VMIC®

12090 South Memorial Parkway • Huntsville, Alabama 35803-3308

VMIC

VMIVME-5588DMA
VMEbus Enhanced High-Speed Fiber-Optic Reflective Memory with Interrupts

• On-board direct memory access controller
• High-speed, easy-to-use fiber-optic network (1.2 Gbaud serially)
• Data written to memory in one node is also written to memory in all nodes on the network
• Up to 256 nodes
• Connection with multimode fiber up to 1,000 ft, single-mode fiber up to 10 km, or twinax cable up to 30 m
• Data transferred at 29.5 Mbyte/s without redundant transfer
• Data transferred at 14.8 Mbyte/s with redundant transfer
• Any node on the network can generate an interrupt in any other node on the network or in all network nodes with a single command
• Error detection
• Redundant transmission mode for suppressing errors
• No processor overhead
• No processor involvement in the operation of the network
• Up to 16 Mbyte of Reflective Memory
• A24:A32:D64:D32:D16:D8 memory access
• Slave BLTs supported, master DMA controller
• Single-slot 6U VMEbus board
• Any node may reset any or all other nodes
• Software compatible with VMIVME-5578
• Network compatible with the VMIPCI-5588 and the VMIPMC-5588
• Software compatible and network compatible with VMIVME-5588
• Software-addressable digital output bit (available at front panel and P2 connector) for interfacing with the VMIVME-5599 optical switch board or any user-defined purpose
• Compatible with the VMIVME-5591 active fiber-optic bypass switch
• Compatible with the VMIVME-5592 multimode/single-mode converter board

INTRODUCTION — VMIVME-5588DMA is a high-performance, daisy-chained VME-to-VME, VME-to-PCI, and VME-to-PMC network. Data is transferred by writing to on-board global RAM. The data is automatically sent to the location in memory on all Reflective Memory boards on the network.

The VMIVME-5588DMA is 100 percent software and network compatible with the two-slot VMIVME-5588. The following features distinguish the VMIVME-5588DMA from the VMIVME-5588:

— Single slot 6U VMEbus board
— D64 memory accesses
— BLTs supported
— Program-Controlled Master DMA Controller

PRODUCT OVERVIEW — The Reflective Memory concept provides a very fast and efficient way of sharing data across distributed computer systems.

VMIC’s VMIVME-5588DMA Reflective Memory interface allows data to be shared between up to 256 independent systems (nodes) at rates up to 29.5 Mbyte/s. Each Reflective Memory board may be configured with 256 Kbyte to 16 Mbyte of on-board SRAM. The local SRAM provides fast access times to stored data. Writes are stored in local SRAM and broadcast over a high-speed, fiber-optic data path to other Reflective Memory nodes. The transfer of data between nodes is software transparent, so no I/O overhead is required. Transmit and Receive FIFOs buffer data during peak data rates to optimize CPU and bus performance to maintain high data throughput.

The Reflective Memory also allows interrupts to one or more nodes by writing to a byte register. These interrupt (three levels, each user definable) signals may be used to synchronize a system process, or used to follow any data. The interrupt always follows the data to ensure the reception of the data before the interrupt is acknowledged.

The VMIVME-5588DMA requires no initialization unless interrupts are being used. If interrupts are used, vectors and interrupt levels must be written to on-board registers and the interrupts enabled.

Each node on the system has a unique identification number between 0 and 255. The node number is established during hardware system integration by placement of jumpers on the board. This node number can be read by software by accessing an on-board register. In some applications, this node number would be useful in establishing the function of the node.

In order to achieve a throughput of 29.5 Mbyte/s, nodes capable of writing to the Reflective Memory network at an aggregate rate of 29.5 Mbyte/s must be present. Note that workstation-to-VME adapters may limit the data transfer rate between the workstation and the Reflective Memory network.

LINK ARBITRATION — The VMIVME-5588DMA system is a fiber-optic or twinax daisy chain ring as shown in Figure 1. Each transfer is passed from node-to-node until it has gone all the way around the ring and reaches the originating node. Each node retransmits all transfers that it receives except those that it originated. Nodes are allowed to insert transfers between transfers passing through.

INTERRUPT TRANSFERS — In addition to transferring data between nodes, the VMIVME-5588DMA will allow any processor in any node to generate an interrupt on any other node. These interrupts would generally be used to indicate to the receiving node that new data has been sent and is ready for processing. These interrupts are also used to indicate that processing of old data is completed and the receiving node is ready for new data.
Three interrupts are available. The user may define the function, priority, and vector for each interrupt. Any processor can generate an interrupt on any other node on the network. In addition, any processor on the network can generate an interrupt on all nodes on the network. Interrupts are generated by simply writing to a VMIVME-5588DMA register.

All data and interrupt command transfers contain the node number of the node that originated the transfer. This information is used primarily so the originating node can remove the transfer from the network after the transfer has traversed the ring. The node identification is also used by nodes receiving interrupt commands. When a node receives an interrupt command for itself, it places the identification number of the originating node in a FIFO. Up to 512 interrupts can be stacked in the FIFO. During the interrupt service routine, the identification of the interrupting node can be read from the FIFO.

**DMA CONTROLLER** — The VMIVME-5588DMA can DMA data from the VMEbus to the VMIVME-5588DMA’s on-board memory or from the VMIVME-5588DMA’s on-board memory to the VMEbus. The user is responsible for initiating the DMA activity. The user has the ability to program the following DMA features:

- Bus Request Level BR(3-0)
- Release Mode
  - ROR - Release-On-Request
  - RWD - Release-When-Done
  - ROC - Release-On-BCLR* assertion
  - BCAP - VMEbus Capture and Hold
- DMA Direction (either DMA Reads or Writes)
- Data Width 16-, 32-, and 64-bit supported, 8-bit not supported
- Address Modifier Selection
- DMA Byte Count, 16 Mbyte DMA transfer length maximum
- Burst Length
- Interleave Period
- DMA Complete Interrupt

The VMIVME-5588DMA will break up a DMA block into bursts of size (specified by the burst length) with an inactive period in between bursts (specified by the interleave period) that allows other resources to access the VMEbus and the VMIVME-5588DMA’s on-board memory. The VMIVME-5588DMA can also be programmed to issue a VMEbus interrupt upon DMA completion.

The VMIVME-5588DMA is capable of performing slave accesses during DMA interleave periods. The VMIVME-5588DMA can perform all functions while a

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<table>
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<td><strong>A = Memory Options</strong></td>
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<td>VMICBL-001-33</td>
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<tr>
<td><strong>A = 0 (Option reserved for future use)</strong></td>
<td>00 = Not Used</td>
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For Ordering Information, Call: 1-800-322-3616 or 1-256-880-0444 • FAX (256) 882-0859
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DMA is in progress. For example, receiving/transmitting interrupts and receiving/transmitting data via the fiber optics.

**ERROR MANAGEMENT** — Errors are detected by the VMIVME-5588DMA with the use of the error detection facilities of the Fibre Channel encoder/decoder and additional interlaced parity encoding and checking. When a node detects an error, the erroneous transfer is removed from the system and a VMEbus interrupt is generated, if enabled. The error rate of the VMIVME-5588DMA is a function of the rate of errors produced in the optical portion of the system. This optical error rate depends on the length and type of fiber-optic cable. Assuming a worst-case optical error rate of $10^{-12}$, the error rate of the VMIVME-5588DMA is $1.6 \times 10^{-10}$ transfers/transfer.

The VMIVME-5588DMA can be operated in a redundant transfer mode in which each transfer is transmitted twice. In this mode of operation, the first of the two transfers is used unless an error is detected in which case the second transfer is used. In the event that an error is detected in both transfers, the node removes the transfer from the system. The probability of both transfers containing an error is $2.56 \times 10^{-20}$, or about one error every 330,300 years at maximum data rate.

**PROTECTION AGAINST LOST DATA** — Data received by the node from the cable is error checked and placed in a receive FIFO. Arbitration with accesses from the VMEbus then takes place and the data is written to the node’s SRAM and to the node’s transmit FIFO. Data written to the board from the VMEbus is placed directly into SRAM and into the transmit FIFO. Data in the transmit FIFO is transmitted by the node over the fiber-optic cable to the next node. Data could be lost if either FIFO were allowed to become full.

The product is designed to prevent either FIFO from becoming full and overflowing. It is important to note the only way that data can start to accumulate in FIFOs is for data to enter the node at a rate greater than 29.5 Mbyte/s or 14.8 Mbyte/s in redundant mode. Since data can enter from the cable and from the VMEbus, it is possible to exceed these rates. If the transmit FIFO becomes half-full, a bit in the Status Register is set and, if enabled, an interrupt is generated. This is an indication to the node’s software that subsequent WRITEs to the Reflective Memory should be suspended until the FIFO is less than half-full. If the half-full indication is ignored and the transmit FIFO becomes full, then writes to the Reflective Memory will not be acknowledged until access is granted or the CPU times out with a Bus Error.

If the transmit FIFO is allowed to become over half-full, there is a danger the receive FIFO may overflow resulting in data loss. In order to prevent this situation, a VMEbus throttle mode will become active when the transmitter is over half-full. The VMEbus response time extends to $3.2 \mu s$ per access to allow the receiver time to move data from the receive FIFO to the transmit FIFO.

If the receive FIFO becomes over half-full, VME access is held off until the receive FIFO is less than half-full.

**NETWORK MONITOR** — There is a bit in a Status Register that can be used to verify that data is traversing the ring (that is, the ring is not broken). This can also be used to measure network latency.

**VMEbus TRANSFER SPECIFICATION**

- **Memory Size:** 256 Kbyte, 512 Kbyte, 1 Mbyte, 2 Mbyte, 4 Mbyte, 8 Mbyte, or 16 Mbyte
- **Access Time:**
  - Slave Reads: AS* to DTACK* - 330 ns, typical
  - DSA* to DTACK* - 320 ns, typical
  - Slave Writes: AS* to DTACK* - 140 ns, typical
  - DSA* to DTACK* - 50 ns, typical
  - Slave BLT Reads: DSA* to DTACK* - 30 ns, typical
  - Slave BLT Writes: DSA* to DTACK* - 210 ns, typical
- **Transfer Rate:**
  - Slave Mode (Average Burst Rate):
    - 32-bit Reads: 10.7 Mbyte/s
    - 32-bit Writes: 17.4 Mbyte/s
    - 64-bit Reads: 16.3 Mbyte/s
    - 64-bit Writes: 17.3 Mbyte/s
  - Master Mode (Average Burst Rate):
    - 32-bit Reads: 17.0 Mbyte/s
    - 32-bit Writes: 13.1 Mbyte/s
    - 64-bit Reads: 17.3 Mbyte/s
    - 64-bit Writes: 16.3 Mbyte/s

**NETWORK TRANSFER SPECIFICATION**

- **Transfer Rate:** 29.5 Mbyte/s (longword accesses) without redundant transfer
  14.8 Mbyte/s (longword accesses) with redundant transfer
VMIC offers the following cable assemblies that are compatible with the VMIPCI-5588:

**Multimode Fiber Cable:**
- ST connectors
- 1,000 feet maximum
- 62.5 micron core
- 10 dB maximum attenuation between nodes
- Wavelength = 860 nm

**Twinax Cable:**
- 9-pin D-type connector
- Equalized, 30 m maximum

The VMIVME-5588DMA is compatible with single-mode fiber with SC connectors and a maximum of 10 km. VMIC does not supply single-mode fiber cable.

**MEMORY SIZE COMPATIBILITY**

The 256 Kbyte, 512 Kbyte, and 1 Mbyte options for the VMIVME-5588DMA boards use 20 address bits for the memory interface. If these boards are used in a network with 2, 4, 8, or 16 Mbyte boards (which use more address bits), multiple images of the data written will appear in the 2, 4, 8, or 16 Mbyte boards. For this reason, the different memory option boards are grouped into three different types.

Type A: 256 Kbyte, 512 Kbyte, and 1 Mbyte options
Type B: 2 and 4 Mbyte options
Type C: 8 and 16 Mbyte options

To ensure memory size compatibility, a Reflective Memory network should be composed completely of boards from one of these groups.

**VMEbus COMPATIBILITY**

This product complies with the VMEbus specification (ANSI/IEEE STD 1014-1987, IEC 821 and 297)

- **Form Factor:** 6U
- **DTB Master:** BLT: A32:A24:D64/D32/D16
- **DTB Slave:** BLT: A32:A24:D64/D32/D16/D08(EO)
- **Requester:** Programmable BR (3-0), ROR, RWD, BCAP, ROC
- **Interrrupter:** Programmable IRQ7* to IRQ1*

**PHYSICAL/ENVIRONMENTAL**

- **Temperature Range:** 0 to 65 °C, operating with forced air cooling. -40 to 85 °C, storage.
- **Relative Humidity:** 20 to 80 percent, noncondensing
- **Power Requirements:** 5.0 A maximum at +5 VDC
Figure 1. Network Example Using Reflective Memory System

VME COMPUTER
NODES CAN BE VMEbus-BASED
COMPUTERS OR COMPUTERS
WITH VMEbus I/O CHANNELS
SUCH AS SUN, HARRIS NIGHT
HAWK, CONCURRENT, SILICON
GRAPHICS, DATA GENERAL,
MOTOROLA DELTA SERIES,
ENCORE 91 SERIES, ANY
VMEbus CHASSIS, ETC.

VMEbus CHASSIS
WITH CPU AND
VMIPMC-5588

VMEbus CHASSIS
WITH CPU AND
VMIVME-5588DMA

UP TO 1,000 ft
BETWEEN NODES

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Figure 2. VMIVME-5588DMA Functional Block Diagram
The following is a list of some of VMIC’s products which are associated with the VMIVME-5588DMA.

**VMIVME-5588** - High-Speed Fiber-Optic Reflective Memory with Interrupts

- High-speed, easy-to-use fiber-optic network (1.2 Gbaud serially)
- Data written to memory in one node is also written to memory in all nodes on the network
- Up to 1,000 ft between nodes and up to 256 nodes
- Data transferred at 29.5 Mbyte/s without redundant transfer
- Data transferred at 14.8 Mbyte/s with redundant transfer
- Any node on the network can generate an interrupt in any other node on the network or in all network nodes with a single command
- Error detection
- Redundant transmission mode for suppressing errors
- No processor overhead
- No processor involvement in the operation of the network
- Up to 16 Mbyte of Reflective Memory
- A24:A32:D32:D16:D8 memory access
- Two-slot 6U VMEbus board
- Any node may reset any or all other nodes
- Software compatible with VMIVME-5578
- Software addressable digital output bit (available at front panel and P2 connector) for interfacing with the VMIVME-5599 optical switch board or any user-defined purpose

**VMIPCI-5588** - High-speed fiber-optic Reflective Memory with interrupts

- High-speed, easy-to-use fiber-optic network (1.2 Gbaud serially)
- Data written to memory in one node is also written to memory in all nodes on the network
- Up to 1,000 ft between nodes and up to 256 nodes
- Data transferred at 29.5 Mbyte/s without redundant transfer
- Data transferred at 14.7 Mbyte/s with redundant transfer
- Any node on the network can generate an interrupt in any other node on the network or in all network nodes with a single command
- Error detection
- Redundant transmission mode for suppressing errors
- No processor overhead
- No processor involvement in the operation of the network
- Up to 16 Mbyte of Reflective Memory
- PCI 32 transfers, 5 V, single width mezzanine interface
- Any node may reset any or all other nodes
- Communications link compatible with VMIVME-5588 and VMIPMC-5588
- Software-addressable digital output bit (available at front panel and P2 connector) for interfacing with the VMIVME-5599 optical switch board or any user-defined purpose
- Keyable P2 connector
**VMIVME-5591** - Active fiber-optic bypass switch

- Automatically bypasses attached node in a fiber-optic network in the event of a power loss at the node
- Automatically regenerates the optical signal, thereby eliminating insertion loss
- Designed for use with the VMIPMC-5588, VMIVME-5588, and the VMIPCI-5588
- May be manually operated with front panel switch
- May be remotely operated with a 6-pin DIN cable from a remotely located VMIVME-5588 or VMIPMC-5588
- May be remotely operated by control signal on a VME connector
- In remote operation, network status signals provided on VME and 10-pin ribbon connector
- Any number of nodes can be bypassed in succession (manually or automatically; mixed in any order)
- Up to 1,000 ft between successive switches and up to 256 switches per network
- Up to 10 km between successive switches can be obtained when used in conjunction with a pair of VMIVME-5592, multimode/single-mode converter boards
- Need not be mounted in VMEbus chassis; separate power and ground connections provided
- No processor overhead or involvement required in the operation; however, processors can be involved

**VMIVME-5592A** - Multimode single-mode converter for VMEbus

- Compatible with VMIMxx-5588 fiber-optic network (1.2 Gbaud serial transfer) with up to 10 km between linked converter boards
- Designed for use with the VMIPMC-5588, VMIVME-5588, and the VMIPCI-5588 Reflective Memory boards
- Need not be mounted in VMEbus chassis; separate power and ground connections provided
- Capable of remote operation; needed fiber-optic status signals provided for monitoring

**VMIVME-5593** - Automatic node fiber-optic bypass board

- Automatically bypasses attached nodes in a fiber-optic network
- Automatic bypass of an active node occurs when
  - Power loss at attached node
  - Optical signal is lost from node
  - Fiber-optic cable break between VMIVME-5593 and node
  - Data synchronization is lost
- Automatically regenerates the optical signal, thereby eliminating insertion loss
- Designed for use with VMIC’s high-speed, fiber-optic Reflective Memory products (the 5588 series and VMIVME-5589)
- May be remotely operated by control signal on a VME connector
- Up to 64 switches per network (256 nodes maximum)
- Any number of nodes can be bypassed in succession (manually or automatically; mixed in any order)
- No processor overhead or involvement required in the operation unless desired

**VMIVME-5599** - Automatic fiber-optic bypass switch

- Automatically bypasses a node in fiber-optic network that has lost power
- Designed for use with the VMIVME-5576 and the VMIVME-5588
- May be manually operated with front panel switch
- May be remotely operated by control pin on P2

**TRADEMARKS**

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