73A-455 MIL-STD-1553A/B BUS SIMULATOR MODULE DESCRIPTION

INTRODUCTION

The 73A-455 Module is a printed circuit board assembly for use in a card cage conforming to the VXIbus Specification, such as the 73A-021 used in the CDS 73A IAC System. It allows the system controller in an ATE system to communicate with and test devices that conform to the MIL-STD-1553A/B data bus now being used in many military aircraft and communications systems.

The 73A-455 Module consists of two identical VXIbus instruments in a single-slot VXIbus C-size package. Each of the two separate and independent channels, labeled A and B, has its own VXIbus logical address, its own interrupt, and a complete set of controls and indicators.

NOTE: Each channel of the 73A-455 is truly an independent instrument. Therefore, not only must each separate channel be completely programmed, but all switches on each channel must be properly set. Failure to do so could affect the proper operation of the 73A-455. In addition, the user should pay close attention to proper wiring if any of the 73A-455's auxiliary inputs and outputs are used.

Since each channel must be individually programmed, the descriptions in this manual should be taken to apply to either channel of the module. For example, one of the channels could be set to the 1553 Bus Controller Simulator mode of operation, and the other to 1553 Bus Monitor mode operation.

The 73A-455 Module offers three modes of operation for each channel:

- 1553 Bus Controller (BC) Simulator
- 1553 single or multiple Remote Terminal (RT) Simulator
- 1553 Bus Monitor

In the Bus Controller Simulator mode, each channel of the 73A-455 has the ability to communicate with any or all of the 32 remote terminals (31 real devices plus broadcast mode) specified by MIL-STD-1553A/B. Each channel is loaded by the system controller with a bus controller message sequence list and data lists for each RT to be addressed. When instructed to do so by the system controller, the selected 73A-455 channel transmits pre-programmed messages to the respective RT(s). Any response data received from the RT is stored in on-card memory for that channel.

In the RT Simulator mode, each channel of the 73A-455 Module can simultaneously emulate any or all of the different RTs. The system controller preloads the 73A-455 with the appropriate response data and status words for each simulated RT. Data received from the 1553 bus by the 73A-455 is stored in on-card memory for that channel for later evaluation.

In the Bus Monitor mode, the selected channel of the 73A-455 Module assumes an essentially passive role; it simply observes and stores all bus traffic. Up to 30,000 data, command, or status words can be

stored in channel memory for later evaluation.

The 73A-455 allows introducing controlled errors into the transmitted data stream for each channel to provide worst-case testing of 1553 bus devices. These errors include incorrect parity, erroneous 1553 Manchester encoding, zero crossing errors of ±150 ns, dropped data bits, interword data gaps, incorrect or invalid 1553 sync patterns, incorrect RT response times, incorrect number of data bits per word, incorrect number of words per message, invalid signal levels, and common-mode signal injection.

On received data, the 73A-455 Module can distinguish between incorrect transition time errors, Manchester errors, dropped data-bit errors, bit count errors, parity errors, incorrect sync errors, terminal response time errors, interword data-gap errors, word count errors, and message format errors such as incorrect RT address, missing RT response, invalid status words, invalid mode code usage, and invalid broadcast mode usage.

The 73A-455 Module self test capability is programmable with a single command. Each channel is tested independently.

Each channel of the module is programmed by sending ASCII characters to the 73A System from the system controller. Data is also returned to the system controller as ASCII characters.

Depending on the context, the two components of the 73A-455 may be referred to in this manual as VXIbus instruments, module channels A and B, or 1553 channels.

Note that certain terms used in this manual have very specific meanings in the context of a VXIbus System. A list of these terms is presented in the VXIbus Glossary (Appendix C).

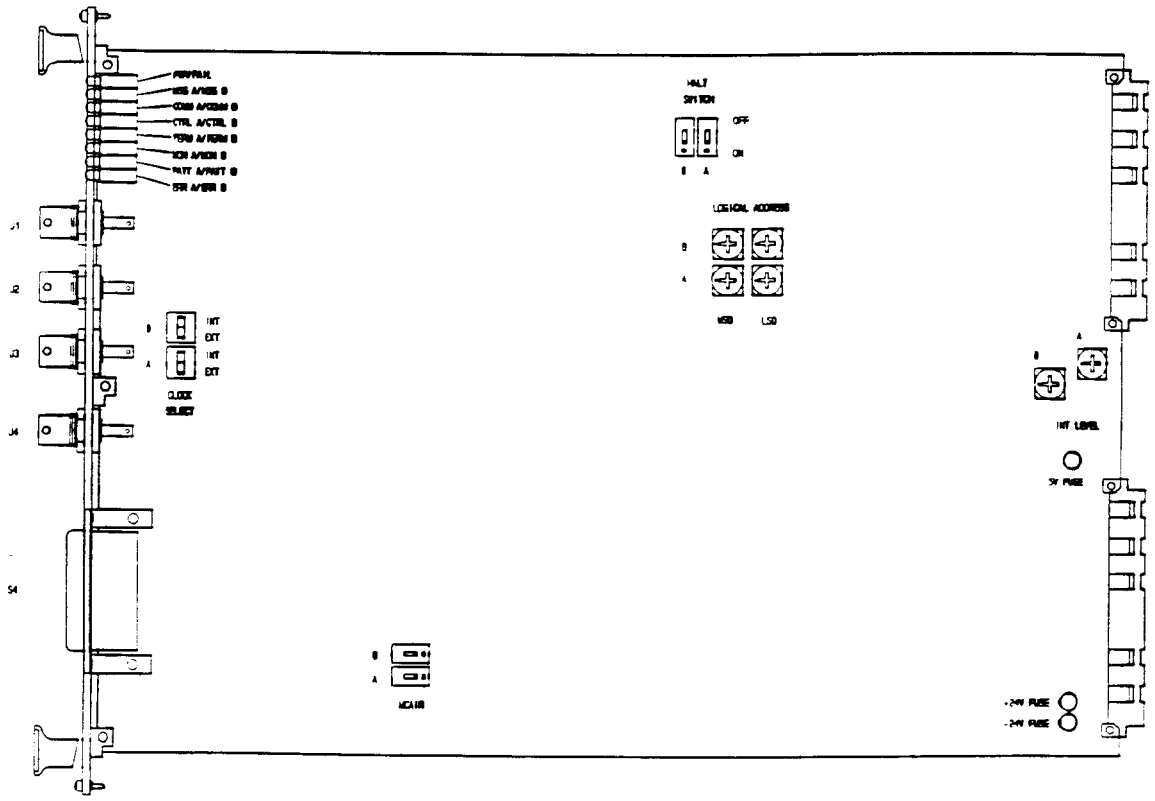


Figure 455-1: 73A-455 Controls and Indicators

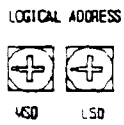
CONTROLS AND INDICATORS

The following controls and indicators are provided to select and display the functions of the 73A-455 Module's operating environment. See Figure 455-1 for their physical locations.

NOTE: Each channel of the module has a complete and separate set of controls and indicators. The switches and controls for the "A" channel (connected to the output connectors labeled "A" on the front panel) are connected to the bottom board and are furthest away from the shield when the module is viewed from the component side.

- **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 each channel of the 73A-455 is set to a value between 1 and FEh (254d) by two hexadecimal rotary switches. There are two sets of these switches, one for each channel, located in the upper rear quadrant of the module.

CAUTION:

The two logical channels that comprise the 73A-455 should never be assigned the same logical address. In an IEEE-488 application, if you override the IEEE-488 address assigned by the slot 0 module, do not assign the same address to the two channels.

The actual physical address of each channel of the 73A-455 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 channel 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 73A-455 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 73A-455 is being used in a CDS IEEE-488 IAC system, consult the operating manual of the CDS 73A-1XX Series slot 0 embedded controller or IEEE-488 Interface Module.

If the 73A-455 is being used in a MATE system, VXIbus logical addresses are converted to IEEE-488 addresses using the algorithm specified in the MATE IAC standard (MATE-STD-IAC). This algorithm is described in detail in the 73A-156 Operating Manual.

If the 73A-455 is not being used in a CDS IAC System, consult the operating manual of the IEEE-488 interface device being used for recommendations on setting the module's logical address(es).

VMEbus Interrupt Level Select Switch

Each function module in a VXIbus System can generate an interrupt on the VMEbus to request service from the interrupt handler located on its commander (for example, the 73A-151B RM/IEEE-488 Interface module in a CDS 73A-IBX System). The VMEbus interrupt level on which a given channel of the 73A-455 Module generates interrupts is set by one of two BCD rotary switches located at the center rear of the module. Align the desired switch position for each channel to the arrow on the module shield.

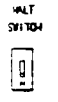
Valid Interrupt Level Select switch settings are 1 through 7, with setting 1 equivalent to level 1, etc. The level chosen should be the same as the level set on the interrupt handler for each channel of the 73A-455, typically the module's commander. Setting the switch to an invalid interrupt level (0, 8, or 9) will disable the module's interrupts.

When using the 73A-455 in a CDS 73A-IBX System, set the interrupt level for each channel to the same level chosen for the 73A-151.

If the 73A-455 is being used as part of a 73S-456 MIL-STD-1553A/B Bus Tester Instrument Set, consult the 73S-456 Operating Manual for information on setting the switch for each channel.

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



These two-position slide switches, located near the top rear of the module, select the response for each channel of the 73A-455 Module when the Reset bit in the module's VXIbus Control register is set.

If the Halt switch is in the ON position, then that channel of the 73A-455 Module is reset to its power-up state and all programmed parameters for that channel are reset to their default values.

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

NOTE: The module (or channel) is not in strict compliance with the VXIbus Specification when the Halt switch for that channel is in the OFF position.

Control of the Reset bit depends on the capabilities of the 73A-455's commander. In a CDS 73A-IBX System, for example, the Reset bit is set if the 73A-151 RM/IEEE-488 Interface Module receives a STOP command through the IEEE-488 bus.

Clock Select Switch

These two-position rocker switches are located on the side of the module near the center front. They select either internal or external data clock for a channel of the module. In the INT position, the internal data clock is selected, and the 1553 bus data rate is 1 MHz. When the switch is in the EXT position, an external 16-MHz data clock is selected. The external clock can be varied over the frequency range of 15 MHz to 17 MHz, allowing the 1553 bus data rate to be varied from 937.5 KHz to 1.0625 MHz.

MAC Air Switch

These slide switches are located on the side of the module near the bottom edge. When a channel's switch is in the OFF position, the rise and fall times of data generated by that channel of the 73A-455 Module will be between 150 and 250 nanoseconds with two 70-ohm bus terminations. When the switch is in the ON position, the rise and fall times

of generated data will be between 220 and 350 nanoseconds with two 70-ohm bus terminations.

- **Fuses**

The 73A-455 Module has fuses for +5V, +24V, and -24V. The fuses protect the module in case of an accidental shorting of the power bus or any other situation where excessive current might be drawn.

Each of the three fuses is shared by both instruments in the 73A-455. The +24V and −24V fuses are 2A socketed fuses. The +5V fuse is a 7A soldered fuse.

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

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

- **LEDs**

The following LEDs are visible at the top of the 73A-455 Module's front panel to indicate the status of the module's operation. See Figure 455-2.

The PWR and FAIL LEDs indicate the status of the entire 73A-455 Module. The remaining LEDs indicate the status of either Bus A or Bus B.

PWR LED

This green LED is normally lit and is extinguished when the +5 volt, ±24 volt, or internal ±15 volt power supplies fail.

FAIL LED

This normally off red LED is lit whenever SYSFAIL* is asserted, indicating a module failure due to loss of a power rail.

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

The 73A-455 Module has two of all of the following LEDs located on its front panel, one for the "A" channel and one for the "B" channel. Since the two channels are identical and separate, the descriptions for each LED apply equally to both channels.

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.

COMM LED

The COMM LED lights when the 73A-455 Module has been triggered to begin communication on the 1553 bus. When not lit, it indicates that the 73A-455 Module is available for data or command transactions with the ATE system controller.

Function LEDs

Three function LEDs indicate which mode of operation has been selected for the channel. The CTRL LED is lit when the card is programmed to be in the Bus Controller Simulator mode, the TERM LED is lit for RT Simulator mode, and the MON LED is lit for the Bus Monitor mode.

PATT LED

The PATT LED will light immediately after a T command has been issued unless a P command was previously issued to the 73A-455 Module; in this case, it will light when the command or status word pattern specified by the P command is received from the 1553 bus.

ERR LED

This amber LED lights whenever the 73A-455 Module detects a syntax error in the data received from the system controller. After the system controller interrogates the error (with an E command), the light will go out. This LED is typically used as a debugging aid during software development.

BITE (Built-In-Test Equipment)

The TEST command (see Operation section) provides a complete RAM and ROM self test for each channel. In addition, the front panel LEDs light in sequence to provide visual indication of the test in progress.

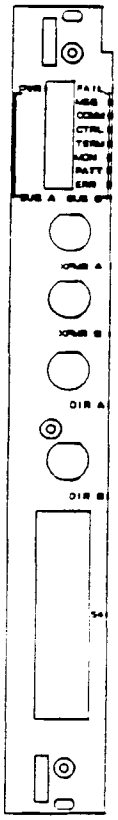


Figure 455-2: Front Panel

GLOSSARY

A glossary of VXIbus terms is provided in Appendix C. In addition, the following terms specific to the 73A-455 Module are defined:

Bus Communications Sequence

The 73A-455 Module is said to be performing a Bus Communications Sequence during the time the card is transmitting or receiving data over the 1553 data bus. A Bus Communications Sequence is initiated when the 73A-455 receives a T (Trigger) command from the system controller.

In the Bus Controller Simulator mode, a Bus Communications Sequence is completed when all messages specified by the Bus Controller Sequence List have been transmitted the number of times required by the T command.

In the RT Simulator mode, a Bus Communications Sequence is completed when the total number of messages specified by the T command have been received.

In the Bus Monitor mode, the Bus Communications Sequence is completed when a Q command or an External Halt Input is received by the 73A-455.

Bus Controller

The single device attached to the 1553 data bus that is assigned the task of initiating information transfers on the bus.

Bus Controller Sequence List

This list specifies the order in which messages are transmitted in the Bus Controller Simulator mode.

Command Word

A 16-bit word sent by the bus controller to identify or address the RT to be involved in a bus transaction. It also specifies whether the terminal will be transmitting or receiving data.

Data List

An individual data list may be defined for each of the transmit buffers (up to 32) provided on each channel of the 73A-455 Module. When the module is in the Bus Controller Simulator mode, an individual data list contains the command and data words to be sent from a specific buffer. When the module is in the RT Simulator mode, an individual data list contains the status and data words a simulated RT will return to the bus controller.

Data Word

A 16-bit word containing the actual data in a 1553 bus transaction.

Message or Message Block

The combined transaction (command, status, and data) associated with one command word.

Remote Terminal (RT)

One of up to 31 devices connected to the 1553 data bus that is capable of sending data to or receiving data from the bus controller.

RT Response Time List

When the 73A-455 Module functions as an RT simulator, the card is preloaded with a list of RT response times to be used when responding to each command word received from the bus controller. RT response time values are used from the RT Response Time List in sequential order, regardless of the RT numbers addressed by the incoming command words.

RT Response Time or Response Time Gap

The response time of an RT is the time in microseconds between the middle transition of the parity bit of the last command or data word received by the RT and the middle transition of the sync pattern in the status word transmitted by the RT.

Status Word

A 16-bit word returned by an RT after being addressed by the bus controller.

System Controller

The test system computer providing control and data information to the 73A System via a suitable communications link (IEEE-488, etc.)

Word

A 1553 word is a sequence of 20 bit-times consisting of a sync pattern of three bit-times, followed by 16 bits of data and one bit of parity. Though each word is 20 bit-times in length, a word contains only 16 bits of data and is commonly referred to as a 16-bit word. The three types of 1553 words are: command words, status words, and data words.

SPECIFICATIONS

Instrument Specifications

These specifications apply equally to both the "A" and "B" instrument channels.

Configuration:	MIL-STD-1553 Bus Controller Simulator, single or multiple RT Simulator, or Bus Monitor.
1553 Bus Coupling:	
Direct Coupling:	1:1 turns ratio, 55-ohm isolation resistor each leg.
Transformer Stub Coupling:	1:0.707 turns ratio.
Operating Modes:	
Bus Controller Simulator:	Programmable for 32 separate data lists.
RT Simulator:	Programmable for data collection and response from 32 separate RT associated buffers.
Bus Monitor:	Collects all data on bus in single buffer, receive-only mode.
Buffer Capability:	30,000 22-bit words - 16 bits data, 6 bits error/sync code. Can be allocated between 32 transmit buffers, 32 receive buffers, and a single Bus Controller Sequence List or RT Response Time List. Allocation is totally user-controlled.
1553 Analog Output:	Level-programmable to approximately 250 different levels.
Range:	Voltage range depends on the bus loading. Differential voltage level output range for the following bus loads is: 35 ohms, direct-coupled output 0.20 to 8.20 V ptp. 70 ohms,direct-coupled output 0.30 to 13.75 V ptp. 1000 ohms, direct-coupled output 0.75 to 34.40 V ptp. 70 ohms, transformer-coupled output, 0.60 to 24.2 V ptp. At 1553 bus with two 70 ohm terminators, either direct-coupled direct connection or transformer-coupled through MIL-STD-1553 coupler. 0.20 to 8.20 V ptp. The above levels are for the MAC Air switch in the OFF position. With the MAC Air switch in the ON position, the peak-to-peak levels are approximately 10% higher than shown.
Accuracy:	±0.3 V ptp with 35 and 70 ohm loads.

Noise Content:	50 mV ptp.
Current Drive:	260 mA RMS maximum, direct-coupled output. 380 mA RMS maximum, transformer-coupled output.
Short-circuit Protection:	The direct-coupled output may be shorted for several minutes without degradation of the transmitter. The transformer-coupled output should not be shorted. Shorting may cause damage to the module.

1553 Analog Input:

Maximum Input:	40 V ptp differential.
Threshold:	Programmable to approximately 250 different levels. Programmable from 0.50 to 9.00 V ptp at direct-coupled input (equivalent to 0.35 to 6.36 V ptp at transformer-coupled input).
Transition Time Error Detection:	Time from one threshold crossing to the next threshold crossing is nominally expected to be 0.5, 1.0, 1.5 or 2.0 microseconds, per MIL-STD-1553. The receiver checks that this time is reliably within 62.5 nanoseconds of the nominally expected time.
Word Format:	Manchester bi-phase, self-clocking, 1 MHz, 20-bit word with command/data sync, data, and parity bits, per MIL-STD-1553A/B.
Message Format:	Programmable command or status word plus user-defined number of data words per message.
Message Capability:	Any number of messages may be specified for transmittal or receipt, subject only to a constraint on available buffer memory (30,000 words). A message requires one word of buffer memory for each command, status, or data word transmitted or received. In the Bus Controller Simulator mode, two additional words per message are required for system overhead.

Message Rate:

Bus Controller Simulator Mode:	(Time from the end of one message to the start of the next message). Programmable from 14 microseconds to 65,535 microseconds on an individual message basis.
RT Simulator Mode:	(RT response time) Programmable from 4.25 microseconds to 65,535.25 microseconds on an individual message basis.

Bus Monitor Mode:	Message rate is defined by active devices on bus.
Message Synchronization:	The start of an RT operation in the RT Simulator mode or the start of data collection in the Bus Monitor mode may be programmed to start on a user-specified pattern word received from the 1553 bus controller.
Induced Transmitter Errors:	Programmable on an individual word basis to give incorrect parity, Manchester error, dropped bit error, sync pattern error, or incorrect bit count (±1 bit). By programming a secondary error mode, programmable on an individual word basis to give ±150-ns bit transition time error, ±150-ns sync transition time error, dropped parity bit, or 1-bit interword gap error. In addition, programmable on an individual message basis to give incorrect RT response time, word count, or status word RT address. Bit position of Manchester, dropped bit, and transition time errors are controllable as a function of the 16-bit word data content.
Receiver Error Checking:	Detects and distinguishes bit transition time errors, parity errors, dropped bit errors, sync pattern errors, and receiver response time errors on an individual word basis for subsequent return to system controller. The response-time error test value is programmable from 4 to 31 microseconds. Detects interword data gap error, word count errors, no RT response, or incorrect RT address on an individual message basis for return to the system controller. Format errors are also detected for improper mode code operation, improper broadcast mode operation, and improper use of status word bits.
Time Base:	16 MHz crystal oscillator. Optional switch-selectable user clock input on front-edge connector for 16 times desired data rate. Optional clock input from 15 MHz to 17 MHz. Frequency tracking of 0.1% to any other units on the bus must be maintained.
Interrupt Capability:	The module may be programmed to interrupt the system controller on completion of a bus communications sequence.
Programmed By:	ASCII characters. Data is transferred between the system controller and 73A-455 Module using either a hexadecimal or a binary encoded format.
Auxiliary Outputs (TTL levels):	Reconstructed Received Data and Clock. Transmitted Data and Clock. Pattern Recognition Output. Status Error Output.

	Data Word Received Output. Data Bus Input Active Output. Position Identification Output.
Auxiliary Inputs (Analog):	
Common-mode Voltage:	For external injection of common-mode voltage onto 1553 bus.
Maximum Input Rating:	6 V RMS.
Auxiliary Inputs (TTL):	External 1553 Data Rate Clock. External Halt Input. External Trigger Input. External Transmitter Enable Input.
Power Up:	Module is ready for programming 1 second after power-up. Power LED on, all other LEDs off 0.5 seconds after power-up. Default condition on power-up is: Interrupt: Disabled (I command). Transmit Level: 6.38 V ptp (VT command). Equivalent Bus Load for Transmit Level: 70 ohms (VT command). Receive Threshold: 2.00 V ptp (VR command). Response Gap: 4 µs (R command). Pace Interval: 1,000 µs (S command). RT Response Time test value: 12 µs (G command). Mode: Undefined (F command). Pattern Trigger: Disabled (P command). Error Mode: Primary error set selected (M command). RT Response Time List: Unallocated (B command). RT Sequence List: Unallocated (B command). Transmit and Receive Buffers: Unallocated (B command). High Speed Mode: Enabled (H command). Transition Time Error Detection: Enabled (J command). Request True interrupts disabled (these interrupts cause an SRQ on IEEE-488 systems).
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, VXIbus Revision 1.2.
VXI Protocol:	Word serial.
VXI Card Size:	C size, one slot wide.
Module-Specific Commands:	All module-specific commands and data are sent via the VXIbus Byte-Available command. All module-specific

commands are made up of ASCII characters. Module-specific data may be in either ASCII or binary format.

VMEbus Interface: Data transfer bus (DTB) slave - A16, D16 only.

Interrupt Level: Switch selectable, levels 1 (highest priority) through 7 (lowest).

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

VXIbus 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:

BYTE AVAILABLE (with or without END bit set)
BYTE REQUEST
BEGIN NORMAL OPERATION
READ PROTOCOL
CLEAR
TRIGGER

VXIbus Protocol Events Supported: VXIbus events are returned via VME interrupts. The following events are supported:

UNRECOGNIZED COMMAND
REQUEST TRUE (This interrupt will cause IEEE 488 interface devices to assert SRQ [service request]).

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

Device Type Register Contents: FE38h (1s complement of binary value of model number).

System Specifications

These specifications apply to the complete 73A-455 Module.

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

Voltage:	+5 Volt Supply:	4.75 V dc to 5.25 V dc.
	+24 Volt Supply:	+23.2 V dc to +25.2 V dc.
	-24 Volt Supply:	-23.2 V dc to -25.2 V dc.

Current (Peak Module, I_{PM}):	5 volt supply:	5 A
	+24 volt supply:	0.4 A
	-24 volt supply:	0.4 A
Current (Dynamic Module, I_{DM}):	5 volt supply:	0.05 A
	+24 volt supply:	0.2 A
	-24 volt supply:	0.2 A

Cooling: Provided by the fan in the VXIbus card cage. Less than 10°C temperature rise with 1.1 liters/sec of air at a pressure drop of 0.02 mm of H_2O.

Temperature: -10°C to +65°C, operating (assumes ambient temperature of 55° and airflow to assure less than 10°C temperature rise).
-40°C to +85°C, storage.

Humidity: Less than 95% R.H. non-condensing, -10°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 +55°C.

VXI Bus Radiated Emissions: Complies with VXIbus Specification.

VXI Bus Conducted Emissions: Complies with VXIbus Specification.

Module Envelope Dimensions: 262 mm high, 352 mm deep, 31 mm wide.
(10.3 in x 13.9 in x 1.2 in).

Dimensions, Shipping: When ordered with a CDS card cage, this module will be installed and secured in one of the instrument module slots (slots 1 - 12).

When ordered alone, the module's shipping dimensions are:

406 mm x 305 mm x 102 mm. (16 in x 12 in x 4 in).

Weight: 1.9 kg. (4.1 lb).

Weight, Shipping: When ordered with a CDS card cage, this module will be installed and secured in one of the instrument module slots (slots 1-12).

When ordered alone, the module's shipping weight is:

2.8 kg. (6.0 lb).

Mounting Position: Any orientation.

Mounting Location:	Installs in an instrument module slot (slots 1-12) of a C or D size VXIbus card cage. (Refer to D size card cage manual for information on required adapters.)
Front Panel Signal Connectors:	4 - TNC Triax female connectors or DD50S for optional signals. Refer to Appendix B for connector pinouts.
Equipment Supplied:	1 - 73A-455 Module.
Optional Equipment:	1 - 73A-780P Hooded Connector for connection to DD50S connector.