stop frequency, and sweep time to be used. The frequency of the output waveform varies exponentially with time. The frequency of the waveform varies with time according to the equation:

f(t) = f1 * 10 ^ [(t/T) * log10(f2/f1)]

where f1 is the start frequency, f2 is the stop frequency, and T is the sweep time.

z_1, z_3, and z_5 are decimal numbers in integer or real format that represent the start, marker, and stop frequencies respectively.

z_7 is a positive decimal number in integer or real format that specifies the sweep time in seconds.

z_2, z_4, and z_6 are ASCII strings that represent the units of frequency associated with arguments z_1, z_3, and z_5 respectively. Valid values for z_2, z_4, and z_6 are:

z	Unit
Hz	Hertz (default)
KHz	KiloHertz
MHz	MegaHertz

If z_2, z_4, or z_6 are not specified, a value of Hz is assumed.

The maximum sweep rate is given by the equation:

f'(T) = f2 * log10(f2/f1) * ln(10) / T

The minimum sweep rate is given by the equation:

f'(0) = f1 * log10(f2/f1) * ln(10) / T

where f1 = start frequency, f2 = stop frequency, and T = sweep time.

For sweeps in the frequency range 1 milliHz to 10 MHz, the minimum sweep rate must be greater than 21 Hz/sec and the maximum sweep rate must be less than 7.45 MHz/sec. For sweeps in the frequency range 10 MHz to 25 MHz, the minimum sweep rate must be greater than 84 Hz/sec and the maximum sweep rate must be less than 29.8 MHz/sec. If an LSWP command specifies a sweep rate that is not within these limits, an error condition is reported.

The ratio of the stop frequency to the start frequency must be less than or equal to 1000000.

The marker frequency must be greater than or equal to the start frequency and less than or equal to the stop frequency. The stop frequency must be greater than the start frequency.

The number of frequency sweeps performed is determined by the BRST command. If no BRST command is issued, or a "BRST 0" command is issued, a continuous frequency sweep is performed.

The marker output is pulsed low when the frequency of the selected waveform is equal to the marker frequency.

A frequency sweep initiated by the LSWP command may be disabled by sending a SWP OFF command to the VX4750.

Example:

BRST 0<TM>
LSWP 1e3, 1e6, 10e6, 20<TM>

This example initiates a continuous log frequency sweep from 1KHz to 10MHz. The marker output is active when the output waveform passes through 1 MHz. It takes 20 seconds to sweep the frequency from 1 KHz to 10 MHz.

Errors:

If the command contains syntax errors, such as LSWP 100 Hz, 2Hz, 24Hz, 4<TM> (the stop frequency is less than the start frequency), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: NBUF (Nonbuffered Mode)

Syntax: NBUF<TM>

Purpose: The NBUF command puts the module into the nonbuffered mode of operation.

Description: In the nonbuffered mode, a byte of command/data is not accepted from the VXIbus until the previous character has been processed. By using this mode, the VX4750 maintains synchronization with its commander, and the user knows that the VX4750 has executed a command when the last byte of the command is received. For example, if <CR><LF> is used as a terminator, it is guaranteed that the command preceding the <CR><LF> has been parsed and executed when the <LF> is accepted.

The major advantage of this method is that another module which may use the output of the VX4750 can immediately be programmed after the VX4750.

NOTE: The following paragraph only applies to the programmer who will be switching back and forth between buffered and nonbuffered mode.

It is important to note that since this command typically will be received while the module is in the Buffered mode, it will not take effect until the processor has parsed it (receiving characters and processing them occur independently in buffered mode). To guarantee that the module is actually in Nonbuffered mode before executing another command, a query command (i.e. ERR? or REV?) should be sent to the VX4750 after the NBUF command and the result read. This will re-synchronize the module and the controller, since the response to the query is not returned until both the NBUF and ERR? or REV? commands have been processed.

Example: NBUF<TM>

Command: OFST (Select the D.C. Offset the Output Waveform)

Syntax: OFST z_1 (z_2)<TM>

Purpose: The OFST command selects the dc offset of the waveform to be output to the VX4750 "Function" output.

Description: Arguments z_1 and z_2 specify the dc offset to apply to the function output.

z_1 a decimal number in integer or real format.

z_2 an optional ASCII string that represents the unit of voltage associated with z_1. Valid values for z_2 are listed below.

z_2	Unit
V	Volts (default)
mV	millivolts

If z_2 is not specified, the unit of voltage associated with z_1 is assumed to be volts.

The impedance specified in the IMP command determines the maximum voltage that the VX4750 can drive into the load connected to the function output. If the impedance is equal to 'R' ohms then the maximum output voltage is given by the equation:

$$V_{max} = 11.0\text{Volts} * R / (50\text{ Ohms} + R)$$

If the amplitude specified in the AMPL command is 'A' volts peak, the d.c. offset specified in the OFST command is 'O' volts, and the modulation index in the AM command is equal to 'k', then the peak voltage of the output waveform is given by the equation:

$$V_{peak} = O + A * (1 + (k/100))$$

If V_{peak} is greater than V_{max}, an error condition is reported by the VX4750.

Examples: OFST 1<TM>

This example selects an offset of 1 volt.

Errors: If the command contains syntax errors, such as OFST 24V<TM> (specified offset plus amplitude is too large), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: OFST? (Offset)

Syntax: OFST?<TM>

Purpose: The OFST? command instructs the VX4750 to return the current offset programmed by the latest OFST command.

Description: This command returns the voltage specified by the latest valid OFST command.

Example: OFST?<TM>

Response Syntax: An example of a typical response is:

D.C. OFFSET = 1.000 VOLTS<CR><LF>

Command: PHAS (Select the Phase of the Output Waveform)

Syntax: PHAS z_1 (z_2)<TM>

Purpose: The PHAS command selects the phase of the waveform to be output to the VX4750 "Function" output.

Description:

z_1 a decimal number in integer or real format that indicates the phase shift to be applied to the output waveform.

z_2 an optional ASCII string that specifies the units associated with z_1. Valid values for z_2 are listed below. If z_2 is not specified, z_1 is assumed to be expressed in degrees.

z_2	Unit
DEG	Degrees (default)
RAD	Radians

This command is useful only if two or more VX4750 Modules are being used together. The front panel reference and trigger outputs of one module are connected to the front panel reference and trigger inputs of each of the other modules. Under these conditions, the PHAS command can be used to program the relative phase of the output of each module. This command produces meaningful results only if the output frequency of each module is programmed to the same value.

Example: The "REF OUT" output of VX4750 #1 is connected to the "REF IN" input of VX4750 #2 and the "TRIG OUT" output of VX4750 #1 is connected to the "TRIG IN" input of VX4750 #2.

Send to VX4750 #1: refo fp33m;wave sine;ampl 1;freq 1e6;

Send to VX4750 #2: refi fp33m;wave sine;ampl 1;freq 1e6;

Send to VX4750 #2: phas 0.0;

Send to VX4750 #1: phas 90.0;

After this sequence of commands is given, each VX4750 Module is generating a 1 MHz sine wave with an amplitude of 1 volt peak. The output of VX4750 #1 leads the output of VX4750 #2 by 90 degrees. The "phase 90.0;" command sent to VX4750 #1 generates a TTL pulse on its "TRIG OUT" output which synchronizes its output with that of VX4750 #2.

Errors: If the command contains syntax errors, such as PHAS 3000<TM> (invalid angle specification), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request

(SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

NOTE: The output will momentarily squelch when the PHAS command is issued.

Command: **PHAS? (Phase)**

Syntax: PHAS?<TM>

Purpose: The PHAS? command instructs the VX4750 to return the current phase setting.

Description: This command returns the phase specified by the latest valid PHAS command.

Example: PHAS?<TM>

Response Syntax: An example of a typical response is:

PHASE = 0.00 DEG<CR><LF>

Command: PM (Set the mode of the external modulation input to phase modulation)

Syntax: PM z_1 (z_2)<TM>

Purpose: The PM command sets the mode of the external modulation input to phase modulation. It also specifies the peak phase deviation assuming that a 1 volt RMS sine wave is applied to the external modulation input.

Description: Arguments z_1 and z_2 determine the maximum phase deviation from the phase specified in the PHAS command assuming that a 1 volt RMS sine wave is applied to the external modulation input. PM modulation may be disabled by setting z_1 to 0.

z_1 a decimal number in integer or real format that indicates the magnitude of the phase deviation.

z_2 an optional ASCII string that specifies the units associated with z_1. Valid strings for z_2 are listed below. If it is not specified, z_1 is assumed to be expressed in degrees.

DEG	Degrees (default)
RAD	Radians

Example: PM 10.0 Deg<TM>

This example sets the peak phase deviation to 10.0 degrees. This phase deviation results from the application of 1V RMS sine wave to the external modulation input.

Errors: If the command contains syntax errors, such as PM 3000<TM> (maximum phase deviation exceeded), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: PSK (Encode data on the output waveform using phase shift keying)

Syntax: PSK z_1 [z_2]<TM>

Purpose: The PSK command enables downloading of data to be encoded on the output waveform. The data is encoded on the output waveform using Phase Shift Keying (PSK) modulation.

Description: Argument z_1 specifies one of three options: down load PSK data, enable PSK modulation, or disable PSK modulation.

z_1 An ASCII string that specifies the action to be taken by the VX4750. Valid strings for z_1 are:

DAT Interpret argument z_2 as data to encode on the output waveform.

ON Encode data defined by a "PSK DAT" command on the output waveform using phase shift keying modulation. The frequency of the output waveform must be less than or equal to 50 KHz when the PSK ON command is issued.

OFF Disable phase shift keying modulation.

z2 A list of hex ASCII digits separated by commas that specifies the data to encode on the output waveform. Up to 1024 values may be specified. This argument is specified only if z_1 is equal to "DAT". Values for the digits listed in z_2 and the corresponding phase shifts produced on the output waveform are:

Digit value	Phase shift (degrees)
0	0.0
1	22.5
2	45.0
3	67.5
4	90.0
5	112.5
6	135.0
7	157.5
8	180.0
9	202.5
a	225.0
b	247.5
c	270.0
d	292.5
e	315.0
f	337.5

The phase shifts specified by z_2 are encoded on the output waveform in the order that they are specified. After each cycle of the output waveform, the next phase shift in the list is applied to the output waveform. After the last phase shift is applied to the waveform, the sequence is repeated, starting with the first phase shift in the list.

Example: wave sine;freq 10e3;ampl .22vp;psk dat 0,2,4,8,a,c,e; psk on;

This example specifies the following sequence of phase shifts: 0, 45, 90, 135, 180, 225, 270, and 315 degrees.

Errors: If the command contains syntax errors, such as "FREQ 100e3 ;PSK ON<TM> (maximum psk frequency exceeded), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: PWM (Set the mode of the external modulation input to pulse width modulation)

Syntax: PWM z<TM>

Purpose: The PWM command selects a pulse waveform with 50% duty cycle and sets the mode of the external modulation input to pulse width modulation. It also specifies the peak duty cycle deviation assuming that a 1 volt RMS sine wave is applied to the external modulation input.

Description: z specifies the duty cycle deviation from 50% assuming that a 1 volt RMS sine wave is applied to the external modulation input.

z a decimal number in integer or real format that indicates the maximum duty cycle deviation from 50% z must be greater than or equal to 5 and less than or equal to 45.

Example: PWM 25.0;

This example sets the peak duty cycle deviation to 25 percent. This duty cycle deviation results from the application of 1V RMS sine wave to the external modulation input.

Errors: If the command contains syntax errors, such as PWM 90<TM> (maximum duty cycle deviation exceeded), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: REFI (Selects a frequency reference source)

Syntax: REFI z<TM>

Purpose: The REFI command selects a frequency reference source to be used by the VX4750. The accuracy of the frequency of the waveforms generated by the VX4750 depends on the accuracy of the selected frequency reference.

Description: The REFI command specifies one of four frequency references to be used by the VX4750. z is an ASCII string that specifies the frequency reference to be used. Valid values for z are:

OB10M Select the VX4750 internal 10 MHz clock as a frequency reference. The accuracy of this frequency reference is 1 ppm.

FP10M Select a 10 MHz TTL signal applied to the front panel REF IN connector as a frequency reference.

VXI10M Select VXI signal CLK10 as a frequency reference. This signal is a 10 MHz clock provided by the SLOT 0 module on P2 of the VXI backplane. The accuracy of this reference may be found in the specifications for the SLOT 0 module used.

FP33M Select a 33 MHz TTL signal applied to the front panel REF IN connector as a frequency reference. This reference is typically supplied by the REF OUT connector of another VX4750 and is useful in generating waveforms with a programmed phase relationship. (See the PHASE and DPHASE commands.) (Opt. 04 at connector S4)

If z is set to one of the 10 MHz references, this 10 MHz signal is used by the VX4750 to generate a synchronous 33 MHz clock which clocks the module's digital circuitry. If z is set to FP33M, the module's digital circuitry is clocked by the 33 MHz signal applied to the front panel REF IN connector.
(Opt. 04 at connector S4)

Example: refi ob10m;

This example selects the internal 10 MHz clock as a frequency reference.

Command:	REFO	(Selects a 10 MHz or 33 MHz reference to be output to the front panel reference output connector)

Syntax: REFO z<TM>

Purpose: The REFO command outputs a buffered (TTL) version of the frequency reference selected by the REFI command to the front panel REF OUT connector.

Description: The REFO selects either the module's 33 MHz clock or the 10 MHz reference that the 33 MHz clock is synchronized to. The selected signal is output to the front panel REF OUT connector. z is an ASCII string that specifies the action to be taken by the VX4750. Valid strings for z are:

FP10M Drive the front panel REF OUT connector with the 10 MHz reference selected by the REFI command.

FP33M Drive the front panel REF OUT connector with the module's internal 33 MHz clock. z may be set to FP33M only if a REFI command has not selected a front panel 33 MHz clock as the frequency reference of the VX4750.

Example:

```
refi ob10m;
refo fp10m;
```

In this example, the VX4750's internal 10 MHz reference is output to the front panel REF OUT connector.

Command:	REV? (Revision Level)
Syntax:	REV?<TM>
Purpose:	The REV? command instructs the module to return the revision level of the onboard microprocessor firmware.
Description:	This command returns the revision level of the onboard firmware as an alphanumeric string representing the revision level.
Example:	REV?<TM>
Response Syntax:	An example of a typical response is: REVISION 1.3<CR><LF>

Command:	RST	(Reset the VX4750 to its power-up state)
Syntax:	RST<TM>	
Purpose:	The RST resets the VX4750 Module.	
Description:	After receiving a RST command, the VX4750 Module configures itself as follows:	

Waveform	Sine
Frequency	1 kHz
Amplitude	150 mV
Phase	0 deg
Offset	0V
Burst count	0 (continuous operation)
External modulation	Off
Internal modulation	Off
Internal sweep	Off
VXI TTL triggers	disabled
Assumed load on function output	50 Ohms
Frequency reference input	Internal 10 MHz reference
Reference applied to REF OUT conn.	Internal 33 MHz clock
Polarity of signal applied to TRIG IN connector Opt. 04 TRIG In at connector S4	Active low (Module is triggered on the trailing edge of a negative TTL pulse applied to the TRIG IN connector.' (Opt. 04 TRIG In at connector S4.)

Command: SPER (Select the sample period to use in the generation of an arbitrary waveform.)

Syntax: SPER z_1 (z_2)<TM>

Purpose: The SPER command selects the sample period used in the generation of an arbitrary waveform. (See the DAT and WAVE ARB commands.)

Description: Arguments z_1 and z_2 specify how long each data point stored in waveform RAM is presented to the output DAC.

z_1 a decimal number in integer or real format.

z_2 an optional ASCII string that indicates the units of time associated with z_1. If it is not specified, z_1 is assumed to be expressed in seconds. Valid values for z_2 are:

z_2	Unit
NSEC	nanoseconds
USEC	microseconds
MSEC	milliseconds
SEC	seconds (default)

The value specified in the SPER command is rounded to the nearest multiple of 29.8 nsec (1 / 2^{25} Hz). This rounded value is the actual value used in the generation of the arbitrary waveform. The sample period specified in the SPER command must be between 29.8 nsec and 400 seconds.

An arbitrary waveform is loaded into waveform RAM using the DAT and WAVE ARB commands.

Example:

```
dat -1,-.714,-.428,-.142,.142,.428,.714,1;
ampl 2;
sper 240nsec;
wave arb;
```

This example produces a stairstep waveform. The duration of each step is 238 nanoseconds.

Errors: If the command contains syntax errors, such as SPER 600 SEC<TM> (invalid sample period), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: SPER? (Sample Period Query)

Syntax: SPER?<TM>

Purpose: The SPER? command instructs the VX4750 to return the current arbitrary waveform sample period setting.

Description: This command returns the time specified by the latest valid SPER command. The value specified in the SPER command is rounded to the nearest multiple of 29.8 nsec (1 / 2^{26} Hz). This rounded value is the actual value used in the generation of the arbitrary waveform. This rounded value is returned in response to the SPER? command.

Example: SPER?<TM>

Response Syntax: An example of a typical response is:

SAMPLE PERIOD = 0.000001013 SEC<CR><LF>

Command:	SWP OFF	(Disable a frequency sweep initiated by the ISWP, LSWP or XSWP commands)

Syntax: SWP OFF<TM>

Purpose: The SWP OFF command instructs the VX4750 to disable a frequency sweep that is in progress.

Description: After a ISWP, LSWP, or XSWP command has been sent to the VX4750, a SWP OFF command may be sent to disable the frequency sweep and restore the frequency specified in the most recent FREQ command.

Command: TRGI (Select a VXI TTL trigger as an input trigger source, or select the polarity of the front panel trigger input signal.)

Syntax: TRGI z_1 z_2<TM>

Purpose: The TRGI command selects a VXI TTL trigger signal as an input trigger source. It is also used to select the polarity of the front panel trigger input.

Description: The VX4750 may be triggered by a TRIG command, by a VXI word serial protocol TRIGGER command, by the front panel TRIG IN signal or by a VXIbus TTL trigger. The TRIG command, VXI Word Serial Protocol Trigger command and the front panel TRIG IN signal are always enabled as trigger sources. The TRGI command is used to select a VXI TTL trigger signal as an additional trigger source. This command is also used to select the polarity of the TTL signal to be applied to the front panel TRIG IN connector. (Opt. 04 TRIG IN at connector S4.)

z_1 Selected trigger source. z_1 must be one of the following:

VXI VXI Trigger. The VX4750 may be triggered by an active low pulse on a VXI TTL trigger signal. The TTL trigger used is specified by parameter z_2. z_2 may be any number between 0 and 7. For example, if z_2 is equal to 3, VXI trigger signal TTLTRG3* is used. The VX4750 is triggered on the trailing edge of the selected TTL trigger signal. A value of OFF for z_2 disables the VX4750 from monitoring the TTL trigger signals.

POS Select positive polarity for the TTL pulse applied to the front panel TRIG IN connector. Since the front panel trigger input is always enabled, this command only selects the active polarity of this input. The trailing edge of the positive TTL pulse applied to the TRIG IN connector triggers the VX4750.

NEG Select negative polarity for the TTL pulse applied to the front panel TRIG IN connector. Since the front panel trigger input is always enabled, this command only selects the active polarity of this input. The trailing edge of the negative TTL pulse applied to the TRIG IN connector triggers the VX4750.

AUTO Set the trigger mode of the VX4750 to automatic. In this mode, after one of the commands listed below is sent to the VX4750, an internal trigger is generated by the VX4750 after the command is parsed. This is the default mode of the VX4750.

NORM Set the trigger mode of the VX4750 to normal. In this mode, after one of the commands listed below is sent to the VX4750, no internal trigger is generated by the VX4750 after the command is parsed. The function output remains gated off until the VX4750 is triggered by one of the following sources:

a trigger signal applied to the front panel TRIG IN connector,
a TTL trigger specified in a TRGI VXI command,
a TRIG command, or
a VXI word serial protocol TRIGGER command.

The commands affected by the TRGI AUTO and TRGI NORM commands are the FREQ, ISWP, LSWP, PHAS, SWPOFF, and WAVE commands. The BRST command is also affected when a burst count of zero is specified. A trigger must always be sent to the VX4750 following a BRST command when a non-zero burst count is specified.

Examples: TRGI VXI 0<TM>

This example enables VXI TTL trigger TTLTRG0* as a trigger source for the VX4750.

TRGI POS<TM>

This example selects an active high polarity for the front panel trigger input signal. The VX4750 is triggered on the trailing edge of a positive TTL pulse applied to the TRIG IN connector. (Opt. 04 TRIG IN at connector S4.)

Errors: If the command contains syntax errors, such as TRGI VXI 8<TM> (invalid value for z_2), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: TRGO (Select a VXI TTL trigger line to be used as a trigger output signal, or select the polarity of the front panel trigger output signal)

Syntax: TRGO z_1 z_2<TM>

Purpose: The TRGO command selects a VXI TTL trigger line to be used as a trigger output signal. The polarity of the front panel trigger output signal can also be selected with the TRGO command.

Description: When the VX4750 is triggered by a VXI TTL trigger, a TRIG command or a VXI Trigger command, the front panel TRIG OUT signal is pulsed. The TTL trigger line to be driven is specified by the TRGO command.

z_1 select trigger output. z_1 must be one of the following:

VXI VXI Trigger. The VX4750 may be enabled to pulse a VXI TTL trigger signal low when it receives a trigger input. The TTL trigger used is specified by parameter z_2. z_2 may be any number between 0 and 7. For example, if z_2 is equal to 3, VXI trigger signal TTLTRG3* is used. A value of OFF for z_2 disables the VX4750 from driving the VXI TTL trigger signals.

POS Select positive polarity for the front panel TRIG OUT signal. Since the front panel trigger output is always enabled, this command only selects the active polarity of this output.

NEG Select negative polarity for the front panel TRIG OUT signal. Since the front panel trigger output is always enabled, this command only selects the active polarity of this output.

Examples: TRGO VXI 1<TM>

This example selects VXI TTL trigger TTLTRG1* as the trigger output from the VX4750.

TRGO POS<TM>

This example programs the VX4750 to output an active high TTL pulse to the front panel TRIG OUT signal when it is triggered.

Errors: If the command contains syntax errors, such as TRGO VXI 8<TM> (invalid value for z_2), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: TRIG (Trigger the VX4750)

Syntax: TRIG<TM>

Purpose: The TRIG command triggers the VX4750.

Description: This command is typically sent to the VX4750 after a BRST command with a non-zero burst count. When the VX4750 receives a TRIG command, the function output is gated on and the number of cycles specified in the BRST command is generated.

Command: WAVE (Select Output Waveform)

Syntax: WAVE z_1[, z_2]<TM>

Purpose: The WAVE command selects the type of waveform to be output to the VX4750 "Function" output.

Description: z_1 an ASCII string that indicates the type of waveform to be output according to the following table.

Value of z_1	Waveform Selected
DC	dc
SINE	sine
SQR	square
TRI	triangle
RAMP	+ramp
RMPP	+ramp
RMPN	-ramp
ARB	arbitrary
PULS	pulse

z_2 is sent only for the pulse waveform. It specifies the desired duty cycle of the pulse waveform.

Examples:

wave dc;ofst -2.5V;
Output a d.c. voltage of -2.5 volts.

wave sine;freq 1e6;ampl 3;
Output a 1 MHz sine wave with an amplitude of 3V peak.

dat -1,-.714,-.418,-.142,.142,.418,.714,1;sper 1e-6;wave arb;ampl 1;
Output an arbitrary waveform with a 1 microsecond sample time.

wave puls 30.0;ampl 220mv;
Output a pulse waveform a duty cycle of 30% and amplitude of .22V peak.

Errors: If the command contains any errors, such as FREQ 1MHz;WAVE RAMP<TM>; (maximum frequency exceeded for selected waveform), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

Command: XSWP (Sweep the frequency of the Output Waveform)

Syntax: XSWP z_1 z_2, z_3 z_4<TM>

Purpose: Set the mode of the external modulation input to frequency sweep. Specify the start and stop frequencies of the sweep.

Description: The XSWP command specifies the start and stop frequencies to be used in the generation of an external frequency sweep.

z_1 and z_3 are decimal numbers in integer or real format that represent the start and stop frequencies respectively.

z_2 and z_4 are ASCII strings that indicates the units of arguments z_1 and z_3 respectively. Valid values for z_2 and z_4 are:

z	Unit
Hz	Hertz (Default)
KHz	KiloHertz
MHz	MegaHertz

If z_2 or z_4 is not specified, a value of Hz is assumed.

After the XSWP command is issued, the frequency of the output waveform is controlled by the external modulation input. The voltage applied to the external modulation input in this mode must be between 0 and 10 volts. An input of 0 volts results in an output frequency specified by the start frequency. An input of 10 volts results in an output frequency specified by the stop frequency. The output frequency varies linearly with the voltage applied to the external modulation input.

A frequency sweep initiated by the XSWP command may be disabled by sending a SWP OFF command to the VX4750.

Example: XSWP 2 KHz, 20 KHz<TM>

This example initiates an external frequency sweep from 2 KHz to 20 KHz. When 0 volts is applied to the external frequency sweep input, the output frequency is 2 KHz. An input voltage of 5 volts results in an output frequency of

2 KHz + [5 V * (20 KHz - 2 KHz) / 10 V] = 11 KHz

Errors: If the command contains syntax errors, such as XSWP 10KHz, 1KHz<TM> (the stop frequency is less then the start frequency), then the module's Error LED will be lit and a VXIbus Request True interrupt will be generated if interrupts have been enabled with the INT command. In an IEEE-488 system, the Request True interrupt will cause the Service Request (SRQ) line on the IEEE-488 bus to be set true. The ERR? command can then be used to interrogate the module for the cause of the error condition.

SYSFAIL, Self Test, And Initialization

The VX4750 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 SYSRESET*. A VXIbus soft reset occurs when another device, such as the VX4750's commander, sets the Reset bit in the VX4750's Control register.

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

1) The SYSFAIL* (VME system-failure) line is set active, indicating that the module is executing a self test, and the Failed LED is lit. If this is a commanded self test, SYSFAIL* is not asserted. In a soft reset, SYSFAIL* is set. However, all CDS commanders, such as the 73A-151, will simultaneously set SYSFAIL INHIBIT. This is done to prevent the resource manager from prematurely reporting the failure of a card.

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

   If the self test fails, the SYSFAIL* line remains active (or is set active, in 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 VX4750 Module after the completion of power-up self test is as follows:

Waveform	Sine
Frequency	1 kHz
Amplitude	150 mV
Phase	0 deg
Offset	0V
Burst count	0 (continuous operation)
External modulation	Off
Internal modulation	Off
Internal sweep	Off
VXI TTL triggers	disabled
Assumed load on function output	50 Ohms
Frequency reference input	Internal 10 MHz reference
Reference applied to REF OUT conn.	Internal 33 MHz clock
Polarity of signal applied to TRIG IN connector	Active low (Module is triggered on the trailing edge of a negative TTL pulse applied to the TRIG IN connector.)

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 reset 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 reset. If the test fails, the SYSFAIL* line is asserted and the module sets itself to the following known programming state:

SYSFAIL* Operation

SYSFAIL* becomes active during power-up, hard or soft reset, self test, or if the module loses any of its power voltages. When the mainframe Resource Manager detects SYSFAIL* set, it will attempt to inhibit the line. This will cause the VX4750 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 VX4750 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 VX4750.
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 = THEN GOTO 450 - will continue operation at line 450 when the value of variable I is 3.
REM	All characters following the REM command are not executed. REM statements are used for documentation and user instructions. EX: REM **CLOSE ISOLATION RELAYS**
RETURN	Ends a subroutine and returns operation to the line after the last executed GOSUB command.
<CR>	Carriage return character, decimal 13.
<LF>	Line feed character, decimal 10.

Programming Examples In BASIC

The following sample BASIC programs show how commands for the VX4750 might be used. These examples assume that the VX4750 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 VX4750 Module's logical address to an IEEE-488 primary address of decimal 24.

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

Example:

```
10 '****************** VX4750 BASIC EXAMPLE PROGRAM ******************
20 '
30 '        USING NATIONAL INSTRUMENT PCIIA CALLS
40 '        ASSUMES VX4750 GPIB ADDRESS = 2
50 '
100 ' ****************** INITIALIZE SYSTEM ***************************
110  CLEAR , 60000!: IBINIT1 = 60000!: IBINIT2 = IBINIT1 + 3: BLOAD "bib.m", IBINIT1
120  CALL IBINIT1(IBFIND, IBTRG, IBCLR, IBPCT, IBSIC, IBLOC, IBPPC, IBBNA, IBONL, IBRSC,
     IBSRE, IBRSV, IBPAD, IBSAD, IBIST, IBDMA, IBEOS, IBTMO, IBEOT, IBRDF, IBWRTF,
     IBTRAP)
```

```
130  CALL IBINIT2(IBGTS, IBCAC, IBWAIT, IBPOKE, IBWRT, IBWRTA, IBCMD, IBCMDA, IBRD,
     IBRDA, IBSTOP, IBRPP, IBRSP, IBDIAG, IBXTRC, IBRDI, IBWRTI, IBRDIA, IBWRTIA, IBSTA%,
     IBERR%, IBCNT%)
140 CLS : BDNAME$ = "PCX"
150 CALL IBFIND(BDNAME$, PCX%)
160 IF PCX% < 0 THEN PRINT "IEEE FAILED": END
170 '
200 '******************** DISPLAY VXI TABLE *************************
205 DEVADDR% = 1                    'ADDRESS OF RESOURCE MANAGER
210 CALL IBPAD(PCX%, DEVADDR%)      'ASSIGN DEVICE ADDRESS TO GPIB
220 TM$ = CHR$(13) + CHR$(10)       'DEFINE LINE TERMINATOR MESSAGE
230 WRT$ = "TABLE" + TM$
240 CALL IBWRT(PCX%, WRT$)          'WRITE TABLE COMMAND TO RESOURCE MANAGER
245 CLS
250 PRINT "The VXI system contains the following Modules. "
255 PRINT "*********************************************************"
260 FOR I = 1 TO 6                  'ASSUMES 5 INSTRUMENTS + RESOURCE MANAGER
265 RD$ = SPACE$(250)               'ASSIGN SPACE FOR READ STRING
270 CALL IBRD(PCX%, RD$)            'CALL READ FUNCTION
280 PRINT LEFT$(RD$, IBCNT%);       'DISPLAY RESPONSE
285 NEXT I
290 PRINT "PRESS ENTER TO CONTINUE" 'PAUSE PROGRAM
295 INPUT A$
296 '
300 '******************* SET UP FUNCTION GENERATOR *****************
305 CLS
310 DEVADDR% = 2                    'ASSUMES VX4750 GPIB ADDRESS = 2
320 CALL IBPAD(PCX%, DEVADDR%)      'ASSIGN DEVICE ADDRESS TO GPIB
330 WRT$ = "RST" + TM$              'RESET CARD TO POWER UP STATE
340 CALL IBWRT(PCX%, WRT$)          'SEND RESET COMMAND TO VX4750
350 WRT$ = "IST" + TM$              'INITIATE SELF TEST
360 CALL IBWRT(PCX%, WRT$)          'SEND SELF TEST TO VX4750
365 WRT$ = "ERR?" + TM$             'CHECK FOR ANY ERRORS
370 CALL IBWRT(PCX%, WRT$)          'SEND ERROR COMMAND TO VX4750
375 CALL IBRD(PCX%, RD$)            'CALL READ FUNCTION
376 PRINT "TESTING VX4750 FOR ERRORS >" + TM$
380 PRINT LEFT$(RD$, IBCNT%);       'DISPLAY RESPONSE
385 GOSUB 1500                      'READ AND DISPLAY VX4750 STATUS
390 PRINT "PRESS ENTER TO CONTINUE" 'PAUSE PROGRAM
395 INPUT A$
396 '
400 '******** PROGRAM VX4750 FOR 1 VOLT RMS 10KHZ SINEWAVE *************
405 CLS
406 PRINT "1.0 VOLT RMS, 10KHZ SINEWAVE" + TM$
410 WRT$ = "WAVE SINE" + TM$        'SET WAVEFORM TO SINE
420 CALL IBWRT(PCX%, WRT$)
430 WRT$ = "AMPL 1VRMS" + TM$       'SET AMPLITUDE TO 1 VOLT RMS
440 CALL IBWRT(PCX%, WRT$)
450 WRT$ = "FREQ 1E4" + TM$         'SET FREQUENCY FOR 10KHZ
```

```
460 CALL IBWRT(PCX%, WRT$)
461 GOSUB 1500                        'READ AND DISPLAY VX4750 STATUS
462 PRINT "PRESS ENTER TO CONTINUE"        'PAUSE PROGRAM
463 INPUT A$
470 '
600 '************* PROGRAM VX4750 FOR 0 TO 5V 1 MHZ SQUAREWAVE *********
610 CLS
620 PRINT "0 TO 5 VOLT, 1.0MHZ SQUAREWAVE" + TM$
630 WRT$ = "WAVE SQR" + TM$              'SET SQUARE WAVE FUNCTION
640 CALL IBWRT(PCX%, WRT$)
650 WRT$ = "AMPL 5VPP" + TM$             'SET AMPLITUDE TO 5 VOLTS P-P
660 CALL IBWRT(PCX%, WRT$)
670 WRT$ = "FREQ 1E6" + TM$              'SET FREQUENCY FOR 1.0MHZ
680 CALL IBWRT(PCX%, WRT$)
685 WRT$ = "OFST 2.5V" + TM$             'SET DC OFFSET TO +2.5 VOLTS
690 CALL IBWRT(PCX%, WRT$)
695 GOSUB 1500                        'READ AND DISPLAY VX4750 STATUS
696 PRINT "PRESS ENTER TO CONTINUE"        'PAUSE PROGRAM
698 INPUT A$
699 '
700 '******* PROGRAM VX4750 FOR LINEAR FREQUENCY SWEPT TRIANGLE ************
710 CLS
720 PRINT "2 VOLT, SWEPT TRAIGLE WAVE" + TM$
730 WRT$ = "AMPL 2VP" + TM$              'SET AMPLITUDE TO 2 VOLTS PEAK
740 CALL IBWRT(PCX%, WRT$)
750 WRT$ = "FREQ 1E3" + TM$              'SET FREQUENCY FOR 1.0KHZ
755 CALL IBWRT(PCX%, WRT$)
760 WRT$ = "OFST 0V" + TM$               'SET DC OFFSET TO ZERO VOLTS
765 CALL IBWRT(PCX%, WRT$)
770 WRT$ = "WAVE TRI" + TM$              'SET TRIANGLE WAVE FUNCTION
775 CALL IBWRT(PCX%, WRT$)
780 WRT$ = "ISWP 2E3,1E5,5E5,10" + TM$     'SET SWEEP FROM 2KHZ TO 500KHZ
790 CALL IBWRT(PCX%, WRT$)              'WITH MARKER AT 10KHZ, 10 SECONDS
791 GOSUB 1500                        'READ AND DISPLAY VX4750 STATUS
792 PRINT "PRESS ENTER TO CONTINUE"        'PAUSE PROGRAM
793 INPUT A$
795 WRT$ = "SWP OFF" + TM$               'STOP SWEEPT WAVEFORM
796 CALL IBWRT(PCX%, WRT$)
797 '
800 '******* PROGRAM VX4750 FOR BURST OF 5 PULSES OF 10 KHZ SINEWAVE ********
810 CLS
820 PRINT "PULSED 10 KHZ SINE WAVE" + TM$
830 WRT$ = "AMPL 1VRMS" + TM$              'SET AMPLITUDE TO 1 VOLT RMS
840 CALL IBWRT(PCX%, WRT$)
850 WRT$ = "FREQ 1E4" + TM$              'SET FREQUENCY FOR 10.0KHZ
860 CALL IBWRT(PCX%, WRT$)
865 WRT$ = "BRST 5" + TM$                'SET BURST COMMAND TO 5
870 CALL IBWRT(PCX%, WRT$)
875 WRT$ = "WAVE SINE" + TM$               'SET FOR SINE WAVE
```

```
880 CALL IBWRT(PCX%, WRT$)
881 GOSUB 1500                          'READ AND DISPLAY VX4750 STATUS
882 FOR I = 1 TO 500                    'SEND BURST 500 TIMES
883 WRT$ = "TRIG" + TM$                     'SEND TRIGGER COMMAND
884 CALL IBWRT(PCX%, WRT$)
885 FOR N = 1 TO 100                    'PROGRAM PAUSE
886 NEXT N
887 NEXT I
890 PRINT "PRESS ENTER TO CONTINUE"        'PAUSE PROGRAM
895 INPUT A$
896 '
900 '************* PROGRAM VX4750 FOR ARBITRARY WAVE FORM *************
910 CLS
920 PRINT "ARBITRARY WAVEFORM" + TM$
930 WRT$ = "SPER 1E-3" + TM$            'SET SAMPLE PERIOD TO 1 MILLISECOND TO 1
VOLT RMS
940 CALL IBWRT(PCX%, WRT$)
950 WRT$ = "BRST 0" + TM$               'SET BURST COUNT TO ZERO
960 CALL IBWRT(PCX%, WRT$)
965 WRT$ = "AMPL 2 VP" + TM$              'SET AMPLITUDE TO 2 VOLTS PEAK
970 CALL IBWRT(PCX%, WRT$)
980 WRT$ = "DAT 0.0,0.5,1.0,0.5,0.0,-0.5,-1.0,-0.5" + TM$
981 CALL IBWRT(PCX%, WRT$)              'ENTER WAVE FORM DATA
982 WRT$ = "WAVE ARB" + TM$               'SET WAVEFORM TO ARBITRARY
983 CALL IBWRT(PCX%, WRT$)
984 GOSUB 1500                        'READ AND DISPLAY VX4750 STATUS
985 WRT$ = "SPER?" + TM$                'SAMPLE PERIOD SETTING INQUIRY
986 CALL IBWRT(PCX%, WRT$)              'SEND COMMAND TO VX4750
987 CALL IBRD(PCX%, RD$)              'CALL READ FUNCTION
989 PRINT "      "; LEFT$(RD$, IBCNT%)  'DISPLAY RESPONSE
990 PRINT "END OF PROGRAM" + TM$
995 END
996 '
1500 '****************** READ BACK VX4750 STATUS **********************
1505 PRINT "      * * VX4750 STATUS * *" + TM$
1510 WRT$ = "FREQ?" + TM$               'FREQUENCY SETTING INQUIRY
1520 CALL IBWRT(PCX%, WRT$)             'SEND COMMAND TO VX4750
1530 CALL IBRD(PCX%, RD$)             'CALL READ FUNCTION
1540 PRINT "      "; LEFT$(RD$, IBCNT%)  'DISPLAY RESPONSE
1550 WRT$ = "AMPL?" + TM$               'AMPLITUDE SETTING INQUIRY
1560 CALL IBWRT(PCX%, WRT$)             'SEND COMMAND TO VX4750
1570 CALL IBRD(PCX%, RD$)             'CALL READ FUNCTION
1575 PRINT "      "; LEFT$(RD$, IBCNT%)  'DISPLAY RESPONSE
1580 WRT$ = "OFST?" + TM$               'DC VOLTAGE OFFSET INQUIRY
1590 CALL IBWRT(PCX%, WRT$)             'SEND COMMAND TO VX4750
1600 CALL IBRD(PCX%, RD$)             'CALL READ FUNCTION
1610 PRINT "      "; LEFT$(RD$, IBCNT%)  'DISPLAY RESPONSE
1620 WRT$ = "BRST?" + TM$               'BURST COUNT SETTING INQUIRY
1630 CALL IBWRT(PCX%, WRT$)             'SEND COMMAND TO VX4750
```

```
1640 CALL IBRD(PCX%, RD$)               'CALL READ FUNCTION
1650 PRINT "        "; LEFT$(RD$, IBCNT%)   'DISPLAY RESPONSE
1655 PRINT
1660 RETURN
```

Appendix A
VXIbus Operation

CAUTION

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

The VX4750 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 VX4750 Module is neither a VXIbus commander or VMEbus master, and therefore it does not have a VXIbus Signal register. The VX4750 is a VXIbus message based servant.

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

A Normal Transfer Mode read of the VX4750 Module proceeds as follows:

1. The commander reads the VX4750's Response register and checks if the Write Ready and DOR bits are true. IF they are, the commander proceeds to the next step. If not, the commander continues to poll these bits until they become true.

2. The commander writes the Byte Request command (0DEFFh) to the VX4750's Data Low register.

3. The commander reads the VX4750's Response register and checks if the Read Ready and DOR bits are true. If they are, the commander proceeds to the next step. If not, the commander continues to poll these bits until they become true.

4. The commander reads the VX4750's Data Low register.

A Normal Transfer Mode Write to the VX4750 Module proceeds as follows:

1. The commander reads the VX4750's Response register and checks if the Write Ready and DIR bits are true. If they are, the commander proceeds to the next step. If not, the commander continues to poll the Write Ready and DIR bits until they are true.

2. The commander writes the Byte Available command which contains the data (0BCXX or 0BDXX, depending on the End bit) to the VX4750's Data Low register.

The VX4750 Module also supports the Fast Handshake Mode during readback. In this mode, the module is capable of transferring data at optimal backplane speed without the need of the commander's testing any of the handshake bits. The VX4750 Module asserts BERR* to switch from Fast Handshake Mode to Normal Transfer Mode, per VXI Specification. The VX4750's Read Ready, Write Ready, DIR and DOR bits react properly, in case the commander does not support the Fast Handshake Mode.

A Fast Handshake Transfer Mode Read of the VX4750 Module proceeds as follows:

1. The commander writes the Byte Request command (0DEFFh) to the VX4750's Data Low register.

2. The commander reads the VX4750's Data Low register.

The VX4750 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 VX4750's address space may cause incorrect operation of the module.

As with all VXIbus devices, the VX4750 Module has registers located within a 64 byte block in the A16 address space.

The base address of the VX4750 device's registers is determined by the device's unique logical address and can be calculated as follows:

Base Address = V * 40H + C000H

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

VX4750 Configuration Registers

Below is a list of the VX4750 Configuration registers with a complete description of each. In this list, RO = Read Only, WO = Write Only, R = Read, and W = Write. The offset is relative to the module's base address:

REGISTER DEFINITIONS

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

REGISTER BIT DEFINITIONS

ID:	BFFCh
Device:	F511h
Protocol:	F7FFh

Word Serial Commands

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

Read Protocol command response: FE6Bh

Appendix B
Input/Output Connections

Signal	Description	VX4750 Connector	Opt.04 Connector
Marker Freq	Sweep frequency marker output	S3 pin 3	
Marker Freq Ret	Sweep frequency marker return	S3 pin 4	
Sweep Sync	Internal frequency sweep sync	S3 pin 5	
Sweep Sync Ret	Internal frequency sweep sync return	S3 pin 9	
TTL	TTL output	S3 pin 1	
TTL Ret	TTL output return	S3 pin 2	
ARB Marker	Arbitrary waveform marker output	S3 pin 7	
ARB Marker Ret	Arbitrary waveform marker return	S3 pin 6	
REF OUT	Reference Output	BNC	S4 pin 5
	Return		S4 pin 9
REF IN	Reference Input	BNC	S4 pin 4
	Return		S4 pin 8
TRIG OUT	Trigger Output	BNC	S4 pin 3
	Return		S4 pin 7
TRIG IN	Trigger Input	BNC	S4 pin 2
	Return		S4 pin 6
MOD IN	External Modulation Input	BNC	
FUNC OUT	Function Output	BNC	

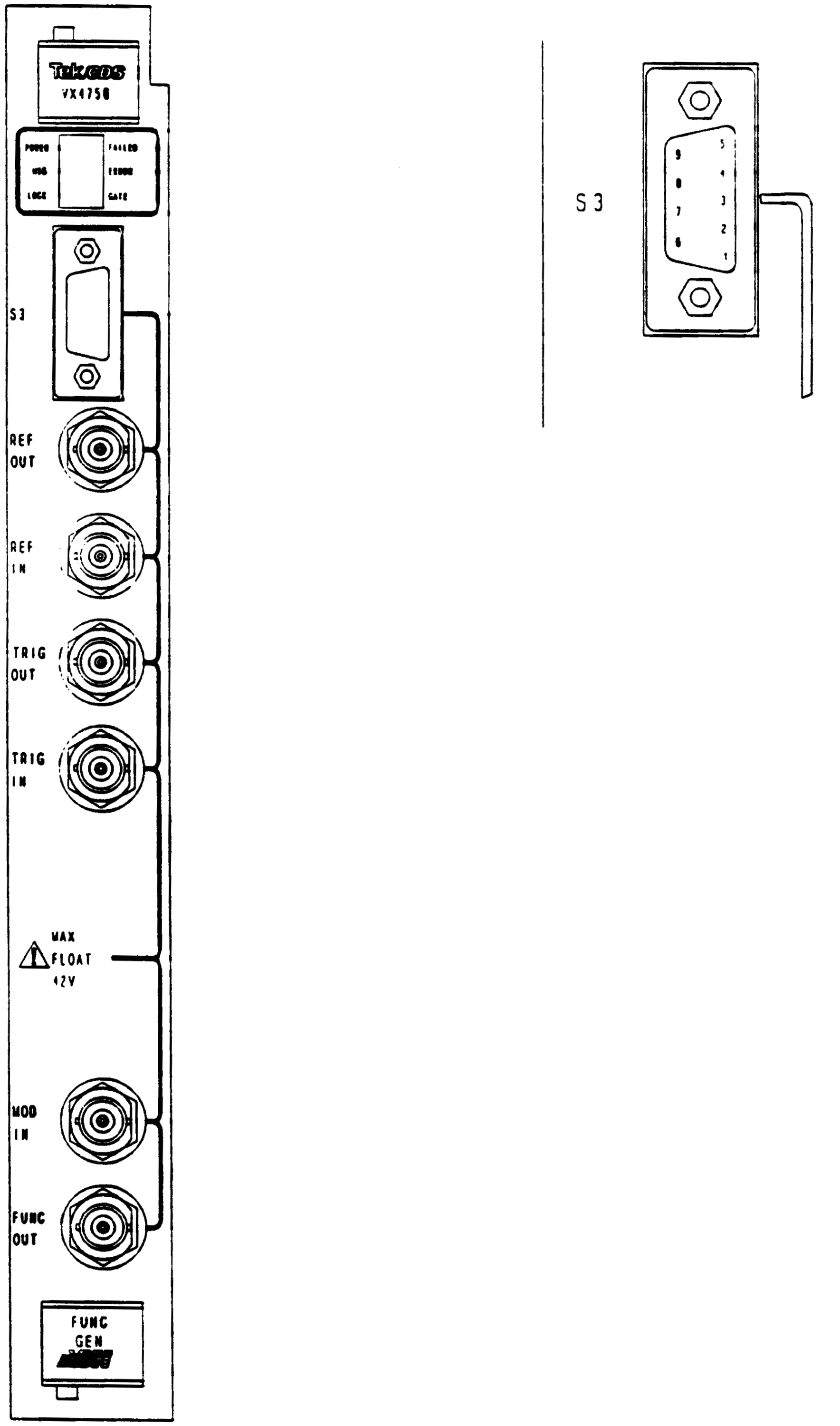


Figure 4: VX4750 Front Panel Connectors

Appendix C
Performance Verification

The following procedures verify the compliance of a VX4750 Function Generator with the specifications listed in the VX4750 Function Generator Operating Manual.

Equipment Required

The following equipment is required to perform the verification procedures. Not all equipment is required for each procedure.

Equipment Required	Recommended Model/Spec
Milliwatt Power Meter	Wandel & Goltermann EPM - 1
Power Meter	Tektronix VX4281
High frequency spectrum analyzer	Tektronix 2712
Waveform digitizer/analyzer	Tektronix VX4240
Oscilloscope	Tektronix 2445A / 150 MHz
Frequency counter	> 1 ppm accuracy from 10 KHz to 25 MHz
Digital multimeter	6½ digit
Digitizing counter	Tektronix 73A-541
DC calibrator	Data Precision 8200 / 1 mv accuracy or better from -1.414 V to +10 V
Function generator	Tektronix VX4750
VXI pulse generator	Tektronix 73A-270 / VXI TTL trigger output capability required
Double balanced mixer	Mini Circuits MCL ZP10514
Low pass filter consisting of: a 51 Ohm terminating resistor, a 4.7 KOhm feedforward resistor and a 1 µF shunt capacitor.	
VXI mainframe with slot 0 module	Tektronix/CDS 73A-021 Mainframe with 73A-151 Slot 0 Module
IBM PC with IEEE-488 controller	IBM PC/AT or compatible with National Instruments PC2 IEEE-488 controller.
Software for IBM PC to control IEEE-488 devices via the IEEE-488 controller	G.EXE available from Tektronix/CDS

Verification Procedures

Any or all of the following procedures may be performed in any order. They are listed in the same order as in the Specifications.

VXI Interface Verification

Test Setup

Connect the FUNC OUT connector of the UUT to channel 1 of the oscilloscope. Select the oscilloscope 50 Ohm load on channel 1. Set the switches of the 73A-151 as follows:

Logical Address	01 Hex
Interrupt Handler Level	01

Set the switches of the UUT as follows:

Logical Address	02 Hex
Interrupter Level	01
Halt	ON

Install the 73A-151 in slot 0 of the VXI mainframe. Install the UUT in slot 1.

Test Procedure

1) Send the following command to the 73A-151:
   "TABLE<cr><lf>"

2) Read four responses from the 73A-151. Verify that the response corresponding to logical address 2 (the UUT) is the same as the following response string:
   "LA 2, IEEE02, SLOT 1, MFG FFCh, MODEL VX4750, PASS, TRIGGER;LOCK;READ STB, MESG, 1, V1.3, NORMAL"

3) Enable the UUT to generate interrupts when it detects a syntax error by sending the following command to the UUT:
   "INT;"

4) Send the following invalid command to the UUT:
   "AMPL 200VP;"

5) Perform an IEEE-488 serial poll to IEEE-488 address 2 and verify that the data returned in the serial poll is equal to 40 hex.

6) Read two responses from the UUT (an error response and a normal response) and verify that the UUT error LED goes out after the normal response is read.

7) Repeat steps 2 through 6 for VXI interrupt levels 2 through 7. The UUT Interrupter Level switch and the 73A-151 Interrupter Level switch must be set to the interrupt level being tested.

8) Send the following command to the UUT:
   "RST;WAVE TRI;"
   Verify that the UUT is outputting a 1 KHz triangle wave.

9) Reset the UUT by sending the following command string to the 73A-151:
"RESET 2<cr><lf>"

10) Verify that the UUT begins to output a 1 KHz sine waveform (its default waveform) indicating that it has been reset.

11) Repeat steps 8 through 10 with the UUT Halt switch set to the OFF position. Verify that the UUT continues to output a triangle wave after the "RESET 2<cr><lf>" command has been sent to the 73A-151.

12) Set the UUT Halt switch to the ON position.

Frequency Accuracy Verification

Test Setup

Connect the FUNC OUT connector of the UUT to channel 1 of the oscilloscope and to the input of the frequency counter. Use 50 Ohm coax cable for both connections. Select the oscilloscope 50 Ohm load on channel 1.

Test Procedure

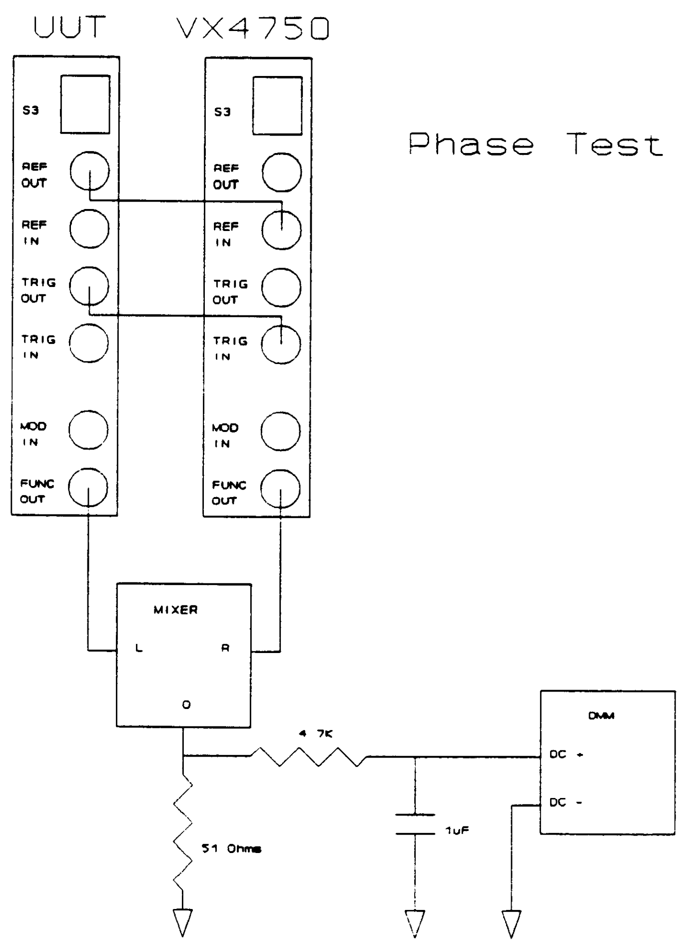
1) Command the UUT to output a sine waveform by sending it the following command string:
"WAVE SINE;AMPL 1 VP;OFST 0;REFI OB10M;"

2) Use the FREQ command to set the frequency of the UUT waveform to the following frequencies: 1 MHz, 2 MHz, 3 MHz, ..., 25 MHz. After each FREQ command, use the frequency counter to measure the actual frequency of the UUT waveform. Verify that the frequency error is less than or equal to 1 ppm.

Phase Accuracy Verification

Test Setup

Connect the UUT, a VX4750, the mixer, the low pass filter, and the DMM as shown in the diagram below. Use 50 Ohm coax cable for connections to the UUT, VX4750 and the mixer.



Test Procedure

1) Set the DMM function to DC volts. Initialize the UUT with the following command string:
"WAVE SINE;FREQ 1MHZ;AMPL 7DBM;REFO FP33M;"

Initialize the second VX4750 with the following command string:
"WAVE SINE;FREQ 1MHZ;AMPL .220 VP;REFI FP33M;"

2) Send PHAS commands to the UUT to set the phase of the output waveform of the UUT relative to the output waveform of the VX4750. Set the phase of the UUT's waveform to values of -160° to +160° in steps of 20°. After each PHAS command is sent to the UUT, measure the actual phase between the two waveforms and verify that the phase error is less than or equal to 3°.

3) Use the following procedure to measure the phase between the waveforms of the UUT and the VX4750:

   a) After a PHAS command has been sent to the UUT, use the DMM to measure the DC voltage at the output of the lowpass filter. Record this value as variable 'cosphi'.

   b) Send a "DPHAS -90;" command to the UUT.

   c) Use the DMM to measure the DC voltage at the output of the lowpass filter. Record this value as variable 'sinphi'.

   d) Calculate the inverse tangent of sinphi/cosphi to find the phase between the UUT and VX4750 waveforms.

Amplitude Flatness/Accuracy Verification

Amplitude Accuracy
Verification

Test Setup

Connect a 50 Ω load to the input of the DMM. Measure the resistance of the 50 Ω load and save for use in the test procedure. Remove the 50 Ω load from the DMM input. Connect one end of a 50 Ω coax cable to the DMM and short the other end. Measure the resistance of the cable and save for use in the test procedure. Connect the 50 Ω load to the DMM input. Connect the FUNC OUT connector of the UUT to the 50 Ω load with the coax cable. Set the DMM function to AC volts.

Test Procedure

1. Calculate a correction factor to be applied to DMM AC voltage readings to account for voltage drop in the coax cable used to connect the UUT FUNC OUT connector to the 50 Ω load. Use the following formula to calculate this correction factor:

   k = (Rc + R1) / R1

   Where Rc is the resistance of the coax cable in Ω and R1 is the resistance of the 50 Ω load in Ω.

2. Reset the UUT by sending the following command string:

   `"RST;"`

3. Send the command `"IMP <1>;"` to the UUT. In this command string, <1> represents the sum of the resistance of the 50 Ω load and the resistance of the coax cable measured above.

4. Command the UUT to output a 1 kHz sine waveform by sending the command:

   `"WAVE SINE;FREQ 1E3;"`

5. Set the UUT amplitude to 5.5 V_p by sending it the command:

   "AMPL 5.5;"

   Take a reading from the DMM. This is the amplitude at the 50 Ω load. Multiply the DMM reading by 1.414213 to convert from volts RMS to V_p. Calculate the amplitude at the UUT FUNC OUT connector by multiplying the result by the correction factor saved in step 1. Save this value for use in steps 6 and 7.

6. Calculate the relative amplitude error in dB using the formula:

   Er = 20 * log10 (Aa / Ap)

   Where Aa is the actual amplitude in V_p at the FUNC OUT connector (saved in step 5), Ap is the programmed value in $V_{p,}$ and Er is the amplitude error in dB.

7. Calculate the absolute amplitude error in V_p using the formula:

   Ea = Aa − Ap

8. Verify that the relative amplitude error calculated in step 6 is in the range ± 0.1 dB and that the absolute error calculated in step 7 is in the range ± 0.04 V_p. Note that checking the amplitude accuracy at 1 kHz to be ± 0.1 dB and checking the amplitude flatness from 1 kHz to 3 MHz to be ± 0.1 dB (see the Amplitude Flatness verification) ensures that the amplitude accuracy from 1 kHz to 3 MHz is within the ± 0.2 dB specification. Flatness from 0.001 Hz to 1 kHz is guaranteed by design to be ± 0.1 dB. This ensures that the amplitude accuracy in this range is also ± 0.2 dB.

9. Repeat steps 5 through 8 for amplitudes of 4.4 V_p, 3.3 V_p, 2.2 V_p, and 1.1 V_p.

10. Repeat steps 5 through 8 for amplitudes of 0.88 V_p, 0.66 V_p, 0.44 V_p, 0.33 V_p, and 0.22 V_p. In step 8 use an absolute tolerance of ± 0.008 V_p.

11. Repeat steps 5 through 8 for amplitudes of 0.17 V_p, 0.132 V_p, 0.088 V_p, and 0.044 V_p. In step 8 use and absolute tolerance of ± 0.004 V_p.

12. Repeat steps 5 through 11 for the triangle, positive ramp, negative ramp, square, pulse and arbitrary waveforms. For the pulse waveform, specify a duty cycle of 50%. When checking the amplitude accuracy of the Arbitrary waveform, use the default arbitrary waveform. In step 5, use the conversion factors in the following table to convert the DMM reading to units of V_p.

Waveform	Conversion Factor
Triangle	1.73205
Positive Ramp	1.73205
Negative Ramp	1.73205
Square	1.0
Pulse	1.0
Arbitrary	2.0

Amplitude Flatness Verification

Test Setup

Connect the FUNC Out connector of the UUT to the input of the EPM-1 power meter with a 50 Ω coax cable. Set the range select switch of the EPM-1 to the ± 1 dBm setting. Set the input impedance switch of the EPM-1 to the 50 Ω setting. Connect the chart recorder output of the EPM-1 to the DMM input. Set the DMM function to DC volts autorange.

Test Procedure

1. Command the UUT to output a 1 kHz sine waveform with an amplitude of 0 dBm by sending it the following command:

   ```
   "rst;freq 0;dfreq 1e3;ampl 0dBm;"
   ```

2. Measure the DC voltage at the EPM-1 chart recorder output and save.

3. Use the DFREQ command to set the waveform frequency of the UUT to the following frequencies: 500 kHz, 1 MHz, 1.5 MHz, 2.0 Mhz, and 3 MHz. At each frequency measure the voltage at the EPM-1 chart recorder output and convert the reading to units of dBm using the following formula:

   ```
   P = ( Vi - Vb ) / 2.5 V/dB
   ```

Where Vi is the DMM reading, Vb is the DMM reading saved in step 2 and P is the UUT output power.

Verify that the output power P is in the range ± 0.1 dBm at each frequency. Note that checking the amplitude flatness from 1 kHz to 3 MHz. to be ± 0.1 dB and checking the amplitude accuracy at 1 kHz to be ± 0.1 dB ensures that the amplitude accuracy from 1 kHz to 3 MHz is within the ± 0.2 dB specification. Flatness from 0.001 Hz to 1 kHz is guaranteed by design to be ± 0.1 dB. This ensures that the amplitude accuracy in this range is also ± 0.2 dB.

4. Repeat step 3 for frequencies of 4 MHz to 10 MHz in 1 MHz steps. At each frequency, verify that the UUT output power is in the range ± 0.4 dB. Note that checking the amplitude flatness from 4 MHz to 10 MHz to be ± 0.4 dB (relative to the amplitude at 1 kHz) and checking the amplitude accuracy at 1 kHz to be ± 0.1 dB ensures that the amplitude accuracy from 4 kHz to 10 MHz is with the ± 0.5 dB specification. This also verifies that the flatness specification of ± 0.5 dB in this frequency range is met.

5. Set the UUT frequency to 11 MHz by sending it the command:

   ```
   "FREQ 11e6;"
   ```

6. Use the DFREQ command to vary the UUT output frequency from 11 MHz to 25 MHz. At each frequency, use the formula of step 3 to calculate the UUT output power. Verify that the output power at each frequency is in the ± 0.4 dBm. Note that checking the amplitude flatness from 11 MHz to 25 MHz to be ± 0.4 dB (relative to the amplitude at 1 kHz) and checking the amplitude accuracy at 1 kHz to be ± 0.1 dB ensures that the amplitude accuracy from 11 MHz to 25 MHz is within the ± 0.5 dB specification. This also verifies that the flatness specification of ± 0.5 dB in this frequency range is met.

7. Perform steps 7 through 10 only for the VX4750 modules with option 30 installed. Disconnect the UUT from the EPM-1 mW power meter and connect it to the power head of the VX4281 power meter.

8. Read the VX4281 with the UUT frequency to 32 MHz and read the VX4281. Save this value for use in step 10.

9. Use the DREF command to set the frequency to 32 MHz and read the VX4281. Save this value for use in step 10.

10. Calculate the amplitude flatness in the frequency range 25 MHz to 32 MHz using the formula:

```
P = P8 - P9
```

Where P8 is the UUt power measured in step 8 and P9 is the UUT power measured in step 9 and P is the UUT amplitude flatness. Verify that the amplitude flatness in this frequency range is between 0.5 dBm and −2.5 dBm. Note that amplitude accuracy in this range is not specified.

DC Offset Accuracy Verification

Test Setup

Connect a 50 Ω load to the input of the DMM. Measure the resistance of the 50 Ω load and save for use in the the test procedure. Remove the 50 Ω load from the DMM input. Connect one end of a 50 Ω coax cable to the DMM and short the other end. Measure the resistance of the cable and save for use in the test procedure. Connect the 50 Ω load to the DMM input. Connect the FUNC OUT connector of the UUT to the 50 Ω load with the coax cable. Set the DMM function to DC volts.

Test Procedure

1. Command the UUT to output a DC waveform by sending the following command string:

   ```
   "RST; WAVE DC; AMPL 0; OFST 0;"
   ```

2. Calculate a correction factor to be applied to DMM DC voltage readings to account for voltage drop in the coax cable used to connect the UUT FUNC OUT connector to the 50 Ω load. Use the following formula to calculate this correction factor:

   ```
   k = (Rc + R1) / R1
   ```

   Where Rc is the resistance of the coax cable in Ω and R1 is the resistance of the 50 Ω load in Ω.

3. Send the command "`IMP <1>;`" to the UUT. In this command string, `<1>` represents the sum of the resistance of the 50 Ω load and the resistance of the coax cable measured above.

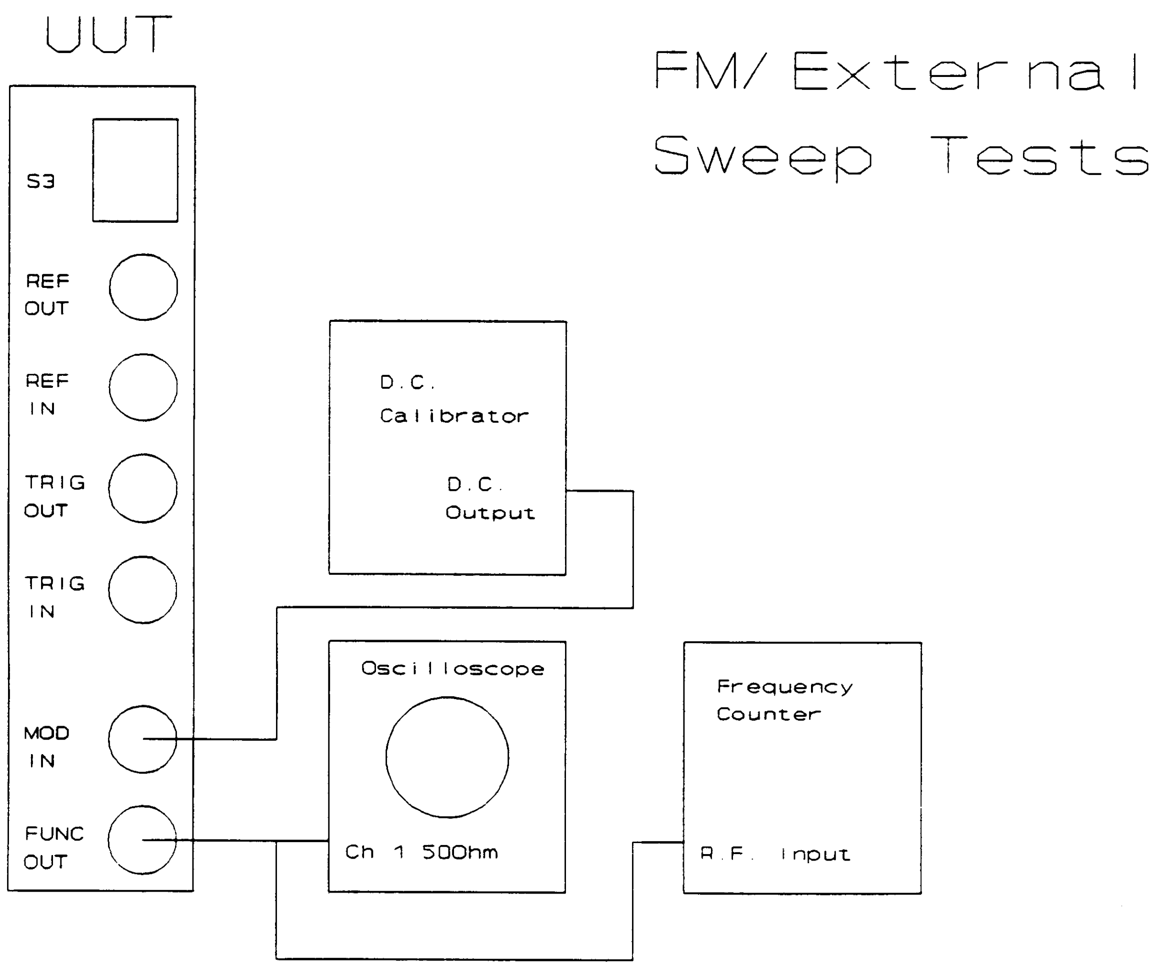
4. Use the `OFST` command to set the DC voltage of the UUT to the following voltages: 5.5 V, 4.5 V, 3.5 V, 2.5 V, 1.5 V, 1.101 V, 1.1 V, 0.9 V, 0.7 V, 0.5 V, 0.3 V, 0.221 V, 0.22 V, 0.18 V, 0.14 V, 0.1 V, 0.06 V, and 0.04 V. After each `OFST` command, use the DMM to measure the DC voltage at the 50 Ω load. Calculate the voltage at the UUT FUNC OUT connector by multiplying the DMM reading by the correction factor calculated in step 2. Verify that the result is within ± 2.5% of the commanded voltage or within ± 20 mV of the commanded voltage.

FM Modulation Frequency Deviation Verification

Test Setup

Connect the UUT, DC calibrator, oscilloscope, and frequency counter as shown in the following diagram. Select a 50 Ohm load on channel 1 of the oscilloscope.

Use 50 Ohm coax cable for all connections.



Test Procedure

1) Initialize the UUT by sending it the following command string:
"WAVE SINE;FREQ 6MHz;AMPL 5.5 VPP;"

   This command instructs the UUT to output a 6.0 MHz sine waveform with an amplitude of 5.5 volts peak-to-peak.

2) Set the mode of the MOD IN connector of the UUT to FM modulation and set the frequency deviation to 10 KHz by sending the following command string to the UUT:
"FM 10KHZ;"

3) Command the DC calibrator to output a DC voltage of -1.414 volts by sending it the following command string:

"V1-01.41400;"

4) Use the frequency counter to measure the frequency of the signal at the FUNC OUT connector of the UUT. Record this value as FREQMIN.

5) Command the DC calibrator to output a DC voltage of +1.414 volts by sending it the following command string:
"V1+01.41400;"

6) Use the frequency counter to measure the frequency of the signal at the FUNC OUT connector of the UUT. Record this value as FREQMAX.

7) Calculate the actual frequency deviation using the following formula:
FM frequency deviation = (FREQMAX - FREQMIN) / 2

8) Verify that the actual frequency deviation is within 1% of the value set in step 2.

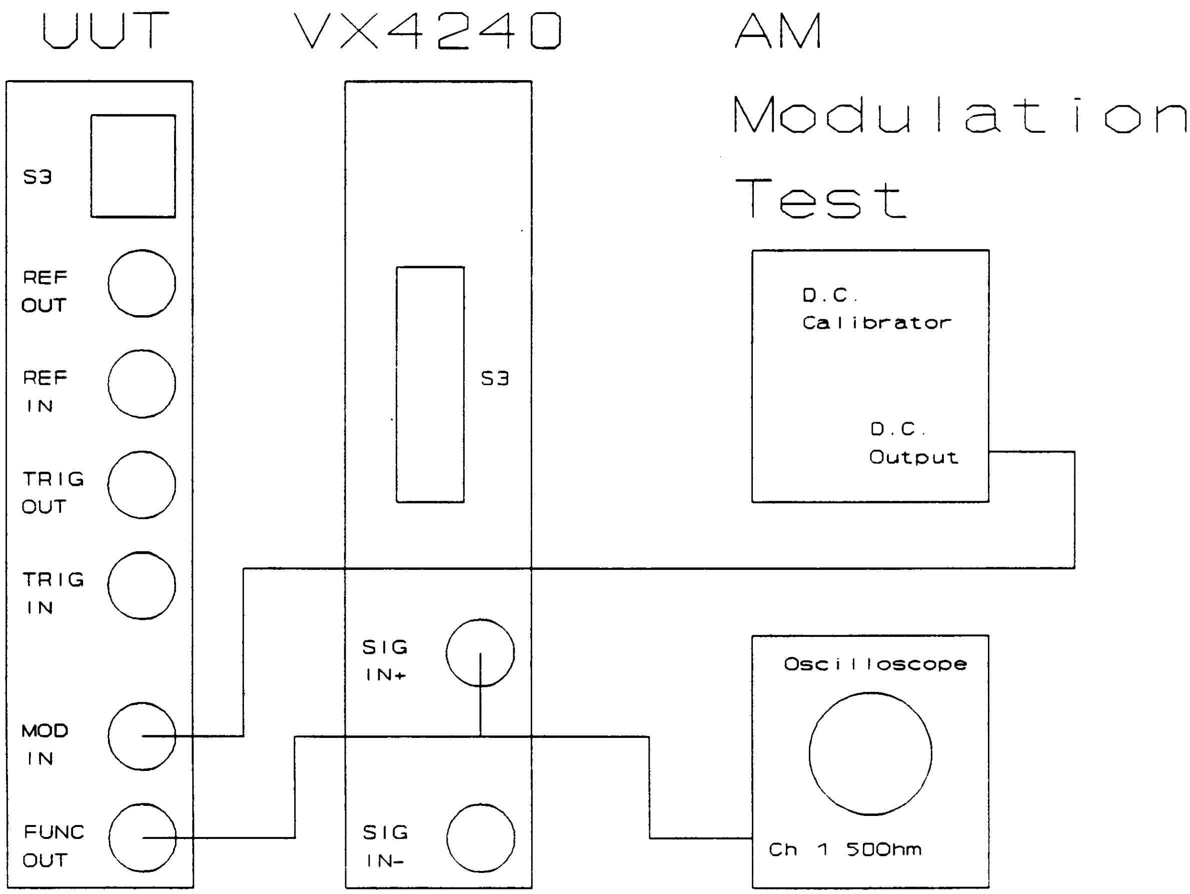
7) Repeat steps 2 through 7 for modulation indices of 20 KHz through 100 KHz in steps of 10 KHz.

8) Disable FM modulation by sending the following command string to the UUT:
"FM 0;"

AM Modulation Index Verification

Test Setup

Connect the UUT, VX4240, DC calibrator and oscilloscope as shown in the following diagram. Select a 50 Ohm load on channel 1 of the oscilloscope.



Test Procedure

1) Initialize the UUT with the following command string:
   "WAVE SINE;FREQ 550KHZ;AMPL 5.5 VPP;"

   This command instructs the UUT to output a 550 KHz sine waveform with an amplitude of 5.5 volts peak-to-peak.

2) Set the mode of the MOD IN connector of the UUT to AM modulation and set the AM modulation index to 10% by sending the following command string to the UUT:
   "AM 10;"

3) Command the DC calibrator to output a DC voltage of -1.414 volts by sending it the following command string:
   "V1-01.41400"

4) Use the following procedure to measure the amplitude of the UUT output signal. Record this value as AMPLMIN.

   a) Initialize the VX4240 with the following command string:
      "R;F10E6;CP2000;MP0;VA10;"
      This command instructs the VX4240 to:
         Set its input voltage range to ±10 volts.
         Set its input impedance to 1MOhm.
         Sample its input every 100 nanoseconds.
         Collect 2000 samples after it is triggered.
         Trigger on the positive edge of the signal applied to its input at a voltage of 0 volts.

   b) Trigger the VX4240 by sending it the "T;" command.

   c) Send a "Q;" command to the VX4240 and read its response until the string "S00011" is returned. This indicates that the VX4240 has been triggered and that it has finished collecting data.

   d) Request the VX4240 to calculate and return the amplitude of the UUT waveform by sending it a "AK2000/0;" command and reading the response. The VX4240 will return three numbers in ASCII floating point format equal to the maximum, minimum and average peak-to-peak amplitude of the UUT waveform. The floating point number representing the average amplitude is preceded by the string "KA =". Use this number as the amplitude in the calculations of the AM modulation index.

5) Command the DC calibrator to output a DC voltage of +1.414 volts by sending it the following command string:
   "V1+01.41400"

6) Use the procedure listed in step 4 to measure the amplitude of the UUT output signal. Record this value as AMPLMAX.

7) Calculate the actual AM modulation index using the following formula:

   AM modulation index =
   100 * ((AMPLMAX/AMPLMIN) - 1) / ((AMPLMAX/AMPLMIN) + 1)

8) Verify that the difference between the actual modulation index and the value specified in step 2 is less than 5.

9) Repeat steps 2 through 8 for modulation indices of 20% through 90% in steps of 10%.

10) Disconnect the DC calibrator from the MOD IN input of the UUT. Connect the FUNC OUT connector of a VX4750 to the MOD IN connector of the UUT. Send the following command string to the second VX4750:
    "WAVE SINE;FREQ 20KHZ;IMP 10E3;AMPL 1.414VP;

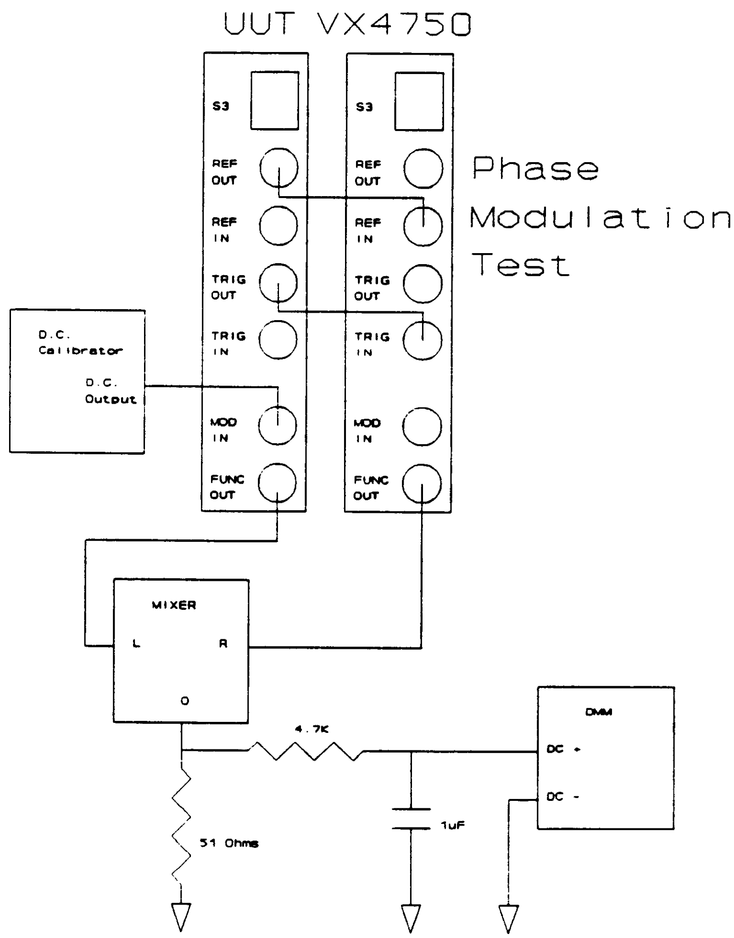
11) Observe the AM modulated sine wave on channel 1 of the oscilloscope. Record the maximum and minimum amplitudes of the modulated waveform and calculate the modulation index using the formula of step 7. Verify that the modulation index is within 5% of 90%.

12) Disable AM modulation by sending the following command string to the UUT:
"AM 0;"

PM Modulation Phase Deviation Verification

Test Setup

Connect the UUT, a VX4750, the mixer, the low pass filter, the DMM and the DC calibrator as shown in the diagram below. Use 50 Ohm coax cable for connections to the UUT, VX4750, and mixer.



Test Procedure

1) Set the DMM function to DC volts. Initialize the UUT with the following command string:
"WAVE SINE;FREQ 1MHz;AMPL 7DBM;REFI OB10M;REFO FP33M;"

2) Initialize the second VX4750 with the following command string:
"WAVE SINE;FREQ 1MHz;AMPL .220 VP;REFI FP33M;PHAS 0.0;"

3) Set the phase deviation of the UUT output waveform command to 20 degrees by sending the following command string to the UUT:
"PM 20 DEG;"

4) Set the DC voltage output of the DC calibrator to -1.414 volts by sending the following command string to the DC calibrator: "V1-01.41400".

5) Use the following procedure to measure the phase between the UUT waveform and the waveform of the VX4750 and record as variable "PHIMIN".

   a) Send the following command to the VX4750: "DPHAS 0.0".

   b) Use the multimeter to measure the DC voltage at the low pass filter output and record the value in variable "COSPHI".

   c) Send the following command to the VX4750: "DPHAS 90.0;".

   d) Use the multimeter to measure the DC voltage at the low pass filter output and record the value in variable "SINPHI".

   e) Use the following formula to calculate the phase difference between the UUT output and the VX4750 output:

      phase = inverse tangent(SINPHI / COSPHI).

6) Set the DC voltage output of the DC calibrator to +1.414 volts by sending the following command string to the DC calibrator: "V1 +01.41400". Use the procedure in step 5 to measure the phase between the UUT waveform and the waveform of the VX4750 and record as variable "PHIMAX".

7) Calculate the phase deviation using the following formula:

   phase deviation = (PHIMAX - PHIMIN) / 2.

   Verify that the measured phase deviation is within 2 degrees of the value specified in the PM command of step 2.

8) Repeat steps 2 through 7 for phase deviations of 40 degrees through 160 degrees in increments of 20 degrees.

9) Disable phase modulation by sending the following command string to the UUT: "PM 0.0;"

FSK Modulation Verification

Test Setup

Connect the output of the UUT to channel 1 of the oscilloscope. Select the 50 Ohm load on channel 1 of the oscilloscope.

Test Procedure

1) Initialize the UUT with the following command string:
"WAVE SINE;FREQ 1E6;AMPL 5.5 VPP;FSK 500KHZ, 1.5MHz;TRGI VXI 2;"

   This command instructs the UUT to output a 1 MHz sine waveform with an amplitude of 5.5 volts peak-to-peak. This command also commands the UUT to use VXI TTL trigger 2 as a modulation source for frequency shift keying (FSK) modulation. The two FSK frequencies specified are 500 KHz and 1.5 MHz.

2) Initialize the 73A-270 pulse generator with the following command string:
"1Q0S3R0A100000L100005L0C28T0B;"

   This commands instructs the 73A-270 to drive VXI TTL trigger 2 with a .5 Hz TTL square wave.

3) Observe the FSK modulated sine waveform on the oscilloscope. Verify that the frequency of the UUT wave form is alternating between 500 KHz and 1.5 MHz at a .5 Hz rate.

4) Command the UUT to deselect VXI TTL trigger 2 by sending it the following command: "TRGI VXI OFF;"

5) Halt the operation of the 73A-270 by sending it the following command: "1Q;"

6) Disable the UUT FSK mode by sending the following command string to the UUT: "RST;"

PWM Modulation Verification

Test Setup

Use the same test setup as for the AM modulation verification.

Test Procedure

1) Initialize the UUT with the following command string:
"WAVE PULS 50;FREQ 30KHZ;AMPL 5.5 VPP;"

This command instructs the UUT to output a 30 KHz pulse waveform with an amplitude of 5.5 volts peak-to-peak and a duty cycle of 50%.

2) Initialize the VX4240 with the following command string:
"R;VD5;F10E6;CP10000;MP0;"

This command instructs the VX4240 to:
Set its input voltage range to ±5 volts.
Set its input impedance to 1MOhm.
Sample its input every 100 nanoseconds.
Collect 10000 samples after it is triggered.
Trigger on the positive edge of the signal applied to its input at a voltage of 0 volts.

3) Set the mode of the MOD IN connector of the UUT to PWM modulation and set the duty cycle deviation to 10% by sending the following command string to the UUT: "PWM 10;"

4) Command the DC calibrator to output a DC voltage of -1.414 volts by sending it the following command string: "V1-01.41400;"

5) Trigger the VX4240 by sending it a "T;" command.

6) Send a "Q;" command to the VX4240 and read its response until the string "S00011" is returned. This indicates that the VX4240 has been triggered and that it has finished collecting data.

7) Request the VX4240 to calculate and return the duty cycle of the UUT waveform by sending it a "AWD10000/0;" command and reading the response. The VX4240 will return three numbers in ASCII floating point format equal to the maximum, minimum and average duty cycle of the UUT waveform. The floating point number representing the average duty cycle is preceded by the string "DA =". Record this value in variable "DUTYMIN".

8) Command the DC calibrator to output a DC voltage of +1.414 volts by sending it the following command string: "V1+01.41400;"

9) Trigger the VX4240 by sending it a "T;" command.

10) Send a "Q;" command to the VX4240 and read its response until the string "S00011" is returned. This indicates that the VX4240 has been triggered and that it has finished collecting data.

11) Request the VX4240 to calculate and return the duty cycle of the UUT waveform by sending it a "AWD10000/0;" command and reading the response. The VX4240 will return three numbers in ASCII floating point format equal to the maximum, minimum and average duty cycle of the UUT square wave. The floating point number representing the average duty cycle is preceded by the string "DA =". Record this value in variable "DUTYMAX".

12) Calculate the actual duty cycle deviation using the following formula.

duty cycle deviation = (DUTYMAX - DUTYMIN) / 2

13) Verify that the difference between the actual duty cycle deviation and the value specified in step 3 is less than 1.5.

14) Repeat steps 3 through 6 for deviations of 20% through 90% in steps of 10%.

15) Disable PWM modulation by sending the following command string to the UUT:
"PWM 0;"

Internal PSK Modulation Verification

Test Setup

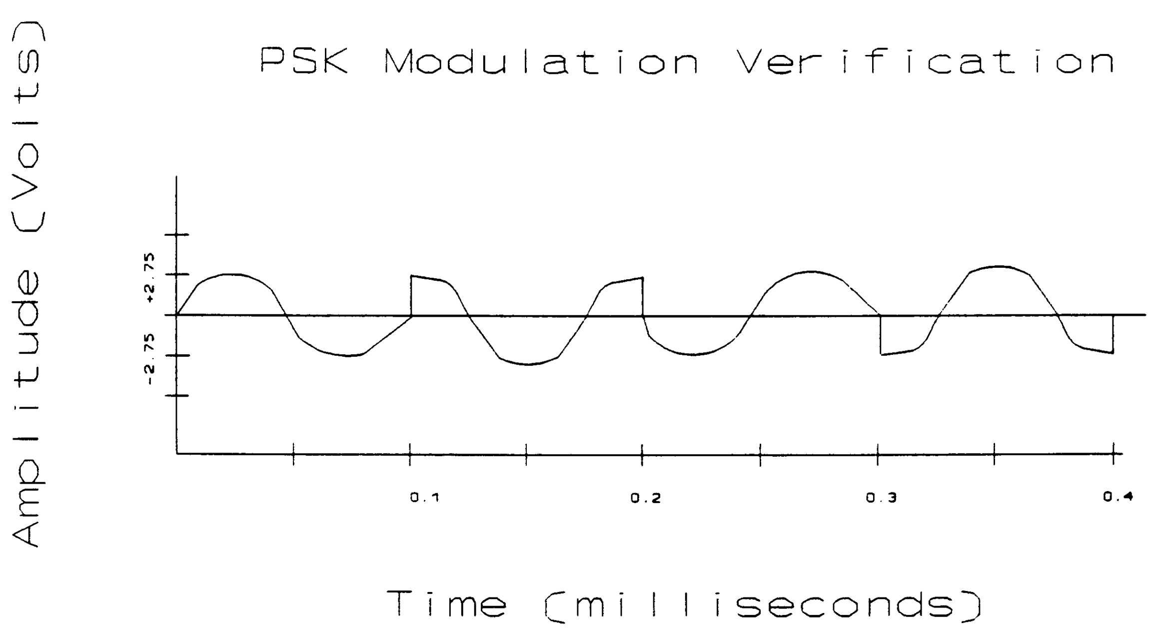
Connect the output of the UUT to channel 1 of the oscilloscope. Select the 50 Ohm load on channel 1 of the oscilloscope.

Test Procedure

1) Initialize the UUT with the following command string:
"WAVE SINE;FREQ 10KHZ;AMPL 5.5 VPP;PSK DAT 0,4,8,C;PSK ON;"

This command instructs the UUT to output a 10 KHz QPSK (quadrature phase shift keying) modulated sine waveform with an amplitude of 5.5 volts peak-to-peak. The phases imposed on the waveform are 0, 90, 180, and 270 degrees.

2) Observe the PSK modulated sine waveform on the oscilloscope. Verify that the waveform looks like the waveform in the following figure.

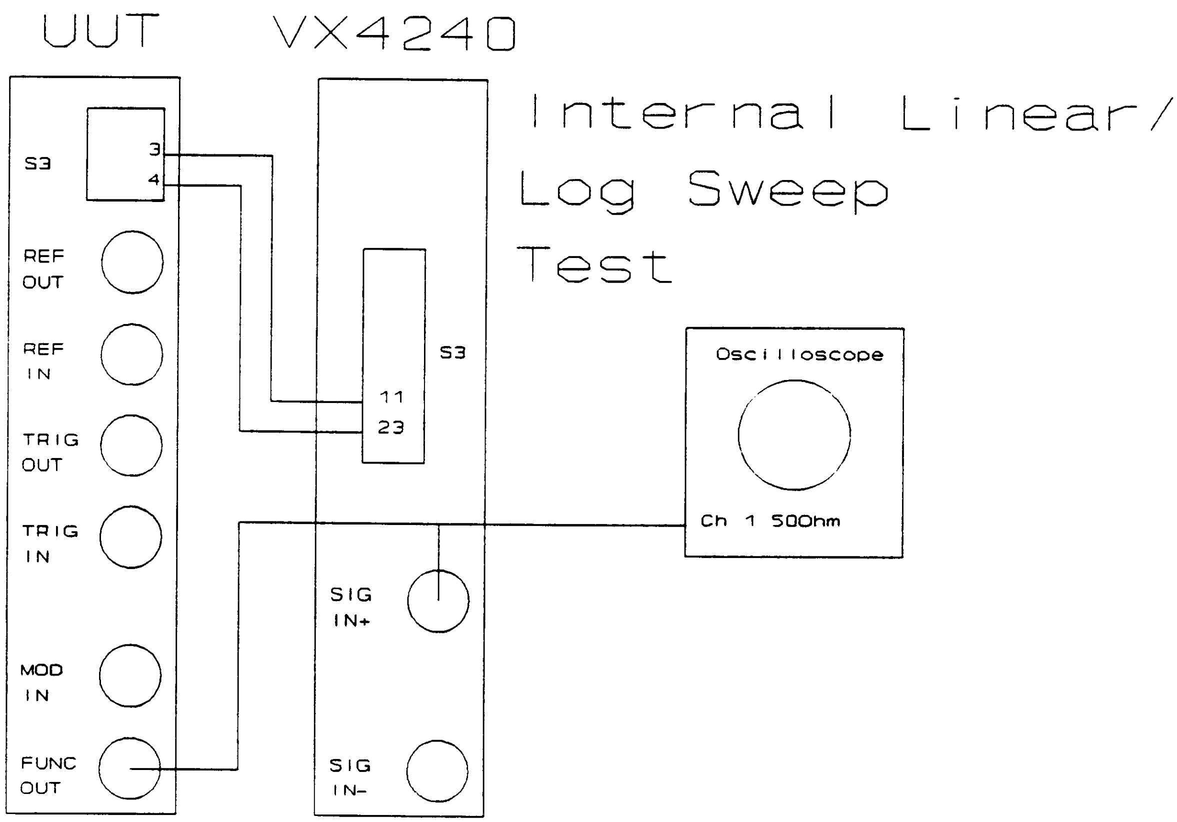


3) Disable PSK modulation by sending the following command to the UUT:
"PSK OFF;"

Internal Linear Frequency Sweep Verification

Test Setup

Connect the UUT, the oscilloscope, and the VX4240 as shown in the following diagram.



Test Procedure

1) Initialize the UUT by sending it the following command string:
"WAVE SINE;FREQ 10KHZ;AMPL 5.5VPP;"

This command instructs the UUT to output a 10 KHz sine waveform with an amplitude of 5.5 volts peak-to-peak.

2) Initialize the VX4240 by sending it the following command string:
"R;F10E6;LS;CP2000;ME-;VA10;"

This command instructs the VX4240 to:
AC couple its signal input.
Set its input voltage range to ±10 volts.
Sample its input every 100 nanoseconds.

Collect 2000 samples after it is triggered.
Trigger on the falling edge of the signal applied to its external trigger input.

3) Send the "TA;" command to the VX4240. This arms the VX4240 external trigger.

4) Send the following command string to the UUT:
"ISWP 10KHZ, 20KHZ, 100KHZ, 5;"

This commands the UUT to sweep the frequency of its output waveform from 10 KHz to 100 KHz in 5 seconds and to pulse its marker frequency output when the frequency of the waveform is equal to 20 KHz. (The marker frequency is set to 20 KHz.) The UUT is commanded to vary the frequency linearly with time.

5) Send a "Q;" command to the VX4240 and read its response until the string "S00011" is returned. This indicates that the VX4240 has been triggered and that it has finished collecting data.

6) Send the following string to the VX4240: "AZHF2000/0;". Read the VX4240 response. Record the floating point number returned as variable ACTMARK. This is the marker frequency measured by the VX4240.

7) Verify that the actual marker frequency measured in step 6 is within 1% of the marker frequency specified in step 4.

8) Repeat steps 3 through 7 for marker frequencies of 30 KHz through 90 KHz in 10 KHz increments.

9) Disable the UUT frequency sweep by sending it the following command string: "SWP OFF;"

Internal Log Frequency Sweep Verification

Test Setup

Use the same test setup as for the internal linear frequency sweep verification.

Test Procedure

1) Initialize the UUT with the following command string:
"WAVE SINE;FREQ 10KHZ;AMPL 5.5VPP;"

This command instructs the UUT to output a 10 KHz sine waveform with an amplitude of 5.5 volts peak-to-peak.

2) Initialize the VX4240 with the following command string:
"R;F10E6;LS;CP2000;ME-;VA10;"

This command instructs the VX4240 to:
AC couple its signal input.
Set its input voltage range to ±10 volts.
Sample its input every 100 nanoseconds.
Collect 2000 samples after it is triggered.
Trigger on the falling edge of the signal applied to its external trigger input.

3) Send the following command to the VX4240: "TA;". This arms the VX4240 external trigger.

4) Send the following command string to the UUT:
"LSWP 10KHZ, 20KHZ, 100KHZ, 5;"

This commands the UUT to sweep the frequency of its output waveform from 10 KHz to 100 KHz in 5 seconds and to pulse its marker frequency output when the frequency of the waveform is equal to 20 KHz. (The marker frequency is set to 20 KHz.) The UUT is commanded to vary the frequency of its output exponentially with time.

5) Send a "Q;" command to the VX4240 and read its response until the string "S00011" is returned. This indicates that the VX4240 has been triggered and that it has finished collecting data.

6) Send the following string to the VX4240: "AZHF2000/0;". Read the VX4240 response. Record the floating point number returned as variable ACTMARK. This is the marker frequency measured by the VX4240.

7) Verify that the actual marker frequency measured in step 6 is within 1% of the marker frequency specified in step 4.

8) Repeat steps 3 through 7 for marker frequencies of 30 KHz through 90 KHz in 10 KHz increments.

9) Disable the UUT frequency sweep by sending it the following command string:
"SWP OFF;"

External Frequency Sweep Verification

Test Setup

Use the same test setup as for the FM modulation frequency deviation verification.

Test Procedure

1) Initialize the UUT with the following command string:
"WAVE SINE;FREQ 100KHZ;REFI OB10M;AMPL 5.5 VPP;"

This command instructs the UUT to output a sine waveform with an amplitude of 5.5 volts peak-to-peak and a frequency of 100 KHz. It also commands the UUT to use its onboard 10 MHz clock as a frequency reference.

2) Set the mode of the MOD IN connector of the UUT to external frequency sweep from 10 KHz to 100 KHz by sending the following command string to the UUT:
"XSWP 10KHZ, 100KHZ;"

3) Command the DC calibrator to output a DC voltage of 1 volt by sending it the following command string: "V1+01.00000;"

4) Use the following formula to calculate the correct frequency of the UUT waveform:
CORRECTFREQ = 10KHz + (100KHz - 10KHZ) * V / 10V

where V is the DC voltage specified in step 3.

5) Use the frequency counter to measure the frequency of the signal at the FUNC OUT connector of the UUT. Record this value as ACTUALFREQ.

6) Verify that the difference between the actual frequency and the frequency calculated in step 4 is less than 900 Hz (1% of 100 KHz - 10 KHz).

7) Repeat steps 3 through 6 for DC calibrator voltages of 2 through 9 volts in increments of 1 volt.

8) Disable external frequency sweep mode by sending the following command string to the UUT: "SWP OFF;"

Sine Wave Harmonic Distortion Verification

Test Setup

Connect the UUT function output to the input of the spectrum analyzer using 50 Ohm coax cable. Use the following command string to set the UUT waveform to a sine wave with an amplitude of 10 dBm.

"WAVE SINE;AMPL 10DBM;"

Test Procedure

1) Set up the spectrum analyzer as follows:

Center frequency	150 KHz
Span	30 KHz
Resolution Bandwidth	3 KHz

Use the FREQ command to set the frequency of the UUT waveform to the values in the first column of the following table. At each frequency, observe the amplitudes of the second and third harmonics on the spectrum analyzer. Verify that the amplitudes of the second and third harmonics are at least 45 dB below the amplitude of the fundamental.

UUT frequency	2nd Harmonic	3rd Harmonic
20 KHz	40 KHz	60 KHz
50 KHz	100 KHz	150 KHz
90 KHz	180 KHz	270 KHz

2) Set up the spectrum analyzer as follows:

Center frequency	1.5 MHz
Span	300 KHz
Resolution Bandwidth	30 KHz

Use the FREQ command to set the frequency of the UUT waveform to the values in the first column of the following table. At each frequency, observe the amplitudes of the second and third harmonics on the spectrum analyzer. Verify that the amplitudes of the second and third harmonics are at least 45 dB below the amplitude of the fundamental.

UUT frequency	2nd Harmonic	3rd Harmonic
200 KHz	400 KHz	600 KHz
500 KHz	1 MHz	1.5 MHz
900 KHz	1.8 MHz	2.7 MHz

3) Set up the spectrum analyzer as follows:

Center frequency	15 MHz
Span	3 MHz
Resolution Bandwidth	300 KHz

Use the FREQ command to set the frequency of the UUT waveform to the values in the first column of the following table. At each frequency, observe the amplitudes of the second and third harmonics on the spectrum analyzer. Verify that the amplitudes of the second and third harmonics are at least 35 dB below the amplitude of the fundamental.

UUT frequency	2nd Harmonic	3rd Harmonic
2 MHz	4 MHz	6 MHz
5 MHz	10 MHz	15 MHz
9 MHz	18 MHz	27 MHz

4) Set up the spectrum analyzer as follows:

Center frequency	37.5 MHz
Span	7.5 MHz
Resolution Bandwidth	300 KHz

Use the FREQ command to set the frequency of the UUT waveform to the values in the first column of the following table. At each frequency, observe the amplitudes of the second and third harmonics on the spectrum analyzer. Verify that the amplitudes of the second and third harmonics are at least 25 dB below the amplitude of the fundamental.

UUT frequency	2nd Harmonic	3rd Harmonic
12 MHz	24 MHz	36 MHz
20 MHz	40 MHz	60 MHz
25 MHz	50 MHz	75 MHz

Square Wave Overshoot, Rise Time And Duty Cycle Verification

Test Setup

Use the same test setup as in the triangle wave linearity verification.

Test Procedure

1) Initialize the UUT with the following command string:
"FREQ 100KHZ;WAVE SQR;AMPL .8 VPP;IMP 25;"

This command instructs the UUT to output a 100 KHz square wave with an amplitude of .8 volts peak-to-peak.

A load impedance of 25 Ohms at the UUT function output is specified because the VX4240 is programmed to set its input impedance to 50 Ohms. This 50 Ohm load is in parallel with the 50 Ohm load of the oscilloscope.

2) Initialize the VX4240 with the following command string:
"R;VD5F;F10E6;CP10000;MP0;"

This command instructs the VX4240 to:
Set its input voltage range to ±5 volts.
Set its input impedance to 50 Ohms.
Sample its input every 100 nanoseconds.
Collect 10000 samples after it is triggered.
Trigger on the positive edge of the signal applied to its input at a voltage of 0 volts.

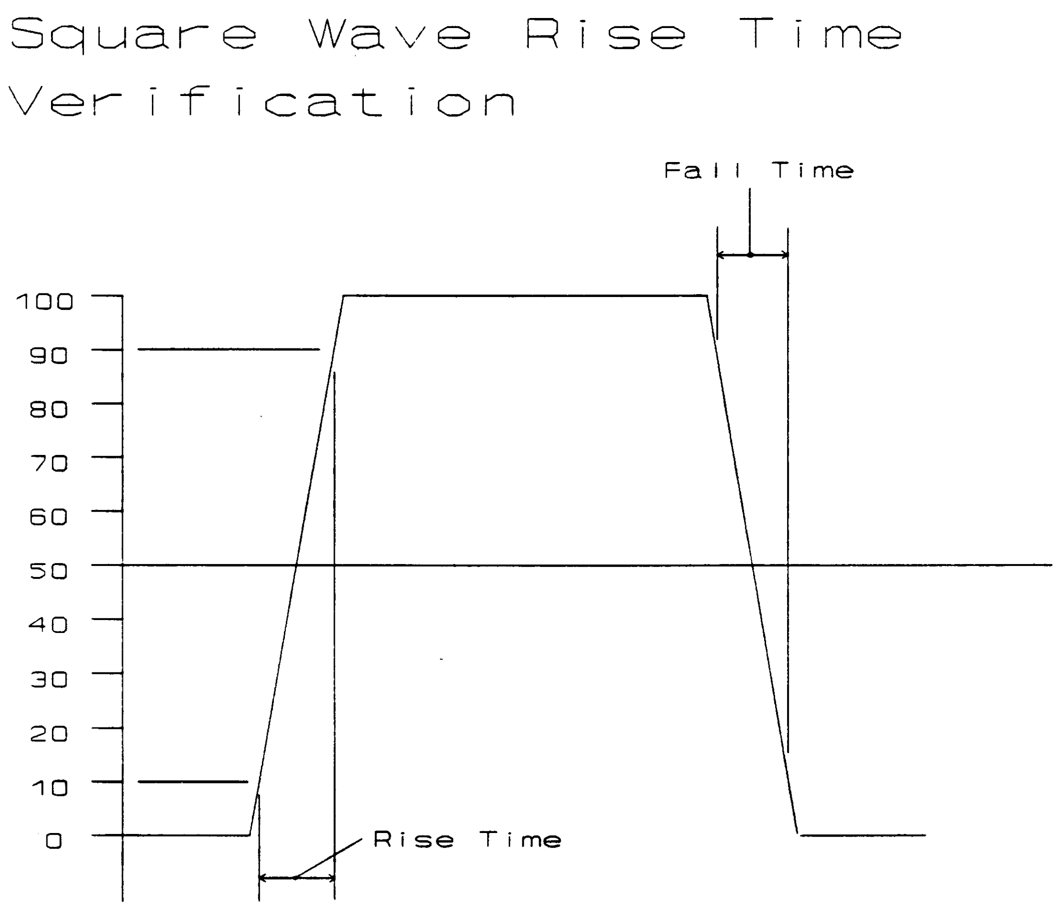
3) Trigger the VX4240 by sending it a "T;" command

4) Send a "Q;" command to the VX4240 and read its response until the string "S00011" is returned. This indicates that the VX4240 has been triggered and that it has finished collecting data.

5) Request the VX4240 to calculate and return the duty cycle of the UUT waveform by sending it a "AWD10000/0;" command and reading the response. The VX4240 will return three numbers in ASCII floating point format equal to the maximum, minimum and average duty cycle of the UUT square wave. The floating point number representing the average duty cycle is preceded by the string "DA =". Verify that the average duty cycle is equal to 50% ±1%.

6) Request the VX4240 to calculate and return the average overshoot of the UUT waveform by sending it a "AO10000/0;" command and reading the response. The average overshoot is preceded by the string "OA =". Also request the VX4240 to return the average peak-to-peak amplitude of the UUT waveform by sending it a "AK10000/0;" command and reading the response. The average peak-to-peak amplitude is preceded by the string "KA =". Express the average overshoot as a percentage of the average peak-to-peak amplitude of the UUT waveform. This percentage should be less than or equal to 5% .

7) Observe the rise/fall times of the UUT square wave on the oscilloscope. Use the following figure as an aid in making these measurements. Verify that the rise/fall times are less than or equal to 25 nanoseconds.



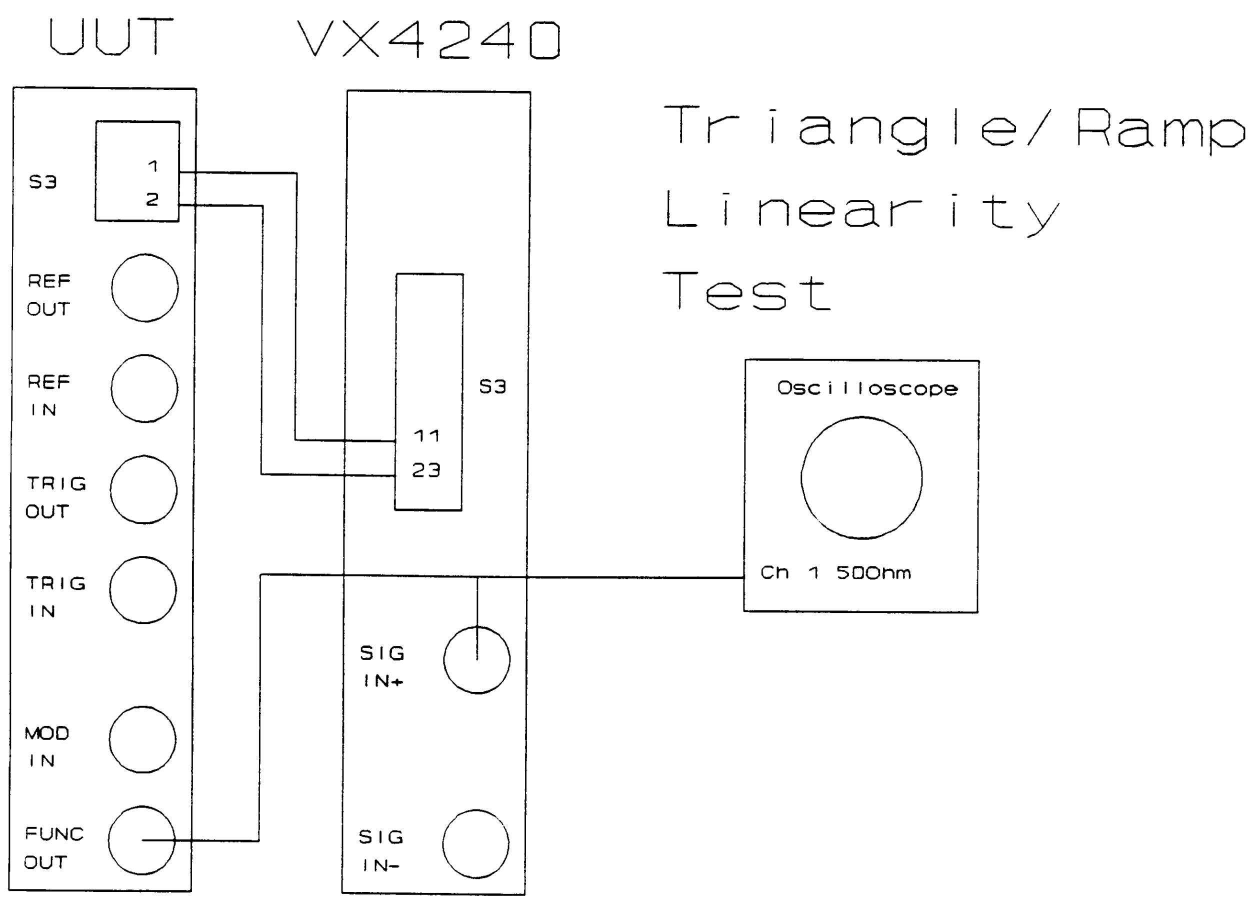
8) Repeat steps 3 through 7 for UUT amplitudes of 1.6 volts peak-to-peak through 7.2 volts peak-to-peak in steps of 0.8 volts peak-to-peak.

9) Restore the output impedance specified at the function output of the UUT to 50 Ohms by sending the following command string to the UUT:
   "IMP 50 Ohm;"

Triangle Wave Linearity Verification

Test Setup

Connect the UUT, the oscilloscope, and the VX4240 Waveform Digitizer/Analyzer as shown in the diagram below. Use 50 Ohm coax cable to connect the UUT function output to the VX4240 input and to the oscilloscope channel 1 input. Select a 50 Ohm load on the oscilloscope channel 1 input.



Test Procedure

1) Initialize the UUT with the following command string:
"FREQ 10KHZ;WAVE TRI;AMPL 8 VPP;PHASE 90 DEG;"

This command instructs the UUT to output a 10 KHz triangle waveform with an amplitude of 8 volts peak-to-peak. The "PHASE 90;" command aligns the falling edge of the UUT's TTL output with the positive peak of the triangle waveform.

2) Initialize the VX4240 with the following command string:
"R;VD5;F1E6;CP50;ME-;T;"

This command instructs the VX4240 to:
Set its input voltage range to ±5 volts.

Sample its input every 1 microsecond.
Collect 50 samples after it is triggered.
Begin sampling on the falling edge of the signal applied to its external trigger input.
Arm the external trigger input.

3) Send a "Q;" command to the VX4240 and read its response until the string "S00011" is returned. This indicates that the VX4240 has been triggered and that it has finished collecting data.

4) Send a "I;" command to the VX4240, then read fifty values from the VX4240. Values are returned in ASCII floating point format.

5) Calculate a least squares fit of the 4th through 46th samples returned by the VX4240. Find the difference between each sample and the corresponding value of the least squares fit straight line. Express the greatest difference as a percentage of the peak-to-peak amplitude of the UUT waveform. This value must be less than or equal to 0.625 percent.

Pulse Waveform Duty Cycle Verification

Test Setup

Use the same test setup as in the triangle wave linearity verification.

Test Procedure

1) Initialize the UUT with the following command string:
   "FREQ 100KHZ;WAVE PULS 50;AMPL 5.5 VPP;IMP 25;"

   This command instructs the UUT to output a 100 KHz pulse waveform with a duty cycle of 50% and an amplitude of 5.5 volts peak-to-peak. A load impedance of 25 Ohms at the UUT function output is specified because the VX4240 is programmed to set its input impedance to 50 Ohms. This 50 Ohm load is in parallel with the 50 Ohm load of the oscilloscope.

2) Initialize the VX4240 with the following command string:
   "R;VD5F;F10E6;CP10000;MP0;"

   This command instructs the VX4240 to:
   Set its input voltage range to ±5 volts.
   Set its input impedance to 50 Ohms.
   Sample its input every 100 nanoseconds.
   Collect 10000 samples after it is triggered.
   Trigger on the positive edge of the signal applied to its input at a voltage of 0 volts.

3) Set the duty cycle of the UUT pulse waveform to 5% by sending it the following string: "WAVE PULS 5.0;"

4) Trigger the VX4240 by sending it a "T;" command.

5) Send a "Q;" command to the VX4240 and read its response until the string "S00011" is returned. This indicates that the VX4240 has been triggered and that it has finished collecting data.

6) Request the VX4240 to calculate and return the duty cycle of the UUT waveform by sending it a "AWD10000/0;" command and reading the response. The VX4240 will return three numbers in ASCII floating point format equal to the maximum, minimum, and average duty cycle of the UUT square wave. The floating point number representing the average duty cycle is preceded by the string "DA =". Verify that the difference between the average duty cycle and the duty cycle specified in step 3 is less than 1.5.

7) Repeat steps 3 through 6 for UUT duty cycles of 10% through 95% in steps of 5%.

8) Restore the output impedance specified at the function output of the UUT to 50 Ohms by sending the following command string to the UUT: "IMP 50 OHM;"

Positive Ramp Wave Linearity Verification

Test Setup

Use the same test setup as in the triangle wave linearity verification.

Test Procedure

1) Initialize the UUT with the following command string:
"FREQ 50KHZ;WAVE RAMP;AMPL 8 VPP;PHASE 0 DEG;"

This command instructs the UUT to output a 50 KHz positive ramp waveform with an amplitude of 8 volts peak-to-peak. The "PHASE 0;" command aligns the falling edge of the UUT's TTL output with the beginning of the positive slope portion of the ramp waveform.

2) Initialize the VX4240 with the following command string:
"R;VD5;F1E6;CP50;ME-;T;"

This command instructs the VX4240 to:
Set its input voltage range to ±5 volts.
Sample its input every 1 microsecond.
Collect 50 samples after it is triggered.
Begin sampling on the falling edge of the signal applied to its external trigger input.
Arm the external trigger input.

3) Send a "Q;" command to the VX4240 and read its response until the string "S00011" is returned. This indicates that the VX4240 has been triggered and that it has finished collecting data.

4) Send an "I;" command to the VX4240, then read fifty values from the VX4240. Values are returned in ASCII floating point format.

5) Calculate a least squares fit of the 4th through 46th samples returned by the VX4240. Find the difference between each sample and the corresponding value of the least squares fit straight line. Express the greatest difference as a percentage of the peak-to-peak amplitude of the UUT waveform. This value must be less than or equal to 0.625 percent.

Negative Ramp Wave Linearity Verification

Test Setup

Use the same test setup as in the triangle wave linearity verification.

Test Procedure

1) Initialize the UUT with the following command string:
"FREQ 50KHZ;WAVE RMPN;AMPL 8 VPP;PHASE 10 DEG;"

This command instructs the UUT to output a 50 KHz negative ramp waveform with an amplitude of 8 volts peak-to-peak. The "PHASE 10;" command aligns the falling edge of the UUT's TTL output with the beginning of the negative slope portion of the ramp waveform.

2) Initialize the VX4240 with the following command string:
"R;VD5;F1E6;CP50;ME-;T;"

This command instructs the VX4240 to:
Set its input voltage range to ±5 volts.
Sample its input every 1 microsecond.
Collect 50 samples after it is triggered.
Begin sampling on the falling edge of the signal applied to its external trigger input.
Arm the external trigger input.

3) Send a "Q;" command to the VX4240 and read its response until the string "S00011" is returned. This indicates that the VX4240 has been triggered and that it has finished collecting data.

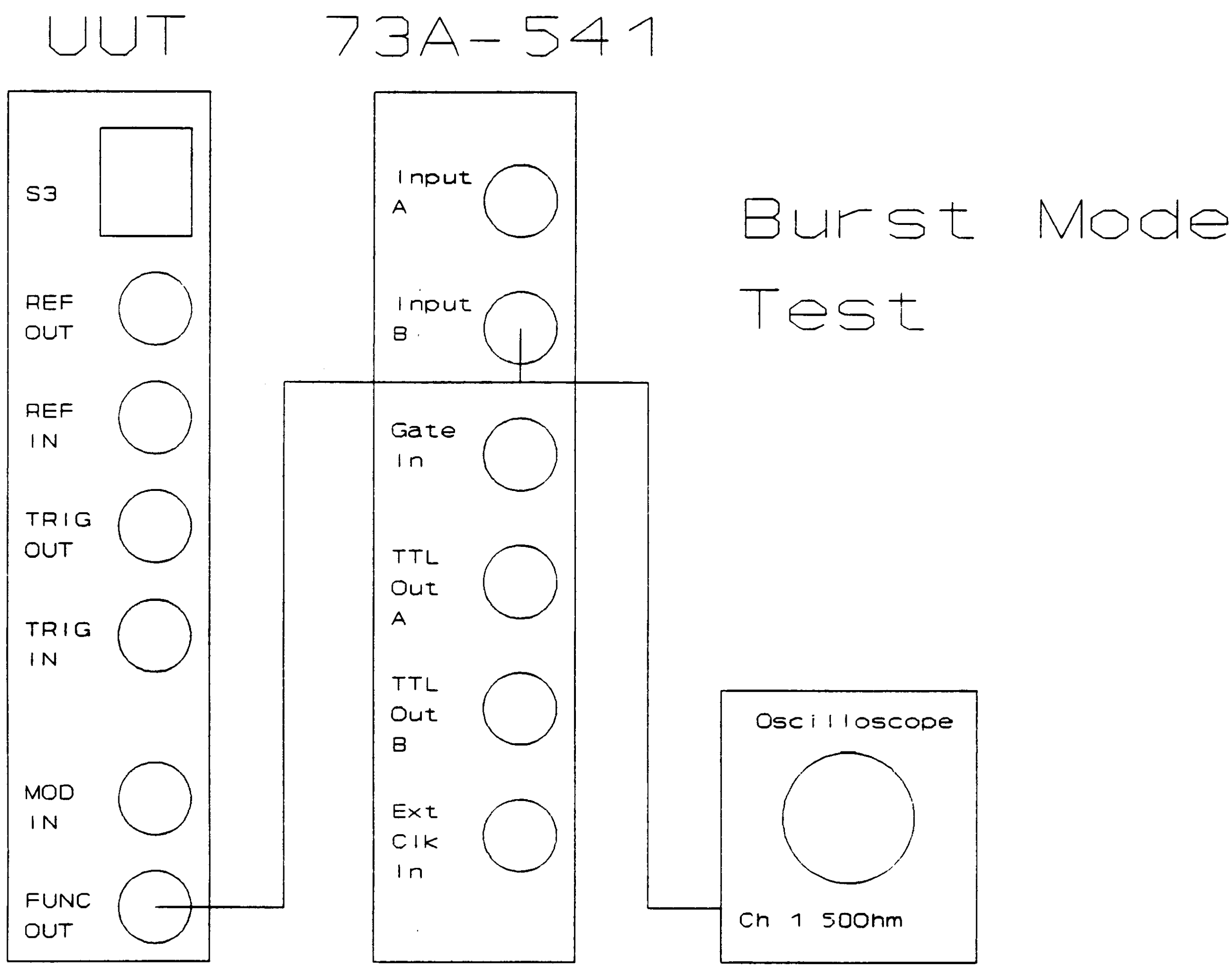
4) Send an "I;" command to the VX4240, then read fifty values from the VX4240. Values are returned in ASCII floating point format.

5) Calculate a least squares fit of the 4th through 46th samples returned by the VX4240. Find the difference between each sample and the corresponding value of the least squares fit straight line. Express the greatest difference as a percentage of the peak-to-peak amplitude of the UUT waveform. This value must be less than or equal to 0.625 percent.

High Frequency Burst Mode Verification

Test Setup

Connect the UUT, the oscilloscope, and the 73A-541 as shown in the following diagram. Use 50 Ohm coax cable for all connections.



Test Procedure

1) Initialize the UUT with the following command string:
"WAVE SINE;FREQ 10 MHz;AMPL 5.5VPP;BRST 1;IMP 25;"

This command instructs the UUT to output 1 cycle of a 10 MHz sine wave with amplitude of 5.5 V peak-to-peak when it is triggered. The load on the function output is set to 25 Ohms because the 50 Ohm loads of the oscilloscope and 73A-541 are in parallel.

2) Initialize the 73A-541 with the following command string:
"MM0;FN4;BT+200;BZ1;GI;IF17;"

This command sets the 73A-541 as follows:
Operate in basic timer/counter mode.
Return event count B when an input request is received.
Trigger when the signal applied to channel B is equal to +200 mV.
Set the input impedance of channel B to 50 Ohms.
Count until a "QM" command is received.
Limit the largest value to return to (2^17) -1.

3) Use the following command to set the burst count of the UUT to 535:
"BRST 535;"

4) Use the following command to initiate a measurement from the 73A-541:
"JM;"

5) Trigger the UUT by sending it the following command:
"TRIG;"

6) Wait for the UUT to finish outputting the number of waveform cycles specified in step 3.

7) Command the 73A-541 to stop counting events by sending it the following command: "QM;"

8) Read an integer value from the 73A-541. Verify that this value is exactly equal to the burst count specified in step 3.

9) Repeat steps 3 through 8 for burst counts of 1535 through 65535 in steps of 1000.

10) Restore the UUT to continuous output mode and set its output impedance to 50 Ohms by sending the following command: "BRST 0;IMP 50;"

Low Frequency Burst Mode Verification

Test Setup

Use the same test setup as for the high frequency burst mode verification.

Test Procedure

Use the same test procedure as for the high frequency burst mode verification, except in step 1, initialize the UUT with the following command:

"WAVE SINE;FREQ 300KHZ;AMPL 5.5VPP;BRST 1;IMP 25;"

This command instructs the UUT to output 1 cycle of a 300 KHz sine wave with amplitude of 5.5V peak-to-peak when it is triggered. The load on the function output is set to 25 Ohms because the 50 Ohm loads of the oscilloscope and 73A-541 are in parallel.

Arbitrary Waveform Burst Mode Verification

Test Setup

Use the same test setup as for the high frequency burst mode verification.

Test Procedure

Use the same test procedure as for the high frequency burst mode verification except in step 1, initialize the UUT with the following command:

"BRST 1;DAT 1,.7,.6,.5,-1,-.7,-.6,-.5;WAVE ARB;AMPL 5.5VPP;IMP 25;SPER 240NSEC;"

This command instructs the UUT to output 1 cycle of an eight point arbitrary waveform with a period of 1.92 μsec and an amplitude of 5.5V peak-to-peak when it is triggered. The load on the function output is set to 25 Ohms because the 50 Ohm loads of the oscilloscope and 73A-541 are in parallel.

Also in step 1 initialize the 73A-541 with the following command:

"MM0;FN4;BT+100;BZ1;GI;IF17;"

This setup of the 73A-541 is the same as in the high frequency burst mode verification except the trigger level is set to 100 mV.

Appendix D
Options

Option 30

The following is a description of the changes made to the operation and specifications of the VX4750 when it is ordered with Option 30.

1. The maximum frequency for the sine waveform is increased from 25 MHz to 32 MHz.

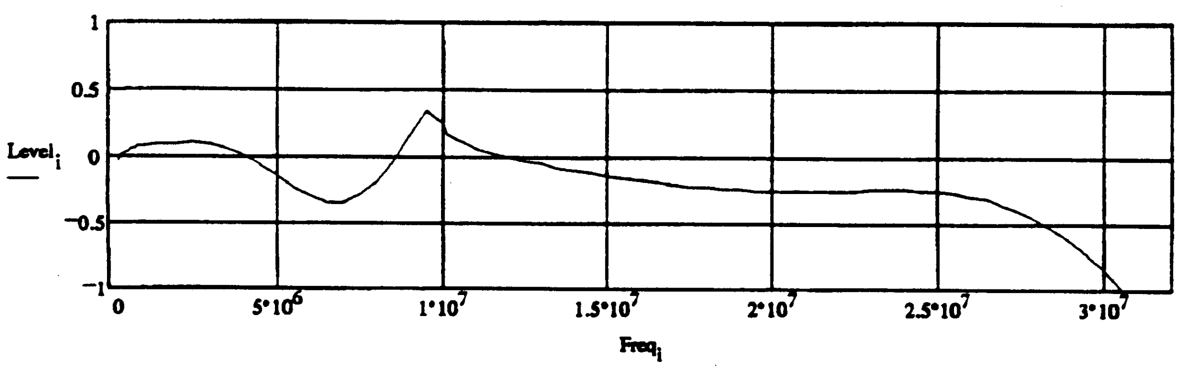
2. The range of a upper range frequency sweep is changed from 7 MHz - 25 MHz to 9.5 MHz - 32 MHz. This change applies to the sine waveform only.

3. In burst mode, a programmable number of waveform cycles is output to the function output when the VX4750 is triggered. This feature is operational for frequencies of 25 MHz or less.

4. If a BRST command is followed by a ISWP or LSWP command, a programmable number of frequency sweeps is output when the VX4750 is triggered. Stop frequencies of up to 32 MHz are allowed when the VX4750 is in this mode of operation.

5. Jitter on the TTL output increases (from 1 nsec at 25 MHz) to approximately 2 nsec at 32 MHz.

6. The amplitude flatness specification for frequencies of 0.001 Hz to 25 MHz remains ±0.5 dB. The flatness specification for frequencies of 25 MHz to 32 MHz is +.5/-2.5 dB. The figure below shows a plot of the amplitude flatness for a typical VX4750 with Option 30 installed. Freqency is in Hz, level is in dBm.



Option 04

The VX4750 Option 04 provides a second DE9 connector that takes the place of the VX4750 REF OUT, REF IN, TRIG OUT, AND TRIG IN BNC's to meet the requirements of *EC Council Directive 89/336/EEC.*

The following pages in this section contain illustrations and test set ups specific to the VX4750 Option 04. Refer to the Appendix C: Performance Verification section of this manual for verification instructions.

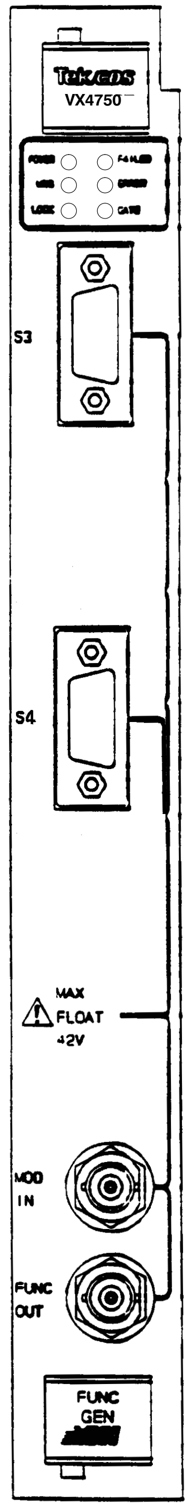


Figure 5: VX4750 Option 04 Front Panel

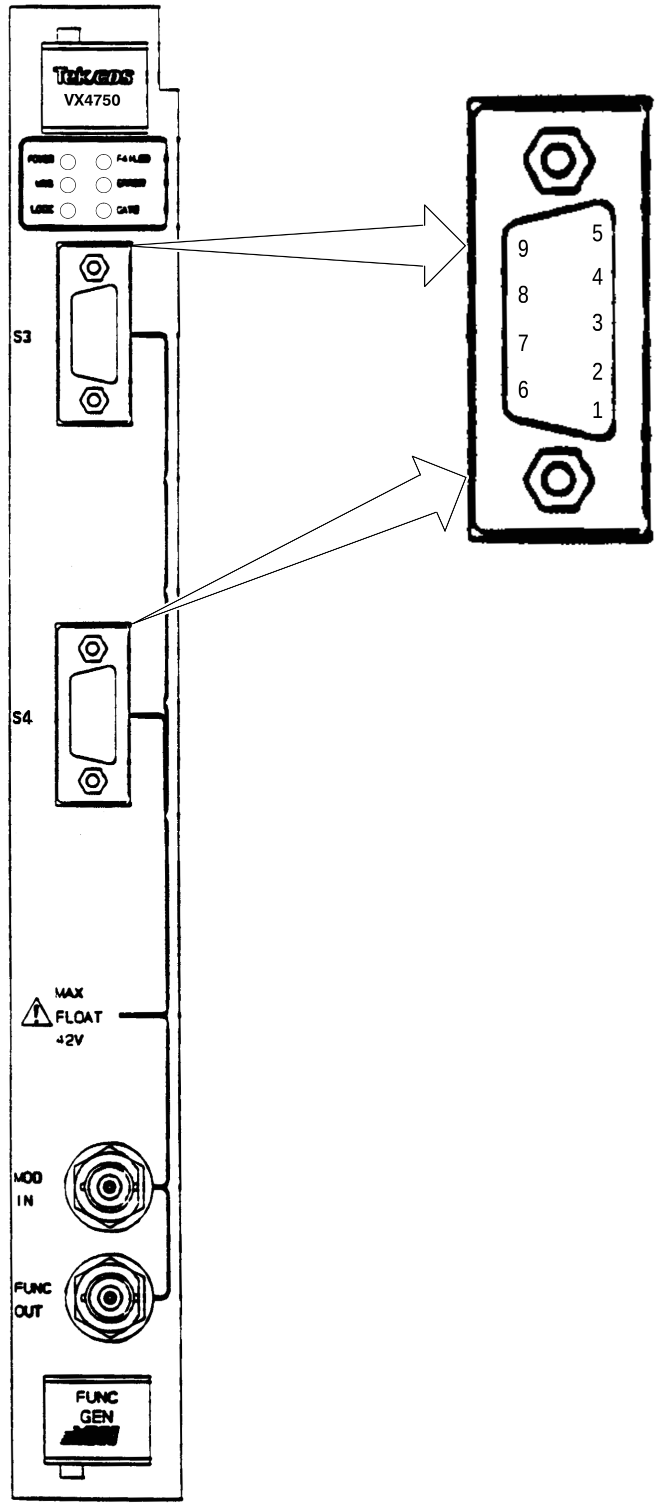


Figure 6: VX4750 Option 04 Front Panel Connectors

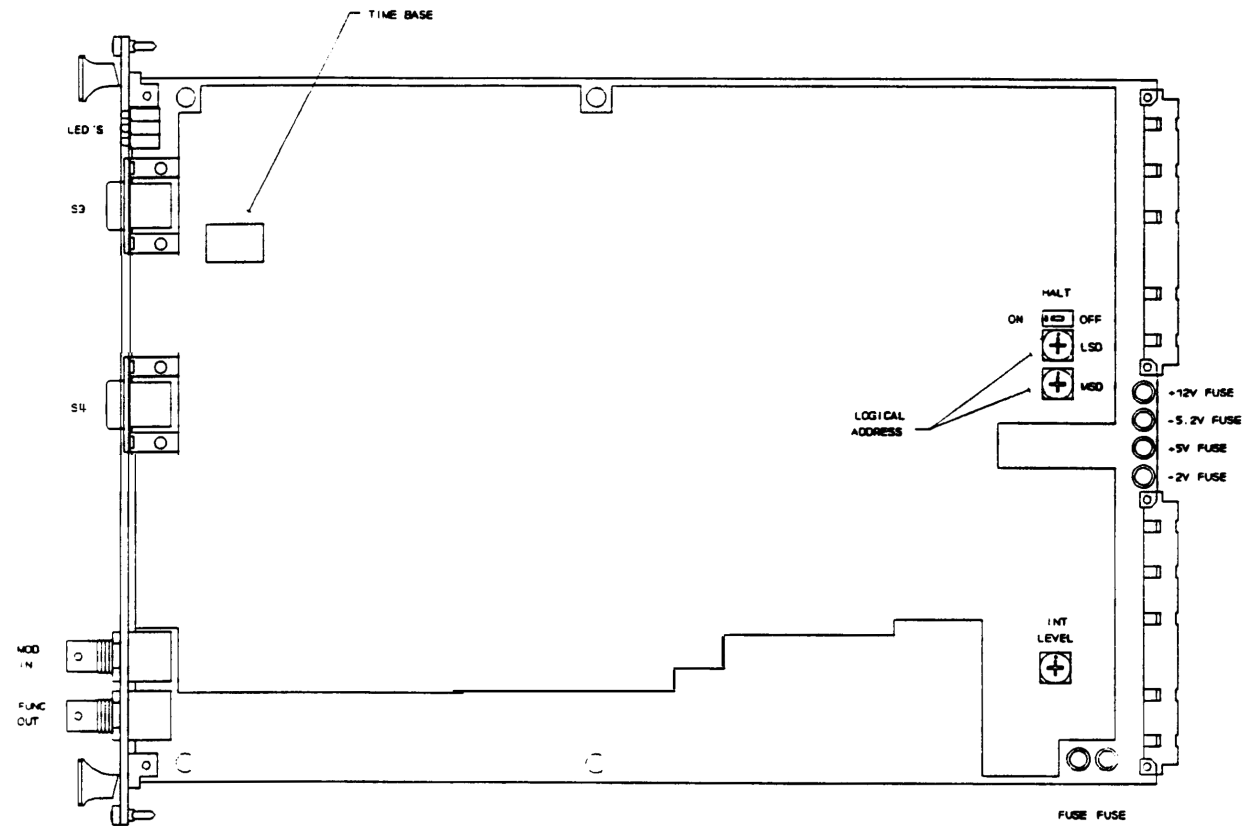


Figure 6: VX4750 Option 04 Controls and Indicators

Phase Accuracy Verification

Test Setup

Connect the UUT, a VX4750, the mixer, the low pass filter, and the DMM as shown in the diagram below. Use 50 Ohm coax cable for connections to the UUT, VX4750 and the mixer. Use twisted pair for S4 to S4 connections.

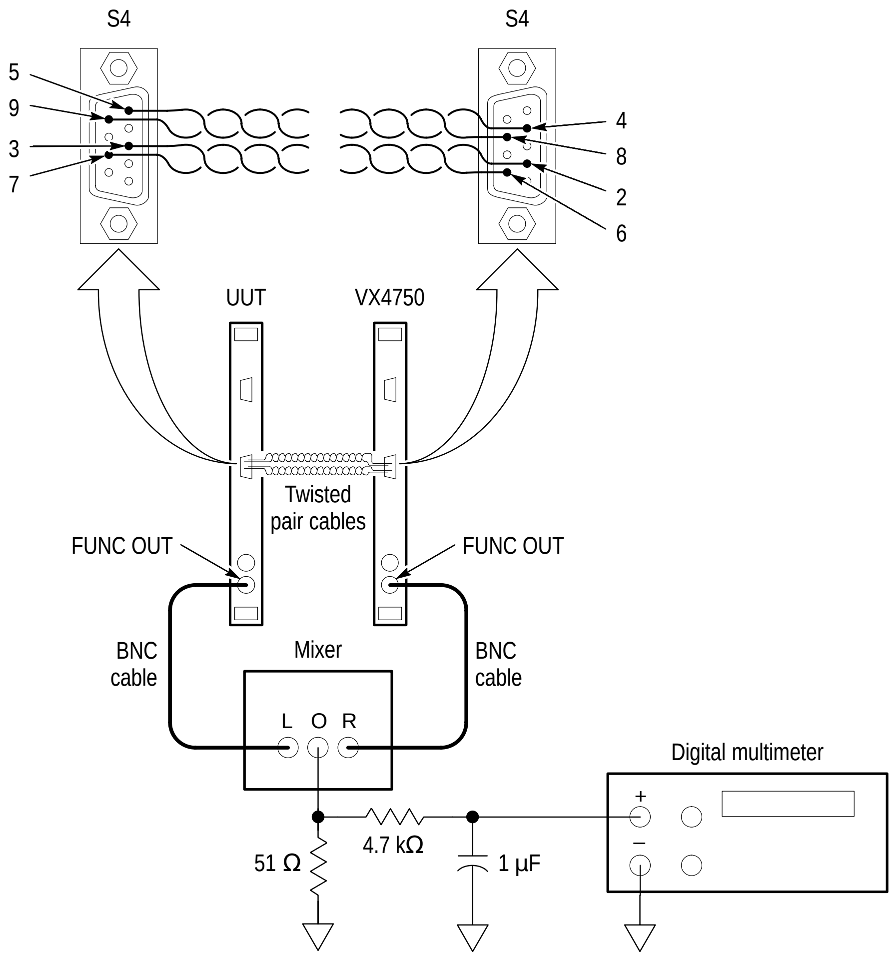


Figure 7: VX4750 Option 04 Phase Accuracy Setup

FM Modulation Frequency Deviation Verification

Test Setup

Connect the UUT, DC calibrator, oscilloscope, and frequency counter as shown in the following diagram. Select a 50 Ohm load on channel 1 of the oscilloscope.

Use 50 Ohm coax cable for all connections.

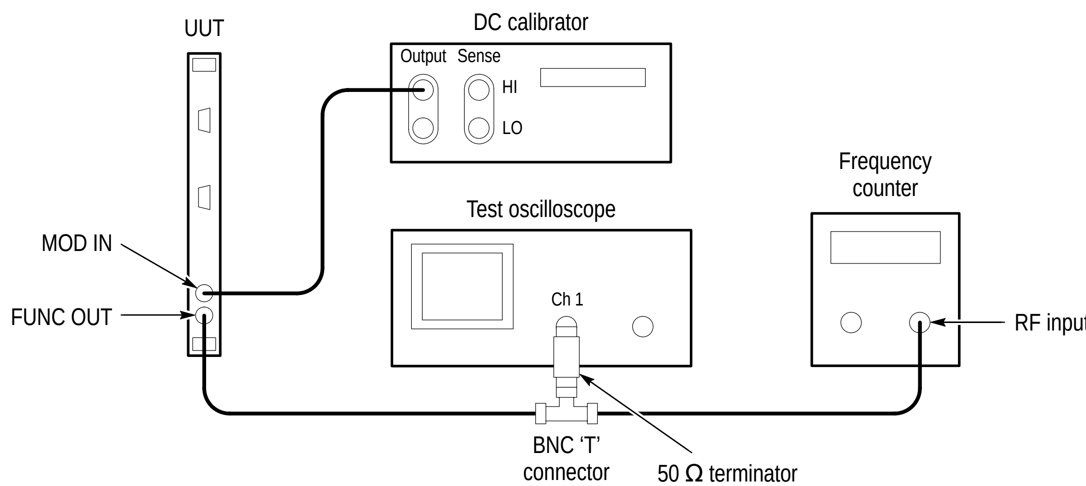


Figure 8: VX4750 Option 04 Modulation Frequency Verification Setup

AM Modulation Index Verification

Test Setup

Connect the UUT, VX4240, DC calibrator and oscilloscope as shown in the following diagram. Select a 50 Ohm load on channel 1 of the oscilloscope.

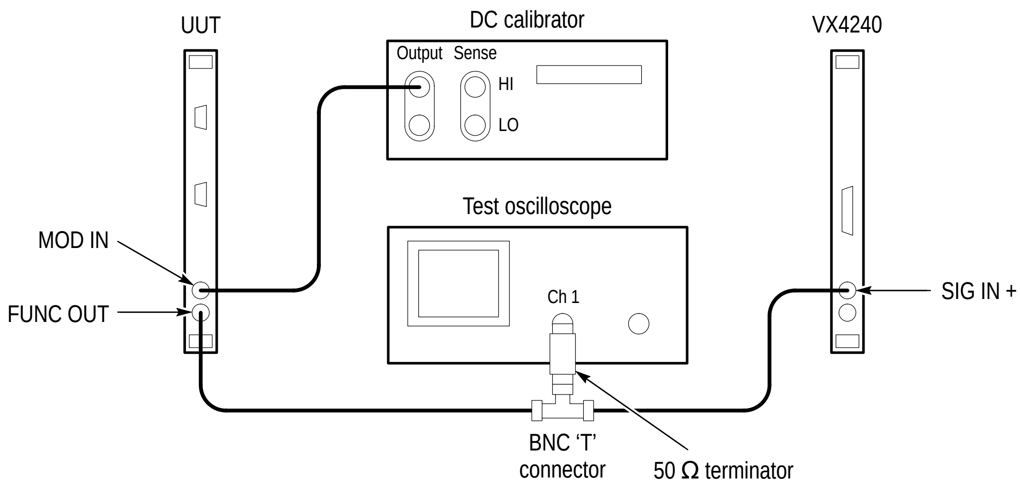


Figure 9: VX4750 Option 04 Modulation Index Verification Setup

PM Modulation Phase Deviation Verification

Test Setup

Connect the UUT, a VX4750, the mixer, the low pass filter, the DMM and the DC calibrator as shown in the diagram below. Use 50 Ohm coax cable for connections to the UUT, VX4750, and mixer. Use twisted pair for S4 to S4 connections.

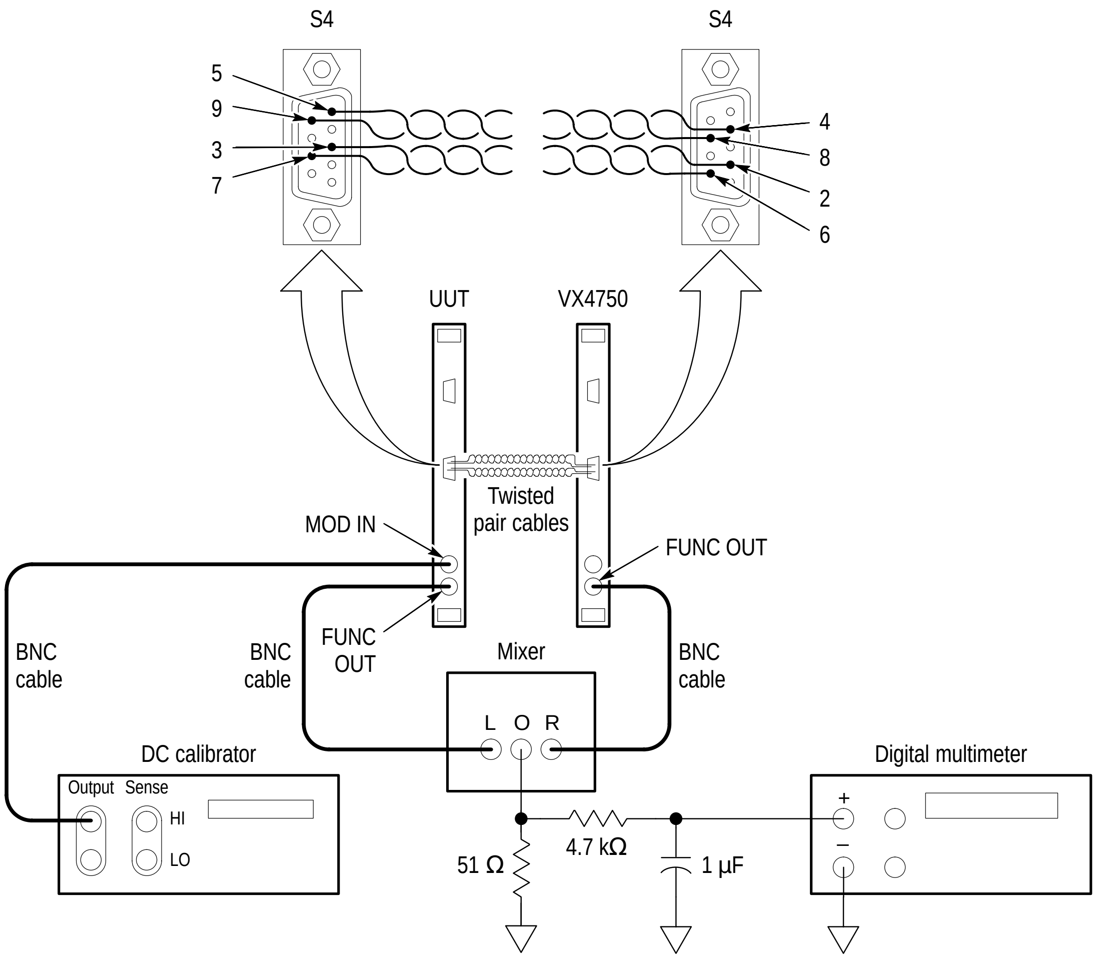


Figure 10: VX4750 Option 04 Modulation Phase Verification Setup

Internal Linear Frequency Sweep Verification

Test Setup

Connect the UUT, the oscilloscope, and the VX4240 as shown in the following diagram.

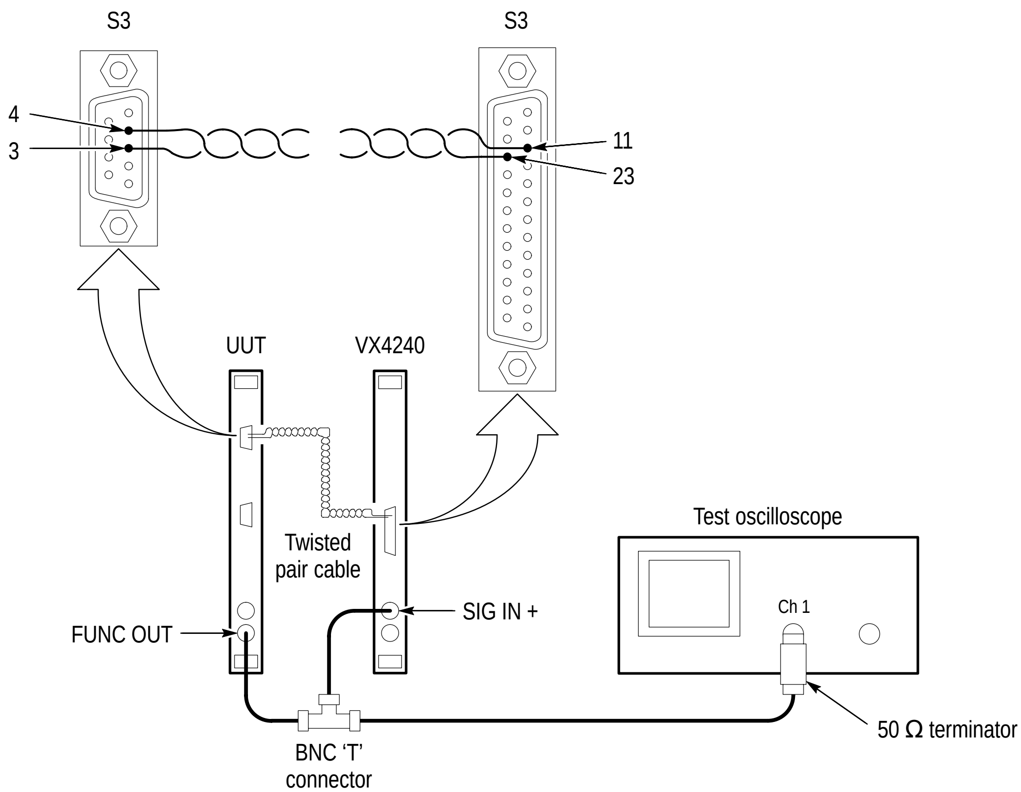


Figure 11: VX4750 Option 04 Internal Linear Frequency Sweep Verification Setup

Appendix E
User Service

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

- Preventive maintenance
- User-replaceable Parts

Preventive Maintenance

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

1. Turn off power and remove the module from the VXIbus mainframe.
2. Remove loose dust on the outside of the instrument with a lint-free cloth.
3. Remove any remaining dirt with lint-free cloth dampened in a general purpose detergent-and-water solution. Do not use abrasive cleaners.

User-Replaceable Parts

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

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

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

User-Replaceable Parts

Part Description	**Part Number**
User Manual	070-9151-XX
Label	**950-9158-XX**
Fuse, Micro 4 Amp 125 V Fast	159-0374-00
Fuse, Micro 1 Amp 125 V Fast	159-0116-00
Shield, Front	**950-1327-XX**
Screw, Phillips Metric 2.5 X 16 FLHD SS	**211-0867-00**

Appendix F
Adjustment and Calibration

The module is fully calibrated when shipped from the factory. No adjustments are required.

It is recommended that the verification procedures be run once a year. **If any of the parameters are out of specification, please contact your local Tektronix field office or representative for repair assistance.**

Appendix G

VXI Glossary

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

DTB See Data Transfer Bus.

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

DUT Device Under Test.

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

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

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

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

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

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

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

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

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

Interface Device — A VXIbus device that provides one or more interfaces to external equipment.

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

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

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

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

Local Controller — The instrument module that performs system control and external interface functions for the instrument modules in a VXIbus mainframe or several mainframes. See Resource Manager.

Local Processor — The processor on an instrument module.

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

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

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

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

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

MODID Lines — Module/system identity lines.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SMP See Shared Memory Protocol.

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

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

STST STart/STop protocol; used to synchronize modules.

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

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

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

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

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

Test Monitor	An executive routine that is responsible for executing the self tests, storing any errors in the ID-ROM, and reporting such errors to the Resource Manager.
Test Program	A program, executed on the system controller, that controls the execution of tests within the test system.
Test System	A collection of hardware and software modules that operate in concert to test a target DUT.
TTLTRG	Open collector TTL lines used for inter-module timing and communication.
VXIbus Subsystem	One mainframe with modules installed. The installed modules include one module that performs slot 0 functions and a given complement of instrument modules. The subsystem may also include a Resource Manager.
Word Serial Protocol	A VXIbus word oriented, bi-directional, serial protocol for communications between message-based devices (that is, devices that include communication registers in addition to configuration registers).
Word Serial Communications	Inter-device communications using the Word Serial Protocol.
WSP	See Word Serial Protocol.
10-MHz Clock	A 10 MHz, ±100 ppm timing reference. Also see CLK10.
100-MHz Clock	A 100 MHz, ±100 ppm clock synchronized with CLK10. Also see CLK100.
488-To-VXIbus Interface	A message based device that provides for communication between the IEEE-488 bus and VXIbus instrument modules.

PM Sets the mode of the external modulation input to phase modulation. Specifies the maximum phase deviation. (3 - 45)

PSK Encode data on the output waveform using phase shift keying modulation. (3 - 46)

PWM Set the mode of the external modulation input to pulse width modulation. Specify the maximum duty cycle deviation from 50%. (3 - 48)

REFI Selects a frequency reference source. (3 - 49)

REFO Selects a 10 MHz or 33 MHz reference to be output to the front panel reference output connector. (3 - 50)

REV? Return the revision level of the VX4750 firmware. (3 - 51)

RST Reset the module to its power-up state. (3 - 52)

SPER Specify the sample period to use when generating an arbitrary waveform. (3 - 53)

SPER? return the current arbitrary waveform sample period setting. (3 - 54)

SWP OFF Disable a frequency sweep initiated by the ISWP, LSWP, or XSWP commands. (3 - 55)

TRGI Select a VXI TTL trigger as an input trigger source. Set the polarity of the front panel trigger input. (3 - 56)

TRGO Select a VXI TTL trigger signal to drive. Set the polarity of the front panel trigger output. (3 - 58)

TRIG Trigger the VX4750 to output a previously defined waveform. (3 - 59)

XSWP Set the mode of the external modulation input to frequency sweep. Define the start and stop frequencies of the sweep. (3 - 61)

WAVE Specify the type of waveform the output to the function output. (3 - 60)

XSWP? Return the start and stop frequencies used in the generation of an external frequency sweep. (?)

VX4750 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 VX4750 Module after the completion of power-up self test is:

Waveform	Sine
Frequency	1 KHz
Amplitude	150 mV
Phase	0 deg
Offset	0V
Burst count	0 (continuous operation)
External modulation	Off
Internal modulation	Off
Internal sweep	Off
VXI TTL triggers	disabled
Assumed load on function output	50 Ohms
Frequency reference input	Internal 10 MHz reference
Reference applied to REF OUT connector	Internal 33 MHz clock
Polarity of signal applied to TRIG IN connector	Active low

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
GATE	the Function output of the VX4750 is enabled. Cleared when the Function output is gated off.
PHASE LOCK	the high-frequency phase-locked loop is locked.

SYSTEM COMMANDS

These non-data commands are initiated by the VX4750's commander. The following VXIbus Instrument Protocol commands will affect the VX4750:

ABORT NORMAL OPERATION	END NORMAL OPERATION
ASYNCHRONOUS MODE CONTROL	READ INTERRUPTER LINE
BEGIN NORMAL OPERATION	READ INTERRUPTERS
BYTE AVAILABLE	READ PROTOCOL
BYTE REQUEST	READ PROTOCOL ERROR

(Option 04 REF OUT and TRIG IN connector at S4.)

CLEAR
CLEAR LOCK
CONTROL EVENT
TRIGGER
READ STATUS BYTE
RESPONSE ENABLE
SET LOCK

COMMAND SYNTAX

Command protocol and syntax for the VX4750 Module is as follows: (3 - 3)

1) Each command consists of a single line of characters. Parameters may not be "wrapped around". Every command must end with a line feed <LF> or semicolon. Carriage returns <CR> are optional before line feeds or semicolons.

2) If a character is not enclosed by brackets, that character itself is sent, otherwise:
   [ ] encloses the symbol for the actual argument.
   ( ) optional parameters or characters
   <CR> = carriage return; <LF> = line feed. <TM> terminator: a line feed or a semicolon.

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

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

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

MODULE COMMANDS

AM Set the mode of the external modulation input to amplitude modulation and set the AM modulation index. (3 - 7)

AMPL Specify the amplitude of the function output. (3 - 8)

AMPL? Returns the current amplitude of the function output. (3 - 9)

BRST Sets the burst count (the number of cycles of the selected waveform to output. (3 - 10)

BRST? Return the current burst count. (3 - 11)

BUF Place the module in buffered mode. (3 - 12)

DAT Load data into the module for use in generating arbitrary waveforms. (3 - 13)

DFREQ Change the output frequency by a specified amount in a phase continuous manner. (3 - 15)

DINT Disable VXI event generation from the module. (3 - 17)

DPHAS Change the phase of the output waveform by a specified number of degrees in a phase continuous manner. (3 - 18)

ERR? Report any error conditions. (3 - 20)

FILT Enable or disable a low pass filter to the output waveform. (3 - 25)

FM Set the mode of the external modulation input to frequency modulation. Specify the peak frequency deviation. (3 - 26)

FREQ Specify the frequency of the output waveform. (3 - 27)

FREQ? Return the frequency specified in the most recent valid FREQ command. (3 - 29)

FSK Set the mode of the front panel trigger input or selected VXI TTL trigger to FSK modulation. Specify the upper and lower FSK frequencies. (3 - 30)

FSK? Return the upper and lower frequencies selected by the front panel trigger input or selected VXI TTL trigger when it is programmed for external FSK modulation. (3 - 31)

IMP Specify the load impedance to be driven by the function output. (3 - 32)

INT Enable VXI event generation from the module. (3 - 33)

IST Initiate a self test. (3 - 34)

ISWP Specify parameters to be used in generating an internal linear frequency sweep of the output waveform. (3 - 35)

LSWP Sweep the frequency of the output waveform from a specified start frequency to a specified stop frequency. (3 - 37)

NBUF Places the module in nonbuffered mode. (3 - 39)

OFST Specifies the dc offset of the output waveform. (3 - 40)

OFST? Returns the current dc offset of the output waveform. (3 - 41)

PHAS Specifies the phase of the output waveform. (3 - 42)

PHAS? Returns the current phase of the output waveform. (3 - 44)