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SCRAMNet+ Network

SC150e PCI, PMC & CPCI Bus (Universal Signaling) Hardware Reference

Document No. D-T-MR-PCPMCPE#-A-1-A3

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1. INTRODUCTION

1.1 How To Use This Manual

1.1.1 Purpose

This document is a reference manual for the SCRAMNet+ SC150e PCI, PMC and CompactPCI network interface cards (NIC). It provides a physical and functional description of the SCRAMNet+ SC150e NIC and describes how to unpack, set up, install and operate the hardware. Hereafter in this manual "CompactPCI" is referred to as "CPCI."

1.1.2 Scope

This information is intended for systems designers, engineers and network installation personnel. You need at least a systems level understanding of general computer processing, of memory and hardware operation, and of the specific host processor to effectively use this manual.

1.1.3 Style Conventions

- Hexadecimal values are written with a "0x" prefix. For example, 0x03FF.
- Switch, signal and jumper abbreviations are in capital letters. For example, RSW1, J5, etc.
- Register bits and bit ranges are specified by the register identification followed by the bit or range of bits in brackets [ ]. For example, CSR6[4], CSR3[15:0], ACR [1,2]
- Bit values are shown in single-quotes. For example, set bit 15 to '1.'
- Code and monitor screen displays of input and output are boxed and indented on a separate line. Text that represents user input is bolded. Text that the computer displays on the screen is not bolded. For example:

```
C:\>ls
file1          file2             file3
```

- Large samples of code are Courier font, at least one size less than context, and are usually on a separate page or in an appendix.

1.2 Related Information

- *SCRAMNet Network Programmer's Reference Guide* (Doc. Nr. D-T-MR-PROGREF) - A collection of routines to assist SCRAMNet users with application development.
- *SCRAMNet Network Utilities User Manual* (Doc. Nr. C-T-MU-UTIL) - A user's manual for the SCRAMNet Classic, SCRAMNet-LX, and SCRAMNet+ SC150e hardware diagnostic software, SCRAMNet+ SC150e EEPROM initialization software, and the SCRAMNet Network Monitor.
- *SCRAMNet Network Media User's Guide* (Doc. Nr. D-T-MU-MEDIA)—A description of network cabling hardware accessories for the SCRAMNet+ SC150e Network.

- All documentation related to the V363EPC PCI Bridge chip including register specification, can be obtained from the *V3 Semiconductor Inc.* web site at www.vcubed.com under, PRODUCTS, V3xxEPC, Documentation.
- *PCI Special Interest Group (PCI-SIG)*. The PCI-X specification is available to PCI-SIG members and can be downloaded from www.pcisig.com
- *PCI Industrial Computer Manufacturer's Group (PCIMG)*. The CPCI Core specification is available to members and can be downloaded from www.picmg.org.

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2. SCRAMNET OVERVIEW

2.1 Overview

The SCRAMNet+ SC150e Network is a real-time communications network, based on a replicated, shared-memory concept. Each host processor on the network has access to its own local copy of shared memory that is updated over a high-speed, serial-ring network. The network is optimized for high-speed data transfer among multiple, real-time computers all solving portions of the same real-time problem.

2.2 Shared Memory

In its simplest form, the SCRAMNet+ SC150e Network system is designed to appear as general-purpose memory. The use of this memory depends only on the conventions and limitations imposed by the specific host computer system and operating system. On most processors, this means that the application program can use this memory in basically the same way as any other data-storage area of memory. However, the memory cannot be used as instruction space.

The major difference between SCRAMNet+ SC150e memory and system memory is any data written into SCRAMNet+ SC150e memory is automatically sent to the same SCRAMNet+ SC150e memory location in all nodes on the network. This is why it is also referred to as replicated shared memory. A good analogy is the COMMON AREA used by the FORTRAN programming language. Where the COMMON AREA makes variables available to subroutines of a program, SCRAMNet+ SC150e makes variables available to processors of a network.

When a host computer writes to the shared memory, the proper handshaking logic is supplied by the SCRAMNet+ SC150e node host adapter. The shared memory behaves somewhat like resident or local memory.

A software driver is usually not required except for interrupt handling.

2.2.1 Dual-Port Memory Controller

The Dual-Port Memory Controller (see Figure 2-1) allows the host to read from or write to shared memory with a simultaneous network write to shared memory. Unless an interrupt has been authorized for that memory address, the host is not aware the network is writing to shared memory. This is why caching must be disabled for SCRAMNet memory. If an interrupt has been authorized, the interrupt will then be sent to the host processor.

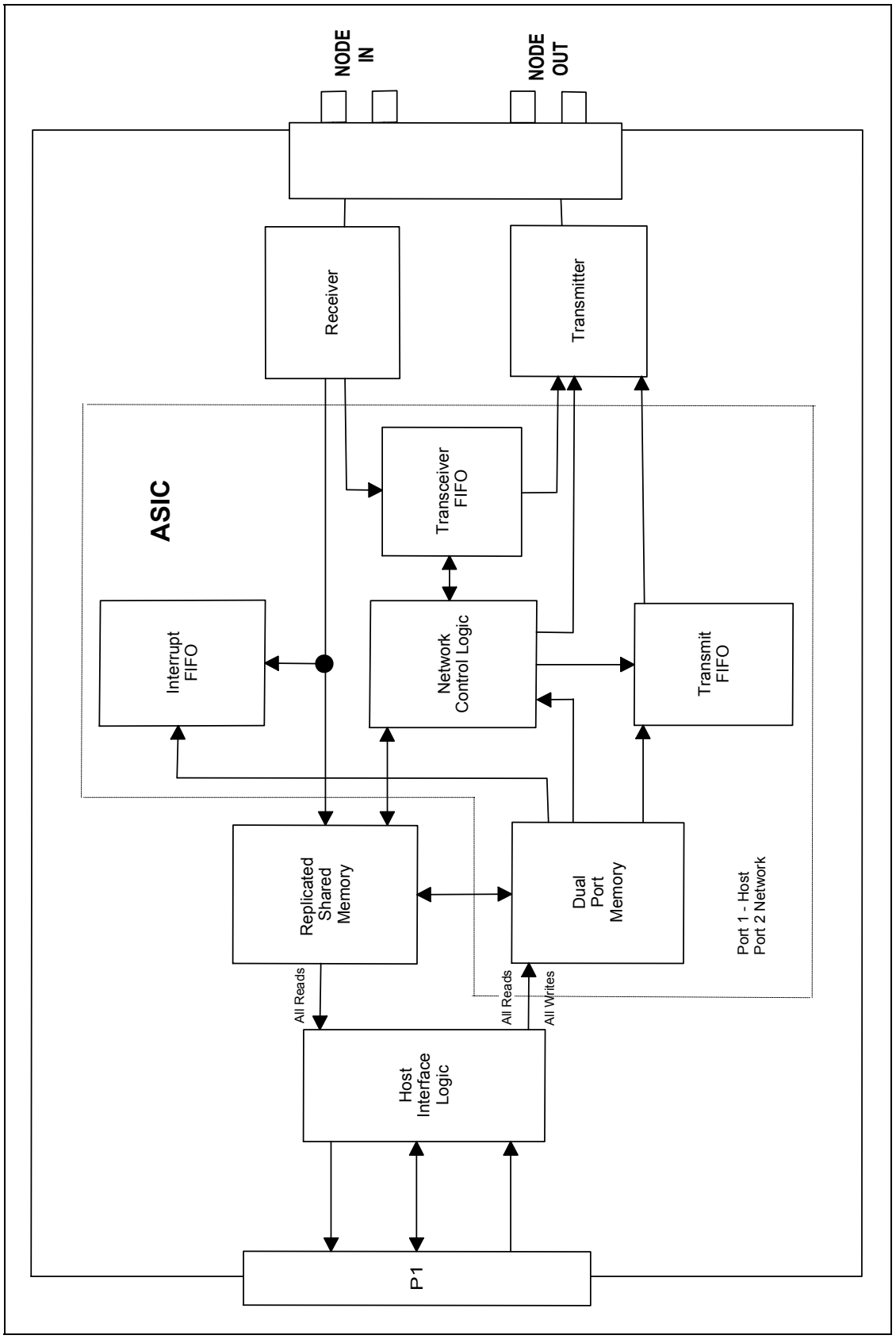


Figure 2-1 Functional Diagram

2.2.2 Control/Status Registers (CSRs)

CSRs control the SCRAMNet+ SC150e card's Input/Output (I/O) operations The location of the CSRs in the computer's address space is determined by the plug-and play BIOS in the host system. You can find the CSRs address offsets in chapter 4: INSTALLATION.

Most modes of operation are set during initialization in registers embedded in the PCI target controller, and remain unchanged during run time.

2.2.3 Virtual Paging

The SCRAMNet+ SC150e network may include a variety of SCRAMNet+ SC150e nodes having varying amounts of shared memory. However, all SCRAMNet+ SC150e nodes use the same 8 MB shared memory map. This feature permits different SCRAMNet+ SC150e cards with 4 MB of shared memory or less to be paged into different sections of the 8 MB memory map. A card with a 4 MB or smaller memory may be located on any shared-memory address boundary that is an even multiple of itself (For example, 2 MB can page to 0, 2, 4 or 6 MB address).

2.3 FIFO Buffers

The SCRAMNet+ SC150e card contains various FIFO buffers used for temporarily storing information during normal send and receive operation of the node. Refer to Figure 2-1.

2.3.1 Transmit FIFO

The Transmit FIFO is a message holding area for native messages waiting to be transmitted. Each host write to SCRAMNet+ SC150e memory may constitute a write to the Transmit FIFO. (Data Filtering and HIPRO features may interfere with this.) Each write to the Transmit FIFO contains 21 bits of address (A22-A2), 32 bits of data, and one bit of interrupt information. The Transmit FIFO can hold up to 1024 writes before becoming full.

When the Transmit FIFO reaches a FULL condition (CSR1[0] ON), one more host write could cause a message to be lost. To prevent this, the CSR-controllable, built-in SCRAMNet+ SC150e feature called HOLDOFF mode extends the computer write cycle until the Transmit FIFO is able to empty at least one message.

2.3.2 Transceiver FIFO

The Transceiver buffer is used to receive foreign messages from the network, and send them on, or to hold received foreign messages while inserting a native message from the host onto the network.

Each node is responsible for receiving foreign messages, writing them to its copy of shared memory, and re-transmitting the message to the next node.

2.3.3 Interrupt FIFO

The Interrupt FIFO contains a 21-bit address (A22 - A2) and a retry-status bit for each shared-memory-based interrupt received. The Interrupt FIFO can hold 1024 interrupt addresses. This FIFO can be read using CSR4 and CSR5.

2.3.4 Receiver FIFO

The Receiver FIFO is designed as a temporary holding place for incoming foreign messages while the shared memory is busy servicing a host request. This FIFO is three

messages deep, and is designed so it can never be overrun. Each item in the Receiver FIFO contains 21 bits of address (A22 - A2), 32 bits of data, and one incoming interrupt bit. When the messages are 1024 bytes, the initial header information data stays in the FIFO, the subsequent four bytes of data are loaded in, and the address is incremented by four.

2.4 Network Ring

The SCRAMNet+ SC150e Network is a ring topology network. Data is transmitted at a rate of 150 Mbits/s over dual fiber-optic cables. Together, the two lines produce the incoming data clock. Due to the network speed and message packet size, the network can accommodate over 1,800,000 message packets passing by each node every second. There is an approximate 247 ns (minimum) delay at each node as the message packet works its way around the ring. The maximum delay depends on the selection of fixed-length or variable-length message packets. A fixed-length message packet has a maximum delay of 800 ns, a 256-byte variable-length message packet is 16.2 µs, and a 1024-byte variable-length message packet is 62 µs. Delay can be imposed when a node must complete the transmission of a native message packet before retransmitting a foreign message packet. A SCRAMNet+ SC150e Network can accommodate up to 256 nodes per network ring.

2.4.1 Protocol

The protocol is a register-insertion methodology and is NOT a token ring. Depending on the protocol selected, all message packets are the same size or are variable (as in the PLUS modes), and multiple nodes can transmit data simultaneously. There is no master node, and all nodes have equal priority for network bandwidth. The message protocol is designed specifically for real-time applications where data must be passed very rapidly. When the node operates in BURST or BURST PLUS mode, the node will never re-transmit its own messages for error correction. When operating in PLATINUM or PLATINUM PLUS mode, error detection is enabled, and re-transmission can occur.

BURST MODE

BURST mode is an open loop, non-error-corrected communication mode. This mode allows multiple 82-bit messages (46-bit header plus 32-bite data and four parity bits) per node on the ring at a time. The limited-message-packet length enhances the data latency characteristics of the network by providing the shortest possible media access delay. The messages are transmitted as fast as the system will allow.

PLATINUM MODE

PLATINUM mode is BURST mode with error correction enabled. The messages are transmitted as fast as the system will allow, but error checking is used to detect and re-transmit corrupted message packets.

PLUS MODES

The PLUS mode protocol enhancement can increase the maximum network throughput from 6.5 MB/sec to approximately 15.2 to 16.7 MB/sec by the use of variable-length message packets. Each SCRAMNet+ SC150e message packet has a 46-bit header plus the data. The user-selectable maximum message packet size increases the data size from the normal 32 bits to either 256 or 1024 bytes of data. Data must be written to sequential longword addresses.

2.5 Auxiliary Control RAM (ACR)

The Auxiliary Control RAM (ACR) provides external triggering and interrupt control by offering a choice of four actions to occur when a particular SCRAMNet+ SC150e shared-memory address is written into. Each shared-memory location has its own action or set of actions associated with it.

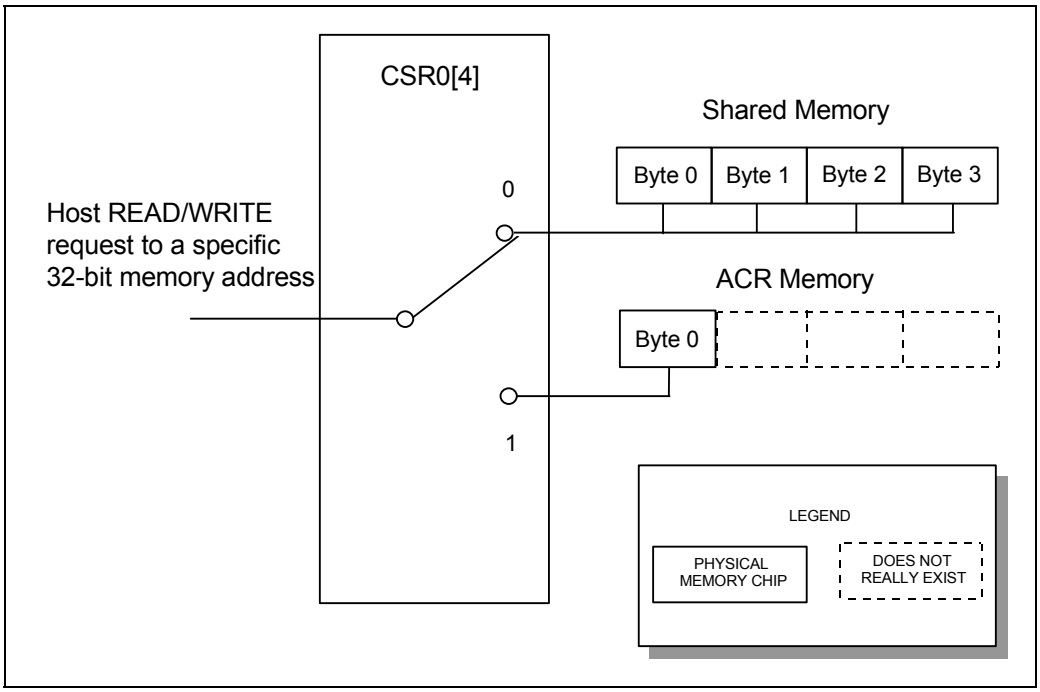


Figure 2-2 ACR/Memory Access

In Figure 2-2, host CPU read/write operations are channeled to either SCRAMNet+ SC150e memory or to the ACR. The ACR is a physically separate memory from the shared memory. Channeling is based on a user-controlled switch setting and may be toggled to the desired position by writing to a bit in the SCRAMNet+ SC150e CSR. When access to the ACR is enabled, shared memory is not accessible by the host and the ACR byte is viewed as the least significant byte (LSB) of every shared-memory four - byte address. The ACR bits define the necessary external trigger and/or interrupt action(s) taken whenever writing to any byte of the SCRAMNet+ SC150e shared-memory four-byte word.

Only five bits of the ACR are associated with every four-byte word of shared memory (on even four-byte boundaries). The other 27 bits of the ACR are not used.

2.6 Interrupts

SCRAMNet+ SC150e allows a node processor to receive interrupts from and transmit interrupts to any node on the network. This includes the originating node, provided the receiving node is set up to receive an interrupt message. Interrupts are generated under two different conditions:

- SCRAMNet+ SC150e network data writes to shared memory; and
- SCRAMNet+ SC150e network errors detected on the local node.

SCRAMNet+ SC150e interrupts usually require a device driver to interface with the node processor. The driver is required primarily to permit the host processor to handle interrupts from the SCRAMNet device.

2.6.1 Network Interrupt Writes

FOREIGN MESSAGE

The node can receive a message from another node with the interrupt bit set. If Receive Interrupt Enable ACR[0] and Interrupt Mask Match Enable CSR0[5] are enabled, the data is written to shared memory and the address is placed on the Interrupt FIFO.

NATIVE MESSAGE

If the message received was originated by the node, and Write Own Slot Enable CSR2[9] and Enable Interrupt on Own Slot CSR2[10] are enabled, the host has authorized a Self-Interrupt. The data is written to shared memory and the address is placed on the Interrupt FIFO.

Network Interrupt writes are accomplished by two methods:

- **Selected**. Data writes to selected shared-memory locations from the network.
- **Forced**. Any data writes to any shared memory from the network.

In either case, the node can be configured to write to itself. This condition is called "Self Interrupt".

2.6.2 Selected Interrupt

The selected-interrupt method requires choosing SCRAMNet+ SC150e shared-memory locations on each node to receive and/or to transmit interrupts. These shared-memory locations may also be used to generate signals to external triggers. The procedure for selecting shared-memory locations for interrupts and/or external triggers is explained in the paragraph on the Auxiliary Control RAM, paragraph 2.5.

OUTGOING INTERRUPT

The Outgoing Interrupt is described in Figure 2-3. If both Transmit Interrupt Enable ACR[1] and Network Interrupt Enable CSR0[8] are set, and a data item is transmitted to any of the selected-interrupt memory locations, then an interrupt message is sent out on the network. This message will generate interrupts to any processors on the network that have that same shared-memory location selected to receive interrupts.

INCOMING INTERRUPT

Figure 2-4 demonstrates the process of receiving a message with the interrupt bit set. The data is written to shared memory and the address is placed in CSR5 and CSR4 to await being sent to the host. If the Receive Interrupt Enable ACR[0], Host Interrupt Enable CSR0[3], and the Interrupt Memory Mask Match Enable CSR0[5] are set, and network interrupt data is received for any one of the selected interrupt memory locations the following occurs:

- The data is stored in that location
- The SCRAMNet+ SC150e address of the memory location is placed on the Interrupt FIFO queue, and
- An interrupt is sent to the processor.

NETWORK ERRORS

The Interrupt on (Network) Errors mode is enabled by setting CSR0[7] ON. Network errors are defined in CSR1 according to an interrupt mask set in CSR9. When an incoming foreign message generates an interrupt, there is no way to mask the interrupt according to the content of the message. However, specific error conditions are identified.

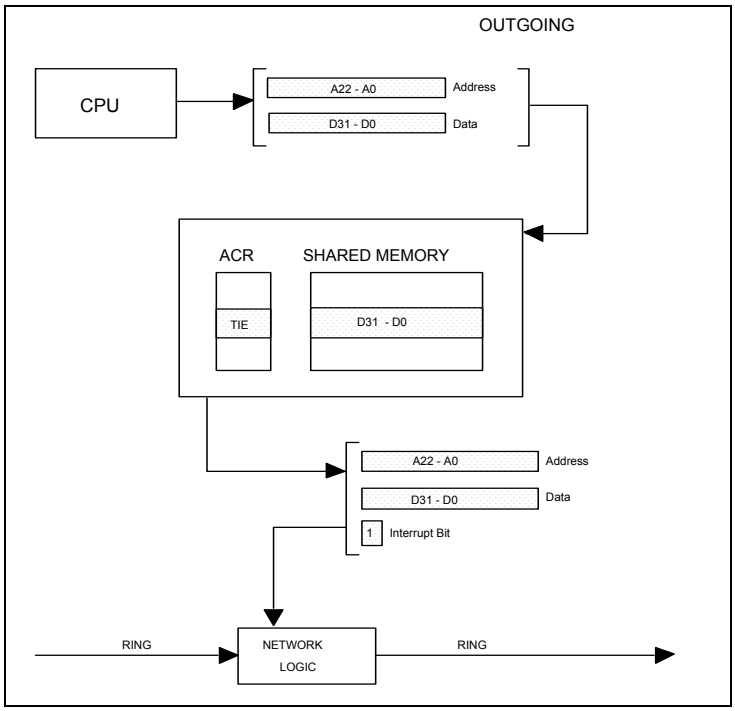


Figure 2-3 Outgoing Interrupt

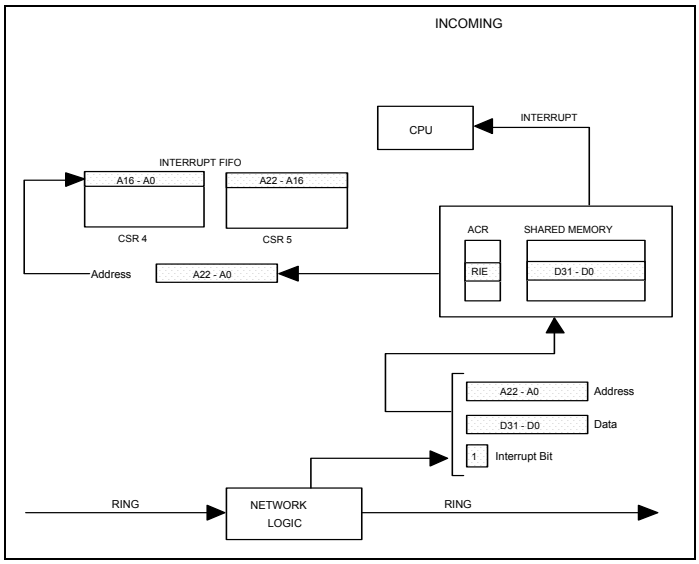


Figure 2-4 Incoming Interrupt

Error conditions are listed in CSR1 and are masked by setting the corresponding bit in CSR9. If the Mask bits in CSR9 are all set to '1', any error will generate an interrupt. Otherwise, only errors with a '1' in the appropriate Mask bit will generate an interrupt.

2.6.3 Forced Interrupt

The forced-interrupt method works the same for selected-interrupt except for the choice of interrupt locations. All shared-memory locations are automatically set up to receive and/or transmit interrupts depending on the ACR override conditions set in CSR0[6] and/or CSR0[9].

When Override Receive Interrupt Enable CSR0[6] is set, an interrupt will be sent to the host by any network-interrupt-data message , regardless of the status of the ACR Receive Interrupt bit.

When Override Transmit Interrupt Enable CSR0[9] is set, an interrupt will be sent out on the network regardless of the status of the ACR Transmit Interrupt bit.

A third condition, Receive Interrupt Override CSR8[10], is used to designate all incoming network traffic as interrupt messages. The network message interrupt bit does not need to be set.

2.7 External Triggers

SCRAMNet+ SC150e PCI cards support two external triggers. The external triggers will occur only if the ACR has been configured to enable them. Triggers 1 and 2 are generated by SCRAMNet+ SC150e shared-memory access. Both triggers generate a 26.64 ns TTL level compatible, non-terminated, output.

- Trigger 1 - Host Write (ACR[2] enables)
- Trigger 2 - Network Write (ACR[3] enables)



NOTE: User access to Trigger 1 and Trigger 2 is not available on the PMC card.

2.8 General Purpose Counter/Global Timer

The General Purpose Counter/Timer has six modes of CSR8 and CSR9 controlled operations, The output from the General Purpose Counter/Timer is stored in CSR13. Counter modes can count errors, external trigger events, or network messages. A high-resolution timer mode can run free or measure the ring time with a 26.66 ns resolution.

The global timer mode clocks with a resolution of 1.706 µs and resets on an external trigger event. (See 2.7: External Triggers). A specific shared-memory location may be identified with External Trigger 2 ACR[3] so that a memory write from a single node on the network can simultaneously reset all the global timers in the ring.

If the Trigger 2 event is the frame counter, the timers in the ring effectively become synchronized sub-frame timers, which can then be used to tag time-critical data or to measure and compare the completion time of various tasks within a distributed real-time system.

2.9 Modes of Operation

2.9.1 Data Filter Mode

When SCRAMNet+ SC150e Data Filtering is enabled, only those writes to SCRAMNet+ SC150e memory producing a data change are transmitted to the network.

EXAMPLE:

If location 1000 in SCRAMNet+ SC150e memory contains the value '20' and the host processor writes the value '20' to location 1000, then no network traffic will be generated. However, if any other value is written to location 1000, then the new value will be passed around the network to update the other SCRAMNet+ SC150e node memories.

When a write is received from the host, a comparison is made to the old data at that address to see if there was a change before writing to shared memory. If the data has changed, then it is written to shared memory, and is also transmitted onto the network. This entire process is completed within the host memory standard bus write cycle.

Data filtering is a powerful communications compression technique for cyclical applications. This technique has been shown to significantly reduce the network traffic and therefore increase the effective throughput on the network.

2.9.2 High Performance (HIPRO) Mode

HIPRO provides an efficient means to transmit 8-bit and 16-bit data transactions as one 32-bit network write. It also provides a means of keeping 32-bit data from becoming fractured.

EXAMPLE #1:

A floating-point length numeric sent in 8-bit or 16-bit pieces may not be accurately re-assembled at the destination.

EXAMPLE #2:

The receiving node may otherwise try to use part or half of such a value before the entire 32 bits is received.

HIPRO WRITE

The SCRAMNet+ SC150e network message is based on 32-bit longword data. This means if any 8-bit field of the 32-bit buffer is changed, the entire 32-bit message is transmitted. If a host is limited to only 8-bit or 16-bit data bus transactions the network throughput is quartered or halved, respectively.

HIPRO mode permits a 32-bit location to be set up in shared memory so any initial write smaller than 32 bits to that location will not automatically go onto the network. The 32-bit write to the network will only occur when all four bytes within the 32-bit location have been written through subsequent writes by the host CPU. This can be accomplished by four consecutive 8-bit or two consecutive 16-bit writes to the SCRAMNet memory.



NOTE: HIPRO WRITE will not work if Disable Host to Memory Write CSR2[8] is set, or when writing two separate shortwords while using interrupts.

2.9.3 Holdoff Mode

It is possible that the Transmit FIFO can become full when the host is writing to the SCRAMNet+ SC150e interface faster than the network can absorb the data.

In Holdoff mode, the host write cycle is automatically extended until the SCRAMNet+ SC150e Transmit FIFO buffer transmits at least one message. This prevents the loss of data and is transparent to the user.

In some system designs, and on some computer buses, it is not desirable or effective to have the write cycle lengthened to match network throughput—even at the expense of possible data loss across the network. In this case you can disable this option by setting CSR8[1] ON. Transmit FIFO 7/8 Full CSR1[2] can then be used to control the data flow via software control.

2.9.4 Loopback Modes

Loopback mode is used for testing and routing data normally transmitted onto the network back into the node. This mode is used to check performance internally (Wire Loopback) at the Media Card (Mechanical Switch Loopback) and Transmit/ Receive (Fiber-optic Loopback).

WIRE LOOPBACK MODE

The Wire Loopback mode needs no manual external modifications to work. Wire Loopback is enabled by setting CSR2[7] ON. This mode checks the on-card circuitry for continuity.



NOTE: If a node is inserted into the network while in wire loopback mode, it will create a break in the network ring, making all nodes down-line unreachable.

MECHANICAL SWITCH (MEDIA CIRCUITRY) LOOPBACK MODE

Mechanical Switch (Media Circuitry) Loopback modeis enabled by setting Mechanical Switch Override CSR8[11] to OFF. This test is used to check the media circuitry but excludes the fiber-optic circuitry. In this test the signal does not leave the Media circuitry.

FIBER-OPTIC LOOPBACK MODE

A valid Fiber-optic Loopback mode must have the optional Fiber Optic Bypass Switch connected, Disable Fiber-optics Loopback CSR2[6] set to OFF (power up default), and the Insert Node CSR0[15] enabled. When the Fiber-optic Loopback mode is in effect, the output of the transmitter is connected by fiber optics directly to the input of the receiver, and the receiver is disconnected from the network.

The optional Fiber Optic Bypass Switch must be installed for this loopback to work. However, in the absence of the Fiber Optic Bypass Switch, fiber-optic cables could be run from the node's transmitter output connectors to the receiver input connectors. This configuration, with Insert Node enabled, would constitute a Fiber-optic Loopback mode for stand-alone testing. Set CSR2[6] ON to disable the Fiber-optic Loopback mode when the node is in use as a part of the network. This configuration is not a substitute for the Fiber Optic Bypass Switch for network operation.

2.9.5 Write-Me-Last Mode

The Write-Me-Last mode of operation allows the originating node to be the last node in the ring to have the data deposited to its memory. This can be useful for synchronization. This means that when the host performs a write to the SCRAMNet+ SC150e shared memory, the data is not immediately written to the host node's memory, but is first sent to the other nodes on the network. When the message returns to the originating node it is written to shared memory, and is then removed from the network ring.

Therefore, host-originated data written to shared memory travels the ring updating the SCRAMNet+ SC150e node memories. Upon returning to the originating node, the node writes the data to its own shared memory as the last node on the ring. This guarantees that the data is available on all other nodes.

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3. PRODUCT OVERVIEW

3.1 Overview

The SCRAMNet+ SC150e cards are backwards compatible with SCRAMNet+ and the original SCRAMNet Classic product with the exception of the GOLD RING communication protocol.

The SCRAMNet+ SC150e products use an enhanced architecture where shared memory read operations bypass the SCRAMNet ASIC for improved performance. Although both PIO and DMA operations are improved, DMA operations will give the greatest increase in performance. For PIO read operations, the overall system performance is also improved as read latency is reduced, the number of PCI retries is decreased, and the PCI bus utilization is improved. However, the performance increase is limited by PIO accesses by the host

3.2 SCRAMNet+ SC150e Cards

3.2.1 SCRAMNet+ SC150e PCI Card

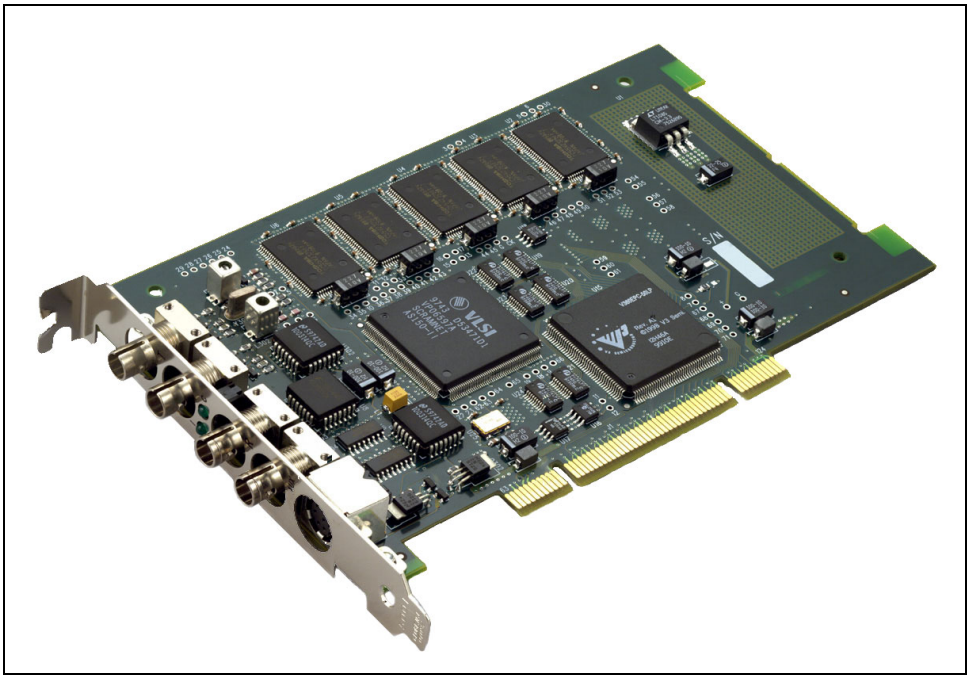


Figure 3-1 SCRAMNet+ SC150e PCI Card

The SCRAMNet+ SC150e PCI card offers the following features:

- Single-Slot PCI solution
- Designed in accordance with the PCI specification 2.1.
- 32-bit PCI interface, maximum bus speed of 33 MHz.
- Uses the V363EPC PCI Bridge chip from V3 Semiconductor.
- Supports PCI interrupt INTA
- Compatible with Universal (both +5.0 V and +3.3 V) PCI signaling levels.
- 2 MB, 4 MB, and 8 MB of on-card shared memory.
- 820 nm fiber-optic interface, maximum node separation of 300 meters.
- 1300 nm fiber-optic interface, maximum node separation of 3500 meters.

3.2.2 SCRAMNet+ SC150e PMC Card

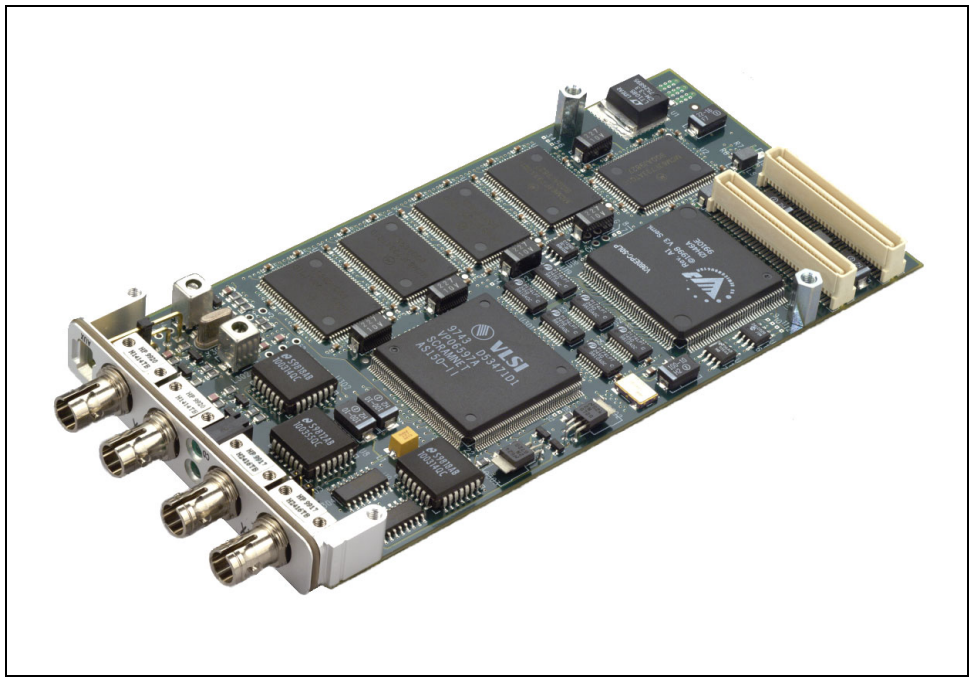


Figure 3-2 SCRAMNet+ SC150e PMC Card

The SCRAMNet+ SC150e PMC card offers the following features:

- Card can be mounted on any PMC-compliant carrier card in the computer chassis.
- Designed in accordance with the PCI specification 2.1.
- 32-bit PCI interface, maximum bus speed of 33 MHz.
- Uses the V363EPC PCI Bridge chip from V3 Semiconductor.
- Supports PCI interrupt INTA
- Compatible with Universal (both +5.0 V and +3.3 V) PCI signaling levels.
- 2 MB, 4 MB and 8 MB of on-card shared memory.
- 820 nm fiber-optic interface, maximum node separation of 300 meters.
- 1300 nm fiber-optic interface, maximum node separation of 3500 meters*.

* Contact Systran regarding availability of SC150e card options.

3.2.3 SCRAMNet+ SC150e CPCI Card

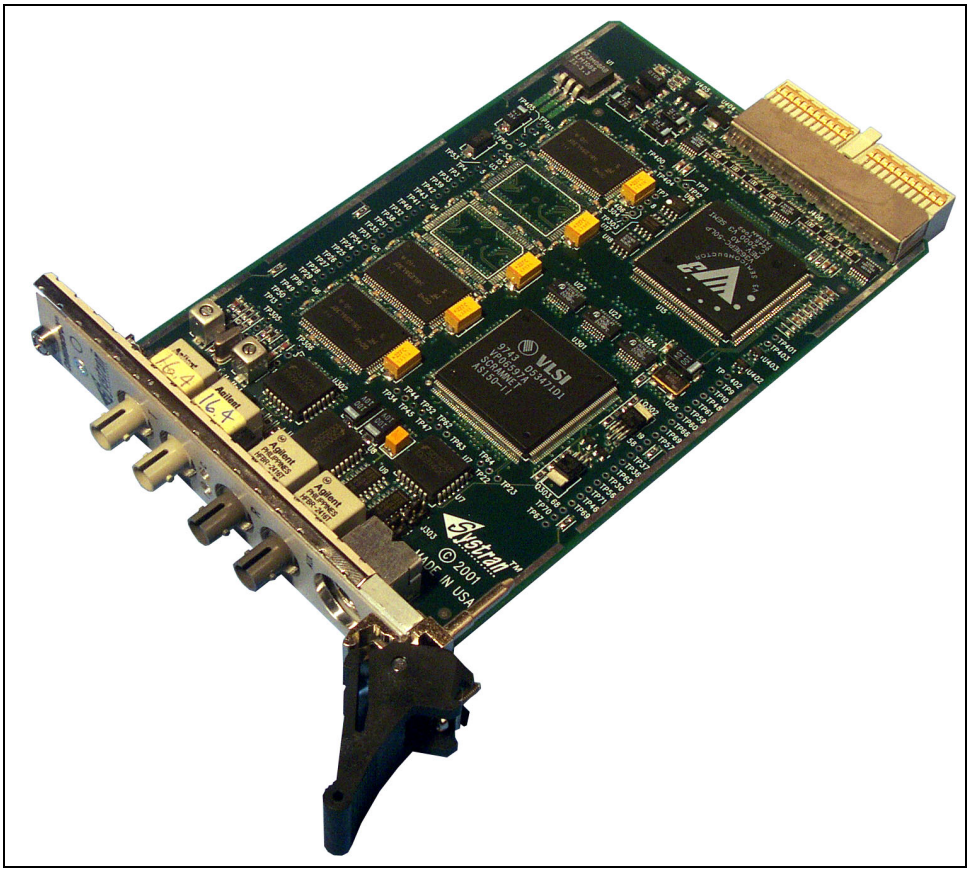


Figure 3-3 SCRAMNet+ SC150e CPCI Card

The SCRAMNet+ SC150e CPCI board offers the following features:

- 3U Single-Slot CPCI solution, which includes 6U faceplate
- Designed in accordance with the PCI specification 2.1 and CompactPCI Core Specification, PICMG 2.0 R3.0.
- 32-bit PCI interface, maximum bus speed of 33 MHz.
- Uses the V363EPC PCI Bridge chip from V3 Semiconductor.
- Supports PCI interrupt INTA
- Compatible with Universal (both +5.0 V and +3.3 V) PCI signaling levels.
- 2 MB, 4 MB, or 8 MB of on-board shared memory.
- 820 nm fiber-optic interface, maximum node separation of 300 meters.
- 1300 nm fiber-optic interface, maximum node separation of 3500 meters*.
- Provides Basic Hot Swap capability in accordance with the CompactPCI Hot Swap Specification, PICMG 2.1 R1.0 which allows:
  - Insertion of board into a powered system, without adversely affecting system operation. (Operator must manually load appropriate driver upon card insertion)
  - System reconfiguration and fault recovery to occur with no system down time.
  - A system to isolate faulty boards and continue operation.

* Contact Systran regarding availability of SC150e card options.

3.3 LED Status Indicators

3.3.1 Insert LED

The green Insert LED is ON when the node is inserted into the SCRAMNet+ SC150e Network ring. A node is inserted when it is electrically placed on the network for the purpose of transmitting and receiving messages. This LED is labeled “I” on the faceplate.

3.3.2 Carrier Detect LED

The green Carrier Detect LED is ON when there is a valid pair of transmit lights from the previous SCRAMNet+ SC150e node into this node’s receiver pair. Assuming at least one node is inserted in the ring, the ring integrity is NOT valid if the fiber-optic cables are connected and the Carrier Detect LED is OFF. This condition indicated improper fiber-optic cabling or problems with the down-line transmitter(s). This LED is labeled “C” on the faceplate.



NOTE: On a system power-up, a message from any node on the ring may be necessary to establish the carrier.

3.4 Software

Contact Systran for availability of SCRAMNet+ SC150e diagnostic source code and software libraries.

3.5 Utility Software

3.5.1 SCRAMNet Diagnostics

The SCRAMNet Network Hardware Diagnostics are designed to test the functionality of the hardware. This suite of tests automatically detects the type of card and adjusts the test menus accordingly.

3.5.2 EEPROM Initialization (EPI)

The EEPROM Initialization program is a SCRAMNet+ SC150e utility used to simplify configuration of the network node. The EPI program stores a start-up configuration in the serial EEPROM that can initialize the node on power up. This initialization program can be run when the card is installed to set the desired power-up state of the SCRAMNet+ SC150e node. EPI is completely menu driven and contains a context-sensitive help feature.

3.5.3 SCRAMNet Monitor

The SCRAMNet Monitor allows viewing and editing of memory and CSR locations on the SCRAMNet node. This utility is useful during software development to verify that the correct values are being written to SCRAMNet memory and CSRs.

3.6 Options

3.6.1 Fiber Optic Bypass Switch

A Fiber Optic Bypass Switch is a moving fiber switch that can redirect the fiber-optic path to change source and destination in a ring configuration. By placing a bypass switch

between the node and the ring, the transmitter and receiver paths are controlled by the switch.

BYPASS MODE

When a node is powered down, the bypass switch automatically routes the network data around the node. This keeps the fiber-optic ring operational. If there were no bypass switches in place when the node was powered down, there would be no means to receive or transmit incoming network data. Hence, the ring would be broken and no network traffic could occur. The bypass switch allows the data to continue on as if there were no node there at all.

When the switch is in the bypass state, the node is enabled to transmit data out and then right back into itself through the switch without going out onto the ring. Likewise, ring traffic "bypasses" the node through the switch. The LED on the switch will not be illuminated during this state.

INSERTED MODE

When a node is powered up, the switch is automatically in the bypass state by default. With power at the node, the bypass switch is under software control. By setting a bit in one of the SCRAMNet+ SC150e node's control registers, the switch can be placed in the "inserted" mode. The control signals are passed by an electrical connection between the node and the bypass switch using the 8-Pin Mini-DIN connector provided with the bypass switch. Refer to section 4.7 for instructions to interface the SCRAMNet+ SC150e card with the bypass switch.



NOTE: Details for setting Status/Control Registers are contained in Appendix B.

When the fiber switch is in the inserted state, the node is enabled to transmit data onto the ring and receive data from the ring while passing through the switch. The LED indicator on the switch will be illuminated during this state. Nodes 1, 3, 4, and 6 in Figure 3-4 are in the inserted state.

FUNCTIONALITY

The SCRAMNet+ SC150e network is based upon a fiber-optic-ring topology. While a fiber-optic configuration has many advantages a ring configuration depends on connectivity. If any of the nodes in a fiber-optic ring loses the ability to retransmit an incoming message, then the ring is "broken."

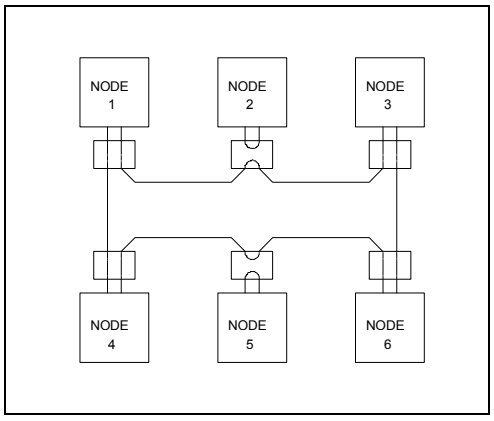


Figure 3-4 Ring with Bypass Switches

The Fiber Optic Bypass Switch automatically mends a broken ring by offering an alternative route for the fiber-optic message to travel. If nodes #2 and #5 in Figure 3-4 were to lose power or chose not to be included in the ring, then those two nodes would be bypassed.

3.6.2 Quad Switch

The SCRAMNet Quad Switch is designed to provide configuration control over the network topology and computing resources. The Quad Switch allows local clusters of up to four SCRAMNet nodes to be switched in or out of a primary SCRAMNet ring, independently and dynamically (Figure 3-5). It also allows sharing of a critical real-time resource between multiple systems.

The Quad Switch performs other useful functions such as optical bypassing, fiber-optic repeating to gain transmission length beyond the SCRAMNet node's transmission power limit, and to act as a media converter.

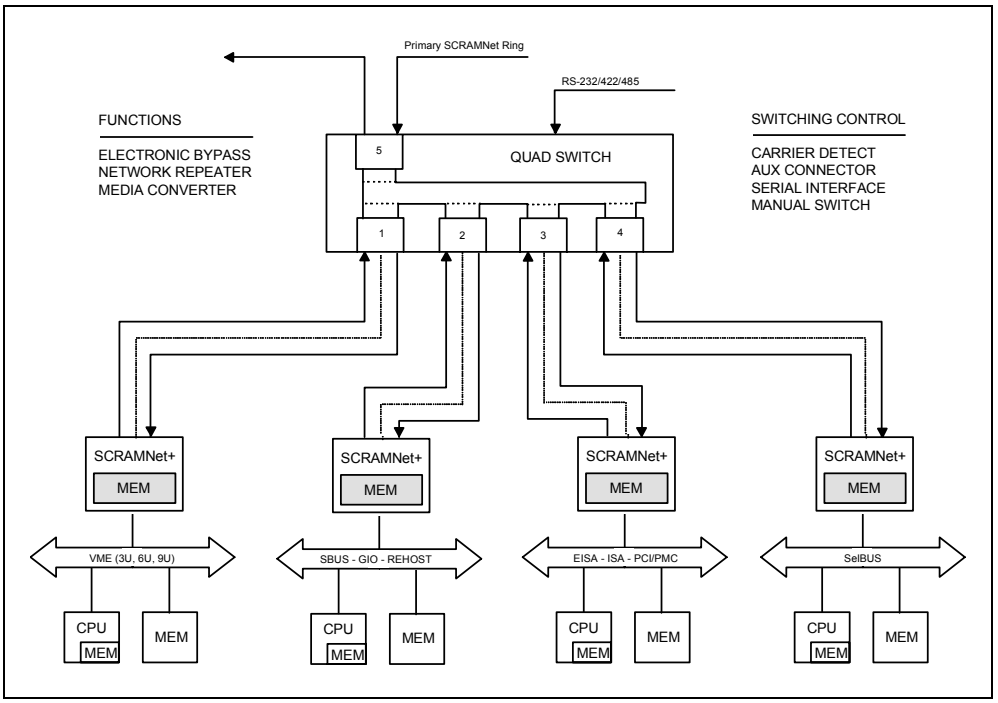


Figure 3-5 Node Inclusion and Isolation

The electronic bypass switching action is very fast, introducing a total network disruption of about one microsecond. This is over 10,000 times faster than mechanical optical bypass switches, and permits ring re-configuration to be performed in real-time with minimal impact on the system.

As a repeater, each Quad Switch port converts optical signals to electrical signals. These signals are re-synchronized and re-transmitted. This allows each connection to the Quad Switch to be the maximum length for the type of media selected.

The Quad Switch can also perform media conversion. Since each port has a Media Card, each port can be configured to handle coaxial, standard link or long link fiber. This allows a signal to arrive on one media type, and go out on another.

Visually, LED's signify the state of node inclusion in the ring and if carrier is detected. If the carrier is not detected, the port is put into the Isolate state and the port is bypassed

retaining ring integrity. The auxiliary connector and the associated control cable links the port to the node allowing the application running the node to switch the Quad Switch in and out of Include or Isolate state. A manual Include/Isolate switch is used to guarantee that a node is isolated or that it can be included. A serial-port interface is used to send message packets to the Quad Switch to perform control functions or to obtain switch status remotely via the RS-232 or RS-422/485 connection. Two mechanical rotary switches are used to set the serial-interface address.

3.6.3 Fiber-Optic Cables

Fiber-optic cables may be purchased from Systran Corporation or third parties. The recommended fiber-optic cable is 62.5/125 micron core multi-mode fiber-optic cable with ST connectors. See Appendix A for part numbers for the fiber-optic cables.

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4. INSTALLATION

4.1 Installation Procedures

This chapter describes the installation of the SCRAMNet+ SC150e card. Installation requires the following steps:

- Unpack the card
- Visually inspect the card
- Externally Configure the card
  - Set/verify EEPROM WRITE jumper (J303)
  - Set/verify EEPROM READ jumper (J304)
- Install the card
- Select Cabling Options
- Install Fiber Optic Bypass Switch (optional)
- Internally Configure the card
  - Set up SCRAMNet+ SC150e Registers
  - Set up SCRAMNet+ SC150e Control/Status Registers
  - Set Node Identification (CSR3[15:8])
  - Set Network Time-out (CSR5)
  - Enable DEC_IGNORE (CSR10[0])

4.2 Unpack the Card

Perform the following steps:

1. Remove the SCRAMNet+ SC150e card, enclosed in its anti-static bag, from the anti-static carton.



CAUTION: Exercise care regarding the static environment. Use an anti-static mat connected to a wristband when handling or installing the SCRAMNet+ SC150e card.

2. Open the anti-static bag and remove the SCRAMNet+ SC150e card.

Save the shipping material in case the SCRAMNet+ SC150e card needs to be returned.

The optional fiber-optic cables and Fiber Optic Bypass Switch are shipped in separate cartons.

4.3 Visually Inspect the Card

A label displaying the part number is located on the back of the card. Compare the part number, found on the card, to the packing slip to ensure you received the proper card. In addition, check the card for any damage that may have occurred during shipping. If the card was damaged in shipping, notify Systran Corporation or your supplier immediately. Figure 4-1 represents the SCRAMNet+ SC150e PCI host card layout (revision B card). Figure 4-2 represents the SCRAMNet+ SC150e PCI host Card layout (card revision C1 or higher). Figure 4-3 represents the SCRAMNet+ SC150e PMC card. Figure 4-4 shows the SCRAMNet+ SC150e CPCI host card layout.

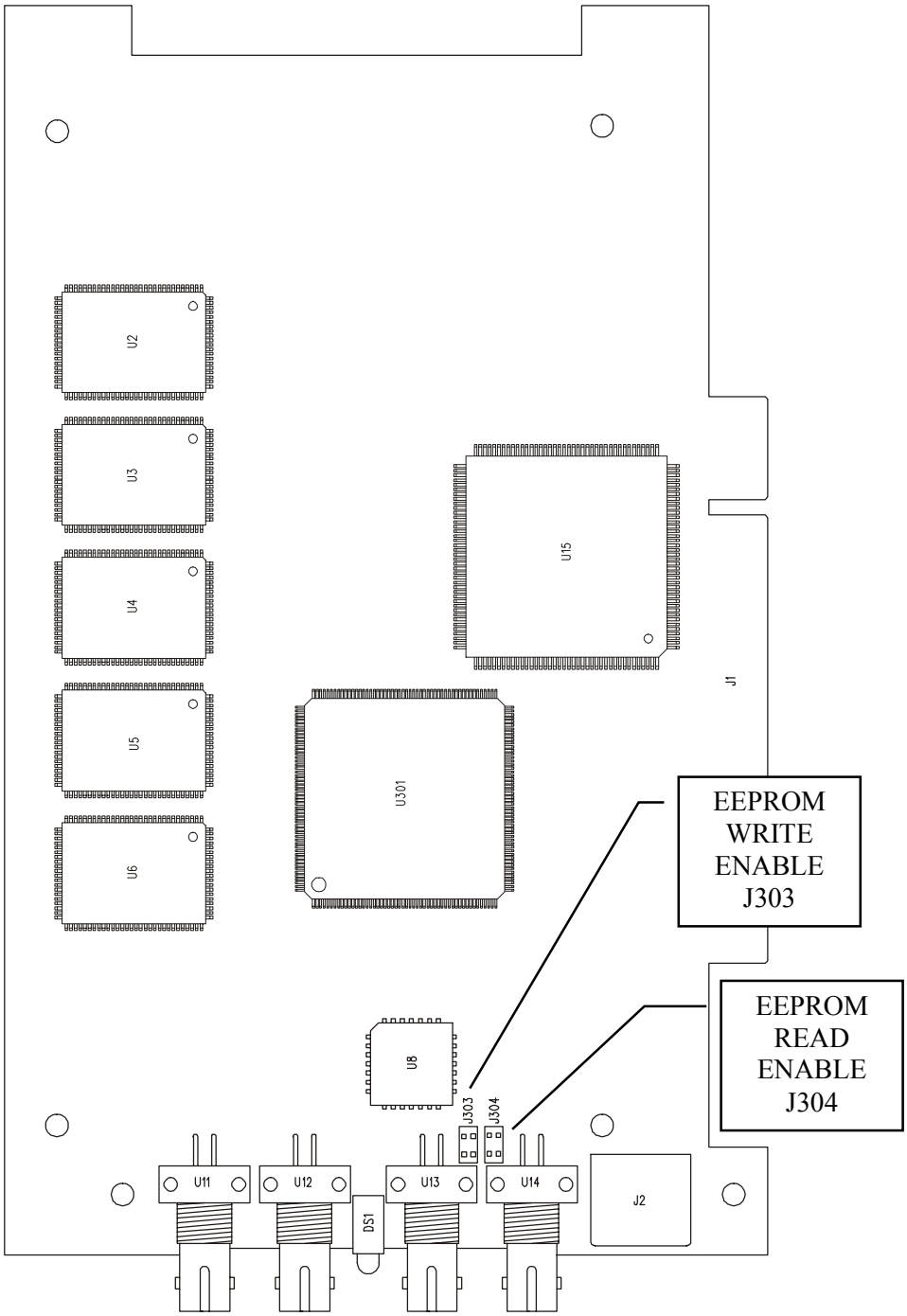


Figure 4-1 PCI Layout (card revision B1)

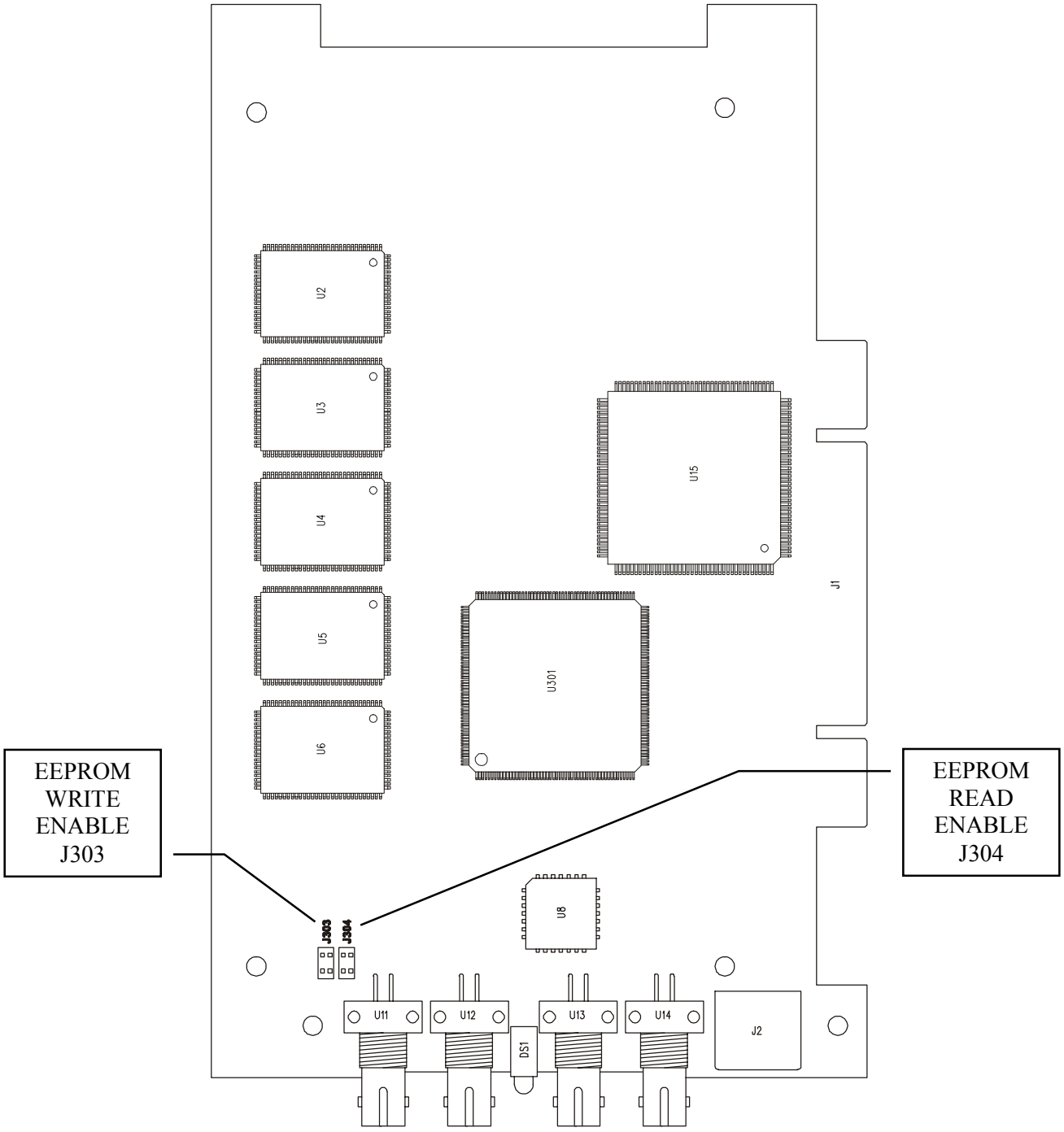


Figure 4-2 PCI Layout (card revision C1 or higher)

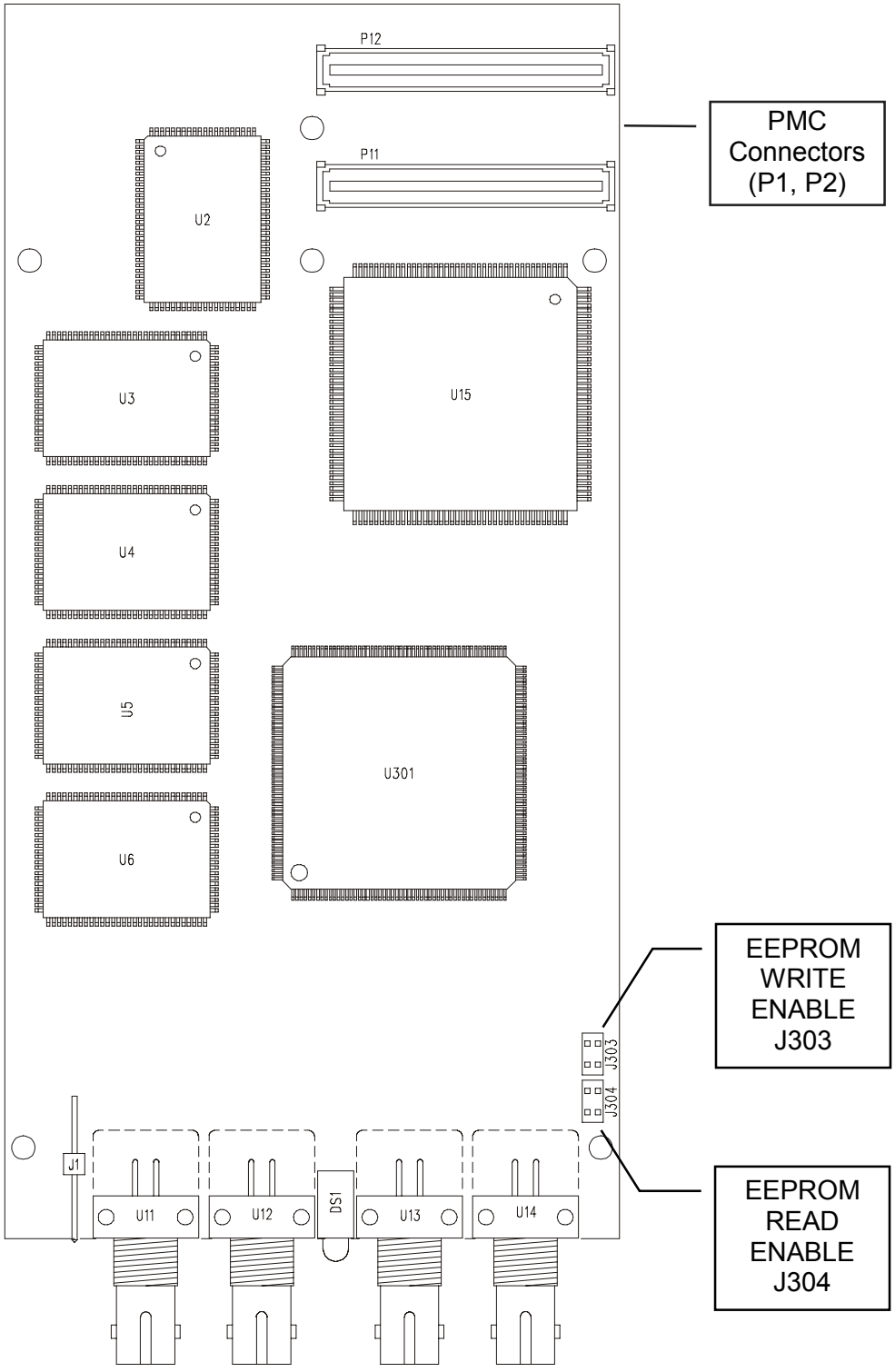


Figure 4-3 PMC Layout

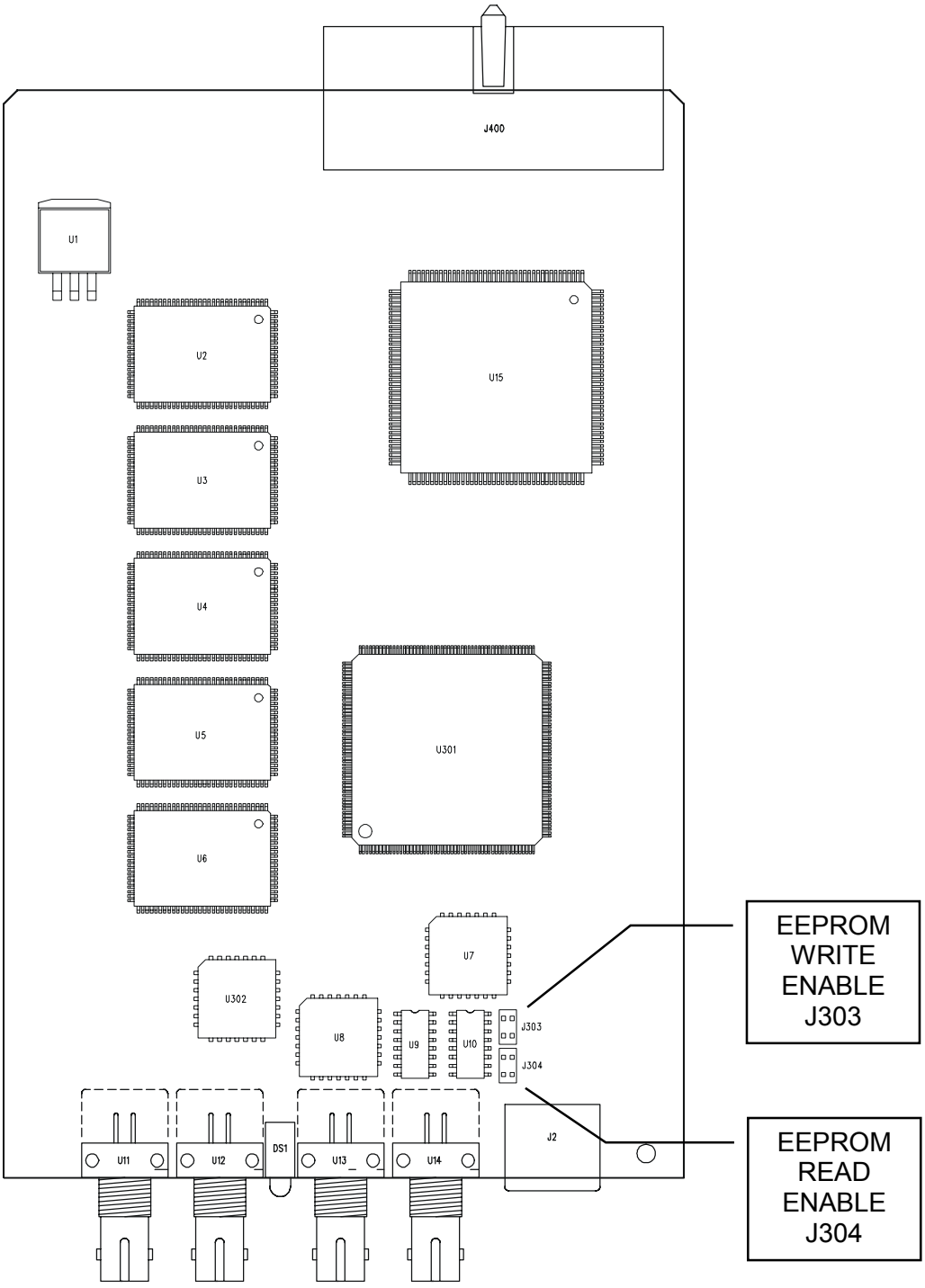


Figure 4-4 CPCI Layout

4.4 External Configuration

4.4.1 Set/Verify EEPROM Jumpers

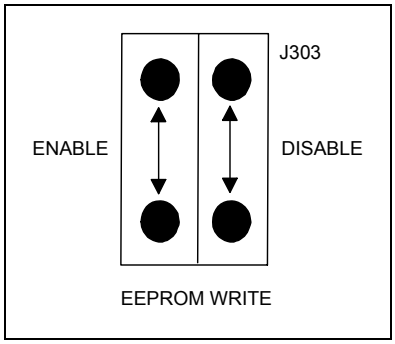


Figure 4-5 EEPROM WRITE (J303)

SET/VERIFY EEPROM WRITE (J303)

To enable EEPROM WRITE, install a two-pin header on the left pair of the write jumper as viewed from the fiber-optic connector end of the card as shown in Figure 4-1 through Figure 4-3.

Factory default: ENABLED

SET/VERIFY EEPROM READ (J304)

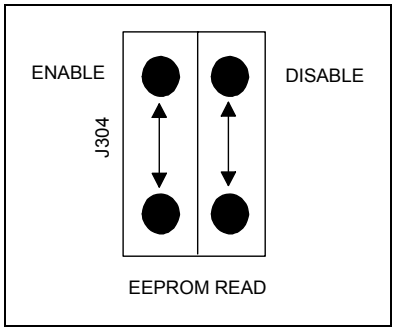


Figure 4-6 EEPROM READ (J304)

To enable EEPROM READ install a 2-pin header on the left pair of the read jumper as viewed from the fiber-optic connector end of the card as shown in Figure 4-1 through Figure 4-3.

Factory default: ENABLED

4.5 Install the Card

4.5.1 PCI/PMC Card Installation

Node configuration is pre-set or defined in the Configuration File. Therefore, after the card has been inspected it is ready to be installed.

CAUTION: Make certain that the power to the host computer is OFF. Check with the host computer manufacturer to find out which slots are available for third party memory cards before installing the SCRAMNet+ SC150e Network card into any system. Installing any type of card in a non-standard PMC slot may result in serious damage to the host machine.

1. Remove the bulkhead cover plate where the SCRAMNet+ SC150e host card will be.
2. (SC150e PMC only) Mount the PMC card on a motherboard, adapter, or carrier card as shown in Figure 4-7.
3. Slide the card into a desired peripheral bus slot while applying enough force to ensure a tight fit into the backplane connector. After insertion, use a standard Phillips-head screwdriver to secure the faceplate onto the frame of the computer chassis.
4. Connect the Transmitter and Receiver fiber-optic cables to the SCRAMNet+ SC150e card.

NOTE: Contact Systran concerning availability of cabinet kits for closed chassis operation.

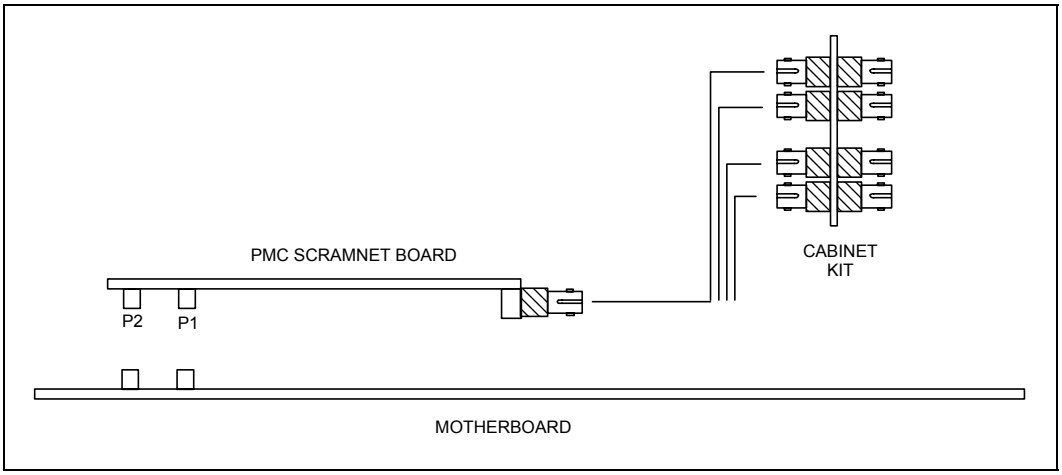


Figure 4-7 PMC Card Installation

4.5.2 CPCI Card Installation

CAUTION: If the host chassis and system board support Hot Swap specification PICMG 2.1, Revision 1.0, the CPCI card may be inserted into a powered system. Otherwise, the host chassis' power should be OFF to ensure that no damage occurs.

1. Remove the bulkhead cover plate where the SCRAMNet+ SC150e CPCI host card will be placed.
2. Slide the board into a desired peripheral bus slot while applying enough force to ensure a tight fit into the backplane connector. After insertion, use a standard Phillips-head screwdriver to secure the faceplate onto the frame of the computer chassis.
3. Connect the Transmitter and Receiver fiber-optic cables to the SCRAMNet+ SC150e card.

4.6 Cabling Configuration and Connection

4.6.1 Fiber-optic Configuration

The SCRAMNet+ SC150e product is available in standard fiber optic media (820 nm wavelength) for short distances and long link fiber-optic media (1300 nm wavelength) for long distances. The part number label described in section 4.3 can be used to differentiate a SCRAMNet+ SC150e card with standard fiber-optic media from a card with long-link fiber-optic media.

The basic SCRAMNet+ SC150e Network communication architecture consists of SCRAMNet+ SC150e cards tied together by paired sets of fiber-optic cable in a ring configuration. The maximum recommended distance between each node of the network using standard fiber optic media is approximately 300 meters. The maximum node separation using long link fiber optic media is 3,500 meters. The recommended fiber-optic cable, for both standard and long-link fiber-optic media, is 62.5/125 micron core multi-mode fiber cable with ST connectors.



NOTE: On a freshly powered system, a message from any node on the ring may be necessary to establish the carrier.

4.6.2 Fiber-optic Cables

The optional paired fiber-optic cables are shipped in a separate carton. The fiber-optic cables are to be attached to the connectors on the SCRAMNet+ SC150e card or on the Cabinet Kit, as appropriate. Remove the rubber boots on the fiber-optic transmitters and receivers as well as the ones on the fiber-optic cables. These rubber boots should be replaced when cables are not in use or in the event the node must be returned to the factory.

It is important the ends of the fiber-optic cable be kept clean. If there is an exceptional amount of light-power loss experienced, the cable ends should be inspected for cleanliness. Alcohol-based fiber-optic cleaning pads are available to remove minor contaminants such as dust and dirt.

Figure 4-8 is a representation of a fiber-optic connector.

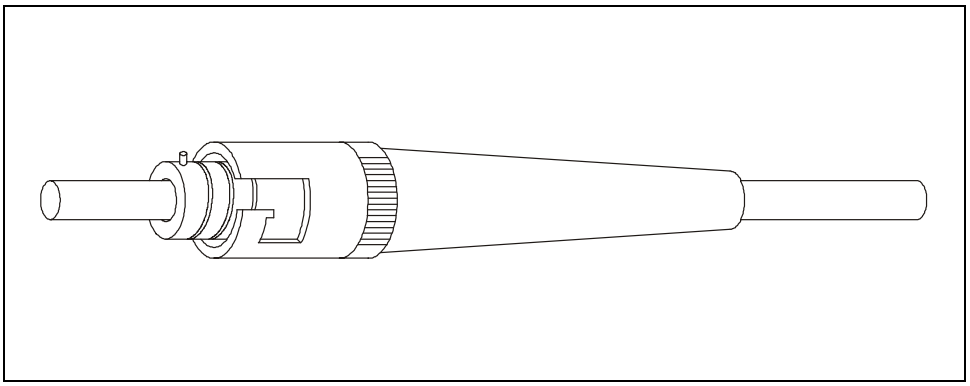


Figure 4-8 Fiber-optic ST Connector

FIBER-OPTIC CABLE PRECAUTIONS

Fiber-optic cables are made of glass and may break if crushed or bent in a loop with less than a 2-inch radius.

Perform a visual check of the cable ends before inserting into the transmitter/receiver connector. If debris is inserted into the transmitter/receiver connector it may not be possible to clean it out or could result in damage to the transmitter or receiver lens. Hair, dirt and dust can interfere with the light signal transmission.

Use an alcohol-base wipe to clean cable ends.

4.6.3 Fiber-optic Connection

There are two types of "bayonet" fiber-optic connectors used on ST fiber-optic cables. The newer type is made by 3M and is smaller than the AT&T ST connector. Install the connector by pushing it into the card connection and twisting the connector to the right (clockwise) to engage the blade. Remove it by pressing the metal sleeve toward the card and twisting to the left (counter-clockwise) to disengage the blade.

The primary difference between the connector types is that the AT&T connector provides a "locking" mechanism. Before it can engage or disengage the blade on the card connection, the plastic boot must be unscrewed at least ¼ inch and then re-tightened.

The fiber-optic cable pairs are connected between the transmitter pair of the "down-stream" node and the receiver pair of the "up-stream" node. Continuing this type of connection to all nodes in the network will result in a daisy-chain network ring as indicated in Figure 4-9.



NOTE: It does not matter if Tx_1 or Tx_2 is connected to the next node's Rx_1 or Rx_2 as long as both Tx cables are connected to both of the next node's Rx connectors.

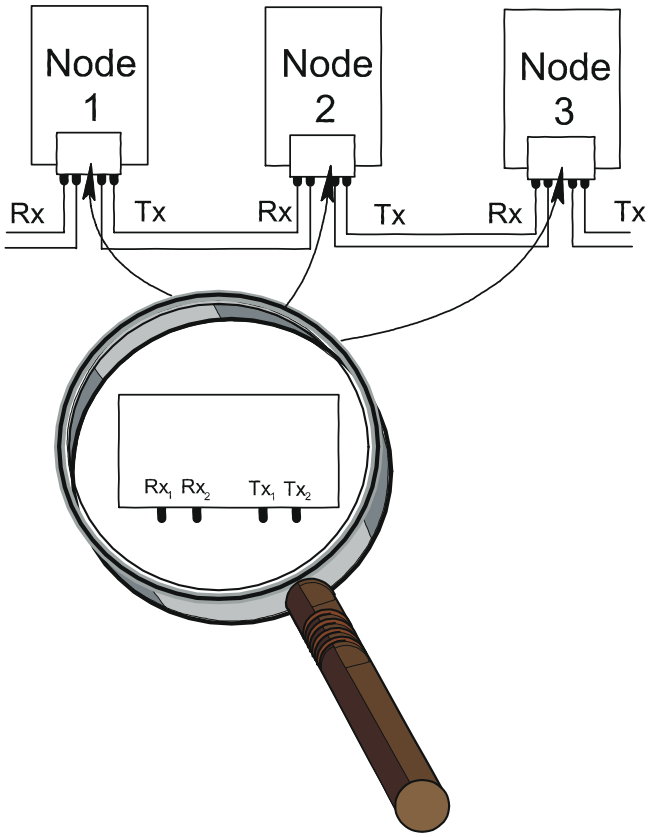


Figure 4-9 Fiber-Optic Connections

4.7 Fiber Optic Bypass Switch Option

4.7.1 Configuration and Connection with SC150e PCI and CPCI

Figure 4-10 and Figure 4-11 show the layout for the SCRAMNet+ SC150e PCI and CPCI, which differs from the standard connection shown in Appendix A, Figure A-2. Make Fiber Optic Bypass Switch connections as shown in Figure 4-10 and Figure 4-11.

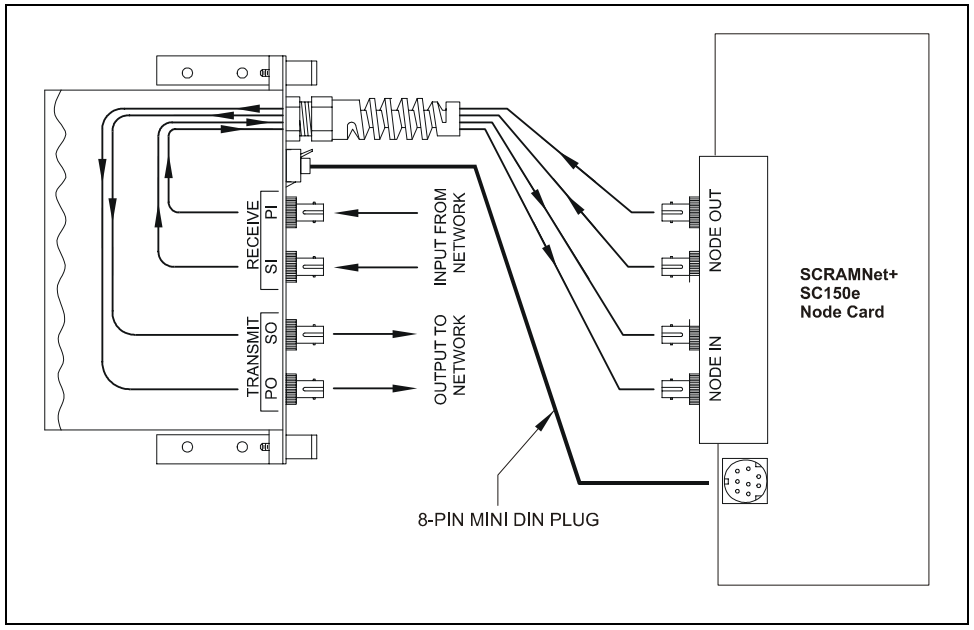


Figure 4-10 Inserted State (Power On)

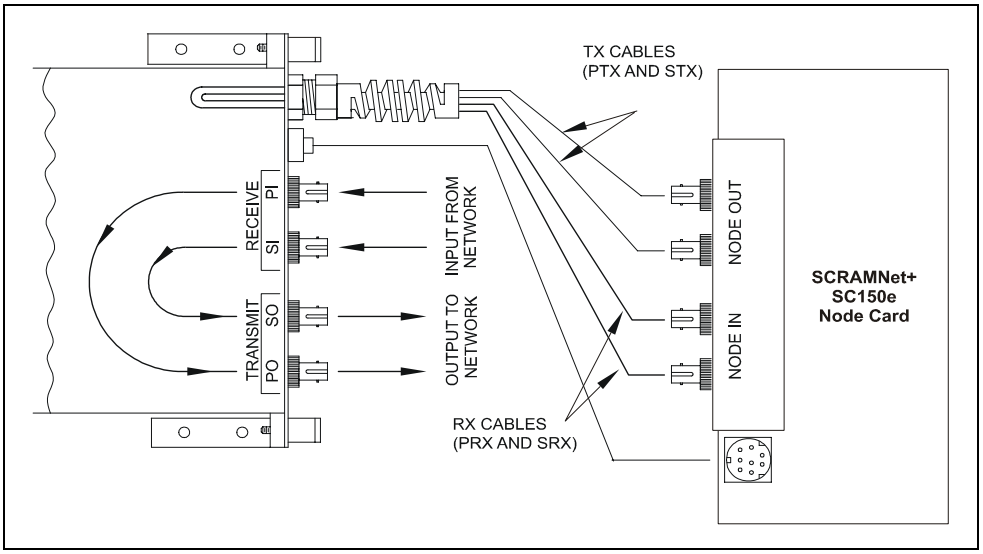


Figure 4-11 Bypass State (Power Off)

4.7.2 Configuration and Connection with SC150e PMC

Figure 4-12 and Figure 4-13 show the layout for the SCRAMNet+ SC150e PMC and differs from the standard connection shown in Appendix A, Figure A-2. Make Fiber Optic Bypass Switch connections as described in Figure 4-12 and Figure 4-13.

Connect the 8-pin male DIN plug from the Fiber Optic Bypass Switch to the 8-pin female end of the PMC auxiliary connection cable. Then connect the 3-pin female-end of the PMC auxiliary connection cable to the auxiliary 3-pin male header of the PMC.



NOTE: The PMC auxiliary connection cable is not provided with the bypass switch and must be purchased separately. Contract Systran Corporation regarding the purchase of the PMC auxiliary connection cable.

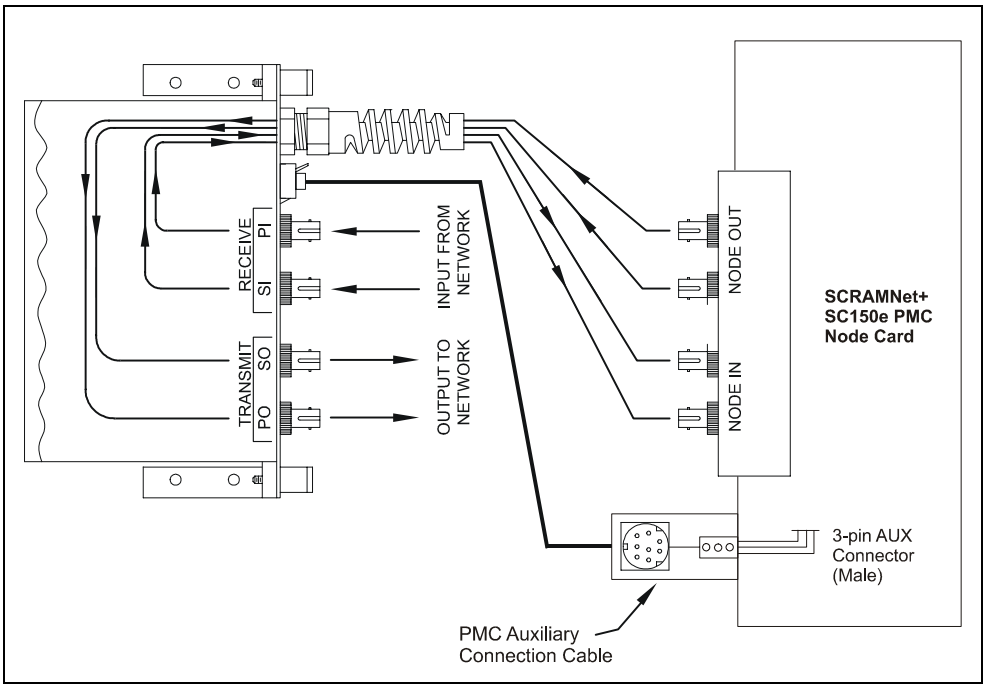


Figure 4-12 Inserted State (Power On)

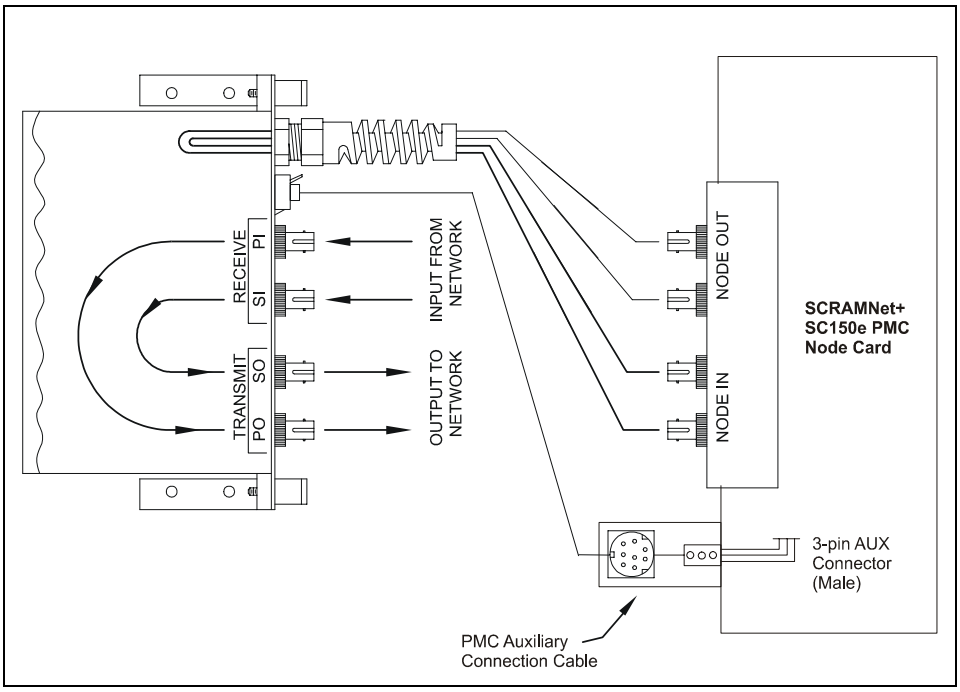


Figure 4-13 Bypass State (Power Off)

4.8 Auxiliary Connection

4.8.1 Auxiliary Connection on SC150e PCI and CPCI

The Auxiliary Connection is used for communication with the Fiber Optic Bypass Switch. The 8-pin modular in-line plug male-pin connection described in Figure 4-14 is defined in Table 4-1. (The view is looking into the end of the connector on the cable).

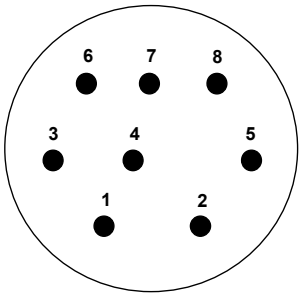


Figure 4-14 Auxiliary Connection

Table 4-1 PCI Auxiliary Connection Pinout

Pins	Name	Definition
1	GND	Logic Ground
2	N/C	No connection
3	F_RELAY	Fiber-optic Relay Drive and Sense
4	N/C	No connection

Pins	Name	Definition
5	EXT_PWR	+5 Source to External Ground
6	N/C	No connection
7	TRIGGER	Trigger Output (TRIG1 or TRIG2)
8	N/C	No connection

4.8.2 Auxiliary Connection on SC150e PMC

The Auxiliary Connection is used for communication with the Fiber Optic Bypass Switch. The 3-pin male connection described in Figure 4-15 is defined in Table 4-2. (The view is looking into the connector).

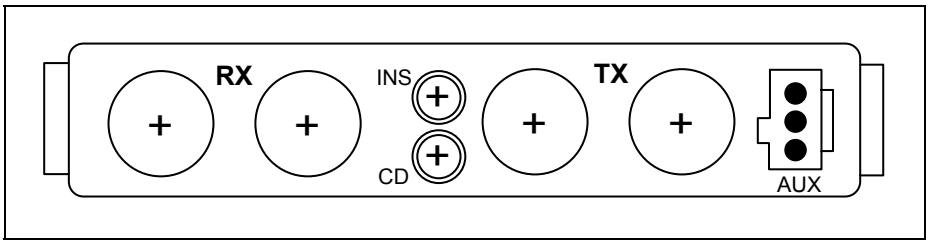


Figure 4-15 PMC Faceplate With Auxiliary Connection

Table 4-2 PMC Auxiliary Connection Pinout

Pins	Name	Definition
1	GND	Logic Ground
2	F_RELAY	Fiber Optic Relay Drive and Sense
3	EXT_PWR	Backup +5 Source to External Device

4.9 Internal Configuration

4.9.1 SCRAMNet+ SC150e Control/Status Registers (CSR)

Table 4-3 is a listing of the SCRAMNet+ SC150e Control/Status Registers.

If using software other than that supplied by Systran, the offsets in the first two columns must be added to the 0x800000 CSR base address.

The Systran software automatically calculates the offsets.

Table 4-3 SCRAMNet+ SC150e Control/Status Registers

Shortword Offset (Hex)	Byte Offset (Hex)	Alias	Size (Bytes)	Active Bits	Type	Register Description
1	2	CSR0	2	16	R/W	General SCRAMNet+ SC150e Enable and Reset
80	100	CSR1	2	16	R/W	SCRAMNet+ SC150e Error Indicators
103	206	CSR2	2	16	R/W	General SCRAMNet+ SC150e Control
182	304	CSR3	1 1	8 8	R/W R/W	Number of nodes Node ID
205	40A	CSR4	2	16	R	Interrupt FIFO Address (LSW)
284	508	CSR5	2	9 7	R* -	Interrupt FIFO Address (MSW) Reserved *Write Transmit Time-out to shadow memory
307	60E	CSR6	2	0	-	Reserved
386	70C	CSR7	2	0	-	Reserved
409	812	CSR8	2	16	R/W	Extended Control Register
488	910	CSR9	2	16	R/W	Interrupt On Error Mask
50B	A16	CSR10	2	4 12	R/W -	Shared Memory Address (LSW) Reserved
58A	B14	CSR11	2	16	R/W	Shared Memory Address (MSW)
60D	C1A	CSR12	2	16	R/W	Virtual Paging Register
68C	D18	CSR13	2	16	R/W	General-purpose Counter/Timer
70F	E1E	CSR14	2	0	-	Reserved
78E	F1C	CSR15	2	0	-	Reserved
		ACR	1	5 3	R/W -	Auxiliary Control, RAM Reserved

4.9.2 SCRAMNet on DEC Computers

Some DEC computers use PCI controllers that execute PCI write transactions with no byte enables (no data to be written). The SCRAMNet card can be set to tolerate these transactions at the expense of minor performance degradation by setting DEC_IGNORE CSR10[0] to ‘0’.

For improved performance on all other platforms, set DEC_IGNORE CSR10[0] to ‘1’. This is the factory default setting.

4.9.3 EEPROM Initialization

The EEPROM is used to store the initial power-up register values. The EEPROM can be programmed either over the host backplane or by most PROM programmers. An EEPROM initialization (EPI) program is included in the Systran Software Utilities Package for most systems.

The card comes with power-up default values in each of the registers and default switch settings so the card can be used without making any changes. Defaults are shown in Table 4-4 and Table 4-5 where 000 = CSR0, 002 = CSR1, 004 = CSR2. Both location

006 and 008 write to CSR3, TX_ID, RX_ID. This is possible because CSR4 is Read Only. Then location 00A = CSR5, etc.

Table 4-4 EEPROM Table

	0	2	4	6	8	A	C	E
00	0000	0000	C040	XX00	XX00	0010	0000	0000
10	0800	0029	0001	0080	0000	0000	0000	0020
...	0000	0000	0000	0000	0000	0000	0000	0000
70	00B1	5300	0600	5555	006E	5555	5555	5555

NOTE: XX denotes TX_ID and RX_ID. Both values are the same.

These values are assigned to the Control/Status Registers on power-up. The values may be changed at any time using the appropriate software to access the CSRs. When the system is powered down and powered up again, the CSRs will be reinitialized to these EEPROM values. Only the first 16 or 17 values are used in the registers.

Table 4-5 EEPROM Initialization

SCRAMNet+ SC150e Registers	
CSR0 - 0	CSR1 - Read Only (Errors)
CSR2 - C040 (BURST Mode)	CSR3 - Node ID (0 - 255)
CSR4 - 0 (Read Only)	CSR5 - 0010 Read Only (write a non-zero Network Time-out to shadow register)
CSR6 - 0 (Reserved)	CSR7 - 0 (Reserved)
CSR8 - 0800 (Mech Switch Override)*	CSR9 - 0029
CSR10 - 0001 (DEC_IGNORE)	CSR11 - 0080 (Reserved)
CSR12 - 0 (Virtual Page)	CSR13 - 0 (GP Counter)
CSR14 - 0 (Reserved)	CSR15 - 0020 (Reserved)

* HOLDOFF is enabled

4.9.4 Node Identification

Each node on the ring must have a unique Node ID. To set the Node ID, write a unique value 8-bit number between 0 and 255 to CSR3[15:8].

4.9.5 Network Time-out

The recommended value for the Network Time-out is:

 # NODES IN RING + (TOTAL LENGTH OF CABLE IN METERS÷50) + 1

To set the network time-out value, write the result as a 16-bit hexadecimal number to CSR5. This register has a “shadow register” which holds the network time-out value. Each increment in the “shadow register” is worth approximately 240 ns. The time-out will be 240 ns multiplied by the value written.

The time-out register is write only. If a read is performed, it will result in a read to the Interrupt FIFO.



CAUTION: Ensure a non-zero value is written to CSR5. A value of '0' will keep host-generated data from leaving the Transmit FIFO.

4.10 Byte Swapping

Some computer systems use different methods of byte ordering. Some have the byte order arranged from right to left (Little Endian) and others have the byte order going from left to right (Big Endian). Motorola is an example of a Big-Endian system. Intel is an example of a Little-Endian system.

Table 4-6 is a simplified summary for 8-bit, 16-bit, and 32-bit byte ordering for big endian and little endian.

Table 4-6 Byte Ordering Comparisons

Size	Big Endian	Little Endian
byte (8-bit)	12 34 56 78	78 56 34 12
shortword (16-bit)	1234 5678	5678 1234
longword (32-bit)	12345678	12345678

The SCRAMNet-LX, SCRAMNet+ and SCRAMNet+ SC150e product lines use the big-endian ordering philosophy as the default for data passing. These cards do not have a built-in byte-ordering conversion function. However, SCRAMNet+ and SCRAMNet+ SC150e cards permit byte-swapping options via the V3 registers PCI_MAP0 and PCI_MAP1.

Table 4-7 PCI_MAP0/PCI _MAP1 Swapping Options

Bits 9	Bits 8	Swapping Option
0	0	No Swapping
0	1	16-bit Swapping
1	0	8-bit Swapping
1	1	Reserved

The SC150e card allows byte swapping on an aperture basis; PCI_MAP0 controls aperture 0, and PCI_MAP1 controls aperture 1. The options are shown in Table 4-7.

4.11 DMA Operation

The SCRAMNet+ SC150e card hardware provides two bi-directional DMA channels for transferring blocks up to 4 MB in length. Refer to *V363EPC User Manual* for details of the DMA operation. See section 1.2 in this manual for information on how to access the *V363EPC User Manual*.

4.12 Maintenance

No routine maintenance is required for the SCRAMNet+ SC150e general-purpose nodes beyond that which is required for host computer systems. SCRAMNet+ SC150e network fiber-optic cabling connectors should be inspected periodically.

4.13 Troubleshooting

Problem:	Solution:
No power-up indication on a PC platform	If there is an incorrect address, the system will not boot up.

On UNIX-like systems, the driver generates a message on boot-up similar to the following:

```
SCRAMNet+ installed and on-line
```

Problem:	Solution:
The boot-up message does not appear	The Register base address, memory base address and/or memory size may be incorrect.



NOTE: All SCRAMNet+ SC150e nodes in the fiber-optic network ring must be powered on unless they have Fiber Optic Bypass Switches or Quad Switches installed.

Problem:	Solution:
The hardware installation fails	• The SCRAMNet+ SC150e host card is not installed into a standard slot. (This check should have been performed before installing the SCRAMNet+ SC150e host card into any slots). • The READ/WRITE jumpers J303/J304 are not in the factory-default position.
The system does not boot correctly	Reset the card and double-check cable connections. If problems persist, call Systran Customer Support at (937) 252-5601 for assistance.

5. OPERATION

5.1 Overview

The SCRAMNet+ SC150e Network is a shared-memory system. Every computer on the network has a constantly updated local copy of all global data passed to all the network computers. The network protocol is implemented in the SCRAMNet+ SC150e hardware and therefore no software overhead is required to retrieve this information from the network.

The protocol is transparent to the computer. This frees computer processor time for application algorithm execution and other real-time tasks. Since any computer on the network has access to data in the shared memory, any computer can read or modify the shared data and thereby communicate with the other computers on the network.

Very little special software is required for normal operation because of the SCRAMNet+ SC150e shared-memory configuration. Typically, SCRAMNet+ SC150e memory is installed and linked to a host global common block through the host operating system. Once the link is complete, any program can reference SCRAMNet+ SC150e memory as a standard common-block variable reference.

For interrupt driven applications, an interrupt service routine (ISR) is required to handle the interrupts triggered by the SCRAMNet+ SC150e node. An example of a generic ISR is included Figure 5-11, page 5-29 at the end of this section.

5.2 Shared Memory

Global variables are mapped directly onto the replicated shared memory. The application program typically contains a list of variables or arrays which are stored in a contiguous space and which are to be shared across processors. An analogy is a FORTRAN COMMON BLOCK. For the purpose of identification, these variables are referred to as SCRAMNet+ SC150e variables.

The application program usually requires a short section of instructions to initialize the SCRAMNet+ SC150e hardware and to link the SCRAMNet+ SC150e memory to the SCRAMNet+ SC150e variable list. The shared memory cannot be used as instruction space.

5.2.1 Virtual Paging

CSR12 is the virtual-paging register. Set CSR12[0] to ‘1’ to enable virtual paging.

The SCRAMNet+ SC150e network may include a variety of SCRAMNet+ SC150e nodes having varying amounts of shared memory. All SCRAMNet+ SC150e nodes use the same 8 MB network shared-memory map. Virtual paging allows a node with 4 MB or less shared memory to move its memory window throughout the SCRAMNet+ SC150e physical 8 MB network shared-memory map.

If a node has 4 MB of shared memory, it can be paged into the upper 4 MB or the lower 4 MB of the network shared-memory map. If it is paged into the lower 4 MB, it would

operate the same as if Virtual Paging were disabled. The network address would be the same as the shared-memory address.



NOTE: Virtual paging does not affect host access to shared memory. Virtual Paging only changes the network address. The HOST-SPECIFIC logic always sees the base address of SCRAMNet+ SC150e shared memory as zero.

If the 4 MB block were paged into the upper 4 MB, a host-specific write to a shared-memory address of 2 MB would result in a network address of 6 MB. This translation is bi-directional. An incoming network message with a network address of 6 MB will be written to shared memory at 2 MB. Any write accesses to the lower 4 MB will be ignored since there is no memory addressed there.

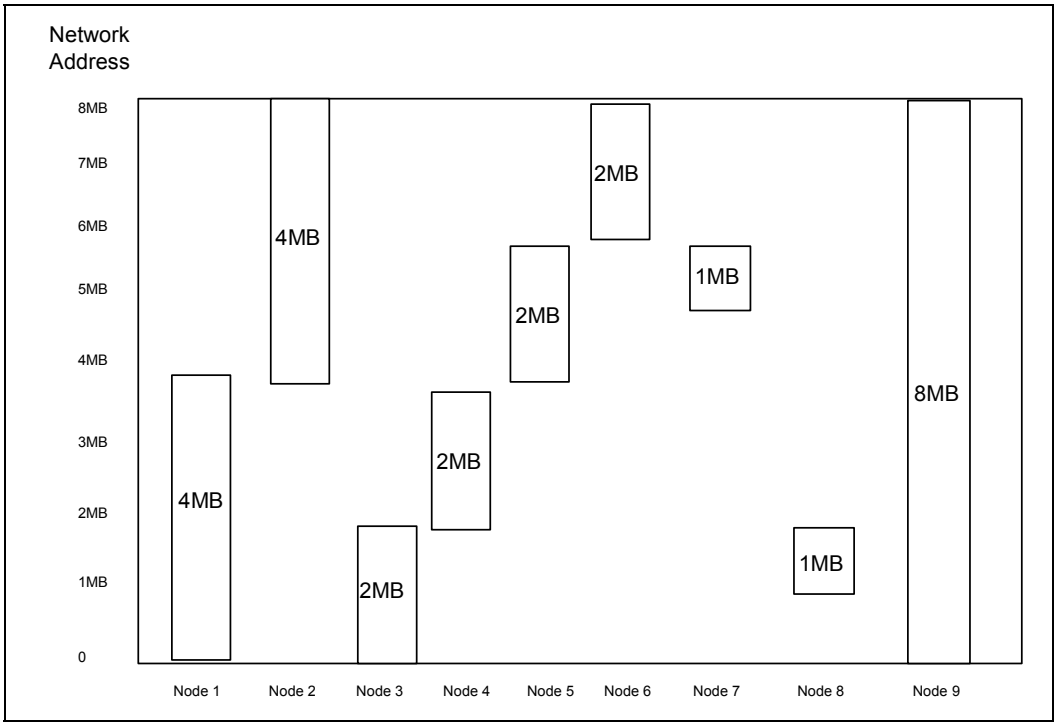


Figure 5-1 Memory Sharing With Virtual Paging

To produce a network address, the host write adds the relative SCRAMNet+ SC150e address and virtual page offset.

Relative address + Virtual page offset = Network address
For example: 12340 + 400000 = 412340

This network address is transmitted to all SCRAMNet+ SC150e nodes and is written to that address. In nodes where the address does not exist in SCRAMNet+ SC150e memory, the write is ignored.

The example in Figure 5-1 shows the memory-sharing relationships between various nodes in the virtual-paging mode. Node 1 shares data with nodes 3, 4, 8, and 9. Node 2 shares data with nodes 5, 6, 7, and 9. Node 8 shares data with nodes 1,3, and 9. Node 7 shares data with nodes 2, 5, and 9. Node 9 shares data with all nodes.

5.2.2 Memory Considerations

When using SCRAMNet+ SC150e shared-memory, consider the following:

PROGRAM AND DATA LIMITATIONS

Limitations on application program size and data variable size for a host computer system also apply to applications using SCRAMNet+ SC150e memory because it becomes part of the host system.

DATA CACHING

The ability for a computer to write a copy of data to a local fast memory for quicker access later must be turned off during a SCRAMNet+ SC150e memory read. Since other nodes may be changing the data, it is critical that the processor read the data directly from SCRAMNet+ SC150e memory. This is processor-dependent and does not always apply.

MEMORY MAPPING

SCRAMNet+ SC150e memory is mapped by all operating systems in constant-length blocks called memory pages.



NOTE: To ensure that a compiler or operating system does not try to access unused portions of SCRAMNet+ SC150e memory to store other program segments, declare the SCRAMNet+ SC150e memory common blocks to be sized to an integer multiple of the processor memory page size. If this is not done, most compilers will try to optimize memory usage by filling out the SCRAMNet+ SC150e memory pages with other data. This can cause random results when this local data is transmitted around the network.

5.2.3 Control/Status Registers

The SCRAMNet+ SC150e cards are controlled through CSRs for node status, setting interrupt vectors, setting interrupt locations, receiving interrupt addresses, mode control and other functions. These registers may be accessed by linking to the I/O page and reading from or writing to the registers as if they were memory. The method used to access the registers depends on the particular computer and operating system being used.

These registers are set only during the SCRAMNet+ SC150e Network initialization. Once the control portion of the CSR is set up for the desired mode operation, the node functions as transparent shared memory and references to the CSRs are not required. However, the status portions of the registers will need to be accessed for interrupt servicing and for checking for error conditions. Appendix B: CSR DESCRIPTIONS discusses the definition and use of each bit in the CSRs. Appendix C: CSR SUMMARY contains a list of the CSRs and a brief identification of each bit.

5.3 Initialization

The initialization of the SCRAMNet+ SC150e node from a cold boot is determined by the settings of the EEPROM.

No fiber-optic cable connections are required to perform a read/write to the local host's SCRAMNet+ SC150e memory. When the control registers CSR0 and CSR2 are set to zero the SCRAMNet+ SC150e memory is available for access. The memory address will remain at '0' and be disabled until programmed with the EEPROM Initialization (EPI) Program.



NOTE: All SCRAMNet+ SC150e nodes in the fiber-optic network ring must be powered on unless they have Fiber Optic Bypass Switches or Quad Switches installed.

5.4 Basic Send/Receive Configuration

The following minimum configuration allows basic send and receive operation and is accomplished without interrupts.

- Set CSR0 to '0xF000' to insert the node and initiate the reset of the FIFOs.
- Set CSR0 to '0x8003' to insert the node, toggle the reset of the FIFOs and enable network activity.
- Set CSR2 to '0xC040' to disable the Fiber-optic Loopback mode.
- Read CSR1 to read-out any latched error conditions.
- Read CSR1 again to check for any existing error conditions.
- Check for carrier-detect fail (this means there are fiber-optic cabling problems from the transmitter of the node downstream).
- Write a value to memory from at least one node. This enables all powered node transmitters and check for fiber-optic ring integrity.
- Read CSR1 to check for any error/status conditions.

5.5 Network Ring

Data is passed from one node to the next by fiber-optic or coaxial cable. Given a three-node network configuration with nodes A, B and C, the following connections would be made:

- The transmitter pair from node A is connected by fiber-optic cable to the receiver pair of the next node B.
- The transmitter pair from node B is connected by fiber-optic cable to the receiver pair of node C.
- The transmitter pair of node C is then connected to the receiver pair of node A, thus completing a fiber-optic network ring.

5.5.1 Message Contents

The smallest SCRAMNet+ SC150e Network message packet consists of 82 bits. This basic message format contains five fields: Source ID, Age, Control, Data Address, and Data Value. The message can be described as follows:

Table 5-1 SCRAMNet+ SC150e Message Contents

START	ID	AGE	CONTROL	DATA ADDRESS	DATA VALUE
1	8+P	8+P	1 1 1 RES INT RTY	5+P 8+P 8+P	8+P 8+P 8+P 8+P

For every 8 bits of data in the message there is a parity bit attached.

SOURCE ID

This 8-bit field contains the node ID of the originating node. Value ranges from 0 to 255, so there can be 256 nodes on the network ring.

AGE

This 8-bit field increments by one as a message passes through each network node. If the age ever exceeds 256 (the maximum number of nodes on the network), the message is removed from the network.

CONTROL BITS

RES - Reserved.
INT - When this bit is set it signals an Interrupt Message.
RTY - Retry message used only in error correction mode (PLATINUM.)

DATA ADDRESS

This 21-bit (A[22:2]) field contains the relative SCRAMNet+ SC150e memory address. Bits A0 and A1 are always zero for a longword boundary.

DATA VALUE

This 32-bit field contains the data value in SCRAMNet+ SC150e memory that is currently being updated around the ring. When the PLUS mode is enabled, data size may vary up to 256 bytes or 1024 bytes depending on the option selected.

5.5.2 Protocol

BURST MODE

BURST Mode is the normal protocol for SCRAMNet+ SC150e. The BURST mode is enabled by setting CSR2[12] off, and CSR2[14:15] ON. The BURST Mode protocol allows each node to continuously transmit messages onto the network ring. This mode uses a 4-byte fixed-length message packet for data transfer.

PLATINUM MODE

The PLATINUM mode is BURST mode with error correction enabled. PLATINUM mode is enabled by setting CSR2[12] OFF; CSR2[14] ON; and CSR2[15] OFF See the Protocol Mode Definition table in appendix C, page C-3.

PLUS MODES

The PLUS mode protocol is available as an option to the SCRAMNet+ SC150e BURST and PLATINUM mode network protocols. Selecting the 1024 byte maximum data length will result in the maximum bandwidth. However, it will also lengthen ring time, error correction time, and node latency.

Set up the PLUS mode protocol as follows:

- Set CSR2[12] to ‘1’ to enable PLUS mode
- Set CSR2[11] to define the maximum data message size. CSR2[11] only has an effect when CSR2[12] is ON. CSR2[11] has the following definition:
  0 = 256 byte maximum data length
  1 = 1024 byte maximum data length
- Set up the writes to SCRAMNet+ SC150e shared memory to be in sequential 32-bit addresses. Data must be written to the SCRAMNet+ SC150e node with sequentially incrementing 32-bit addresses to take advantage of the PLUS mode protocol enhancement. It is not necessary to use the full 256 or 1024 byte data length—they are maximum values.

The PLUS mode allows variable-length message packets in which sequentially addressed data in the Transmit FIFO is transferred as a block in a single packet. Both BURST modes are open-loop, non-error-corrected modes of operation.

The node appends 4-byte data values with sequential addresses until the maximum of 256 or 1024 bytes is reached, a non-sequential address is detected, the Transmit FIFO is empty, or a transmit-interrupt event is detected. In both BURST and PLATINUM modes, the node is permitted to have multiple packets on the ring simultaneously.

The transmission of a PLUS mode message is an automatic function, and for the most part, cannot be controlled. If the appropriate PLUS mode bits are set in the control registers, then the following algorithm applies:

1. If Transmit FIFO is empty, end transmission.
2. If the address field is not equal to the address of the previous transmission + 4, end transmission.
3. If length limit overflow for PLUS mode operation occurs, end transmission.
4. ELSE transmit the four data bytes and when done GOTO step 1.

To maintain a PLUS mode transmission, step 1 requires that new data is written to the SCRAMNet+ SC150e card at a rate greater than or equal to 16.7 MB/sec (this is a 32-bit write every 240 ns). Any delay in the host data write will result in failure of step 1, and a premature end to the PLUS mode transmission.

While this method results in the reliable generation of a PLUS mode transmission, it increases the node latency. The SCRAMNet+ SC150e device automatically increases PLUS mode throughput (when blocking is not used) when needed due to high-throughput host, very busy network, etc.

ERROR CORRECTION

Error correction is the automatic retransmission of a SCRAMNet Network message when the original message is received in error by the originating node. The message will be retransmitted indefinitely until it is received correctly. During transmit retry, the same message is being sent. This prevents any new messages from being transmitted by this node. The transmit FIFO will hold these new messages until the retry message is received correctly.

If the original message is received by the originating node with some type of bit error, then this results in the transmit retry bit in CSR1 being set. If the original message is not received by the originating node in the time-out period specified in CSR5, then this results in the transmit retry time-out bit in CSR1 being set. The time-out period is based on the number of nodes in the network ring and the total length of cable used.

5.5.3 Performance

NODE LATENCY

Node latency is an important factor in networked application in real-time systems design. Data transfer around the network, while fast, does have a measurable delay.

Node latency can be defined as the time delay at a node before a foreign message can be retransmitted. This delay is a minimum of 247 ns—the time to transmit one byte. The maximum node latency depends on the maximum message size and could be from 800 ns to 61.8 µs, depending on the message length selection. To approximate the total maximum delay on the network, multiply the maximum node latency by the number of

nodes in the system, and add a propagation delay of 5 ns/meter multiplied by the total message path of the ring in meters.

DATA TRANSFER

While the SCRAMNet+ SC150e Network appears as a shared-memory system, it is still a data network. The SCRAMNet+ SC150e Network includes a series of FIFO buffers to collect data changes until they are transmitted to the other nodes. The Transmit FIFO and the Interrupt FIFO are both 1024 messages in length. These numbers may become significant when performing data transfers of large blocks of data in a short period of time.

HOLDOFF

If the Transmit FIFO becomes full, subsequent read or write cycles to SCRAMNet+ SC150e memory will be extended until the Transmit FIFO is no longer full (see subsection 5.11.4 for more information).

SHARED-MEMORY WRITE

SCRAMNet+ SC150e shared-memory is based upon a 32-bit word. If an 8- or 16-bit write occurs from the host system, then the 32-bit word that contains that 8- or 16-bit write is sent on the network. Therefore, it is important that other nodes do not simultaneously modify other 8- or 16-bit segments within that 32-bit word.

5.5.4 Throughput

A maximum throughput of 6.5 MB/sec could be achieved if only one node were transmitting data, assuming the host CPU could offer the data at that rate. When more than one node is transmitting in BURST mode, then the effective output per node is 6.5 MB/sec divided by the number of transmitting nodes. In BURST and BURST PLUS modes, the node never retransmits its own messages.

In the BURST PLUS mode, a 256-byte packet provides 16.2 MB/s of data throughput. A 1024-byte packet provides 16.7 MB/s maximum data throughput.

When multiple nodes are transmitting in the BURST mode, the network data passing through the other nodes can affect that node's output performance. If a node's receiver is so busy that the Transceiver FIFO is never empty, and the node has already sent a message, then the node will have to wait before it can send another message of its own until either one of its messages comes back or the timer runs out. When the node's own message is received, it is not placed in the Transceiver FIFO thereby creating an opportunity for the node to send a message from the Transmit FIFO.

In PLATINUM and PLATINUM PLUS modes, error detection is enabled. This will affect node latency in that some messages must be retransmitted.

NETWORK TIME-OUT

Reset the transmit time-out according to the mode of operation selected by writing a 16-bit non-zero value to CSR5 as described in subsection 4.8.4.

5.6 Auxiliary Control RAM

The ACR is a 5-bit register. When ACR Enable CSR0[4] is set, shared memory is not accessible by the host, and the ACR byte is viewed as the least significant byte of every shared-memory four-byte address. The ACR byte value controls the interrupt action(s)

taken whenever a write occurs to any byte of the shared-memory four-byte word. Table 5-2 describes the ACR functions.

Table 5-2 ACR Functions

Bit	Function
0	Receive Interrupt Enable (RIE)
1	Transmit Interrupt Enable (TIE)
2	External Trigger 1
3	External Trigger 2
4	HIPRO Location Enable

If these ACR actions are disabled, then no action will be taken when an interrupt condition exists unless override bits CSR0[6] or CSR8[10] are set.

The interrupt action and/or HIPRO mode for a particular shared-memory location is defined by setting these bits. Once the ACR has been defined, set the ACR Enable bit CSR0[4] back to zero so that shared-memory can again be accessed. The ACR actions are still in effect, but the ACR bytes can no longer be accessed while the ACR Enable bit is zero.

In order for the ACR values to take effect for interrupt action, the following SCRAMNet+ SC150e CSR actions should be considered for the type of interrupt operation desired:

- Host Interrupt Enable CSR0[3] to receive network interrupts
- Network Interrupt Enable CSR0[8] to transmit network interrupts
- Interrupt on Memory Mask Match Enable CSR0[5] for interrupts from memory writes

Receive and/or Transmit CSR0[1:0] must be enabled in order for the node to receive and/or transmit network data. There are other combinations of CSR settings to achieve varied interrupt results. Appendix B: CSR DESCRIPTIONS describes the SCRAMNet+ SC150e CSRs in detail.

In order for the HIPRO mode to become active, ACR[4] must be set for those selected memory addresses where this is to occur. Additionally, CSR2[13] must be set to enable the HIPRO mode. All five of the defined bits of the ACR can be used in any combination to achieve varied results for any shared-memory location.

5.7 Interrupt Controls

SCRAMNet+ SC150e allows a processor to receive interrupts from and/or transmit interrupts to any other processors on the network, including the originating processor. Table 5-3 indicates the various sources for interrupt control.

5.7.1 Interrupt Options

Table 5-3 Interrupt Controls

Condition	Register	Description
Host Interrupt Enable	CSR0[3]	Must be set in order to receive any interrupts from the network.
Receive Interrupt Enable (RIE)	ACR[0]	Generates an interrupt to the host from network data received at the associated Shared Memory location.
Transmit Interrupt Enable (TIE)	ACR[1]	Generates an interrupt to the network for a host write to the associated Shared Memory location.
Interrupt on Memory Mask Match Enable	CSR0[5]	Permits a shared memory interrupt. Must be set in order to receive any interrupts from the network.
Override RIE	CSR0[6]	Generates an interrupt to the host regardless of the ACR RIE setting upon receipt of any network interrupt message.
Enable Interrupt on Error	CSR0[7]	Generates an interrupt request as specified in the CSR9 Mask register as the corresponding bit in CSR1 is set.
Network Interrupt Enable	CSR0[8]	Permits transmission of interrupt data to the network.
Override TIE	CSR0[9]	Transmits Interrupt message to the network regardless of the ACR TIE setting.
Reset Interrupt FIFO	CSR0[13]	Toggle from ‘0’ to ‘1’ to ‘0’ to reset Interrupt FIFO.
Interrupts Armed	CSR1[14]	During the interrupt operation, indicates conditions to receive interrupt are active. If ‘0’, no interrupts will be received by the host. Any write to CSR1 will reset to ‘1’.
Enable Interrupt on Own Slot	CSR2[10]	In conjunction with CSR2[9] enables host self-interrupt.
LSP of Interrupt Address	CSR4[15:0]	Interrupt Address A15 - A0.
MSP of Interrupt Address	CSR5[6:0]	Interrupt Address A22 - A16. Works in conjunction with CSR4[15:0].
Interrupt FIFO Not Empty	CSR5[15]	When ‘0’, Interrupt FIFO is empty. If ‘1’, CSR5 and CSR4 contain legitimate interrupt address(es).
Receive Interrupt Override	CSR8[10]	When set, all incoming network messages are treated as interrupt messages.
Interrupt on Error Mask	CSR9[15:0]	Interrupts for specified error/status conditions.
PCI Interrupt Status	(See NOTE)	This register is used to report interrupt status and to clear the interrupt.

NOTE: PCI configuration register offset 48 [32:0]

SEND/RECEIVE WITH INTERRUPTS

- Set CSR0 to '0x0010' to enable the Auxiliary Control RAM (ACR).
- Clear the SCRAMNet+ SC150e ACR by writing zeros to the entire address range.
- Set the SCRAMNet+ SC150e ACR memory locations designated to receive and/or transmit interrupts.
- Reset CSR0 to disable the ACR.
- Set CSR0 to '0xF000' to insert the node and initiate the reset of the FIFOs.
- Set CSR0 to '0x8003' to insert the node, toggle the reset of the FIFOs and enable network activity.
- Set CSR2 to '0xC040' to use BURST mode and disable the Fiber-optic Loopback mode.
- Read CSR1 to read-out any latched error conditions.
- Read CSR1 again to check for any existing error conditions.
- Check for carrier-detect fail (this means there are fiber-optic cabling problems from the transmitter of the node downstream).
- Write a non-interrupt value to memory from at least one node. This will enable all powered node transmitters and check for fiber-optic ring integrity.
- Read CSR1 to check for any error conditions.
- Have the interrupt service routine in place.
- Set CSR0 to '0x812B' to enable receive and transmit interrupts.
- Set CSR0 to '0x81AB' to enable interrupt on errors.

5.8 Interrupt Conditions

Interrupts are generated under two different conditions:

- A SCRAMNet+ SC150e network data write to shared-memory
- A SCRAMNet+ SC150e network error detected on the local node

5.8.1 Network Data Write

As indicated in Figure 5-2, the Transmit Enable (CSR0[1] must be set before any message can be sent. Only those nodes which have the Transmit Interrupt Enable ACR[1] set for selected addresses send an interrupt bit out with the data packet on the network. Only those nodes which have the Receive Interrupt Enable ACR[0] bit set for that address will generate an interrupt signal to their host processor.

The host issues a write to SCRAMNet+ SC150e shared memory. If Override Transmit Interrupt Enable CSR0[9] or ACR Transmit Interrupt Enable ACR[1] is set and Network Interrupt Enable CSR0[8] is set, then the interrupt message is transmitted (INT = 1). Otherwise, the message is transmitted without the interrupt bit set (INT = 0). (See Table 5-1, page 5-4)

Network data write interrupts can be accomplished by two methods:

- Forced. Any data writes to any shared memory from the network will generate an interrupt.
- Masked or Selected. Data writes to selected shared-memory locations from the network. Under either of these two methods, an interrupt can be generated and received by the same host processor if desired. This condition is termed as "Self-Interrupt"

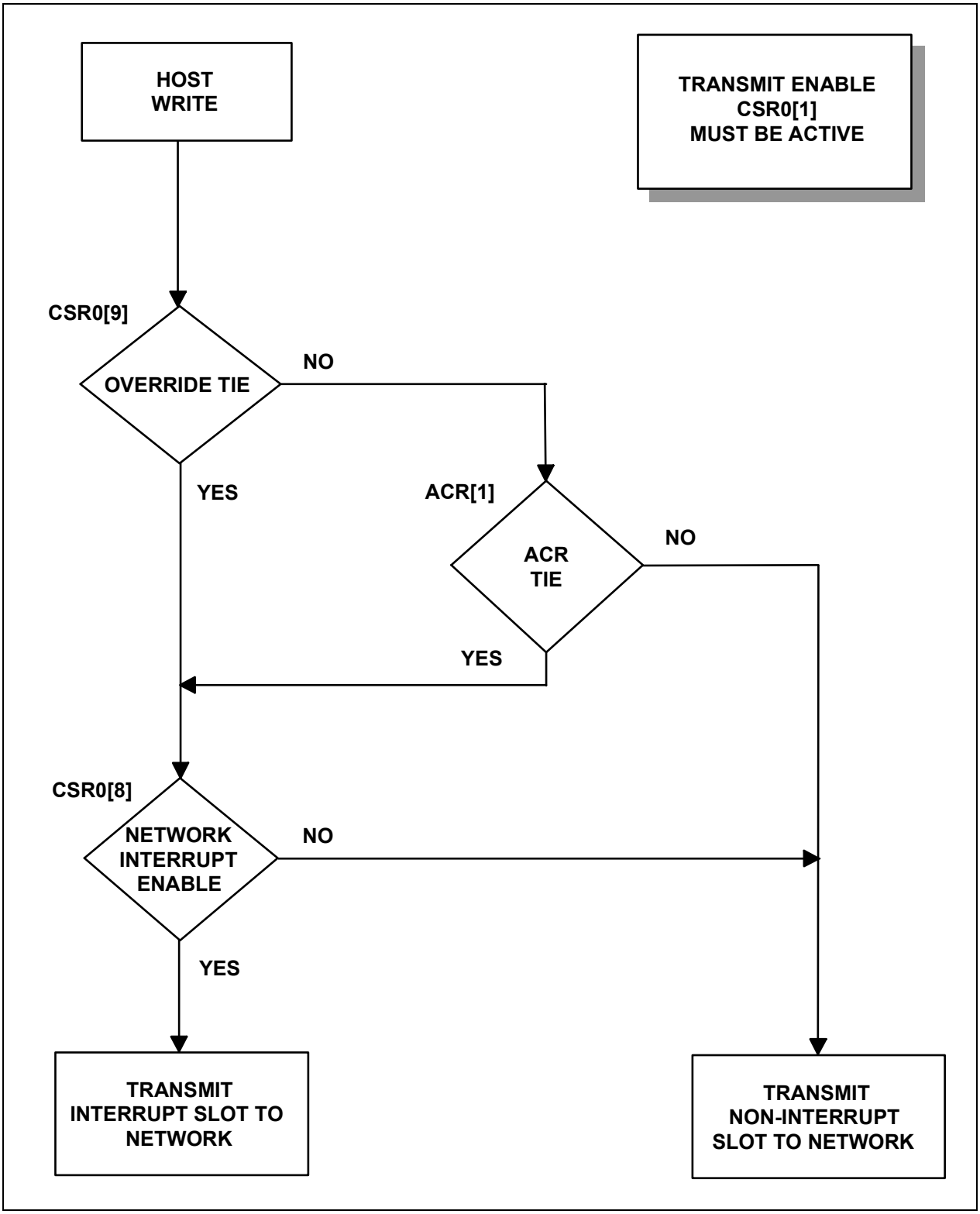


Figure 5-2 Transmit Interrupt Logic

FORCED INTERRUPT

The forced-interrupt method works the same as the selected interrupt method with the exception of choice of interrupt locations. All shared-memory locations are automatically set up to receive and/or transmit interrupts depending upon the override bits set in CSR0 or CSR8.

MASKED OR SELECTED INTERRUPT

The masked- or selected-interrupt method requires choosing SCRAMNet+ SC150e shared-memory locations on each node to receive and/or transmit interrupts. These shared-memory locations may also be used to generate signals to external triggers. The procedure for selecting shared-memory locations for interrupts and/or external triggers is explained in paragraph 5.6: Auxiliary Control RAM.

CSR5 contains the Interrupt FIFO Not Empty CSR5[15]. Set CSR2[9,10] to enable self-interrupts. This allows the message with the interrupt bit set to be processed as an incoming network interrupt. CSR2[9] enables the node's own message to be received as a network message. CSR2[10] allows the interrupt bit to generate an interrupt if it is set.

SELF-INTERRUPTS

Set CSR2[10:9] to enable self-interrupts. This allows the message with the interrupt bit set to be processed as an incoming network interrupt. CSR2[9] enables the node's own message to be received as a network message. CSR2[10] allows the interrupt bit to generate an interrupt if it is set.

Receive Interrupt logic is described in Figure 5-3. If a native message is received and Write Own Slot CSR2[9] is enabled, and Enable Interrupt on Receipt in Own Slot CSR2[10] is set, the logic then checks for Receive Interrupt Enable. If Override Receive Interrupt Enable CSR0[6] is set or Receive Interrupt Enable ACR[0] is set, and if Interrupt on Memory Mask Match Enable CSR0[5] is set, the address is placed on the Interrupt FIFO.



NOTE: Interrupt data is not filtered when the data filter is enabled.

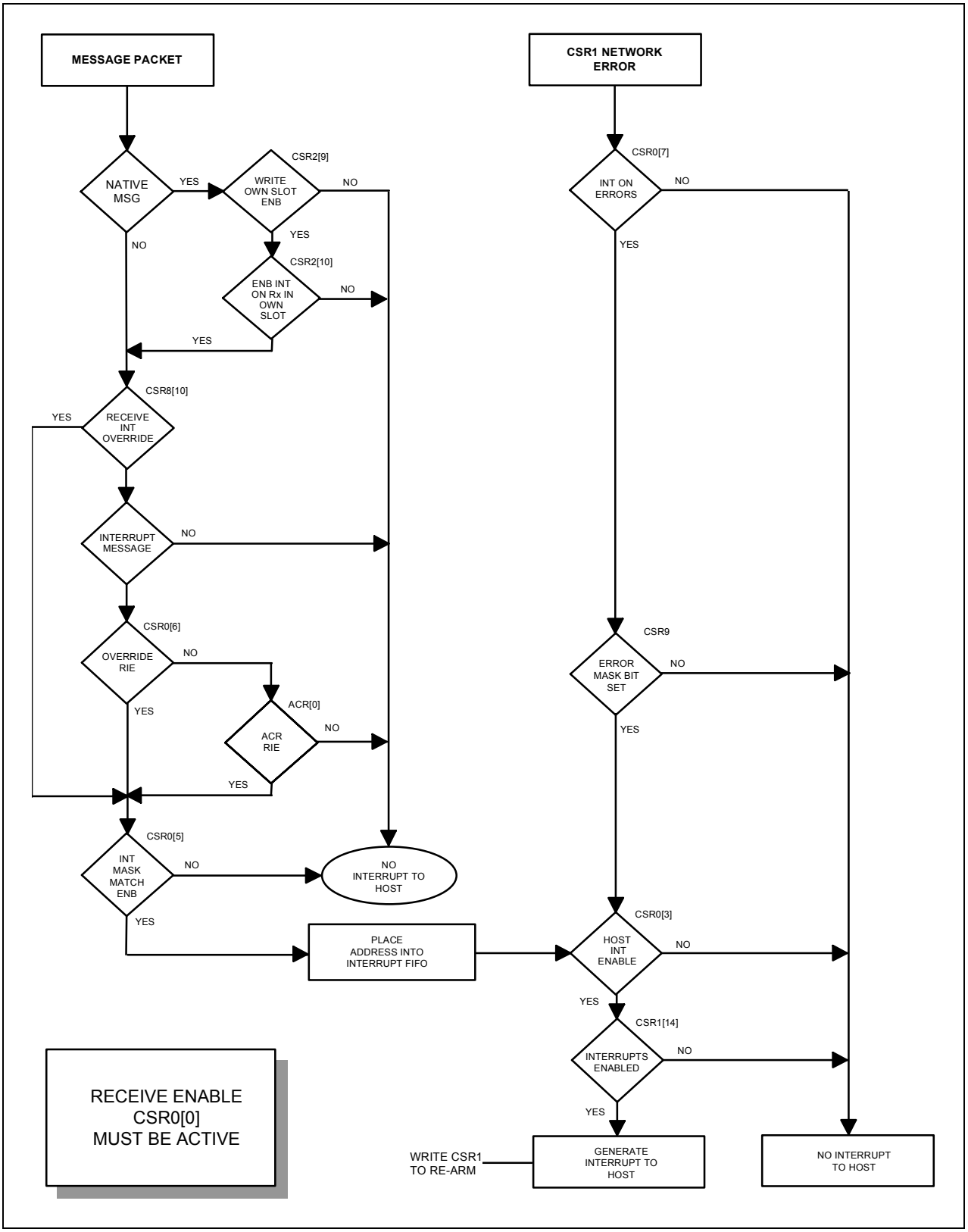


Figure 5-3 Receive Interrupt Logic

5.8.2 Network Error

The second interrupt condition is designed to intercept network errors. CSR1 contains the following error conditions that may be masked by CSR9:

Table 5-4 Interrupt Error/Status Conditions

Bit	Interrupt
0	Transmit FIFO Full
1	Transmit FIFO Not Empty
2	Transmit FIFO $\frac{7}{8}$ Full
3	(Not masked for errors)
4	Interrupt FIFO Full
5	Protocol Violation
6	Carrier Detect Failure
7	Bad Message
8	Receiver Overflow
9	Transmit Retry
10	Transmit Retry Time-out
11	Redundant Rx/Tx Fault
12	General Purpose Counter/Timer
13	(Not masked for errors)
14	(Not masked for errors)
15	Fiber Optic Bypass Not Connected

Each of these conditions is identified by the corresponding bit being set (value 1) in CSR1. If any of the preceding conditions are set and the Interrupt On Memory Mask Match Enable CSR0[5] is set, then an interrupt will be generated to the host computer. Additional information about each error condition is contained in appendix B, Table B-2: CSR1.

If a Network Error is received (Figure 5-3), and if Interrupt on Error CSR0[7] and Host Interrupt Enable CSR0[3] are set, and Interrupts are Enabled CSR1[14], then the message generates an interrupt to the host. If additional network data interrupts occur before the processor is able to service the interrupt, those shared-memory locations are updated and the addresses are added to the Interrupt FIFO queue. However, no additional interrupt signals are sent to the host until interrupts are armed by writing to CSR1. Details are included in the *SCRAMNet Network Programmer's Reference Guide* and the appropriate *DLL Reference Guide* for the host computer interface.

5.8.3 Interrupt Handling

The Interrupt FIFO is accessed via CSR4 and CSR5. CSR5 contains the most significant seven bits of the 23-bit SCRAMNet+ SC150e interrupt address and CSR4 contains the remaining 16 bits of the interrupt address. (The 23-bit address allows for future expansion of memory). CSR5 also contains Interrupt FIFO Not Empty (bit 15).



NOTE: The SCRAMNet+ SC150e Network is a longword (32-bit) oriented shared memory. External Triggers and Interrupts will occur when any of the four bytes associated with a longword are accessed. The Interrupt FIFO contains the longword address. If each of the four bytes of an interrupt location are written into as byte accesses, then four interrupts to the same longword address will be generated. Likewise, if each word of an interrupt location is written into as 16-bit shortwords, then two interrupts to the same longword address will be generated.

The CSR5 and CSR4 values make up the interrupt address. When an interrupt is received, the ISR should read CSR5 first in order to check the Interrupt FIFO Not Empty bit. If this bit is set (value is '1'), then read CSR4. If this bit is CLEAR (value is '0') then the Interrupt FIFO is empty. Therefore, the interrupt was due to an error, assuming that Enable Interrupt On Error is set.

Every read from CSR5 and CSR4 will contain the SCRAMNet+ SC150e memory address of the data received from the network interrupt. Every read of CSR5 and CSR4 will automatically increment the FIFO pointer to the next interrupt address for both registers. CSR4 should be read only if Interrupt FIFO Not Empty CSR5[15] is set. Continue to read CSR5 and CSR4 until the Interrupt FIFO Not Empty bit is zero. Writing any value to CSR1 re-enables interrupts.



NOTE: See Page 5-29 for an example of a standard ISR algorithm for handling interrupts from the SCRAMNet+ SC150e cards.

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WARNING: If HIPRO is enabled, an interrupt may affect the sequence of addresses on a read/write if SCRAMNet+ SC150e is manipulated in the ISR.

If an interrupt occurs before the interrupts have been armed, the interrupt will be placed in the Interrupt FIFO and it will occur when the interrupts are armed (CSR 1).

5.9 External Triggers



NOTE: User access to external triggers is not available on the PMC card.

The SCRAMNet+ SC150e Network provides two external triggers. The external triggers will occur only if the ACR has been configured to enable them. Triggers 1 and 2 are generated by SCRAMNet+ SC150e shared-memory access. Triggers generate a 26.64 ns TTL level compatible, non-terminated, output.

- Trigger 1 - Host Write (ACR[2] enables)
- Trigger 2 - Network Write (ACR[3] enables)

Trigger 1 will be generated for any host write to SCRAMNet+ SC150e memory.
Trigger 2 will be generated by a network write to the SCRAMNet+ SC150e memory.

Pin 7 of the Auxiliary Connector is connected to TRIG1 logically OR'ed with TRIG2.

The triggers can be used to measure time intervals or to start or stop an external event.

EXAMPLE 1 - MEASURE TRANSACTION TIME

To measure transaction time, perform the following steps:

1. Select a shared-memory address in node A and enable trigger 1 by setting ACR[2] and not ACR[3].
2. Select the same memory address in node B and enable trigger 2 by setting ACR[3] and not ACR[2].
3. Connect a wire from TRIG1 to an oscilloscope.
4. Connect a wire from TRIG2 to the oscilloscope.
5. Initiate a HOST write to the node A memory address.

When the corresponding NETWORK write occurs, the time difference can be measured.

EXAMPLE 2 - MEASURE RING TIME

To measure ring time, the time it takes from the HOST write on node A to the NETWORK write on node A, perform the following steps:

1. Enable WRITE-ME-LAST mode on node A.
2. Select a shared-memory address and enable trigger 1 and trigger 2 for that address.
3. Connect a wire from TRIG (pin 7 of the Auxiliary Connector (see section 4.7) to an oscilloscope.
4. Initiate a HOST write to that memory address.

The time difference displayed on the oscilloscope will approximate the ring time.

EXAMPLE 3 - SET OFF AN ALARM

To set off an alarm, perform the following steps:

1. Enable trigger 1 for the shared-memory address of a critical datum by setting ACR[2] and not ACR[3].
2. Connect a wire from TRIG1 to an alarm light.

When the HOST write to that memory address occurs, the light will come on.

5.10 General Purpose Counter/Timer

This 16-bit counter/timer is programmed by changing CSR9[13] and CSR9[14] to select the desired mode as described in Table 5-5. CSR8[9] can be set to override the counter/timer mode settings and allow the counter/timer to run free at 26.66 ns (37.5 MHz). CSR9[12] can be set to generate an interrupt upon overflow of the counter/timer. The output from the event counter/timer is stored in CSR13. See Appendix B, page B-4, B-9, B-10, and B-12 for more information.

5.10.1 Available Modes

The General Purpose Counter/Timer register (CSR13) can be used as a counter or a timer. The mode is selected via a combination of registers and bits that are explained on page B-10. Table 5-5 describes the counter/timer modes available:

Table 5-5 General Purpose Counter/Timer Modes

Mode	Description
Count Errors:	Each error detected in CSR1 will increment the counter by 1.
Count Trigger 1 and 2:	Each time a trigger event occurs the counter will increment.
Transit Time:	Set this mode and clear the counter. The counter will begin counting when the next message is transmitted, and stop counting when any message generated by this node is received.
Network Events:	Count incoming network messages.
Free Run @ 26.66 ns:	Increment counter using internal 37.5 MHz clock. Counter will roll over every 1.78 ms.
Free Run @ 1.706 μs with Trigger 2 to CLEAR:	Increment counter using the 585.9 KHz clock. Counter will roll over every 111.8 ms. Assertion of Trigger 2 will clear the counter.

5.10.2 Rollover/Reset

A rollover/reset can generate an interrupt by setting Interrupt On General Purpose Counter/Timer Overflow Mask CSR9[12]. When this bit is set, an interrupt is generated to the host system whenever the counter register (CSR 13) rolls over or overflows. Interrupt On Errors CSR0[7] mode must be enabled in order for this to work properly. The counter/timer will roll over when it reaches 65,535 + 1.

Only one mode may be selected at a time since they use the same counter/timer register (CSR13) for output.

5.10.3 Presetting Values

The counter/timer register counts upward and may be preset with a value to arrive at the desired interrupt interval.

EXAMPLE

To set an interrupt to occur every 100 ms, the counter register is preloaded with '8717', so that when the counter reaches 65,536, only 100 ms would have passed instead of 111.8 ms.

The value of '8717' was determined by dividing the desired interrupt time of 100 ms (100,000 μs) by the increment frequency of 1.760 μs, which results in 56,818. This is the number that would be in the counter register after 100 ms. To obtain a starting value of '8717', subtract 56,818 from 65535. The counter/timer will not roll over until it reaches 65,535 + 1.

See Appendix B, pages B-4, B-10, and B-12 for additional information.

5.11 Modes of Operation

5.11.1 Data Filter

Many implementations of shared memory tend to rewrite data values to memory that have not actually changed. In order to reduce network traffic, the SCRAMNet+ SC150e card has the ability to compare the new value with the old value of data and avoid sending unchanged data values out on the network. This feature is a type of data filtering and can be enabled without affecting node latency while improving network throughput. See Figure 5-4 Data Filter Logic.

CSR0[10] and CSR0[11] control the operation of data filtering as shown in Table 5-6 (see appendix B for details of CSR operation):

- CSR0[10] enables the data filtering during transmission to the SCRAMNet+ SC150e memory and only for the address space above the first 4 K bytes.
- CSR0[11] enables the address space of the first 4 K bytes to be data-filtered in conjunction with CSR0[10].

Table 5-6 Data Filter Options

CSR0[11]	CSR0[10]*	Result
0	1	Only the address space above 4 K bytes of shared memory is data-filtered
1	1	All shared memory is data-filtered

* CSR0[10] must be ON for any data filtering to take place on that node.

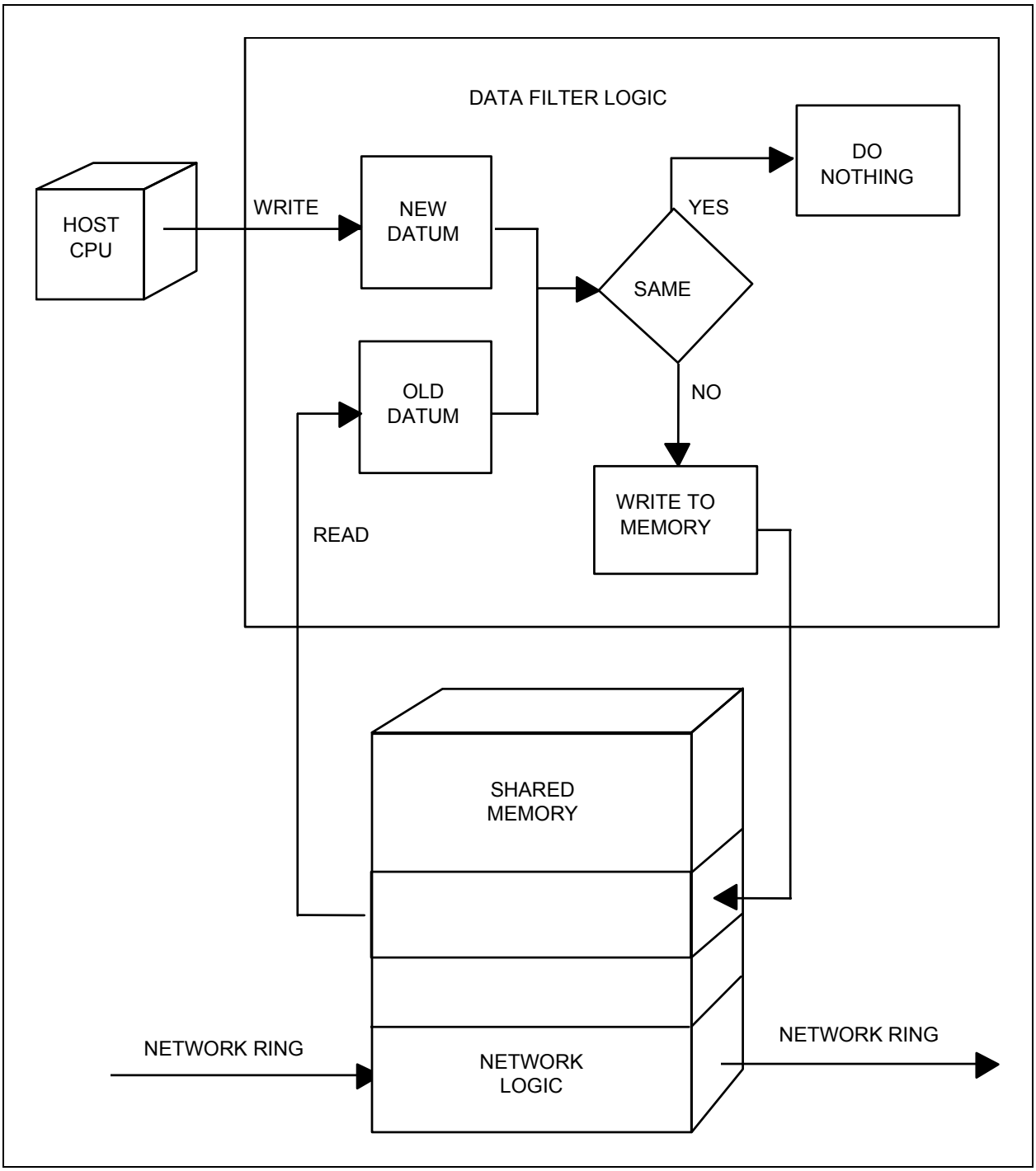


Figure 5-4 Data Filter Logic

5.11.2 HIPRO Mode

WRITE

The SCRAMNet+ SC150e network message is based on 32-bit longword data. If a host processor is only capable of 8- or 16-bit data transactions, then the SCRAMNet+ SC150e bandwidth is quartered or halved, respectively. For each 32-bit data transaction from the host, two 16-bit data transactions, or four 8-bit transactions will occur on the bus each requiring a SCRAMNet+ SC150e network write.

The HIPRO mode was created to provide an efficient means to transmit two 16-bit data transactions as one 32-bit network write. The first of the two 16-bit writes is written to memory but is prevented from going onto the network. The second 16-bit write to memory triggers the write of the 32-bit location to the network. HIPRO WRITE will not work if Disable Host to Memory Write CSR2[8] is set, because the first 16-bit write must be to the SCRAMNet+ SC150e memory.



NOTE: The order of writing the shortwords or bytes into the longword boundary does not matter. However, it is important that a HIPRO location does receive a second shortword write if a first shortword write is initiated, or a total of 4- byte writes if a byte write is initiated, to a HIPRO location. Otherwise, it is possible to partially write a 32-bit location causing the data to be lost and never be transmitted.

The HIPRO mode is also effective for transmitting user-defined 16-bit data items. Two 16-bit data items may be sent as one 32-bit data item if they are consecutive and lie within the same 32-bit address boundary, and interrupts are not being used.

HIPRO mode is selected for those memory addresses which have ACR[4] set. HIPRO Enable CSR2[13] must also be set. Use a non-HIPRO location write to synchronize the HIPRO flags.

5.11.3 Loopback Modes

Each node has a Monitor and Bypass mode, Wire Loopback mode, Mechanical Switch Loopback mode, and a Fiber-optic Loopback mode. These modes are used to check the node's performance and to test transmit/receive circuitry. The loopback mode routes data which would normally be transmitted on to the network, directly back to the node from different points.

Table 5-7 depicts the data path for the Monitor and Bypass Mode.

Table 5-8 depicts the data path for Wire Loopback Mode.

Table 5-9 depicts the data path for Mechanical Switch Loopback Mode.

Table 5-10 depicts the data path for the Fiber-optic Loopback Mode.

Table 5-11 depicts the data path for the Insert Mode.

MONITOR AND BYPASS MODE

This mode permits the node to receive data only. Network data is not re-transmitted.

Table 5-7 Monitor and Bypass Mode States

State	Register	Setting
Receive Enable	CSR0[0]	ON
Transmit Enable	CSR0[1]	DON'T CARE
Insert Enable	CSR0[15]	OFF
Enable Wire Loopback	CSR2[7]	OFF

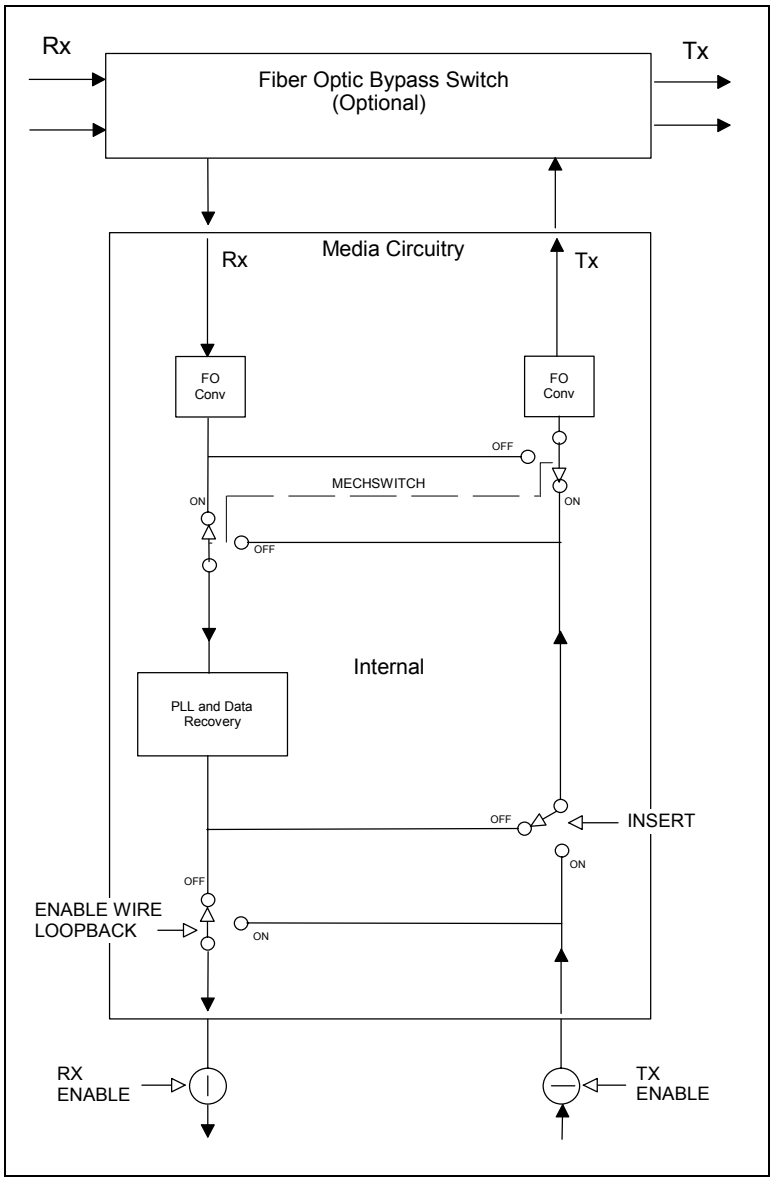


Figure 5-5 Monitor and Bypass Mode

WIRE LOOPBACK MODE

The Wire loopback permits testing of the internal circuitry and needs no manual external modifications to work. In this mode, the transmitted signal does not leave the card.

Table 5-8 Wire Loopback Mode States

State	Register	Setting
Receive Enable	CSR0[0]	ON
Transmit Enable	CSR0[1]	ON
Insert Enable	CSR0[15]	OFF
Enable Wire Loopback	CSR2[7]	ON

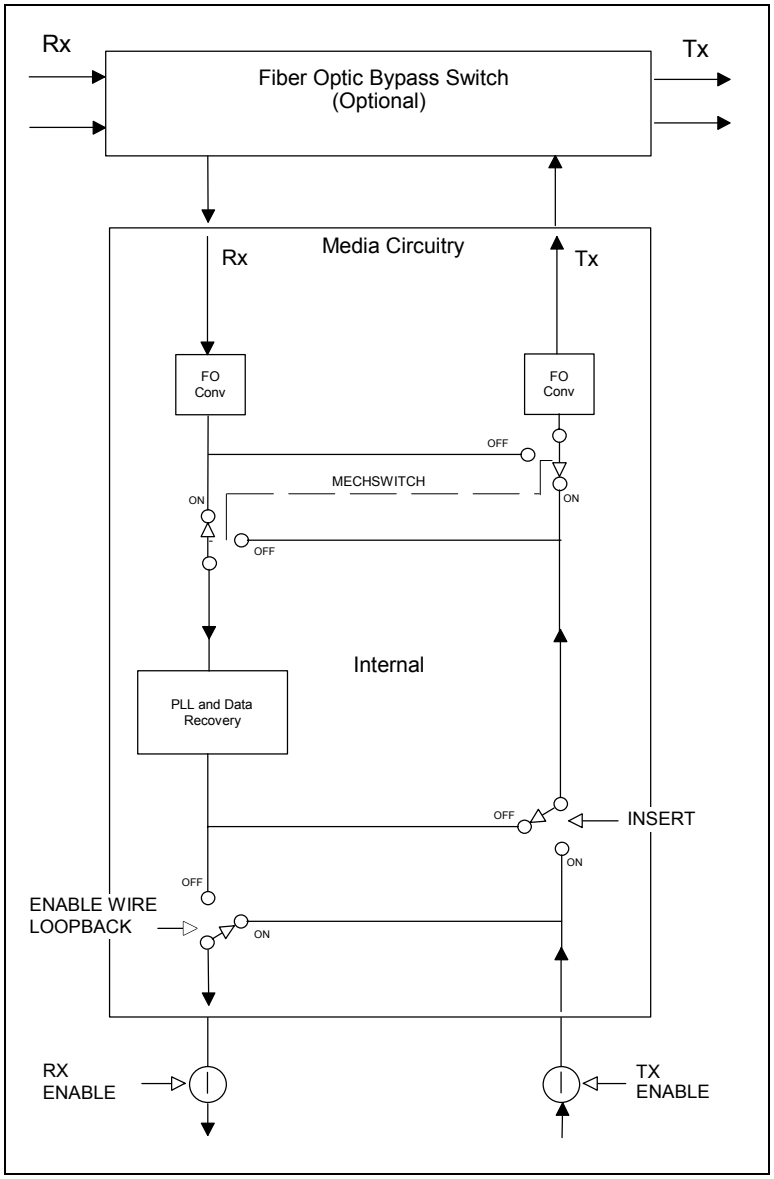


Figure 5-6 Wire Loopback Mode

MECHANICAL SWITCH LOOPBACK MODE

This mode permits testing of all circuitry up to and including a major portion of the Media Card.

Table 5-9 Mechanical Switch Loopback Mode States

State	Register	Setting
Receive Enable	CSR0[0]	ON
Transmit Enable	CSR0[1]	ON
Insert Enable	CSR0[15]	ON
Enable Wire Loopback	CSR2[7]	OFF
Mechanical Switch Override	CSR8[11]	OFF

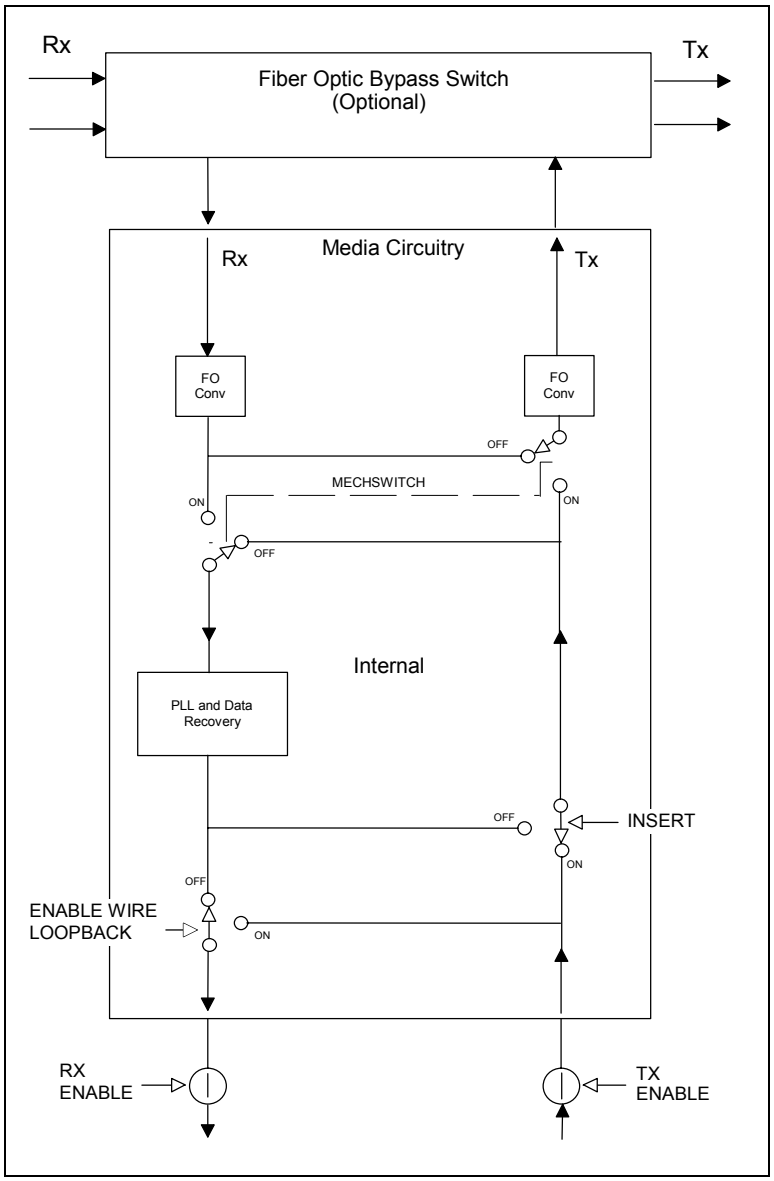


Figure 5-7 Mechanical Switch Loopback Mode

FIBER-OPTIC LOOPBACK

When this mode is invoked, the output of the transmitter is connected by fiber optics directly to the input of the receiver, and the receiver is disconnected from the network.

Table 5-10 Fiber-optic Loopback Mode States

State	Register	Setting
Receive Enable	CSR0[0]	ON
Transmit Enable	CSR0[1]	ON
Insert Enable	CSR0[15]	ON
Enable Wire Loopback	CSR2[7]	OFF
Disable Fiber-optic Loopback	CSR2[6]	OFF
Mechanical Switch Override	CSR8[11]	ON

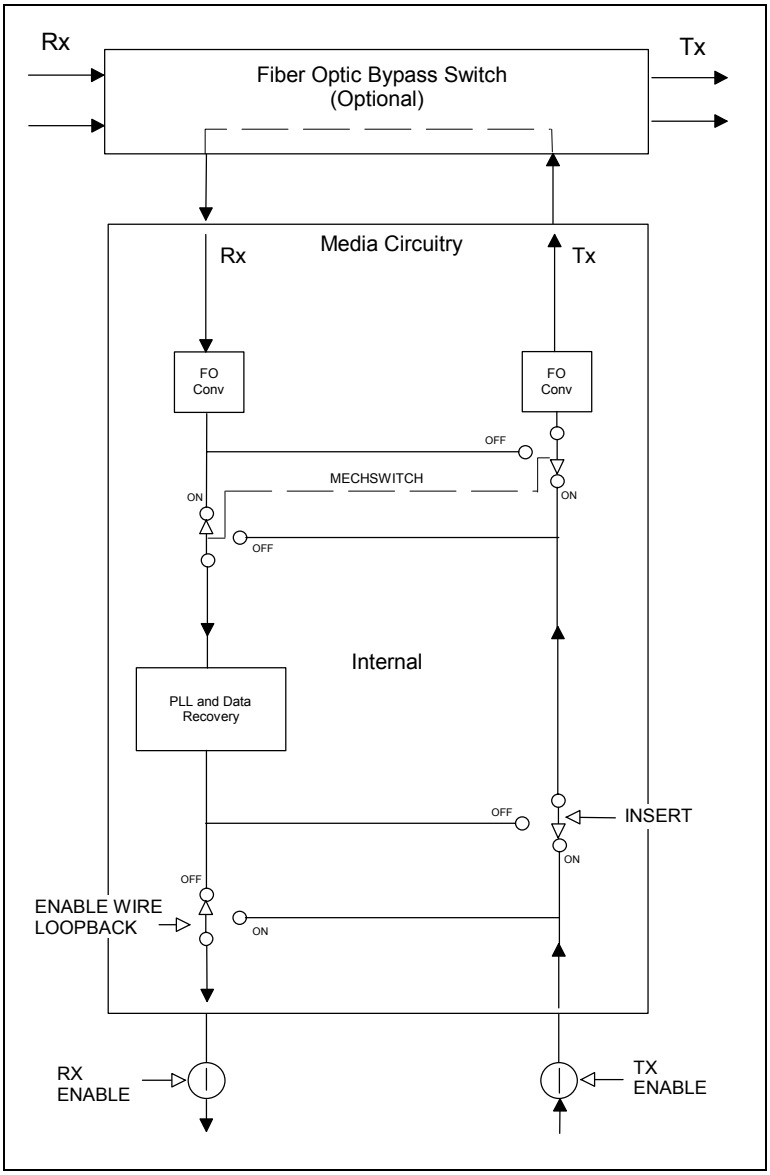


Figure 5-8 Fiber-optic Loopback Mode

The optional Fiber Optic Bypass Switch must be installed for the loopback to work. However, in the absence of the Fiber Optic Bypass Switch, fiber-optic cables could be run from the node's transmitter output connectors to the receiver input connectors. This configuration, with Insert Node enabled, would constitute a Fiber-optic Loopback mode for stand-alone testing. The Disable Fiber-optic Loopback CSR2[6] must be set ON when the node is in use as a part of the network. However, this configuration could not be used in a network ring in the place of a Fiber Optic Bypass Switch because it would cause a break in ring continuity.

The Fiber Optic Bypass Switch is used to provide fiber-optic ring continuity when a node is powered down or in loopback mode. CSR2[6] controls the operation of the Fiber Optic Bypass Switch by enabling or disabling Loopback mode. To disable the Fiber-optic Loopback mode, set CSR2[6] ON. This state allows data to be transmitted and received on the network ring for this node.

When the Fiber-optic Loopback mode is enabled (CSR2[6] OFF), the Fiber Optic Bypass Switch prevents the node from receiving network data. Likewise, the node cannot transmit any data into the network ring.

When power is lost to the Fiber Optic Bypass Switch, Fiber-optic Loopback mode is enabled regardless of its prior state in order to maintain ring integrity. This is also the default power-up state.

NODE INSERT MODE

In this mode the node becomes part of the network (Figure 5-9).

Table 5-11 Node Insert Mode

State	Register	Setting
Receive Enable	CSR0[0]	ON
Transmit Enable	CSR0[1]	ON
Insert Node	CSR0[15]	ON
Enable Wire Loopback	CSR2[7]	OFF
Disable Fiber-optic Loopback	CSR2[6]	ON
Mechanical Switch Override	CSR8[11]	ON



NOTE: Do not enable the Wire Loopback and Fiber-optic Loopback and/or Mechanical Switch loopback modes simultaneously. A node in Wire Loopback mode and Insert Node will create a break in the network ring that will disable all nodes.

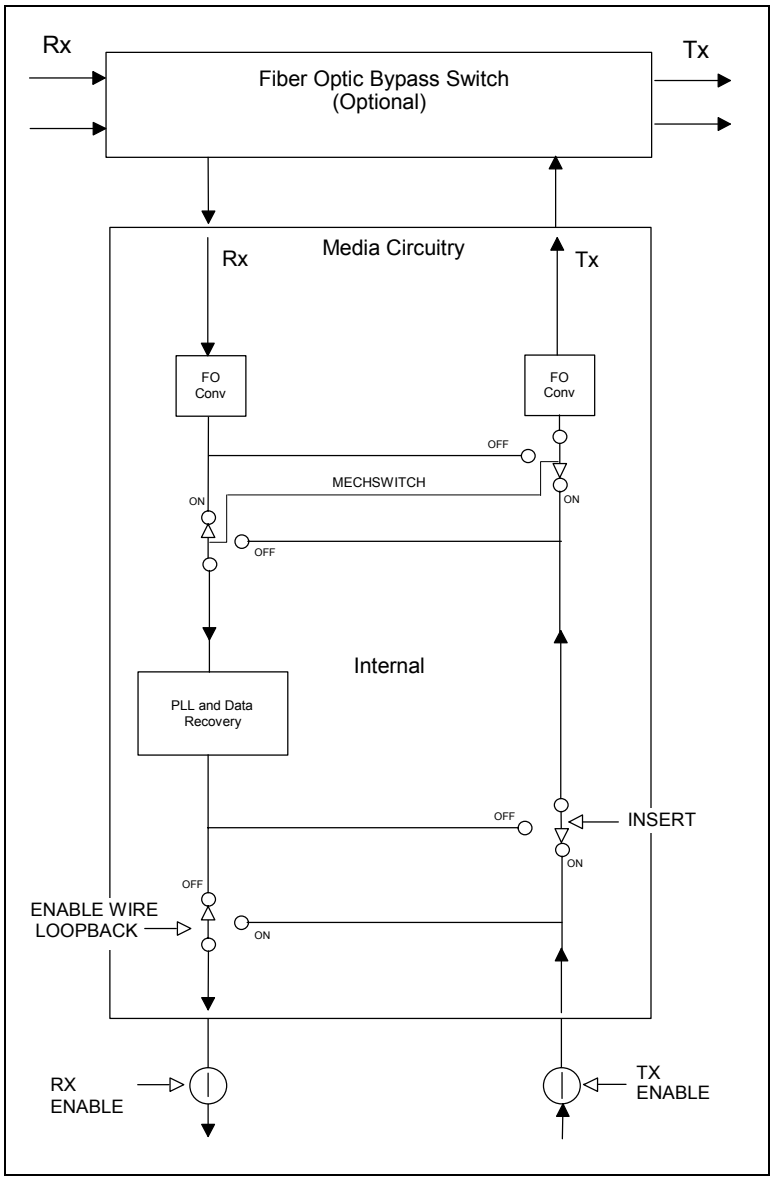


Figure 5-9 Insert Mode

5.11.4 Holdoff Mode

To enable Holdoff, set CSR8[1] OFF. The Holdoff feature automatically slows down CPU data writes to the SCRAMNet+ SC150e memory when the Transmit FIFO becomes full. The Transmit FIFO serves as a buffer between the SCRAMNet+ SC150e memory and the SCRAMNet+ SC150e network.

The Transmit FIFO can become full when the host CPU is writing to SCRAMNet+ SC150e memory faster than the network can absorb the data. If a CPU is capable of writing to the SCRAMNet+ SC150e memory on the PCI bus at such a rate that the Transmit FIFO becomes full (1024 deep), data could be lost. In the event that the Transmit FIFO becomes full, the hardware will automatically extend the next write cycle until the Transmit FIFO empties at least one message. This prevents the loss of any data and is transparent to the user.

5.11.5 Write-Me-Last Mode

The Write-Me-Last mode of operation allows the originating node to be the last node in the ring to have the data deposited to its memory. When the host performs a write to the SCRAMNet+ SC150e shared-memory, it is not immediately written to the host memory, but is first sent to the other SCRAMNet+ SC150e nodes on the network.

Set CSR2[8] and CSR2[9] to enable the Write-Me-Last mode. If desired, this mode can also be used to generate interrupts to the originating node by setting CSR2[10] as well. CSR2[8] is the Disable Host to Shared Memory Write.

5.12 Quad Switch

The Quad Switch is a switching center and is used to dynamically configure active SCRAMNet and SCRAMNet+ SC150e ring(s).

The Quad Switch provides dynamic configuration of up to five separate rings. Each separate ring is connected to a port on the Quad Switch. Refer to Figure 5-10. Each ring can be isolated from the other rings or can be included with one or more of the other attached rings.

There is a single logical ring internal to the Quad Switch. The Quad Switch has five external ports, which allow access to this logical ring. Ports 1 through 4 are accessible on the front of the Quad Switch cabinet. Port 5 access is at the rear of the cabinet.

All five ports have standard SCRAMNet transmitters and receivers. Each port can transmit data to and receive data from the internal ring.

The Quad Switch port will be switched into the ring if all its switching controls are enabled (Include state). Any one of the switching controls can cause the port to be switched out (Isolate state).

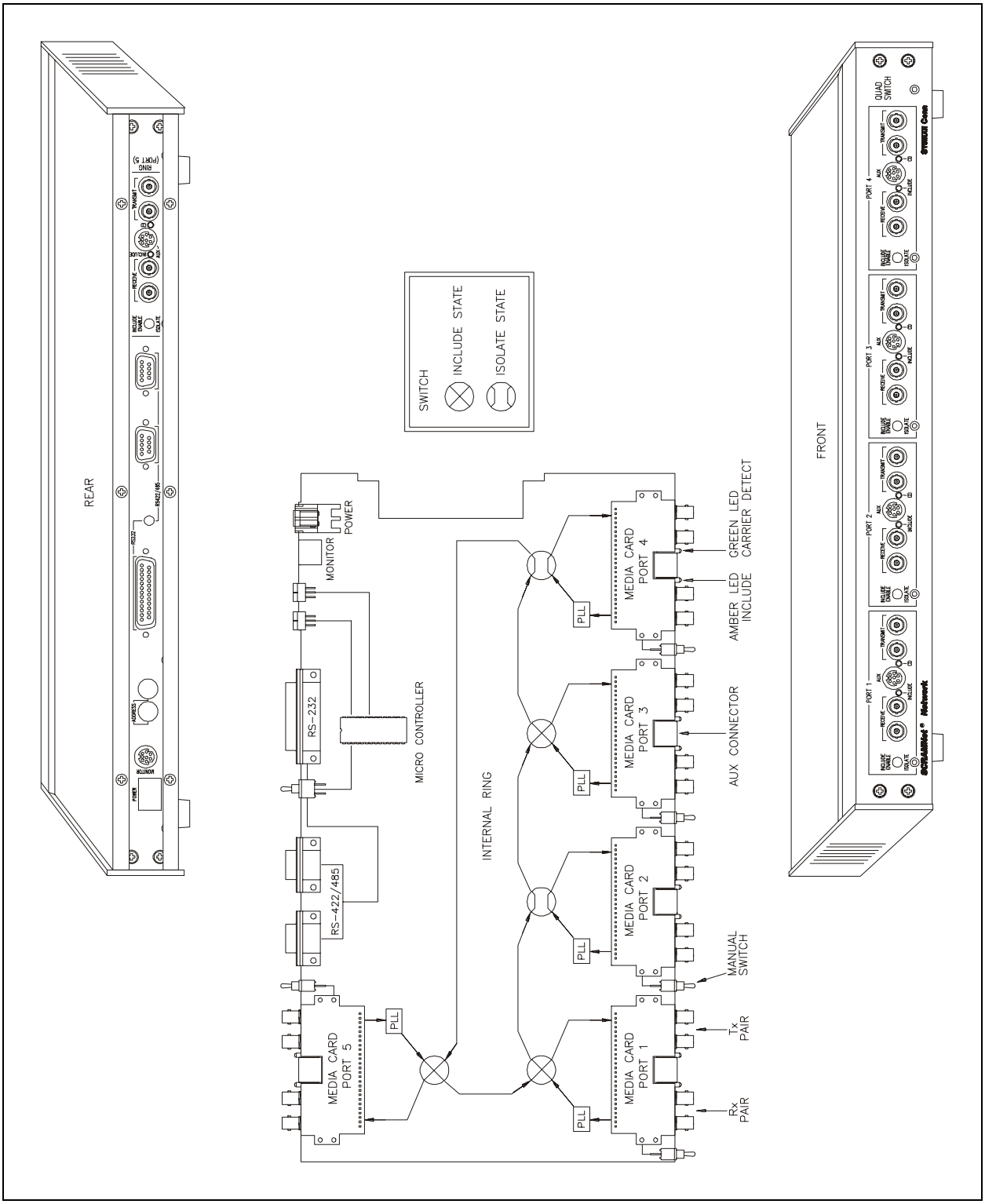


Figure 5-10 Quad Switch

CSR0 IMME and HIE must be set in order to set up interrupts.
CSR1 Bits 0-15 contain various error and status conditions. Interrupts are re-armed whenever any value is written to CSR1.

CSR4 Bits 0-15 contain the interrupt address bits A0-A15.

Read PCI Interrupt Status Register (PCI Configuration Register—offset 48) and save value.
Write Interrupt Status Register value back to PCI Interrupt Status Register to clear the interrupt.

CSR5 Bits 0-6 contain the interrupt address bits A22-A16.
Bit 15 contains the Interrupt FIFO Not Empty status.

If an interrupt has been received by the host processor from the SCRAMNet+ SC150e Network interrupt logic, then the Interrupt Service Routine will be invoked. Interrupts will be disabled until re-armed by writing to CSR1. Until that time, all other interrupts will be written into the Interrupt FIFO where they can be processed in the Interrupt Service Routine.

If Interrupts on Errors is enabled, then an interrupt due to an error has occurred if the interrupt FIFO is empty on the initial check of CSR5 in the Interrupt Service Routine.

```
Read CSR5
        Test the Interrupt FIFO Not Empty status bit 15
        If (Interrupt FIFO is Empty)
                Read CSR1 to determine the error condition(s)
                Respond to any error conditions
        End if

        While (Interrupt FIFO is NOT Empty)
                Save interrupt address bits A22-A16 from CSR5 (from previous read)
                Read CSR4 and save interrupt address bits A15-A0
                                • • •
                Service interrupt according to interrupt address data or address
                                • • •
                Read CSR5 and save Interrupt FIFO Empty status
        Endwhile

        Write to CSR1 to re-arm interrupts
        Return from interrupt service routine
```

Figure 5-11 Interrupt Service Routine

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APPENDIX A

SPECIFICATIONS

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A.1 SC150e PCI

A.1.1 Hardware Specifications

Hardware Compatibility: ..... PCI local bus specification, rev. 2.1
Physical Dimensions: ..... 6.875" x 4.20"
Weight: ..... 0.31 lb. (w/4 MB memory)
Electrical Requirements: ..... +4.75 to +5.25 VDC, 1.5 Amps max.
PCI Signaling Levels ..... Universal (+5.0 V and +3.3 V support)
Temperature Range
- Storage: ..... -40° to +70°C
- Operation: ..... 0° to +60°C

Humidity Range:
- Storage ..... 0% to 95% (noncondensing)
- Operating ..... 10% to 90% (noncondensing)

Network Line Transmission Rate: ..... 150 million bits/second
Message Length:
- Fixed Length: ..... 82 Bits
- Variable Length: ..... 46 bits + 256 or 1024 Data Bytes Maximum

Maximum Nodes on Network Ring: 256
Error Correction: ..... Available in PLATINUM mode only
Maximum Node Separation:
- Standard Fiber: ..... 300 meters
- Long Link Fiber ..... 3500 meters
- Factory installed memory options: ..... 2 MB, 4 MB or 8 MB

Effective Per-Node Bandwidth:
- 4 bytes/packet: ..... 6.5 MB/sec
- 256 bytes/packet: ..... 16.2 MB/sec
- 1024 bytes/packet: ..... 16.7 MB/sec

Node Latency:
- 4 bytes/packet: ..... 250 ns -800 ns
- 256 bytes/packet: ..... 250 ns - 16 µs
- 1024 bytes/packet: ..... 250 ns - 61.8 µs

Mean Time Between Failures (MTBF)*
- 2 MB Memory ..... 55,052 hours
- 4 MB Memory ..... 54,227 hours
- 8 MB Memory ..... 52,069 hours

Internal clock speeds:
- SCRAMNet+ SC150e Card crystal ..... 150 MHz, +/-100 ppm[1]
- 26.66 ns timer is a divide-by-four: ..... 37.5 MHz[2]
- 1.706 µs timer is a divide-by-256: ..... 585.9 KHz[3]

1. Specifications on the crystal demonstrate the precision and stability of the main clock from which all other clocks are derived. This does not include the vagaries introduced by the circuit.
2. The 37.5 MHz clock is the distributed (on Card) clock used by other circuits on SCRAMNet host cards.
3. The 585.9 KHz clock is counted by the internal (to ASIC) users timer.

* The MTBF numbers are based on calculations using MIL-HDBK-217F, Appendix A, for a ground-benign environment.

A.1.2 Card Dimensions

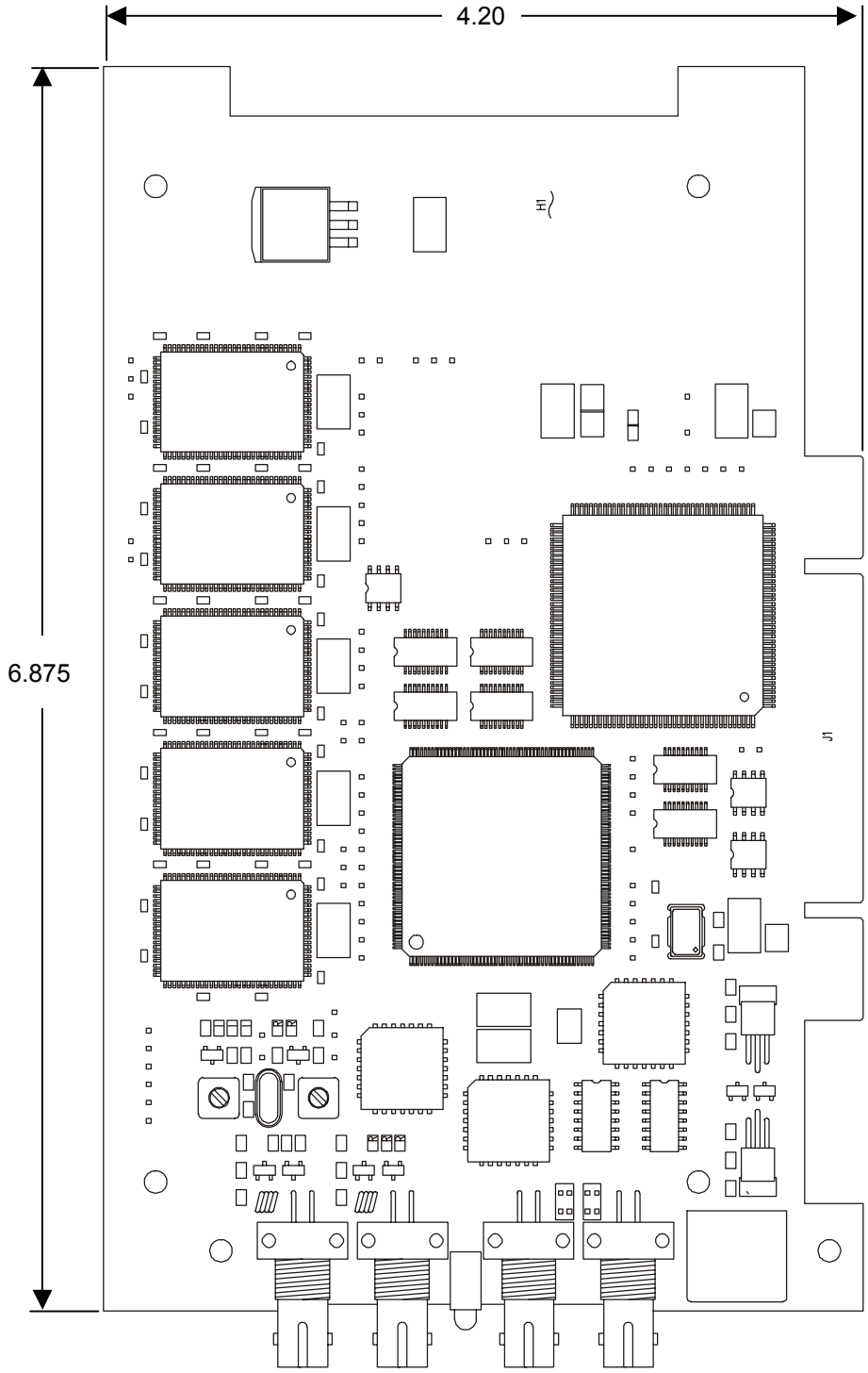


Figure A-1 PCI Dimensions

A.2 SC150e PMC

A.2.1 Hardware Specifications

Hardware Compatibility:	PCI local bus specification, rev. 2.1 Draft standard for a common mezzanine card family: CMC (IEEE P1386/Draft 2.0) Draft standard physical and environmental layers for PCI Mezzanine cards: PMC (IEEE P1386/Draft 2.0)
Physical Dimensions:	2.91" x 5.86"
Weight:	0.24 lb. (w/4 MB memory)
Electrical Requirements:	+4.75 to +5.25 VDC, 1.5 Amps max.
PCI Signaling Levels	Universal (+5.0 V and +3.3 V Support)
Temperature Range	
Storage:	-40° to +70°C
Operation:	0° to +60°C
Humidity Range:	
Storage	0% to 95% (noncondensing)
Operating	10% to 90% (noncondensing)
Network Line Transmission Rate:	150 million bits/second
Message Length:	
Fixed Length:	82 Bits
Variable Length:	46 bits + 256 or 1024 Data Bytes Maximum
Maximum Nodes on Network Ring:	256
Error Correction:	Available in PLATINUM mode only
Maximum Node Separation:	
Standard Fiber:	300 meters
Long Link Fiber	3500 meters
Factory installed memory options:	2 MB, 4 MB or 8 MB
Effective Per-Node Bandwidth:	
4 bytes/packet:	6.5 MB/sec
256 bytes/packet:	16.2 MB/sec
1024 bytes/packet:	16.7 MB/sec
Node Latency:	
4 bytes/packet:	250 ns -800 ns
256 bytes/packet:	250 ns - 16 µs
1024 bytes/packet:	250 ns - 61.8 µs
Mean Time Between Failures (MTBF)*	
2 MB Memory	54,683 hours
4 MB Memory	54,194 hours
8 MB Memory	52,255 hours
Internal clock speeds:	
SCRAMNet+ SC150e Card crystal	150 MHz, +/-100 ppm[1]
26.66 ns timer is a divide-by-four:	37.5 MHz[2]
1.706 µs timer is a divide-by-256:	585.9 KHz[3]

1. Specifications on the crystal demonstrate the precision and stability of the main clock from which all other clocks are derived. This does not include the vagaries introduced by the circuit.
2. The 37.5 MHz clock is the distributed (on Card) clock used by other circuits on SCRAMNet host cards.
3. The 585.9 KHz clock is counted by the internal (to ASIC) users timer.

* The MTBF numbers are based on calculations using MIL-HDBK-217F, Appendix A, for a ground-benign environment.

A.2.2 Card Dimensions

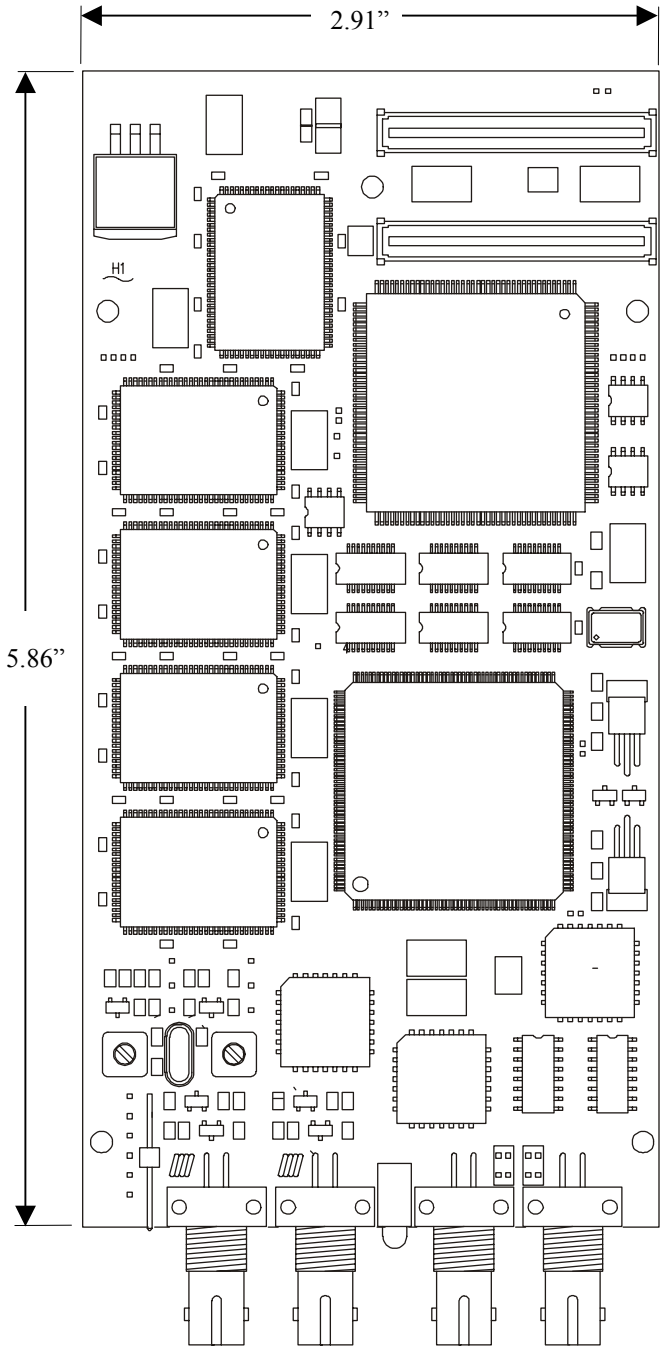


Figure A-2 PMC Dimensions

A.3 SC150e CPCI

A.3.1 Hardware Specifications

Hardware Compatibility: ..... PCI local bus specification, rev. 2.1, CompactPCI Core Specification, PICMG 2.0 R3.0, and CompactPCI Hot Swap Specification, PICMG 2.1 R1.0.
Physical Dimensions: ..... 6.299" x 3.937"
Weight: ..... 0.354 lb. (w/4 MB memory)
Electrical Requirements: ..... +4.75 to +5.25 VDC, 1.5 Amps max.
PCI Signaling Levels ..... Universal (+5.0 V and +3.3 V support)
Temperature Range
- Storage: ..... -40° to +70°C
- Operation: ..... 0° to +60°C

Humidity Range:
- Storage ..... 0% to 95% (noncondensing)
- Operating ..... 10% to 90% (noncondensing)

Network Line Transmission Rate: ..... 150 million bits/second
Message Length:
- Fixed Length: ..... 82 Bits
- Variable Length: ..... 46 bits + 256 or 1024 Data Bytes Maximum

Maximum Nodes on Network Ring: 256
Error Correction: ..... Available in PLATINUM mode only
Maximum Node Separation:
- Standard Fiber: ..... 300 meters
- Long Link Fiber ..... 3500 meters*
- Factory installed memory options: ..... 2 MB, 4 MB, or 8 MB

Effective Per-Node Bandwidth:
- 4 bytes/packet: ..... 6.5 MB/sec
- 256 bytes/packet: ..... 16.2 MB/sec
- 1024 bytes/packet: ..... 16.7 MB/sec

Node Latency:
- 4 bytes/packet: ..... 250 ns -800 ns
- 256 bytes/packet: ..... 250 ns - 16 µs
- 1024 bytes/packet: ..... 250 ns - 61.8 µs

Mean Time Between Failures (MTBF)**
- 2 MB Memory ..... 52,963 hours
- 4 MB Memory ..... 52,173 hours
- 8 MB Memory ..... 50,373 hours

Internal clock speeds:
- SCRAMNet+ SC150e board crystal ..... 150 MHz, +/-100 ppm[1]
- 26.66 ns timer is a divide-by-four: ..... 37.5 MHz[2]
- 1.706 µs timer is a divide-by-256: ..... 585.9 KHz[3]

1. Specifications on the crystal demonstrate the precision and stability of the main clock from which all other clocks are derived. This does not include the vagaries introduced by the circuit.
2. The 37.5 MHz clock is the distributed (on board) clock used by other circuits on SCRAMNet host cards.
3. The 585.9 KHz clock is counted by the internal (to ASIC) users timer.

* Contact Systran regarding availability of SC150e card options
** The MTBF numbers are based on calculations using MIL-HDBK-217F, Appendix A, for a ground-benign environment.

A.3.2 Card Dimensions

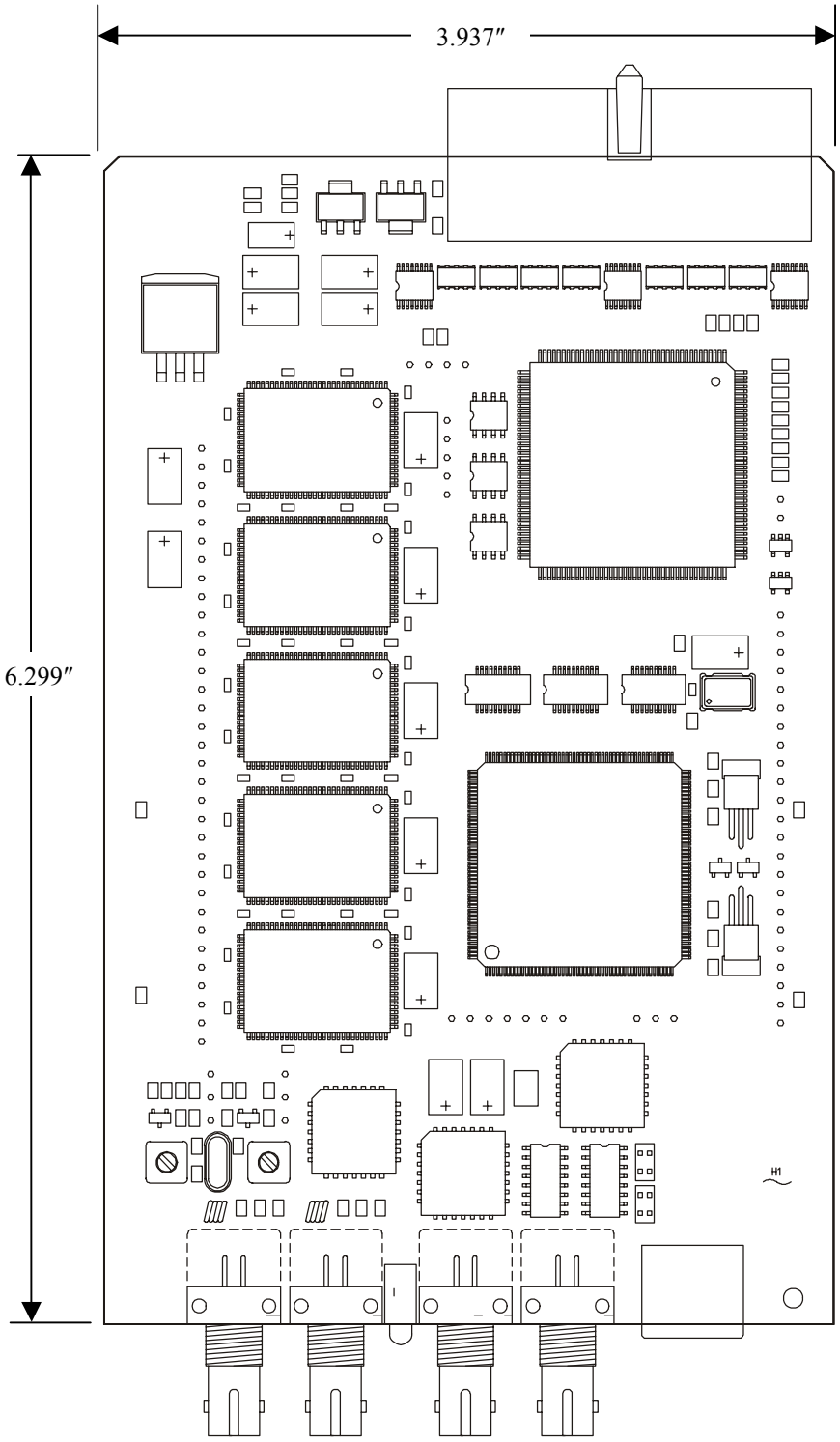


Figure A-3 CPCI Dimensions

A.4 Performance

Table A-1 Data Performance Table[1]

DMA PERFORMANCE in MBytes/s with the data flow direction Toward Network(Write)/Toward System(Read)	V3 with SCRAMNet Prefetching on[2]	V3 with SCRAMNet Prefetching off
SCRAMNet Write Posting ON and DEC_IGNORE ON	16.1/65.9	16.1/65.9
SCRAMNet Write Posting ON and DEC_IGNORE OFF	14.5/16.1	14.5/8.7
I/O PERFORMANCE[3] in MBytes/s with the data flow direction Toward Network(Write)/Toward System(Read)	**V3 with SCRAMNet Prefetching on**	**V3 with SCRAMNet Prefetching off**
SCRAMNet Write Posting ON and DEC_IGNORE ON	15.7/16.1	15.7/8.7
SCRAMNet Write Posting ON and DEC_IGNORE OFF	13.3/16.1	13.3/8.7

1 Results derived from a software test using a time stamp counter.
2 By default, this product is configured with prefetching enabled. Refer to *V363EPC User Manual* for details of prefetching operation, including possible data coherency issues.
3 Host limited.

A.5 Part Number

The PCI Card part number is in the form:

H-AS-DPCIG02M-20 (Standard PCI w/2 MB RAM)
H-AS-DPMCG02M-30 (Long Link PMC w/2 MB RAM)

where:

Code	Definition
H	Hardware
AS	Top Level Assembly
DXXXG	Standard SCRAMNet+ SC150e PCI Card, universal signaling
	PCI = PCI Card
	PMC = PMC Card
	CPC = CPCI Card
XXX	**Memory (bytes)**
	512K = 512 KB
	02M = 2 MB
	04M = 4 MB
	08M = 8 MB
XX	**Transmission Media.**
	20 = Standard FO Media
	30 = Long Link FO Media
X	**Variable**. Used for product variations and/or modifications

Contact Systran regarding the availability of SC150e Card options.

A.6 Fiber-Optic Cables

Fiber-optic cables may be purchased from Systran Corporation or third parties. The recommended fiber-optic cable is 62.5/125 micron core multi-mode fiber with ST connectors. Contract Systran Corporation regarding the availability of fiber-optic cables.

The part number for Systran's 62.5/125 micron fiber-optic cables is in the form:

H-PR-WST23000-0 (paired 62.5/125 micron cable, 3 meters)

where:

Code	Definition
H	Hardware
PR	Part
WST2	Standard Fiber - Commercial Grade Cable Paired 62.5 micron core multi-mode fiber optic cable
XXXX	Length of cable* examples: 3000 = 3 meter cable 5000 = 5 meter cable 1001 = 10 meter cable 3001 = 30 meter cable
0	Reserved

*If desired cable length is not listed, contact Systran for specific part number.

A.7 Fiber Optic Bypass Switch

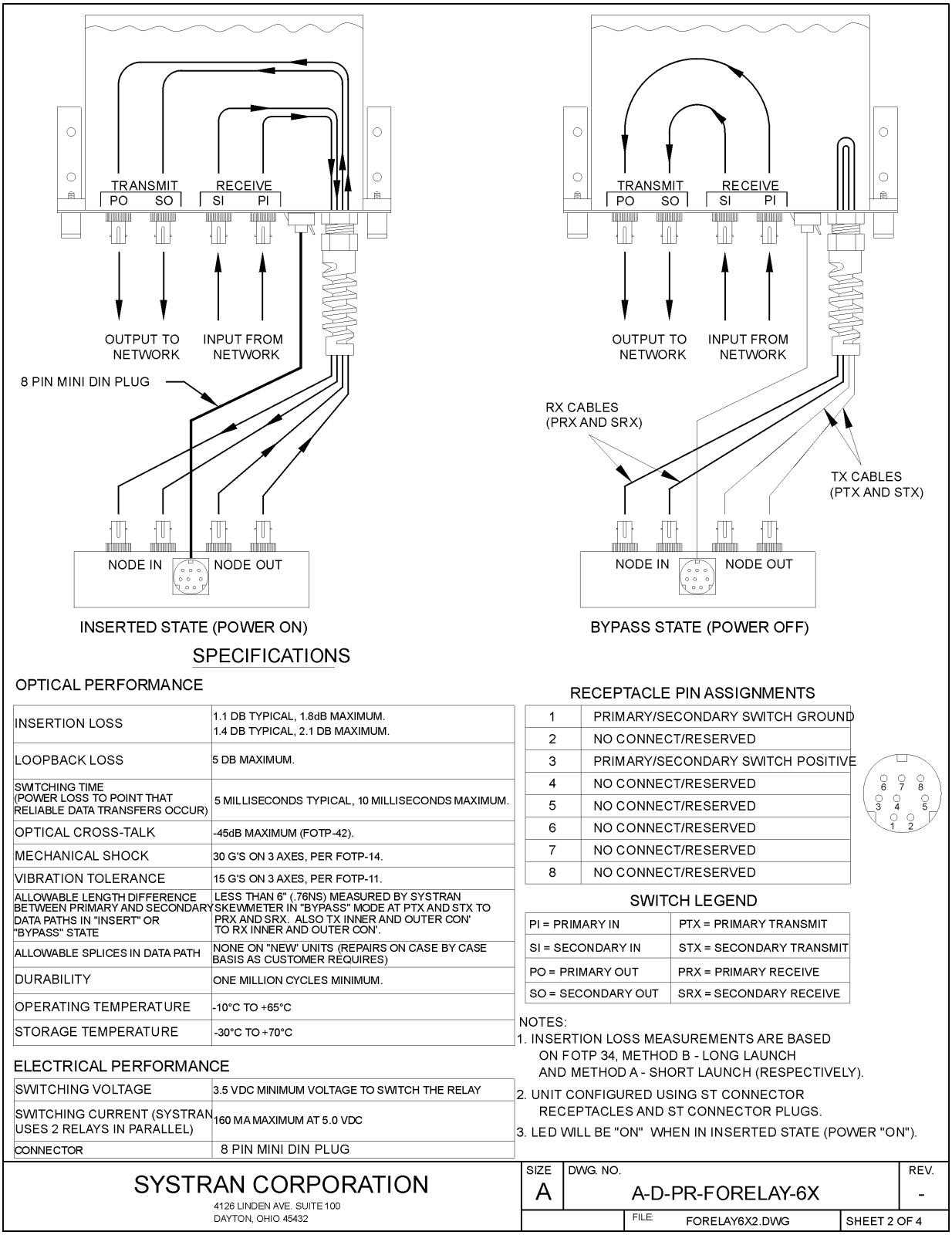


Figure A-4 Fiber Optic Bypass Switch

A.7.1 Fiber Optic Bypass Switch Dimensions

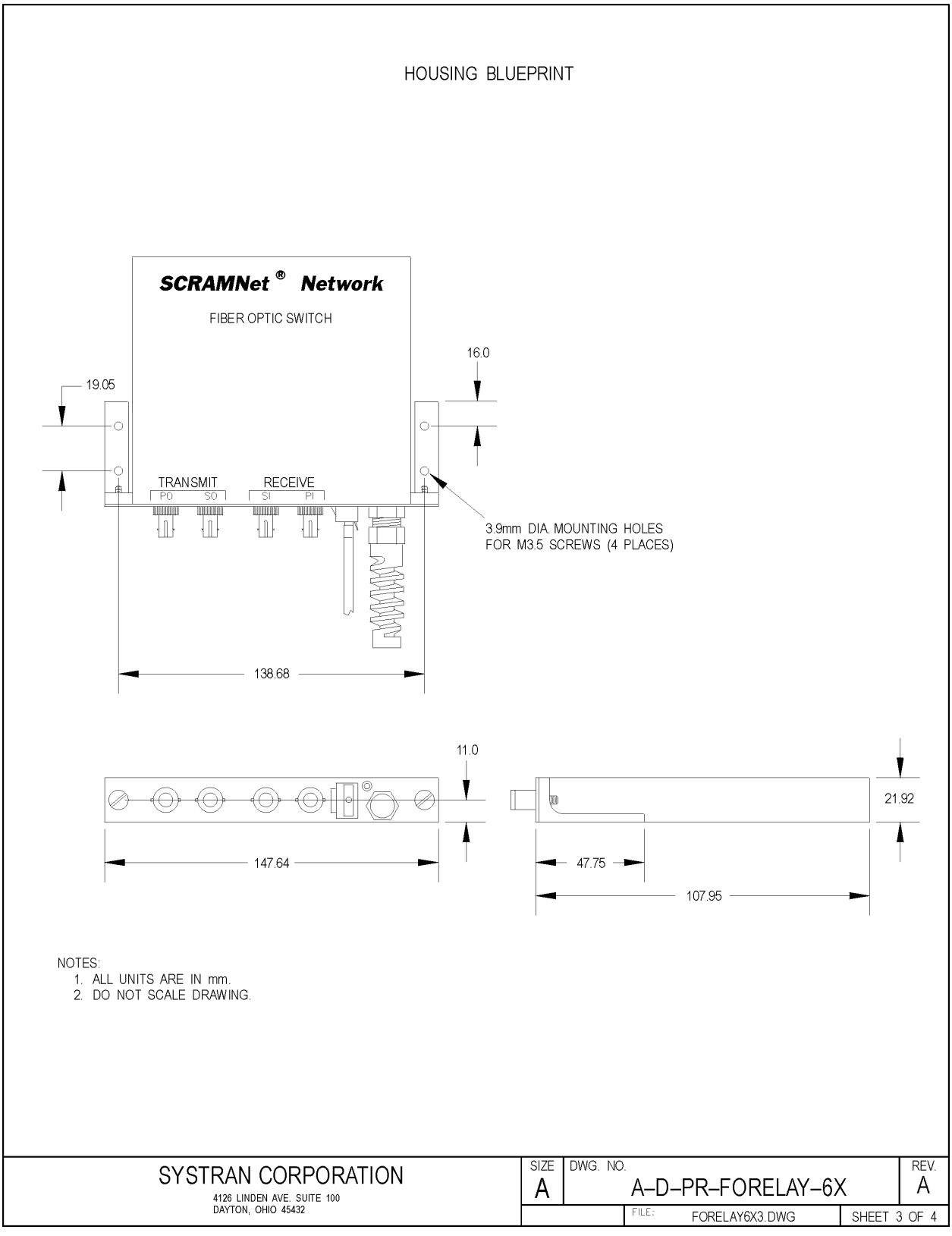


Figure A-5 Housing Dimensions

APPENDIX B

CSR DESCRIPTIONS

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B.1 Description

This section describes each Control/Status Register and the function of each bit. The name of each bit is indicative of its set state.

The registers are described using bit 0 as the Least Significant Bit (LSB). For example: Inserting 0xA7C3 in a 16-bit register would set bits 0, 1, 6, 7, 8, 9, 10, 13, and 15 ON.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	0	1	0	0	1	1	1	1	1	0	0	0	0	1	1
A				7				C				3			

Table B-1 CSR0 - General SCRAMNet+ SC150e Enable and Reset (Read/Write)

Bits	Description
1-0	**Network Communications Mode** - Bit 0 controls the receive enable, and Bit 1 controls the transmit enable.
	00 **None** - In this mode, all communications between the node-shared memory and the network is inhibited. The node is still able to pass network traffic but does not receive or transmit any data. Loopback modes are also meaningless unless the Host to Shared Memory Write bit is enabled.
	01 **Receive Only** - In this mode, any received message is processed and written to node shared memory. Data written by the host is placed in the node-shared memory and in the Transmit FIFO but is not sent out on the network. In this mode, the Transmit FIFO will fill and if the Error Interrupt is enabled, Transmit FIFO full interrupt will be triggered. Before changing modes from Receive-Only to either Transmit-Only or Transmit/Receive, the Transmit FIFO should be cleared. If not, all buffered transmit messages will be sent out on the network.
	10 **Transmit Only** - In this mode, any received message bypasses the shared memory and is passed on. Any message written by the host to node-shared memory is transmitted on the network. However, any received message is not written to node-shared memory. (Transmissions are subject to data filter characteristics.)
	11 **Transmit/Receive** - In this mode, any received message is processed, written to node shared memory and passed on. Any message written by the host to node-shared memory is transmitted on the network. This is the normal operation. (Transmissions are subject to data filter characteristics.)
2	**Redundant Transceiver Toggle** - When this bit is cycled ‘0’, ‘1’, ‘0’, the optional redundant transceiver selected link is changed.
3	**Host Interrupt Enable** - When this bit is set, a received message that is written to node shared memory as an interrupt will generate an interrupt request, and the address will be written to the Interrupt FIFO. This bit must be set in order to receive any interrupts from the network.
4	**Auxiliary Control RAM Enable** - When this bit is set, the ACR bytes are swapped in place of the corresponding least-significant byte of every four-byte word in SCRAMNet+ memory. The values written to those ACR byte locations dictate the type of interrupt that will occur when the 4-byte memory location is written into. The ACR has five bits for interrupt control. They are as follows:
	ACR[0] - **Receive Interrupt Enable** - Setting this bit generates an interrupt to the host for network interrupt data received in this location.
	ACR[1] - **Transmit Interrupt Enable** - Setting this bit generates an interrupt to the network for a host write to this shared memory location.
	ACR[2] - **External Trigger 1** - Setting this bit generates a trigger signal to an external connector whenever there is a host write access to this shared memory location.*
	ACR[3] - **External Trigger 2** - Setting this bit generates a trigger signal to an external connector whenever there is a network write to this shared memory location.*
	ACR[4] - **HIPRO location enable** - Setting this bit causes the two 16-bit data or four 8-bit items within the 32-bit address boundary to be transmitted as one 32-bit network message. CSR2, bit 13 must also be set for this action to occur.
5	**Interrupt On Memory Mask Match Enable** - This bit must be set in order for any type of memory interrupt to occur.
6	**Override Receive Interrupt Enable Flag** - When this bit is set, an interrupt is generated to the host by any interrupt data received from the network regardless of the status of the ACR Receive Interrupt bit.

Bits	Description
7	**Enable Interrupt on Error** - When this bit is set, Interrupt FIFO Full, Protocol Violation, Bad Message and/or Receiver Overflow conditions causes an interrupt request.
8	**Network Interrupt Enable** - This bit must be set to transmit interrupt data to the network.
9	**Override Transmit Interrupt Enable Flag** - When this bit is set, an interrupt is sent out on the network regardless of the status of the ACR Transmit Interrupt bit.
10	**Enable Transmit Data Filter** - When clear, the entire address space is not filtered and the node is capable of transmitting all messages written to the node shared memory by the host on the network. When set, the data-filter function is enabled for the address space above the first 4 K bytes of SCRAMNet+ memory. Bit 11 controls the lower 4 K bytes.
11	**Enable Lower 4 K Bytes For Data Filter** - When set, the lower 4 K bytes of address space is data filtered if bit 10 is also set. When disabled, the address space will not be filtered.
12	**Reset Receive/Transmit FIFO** - This bit must be toggled from '0' to '1' and back to '0' in order to reset the Receive/Transmit FIFO. The R/T FIFO is a temporary high-speed holding area for data flowing through the network. **NOTE**: If the R/T FIFO were to be reset during active network transmissions, the data in the FIFO at that time would be lost and it would cause errors on the downstream nodes in the network ring.
13	**Reset Interrupt FIFO** - This bit must be toggled from '0' to '1' and back to '0' to reset the Interrupt FIFO.
14	**Reset Transmit FIFO** - This bit must be toggled from '0' to '1' and back to '0' to reset the Transmit FIFO.
15	**Insert Node** - This bit controls the nodes communications mode on the network as either a receiver only or a receiver/transmitter. On power-up, this bit is OFF which translates to the receiver-only mode. This allows user-written software (on each host processor on the network) to be initiated from one node whenever the network is started cold. When this bit is ON, the node is "inserted" into the network ring as a receiver/transmitter which is the normal operating mode if the Fiber Optic Loopback CSR2[6] is disabled. This bit is invalid when the Enable Wire Loopback CSR2[7] is ON.

*User access to Trigger 1 and Trigger 2 is not available on the PMC Card.

Table B-2 CSR1 - SCRAMNet+ SC150e Error Indicators (Read Only with Write/Reset for interrupts)

Bits	Description



NOTE: Reading CSR1 will reset the latched error conditions by clearing bits 0,2,4,6,7,8,9,10,11,12,13.

0	**Transmit FIFO Full (Latched)** - When this bit is set, the Transmit-FIFO-Full condition exists. This occurs when there is more data coming from the host to the network than the network can absorb. When the shared memory is full, host writes will be held off by the SCRAMNet+ SC150e host interface logic until the Transmit FIFO is no longer full.
1	**Transmit FIFO Not Empty** - This bit does not represent any type of error condition, but rather just a report on the state of the Transmit FIFO. A '0' represents an empty FIFO, where a '1' indicates at least one message in the FIFO.
2	**Transmit FIFO 7/8 Full (Latched)** - This bit indicates that the Transmit FIFO is 7/8 full. A '0' represents a FIFO that is less than 7/8 full, where a '1' indicates the FIFO is backing up and is more than 7/8 full.
3	Always 0
4	**Interrupt FIFO Full (Latched)** - When this bit is set, the Interrupt FIFO Full error condition exists. Reset the Interrupt FIFO by toggling CSR0[13] to ON then to OFF.
5	**Protocol Violation (Latched)** - When this bit is ON, there has been a signal error at the physical layer (fiber or coaxial) resulting from noise on the transmission lines or a result of hardware failure. It can be any one of the following: Missing transition for two clock periods on either line, Parity error or a Framing error.
6	**Carrier Detect (Latched)** - This bit is set if the receivers do not detect any or enough output from the previous nodes transmitters. This is usually an indication that the fiber optic lines have become disconnected or there may be dust/dirt where the fiber optic connections have been made. A visual inspection of the network lines will need to be made.
7	**Bad Message (Latched)** - When this bit is set, the hardware has detected an error in the message packet received on the network. If this error persists, it is an indication that a hardware problem on the SCRAMNet+ Card may exist.
8	**Receiver Overflow (Latched)** - When this bit is set, the Receive FIFO has received more data than the node is able to process. This condition may indicate a hardware problem on the Card.
9	**Transmit Retry (Latched)** - This bit is set if a message returns to the originating node with bit errors. The message is automatically retransmitted indefinitely until it returns without bit errors. This is considered to be an error condition.
10	**Transmit Retry Time-out (Latched)** - This bit is set if a message does not return to the originating node within the time-out value specified in CSR5. The message is automatically retransmitted indefinitely until it returns. This is considered to be an error condition.
11	**Redundant Transmit/Receive Fault (Latched)** - This bit is set if the currently selected optional redundant transceiver has faulted and reverted to the other link. The default value is '0'
12	**General Purpose Counter/Timer Overflow (Latched)** - This bit toggles a 16-bit counter/timer. The events to be counted/timed are set using CSR8[9]; CSR9[13]; and CSR9[14]. The output is held in CSR13. The counter/timer can: count errors, count trigger events for triggers 1 and 2, transmit time, network events, free run @ 26.66 ns, and free run @ 1.706 ns with trigger 2 CLEAR.

Bits	Description
13	**Current Link (Latched)** - This bit tells which of the optional redundant transceivers is currently selected as the active link. The default value is 1=A.
14	**Interrupts Armed** - During interrupt operation, this bit indicates that the conditions to receive an interrupt are active. If this bit is '0', then the host will receive no interrupts. When CSR1 is written to, then the interrupts-armed bit will return to an active status.
15	**Fiber Optic Bypass Not Connected** - This is a status bit concerning the installation of the optional Fiber Optic Bypass Switch. A '0' in this bit indicates that the bypass switch is installed while a '1' indicates it is not installed. Fiber Optic Loopback CSR2[6] mode is dependent upon the Fiber Optic Bypass Switch being installed.

Table B-3 CSR2 - Node Control (Read/Write)

Bits	Description
5-0	These bits are related to lines connected through the MUX control port and are available to the host interface. They are not required to connect to anything
6	**Disable Fiber Optic Loopback** - When this bit is '0' (power up default), the output of the transmitter is connected by fiber optics directly to the input of the receiver, and the receiver is disconnected from the network. The optional Fiber Optic Bypass Switch must be installed for this mode to be effective. This mode is valid only when the Insert Node CSR0[15] is ON. Set this bit to disable the loopback mode when the node is in use as a part of the network.
7	**Enable Wire Loopback** - When this bit is set, the output of the transmitter is connected by wire directly to the input of the receiver, and the receiver is disconnected from the network. The purpose of this bit is purely diagnostic. This mode is valid only when the Insert Node CSR0[15] is OFF.
8	**Disable Host to Memory Write** - When this bit is set, the host writes are not written to the host node's shared memory, but are sent out on the network if Transmit CSR0[1] is ON.
9	**Write Own Slot Enable** - When this bit is set, the message slot (packet) sent out to the network can be received by the originating node. This is not the normal procedure but may be used (in conjunction with CSR2[10] when it is desired to generate an interrupt to the host, written by the host.
10	**Enable Interrupt On Own Slot** - When this bit is set, a message with the interrupt bit set can be received by the originating node if CSR2[9], is also set. This coupling enables a host processor to interrupt itself (Self Interrupt).

Write-Me-Last/Self-Interrupt Mode Definition

CSR2[10]	CSR2[9]	CSR2[8]	Mode
0	1	1	WRITE ME LAST mode
1	1	0	SELF-INTERRUPT mode
1	1	1	WRITE ME LAST with SELF-INTERRUPT mode

11	**Message Length Limit** - Variable maximum message size: 1024 bytes or 256 byte. It is used in conjunction with CSR2[12], CSR2[14] and CSR2[15] to enable PLUS mode communication protocols.
12	**Variable Length Messages on Network** - When ON, this bit enables variable length messages. It is used in conjunction with CSR2[11], CSR2[14] and CSR2[15] to enable PLUS mode communication protocols (see below).
13	**HIPRO Enable** - When this bit is set, the two 16-bit shortwords associated with the longword addressed at ACR[4], will be transmitted onto the network as one 32-bit longword. The first shortword write will be held until the second shortword write occurs, which results in the 32-bit data value to be written to the network. **Exceptions:** HIPRO will not work when Disable Host to Memory Write CSR2[8] is set. HIPRO will not work when writing two separate shortwords while using interrupts.
14	**Multiple Messages** - This bit allows multiple native messages on the network. It is used in conjunction with CSR2[11], CSR2[12] and CSR2[15] to enable the BURST mode communication protocol (see below).

Bits	Description
15	**No Network Error Correction** - This bit is used in conjunction with CSR2[12] and CSR2[14] to enable communication protocols: BURST or PLATINUM mode and the variable length message PLUS (+) mode (see below).

SCRAMNet+ SC150e Protocol Mode Definition

Network Mode	CSR2[15] No Error Correction	CSR2[14] Multiple Message	CSR2[12] Variable Length	CSR2[11] Message Size Maximum
BURST	1	1	0	NO MEANING
PLATINUM	0	1	0	NO MEANING
BURST+	1	1	1	1=1024, 0=256
PLATINUM+	0	1	1	1=1024, 0=256

Table B-4 CSR3 - Node Information (READ ONLY)

Bits	Description
7-0	**Node Number Count** - These bits represent the total number of SCRAMNet+ SC150e nodes on the network. This value is dynamically determined by the hardware and ranges from 0 to 255 depending upon the number of nodes actually on the network. **Transmit AGE** - This field is also used to read/write the T_AGE[7:0] field. This register reflects this field when the ID_MUX bit in CSR8[0] is set.
15-8	**Node Identification Number** - These bits represent the SCRAMNet+ SC150e node identification number. Each node must have a unique identification number from 0 to 255 for each network ring. The NODE ID need not be in sequential order. **Receive ID** - This field is also used to read/write the RXID[7:0] field. This register reflects this field when the ID_MUX bit in CSR8[0] is set.

Table B-5 CSR4 - Interrupt Address (LSP) (READ ONLY)

Bits	Description
15-0	**LSP of the Interrupt Address** - These bits represent the LSP of the interrupt address (A15 - A0). Bits 0 and 1 are always '0' since the addresses are on four-byte boundaries.

Table B-6 CSR5 - Interrupt Address and Status (READ ONLY)*

Bits	Description
6-0	**MSP of the Interrupt Address** - These 7 bits represent the MSP of the interrupt address (A22 - A16). When coupled with CSR4, this address represents the SCRAMNet+ memory location of the interrupt.
13-7	Reserved.
14	**Retry Interrupt FIFO Bit** - This bit is set when an interrupt message is received that has its message retry bit set. This can be checked in the interrupt service routine to guard against double interrupts from the same message if it happens to be retransmitted.
15	**Interrupt FIFO Not Empty** - When this bit is clear, the Interrupt FIFO is empty. Do not READ CSR4 when this bit is '0'. When this bit is set, it signals that CSR5 and CSR4 contain a legitimate interrupt address.

* Writing the Transmit Time-out value to CSR5 stores it in shadow memory. Do not set this value to '0'. A value of '0' prevents host-generated data from leaving the Transmit FIFO.

Table B-7 CSR6 - Reserved

Bits	Description
15-0	Not Used

Table B-8 CSR7 - Reserved

Bits	Description
15-0	Not Used

Table B-9 CSR8 - General SCRAMNet+ SC150e Extended Control Register

Bits	Description
0	**ID Multiplex** - When set to '1', CSR3 contains the T_AGE and RXID fields.
1	**Disable Holdoff** - When set, this bit disables the Holdoff feature.
7-2	These bits are used for programming the EEPROM.
8	**CSR Reset** - Setting this bit causes bus errors. On reset, CSRs loads from EEPROM.
9	**General Purpose Counter/Timer Free Run** - Setting this bit causes the GPC to free run at a rate of 37.5 MHz (26.66 ns). This counter mode overrides all other counter mode settings.
10	**Receive Interrupt Override** - When this bit is set, all incoming network messages are treated as interrupt messages.
11	**Mechanical Switch Override** - Normally set to ON. When OFF, Mechanical Switch Loopback Mode is invoked.
14-12	**Memory Size Configuration** - These bits indicate the memory-size code and are used in conjunction with the memory address stored in CSR10 and 11. The memory size is automatically calculated. (See below)
15	Reserved. (Always 1).

Memory Size Configuration

CSR8[14]	CSR8[13]	CSR8[12]	Memory Size
1	1	1	4 KB
1	1	0	128 KB
1	0	1	512 KB
1	0	0	1 MB
0	1	1	2 MB
0	1	0	4 MB
0	0	1	8 MB

Table B-10 CSR9 - SCRAMNet+ SC150e Interrupt On-Error Mask*

Bits	Description
0	Transmit FIFO Full Mask
1	Transmit FIFO not Empty Mask
2	Transmit FIFO 7/8 Full Mask
3	Built In Self Test Stream (BIST) - Internal 82-bit BIST shift register output.
4	Interrupt FIFO Full Mask
5	Protocol Violation Mask
6	Carrier Detect Fail Mask
7	Bad Message Mask
8	Receiver Overflow Mask
9	Transmitter Retry Mask
10	Transmitter Retry Due to Time Out Mask
11	Redundant TX/RX Fault Mask
12	Interrupt on General Purpose Counter/Timer Overflow Mask
13	See Below
14	See Below
15	Fiber Optic Bypass Switch Not Connected Mask

General Purpose Counter/Timer Modes

CSR8[9]	CSR9[14]	CSR9[13]	Counter/Timer Modes
0	0	0	Count Errors
0	0	1	Count Trigs (1&2)
0	1	0	Transit Time
0	1	1	Network Events
1	1	X	Free Run @ 26.66 ns
1	0	1	1.706 µs w/trig 2 CLR

* To enable an On-Error mask, set the bit to '1'.

Table B-11 CSR10 - DEC_IGNORE

Bits	Description
0	1 = Non-DEC system (Factory default) 0 = DEC system **NOTE**: This CSR is shadowed in the controller state machine so that its value, when written, can be read from CSR10.
15-1	Reserved (always 0)

Table B-12 CSR11 - Reserved

Bits	Description
15-0	Not Used

Table B-13 CSR12 - SCRAMNet+ SC150e Virtual Paging Register

Bits	Description	
0	VP	**Virtual Paging Enable**. When ON, this bit enables Virtual Paging.
4-1	-0-	Always zero
5	VP_A12	**Virtual Page number.** The significance of this register is dependent on the memory size. (For example, For 4 MB, only VP_A22 is valid; for 4 KB, P_A[22:12] are valid.
6	VP_A13	
7	VP_A14	
8	VP_A15	
9	VP_A16	
10	VP_A17	
11	VP_A18	
12	VP_A19	
13	VP_A20	
14	VP_A21	
15	VP_A22	

Table B-14 CSR13 - General Purpose Counter/Timer

Bits	Description	
0	RD_COUNT[0]	This is a General Purpose Counter/Timer register. It can be used to count trigger 1 and 2 events, count errors, or other events as programmed by CSR9[13] and CSR9[14].
1	RD_COUNT[1]	
2	RD_COUNT[2]	
3	RD_COUNT[3]	
4	RD_COUNT[4]	
5	RD_COUNT[5]	
6	RD_COUNT[6]	
7	RD_COUNT[7]	
8	RD_COUNT[8]	
9	RD_COUNT[9]	
10	RD_COUNT[10]	
11	RD_COUNT[11]	
12	RD_COUNT[12]	
13	RD_COUNT[13]	
14	RD_COUNT[14]	
15	RD_COUNT[15]	

Table B-15 CSR14 - Reserved

Bits	Description
15-0	Not Used

Table B-16 CSR15 - Reserved

Bits	Description
15-0	Not Used

APPENDIX C

CSR SUMMARY

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C.1 CSR0 – General SCRAMNet+ SC150e Enable and Reset

Bit	Function	Name
0	Receive Enable	RX_ENB
1	Transmit Enable	TXEN
2	Redundant TxRx Toggle	RTT
3	Host Interrupt Enable	HIE
4	Auxiliary Control RAM Enable	ACRE
5	Interrupt on Memory Mask Match Enable	IMME
6	Override RIE Flag	ORF
7	Interrupt on Errors	IOE
8	Network Interrupt Enable	NIE
9	Override TIE Flag	OTF
10	Enable Tx Data Filter	DFEN
11	Enable Lower 4 Kbytes for Data Filter	EN4K
12	RESET Rx/Tx FIFO	RTRF
13	RESET Interrupt FIFO	RSTIF
14	RESET Transmit FIFO	RTXF
15	Insert Node	INSRT

C.2 CSR1 – Error Indicators

Bit	Function	Name
0	Transmit FIFO Full	TXFF
1	Transmit FIFO Not Empty	TXFNE
2	Transmit FIFO 7/8 Full	TXFAF
3	(Always 0)	Not Used
4	Interrupt FIFO Full	IFF
5	Protocol Violation	PV
6	Carrier Detect Failure	CDF
7	Bad Message	BB
8	Receiver Overflow	RXO
9	Transmit Retry	TXRTY
10	Transmit Retry Time-out	TO
11	Redundant TxRx Fault	RTF
12	General Purpose Counter/Timer Overflow	GPCTO
13	Redundant TxRx Link 1=A/0=B	RTLAB
14	Interrupts Armed - Write to re-arm	IARM
15	Fiber Optic Bypass Not Connected	FOB

C.3 CSR2 – Node Control

Bit	Function	Name
5-0	Available to Host	
6	Disable Fiber Optics Loopback	FO_DIS
7	Enable Wire Loopback	EN_WR_LPB
8	Disable Host to Memory Write	DIS_H_M_WR
9	Enable Write of Our Own Slot to Memory	WOSEN
10	Enable Interrupt on Receipt of Own Interrupt Slot	IOSEN
11	1024 vs 256 variable size max (bytes)	LEN_LIMIT
12	Variable length messages on network	VAR_LEN
13	HIPRO Write Enable	HIPRO
14	Allow multiple native messages on network	MULTIPLE_MSG
15	No Network Error Correction	NO_ERR_CRCT

Write-Me-Last/Self-Interrupt Mode Definition

CSR2[10]	CSR2[9]	CSR2[8]	Mode
0	1	1	WRITE ME LAST mode
1	1	0	SELF-INTERRUPT mode
1	1	1	WRITE ME LAST with SELF-INTERRUPT mode

SCRAMNet+ Protocol Mode Definition

Network Mode	CSR2[15] No Error Correction	CSR2[14] Multiple Message	CSR2[12] Variable Length	CSR2[11] Message Size Maximum
BURST	1	1	0	NO MEANING
PLATINUM	0	1	0	NO MEANING
BURST+	1	1	1	1=1024, 0=256
PLATINUM+	0	1	1	1=1024, 0=256

C.4 CSR3 – Node Information

Bit	Function	Name
0	Node Number Count* (Valid After a Transmission from the Node)	NN0
1		NN1
2		NN2
3		NN3
4		NN4
5		NN5
6		NN6
7		NN7
8	Node ID Number*	NID0
9		NID1
10		NID2
11		NID3
12		NID4
13		NID5
14		NID6
15		NID7

* When ID_MUX CSR[0] is set:
Bits 7 - 0 are Transmit AGE
Bits 15 - 8 are Receive ID.

C.5 CSR4 – Interrupt Address (LSW)

Bit	Function	Name
0	Interrupt FIFO Address Field (LSW)	Always = 0
1		Always = 0
2		RFA2
3		RFA3
4		RFA4
5		RFA5
6		RFA6
7		RFA7
8		RFA8
9		RFA9
10		RFA10
11		RFA11
12		RFA12
13		RFA13
14		RFA14
15		RFA15

C.6 CSR5 – Interrupt Address (MSW) and Status (READ Only*)

Bit	Function	Name
0	Interrupt FIFO Address Field (MSW)	RFA16
1		RFA17
2		RFA18
3		RFA19
4		RFA20
5		RFA21
6		RFA22
13-7	Reserved	0
14	Retry Bit in Interrupt FIFO	(RF_RETRY)
15	Interrupt FIFO Not Empty	(~RX_F_E)

* Writing the Transmit Time-out value to CSR5 stores it in shadow memory. Do not set this value to '0'. A value of '0' prevents host-generated data from leaving the Transmit FIFO

C.7 CSR6 – Reserved

A 16-bit, Read-Only Systran reserved register.

C.8 CSR7 – Reserved

A 16-bit, Read-Only Systran reserved register.

C.9 CSR8 – General SCRAMNet+ SC150e Extended Control Register

Bit	Function	Name
0	1 is CSR3=T_AGE & RXID fields	ID_MUX
1	Disable Holdoff feature	DIS_HOLD
2	Chip select to EEPROM	CSR_CS0
3	Ext. Chip Select for AUX MICROWIRE peripheral	CSR_CS1
4	MICROWIRE DOUT pin	CSR_DOUT
5	EEPROM program enable	E_PRE
6	CLK line to MICROWIRE port	CSR_CK
7	DIN line connected to the MICROWIRE DOUT pins	E_DIN
8	Initiate initiation sequence - CSR Reset	CSR_RST
9	Override Counter mode	GPC_FRE
10	Receive Interrupt Override	RX_INT_OVR
11	1 = Mechanical Switch Override	C_MECHSW
	0 = Invoke Coax Loopback Mode	
12	Memory Size Configuration - (See below)	MC10
13	Memory Size Configuration - (See below)	MC11
14	Memory Size Configuration - (See below)	MC12
15	Reserved (always 1)	1

Memory Size Configuration

CSR8[14]	CSR8[13]	CSR8[12]	Memory Size
1	1	1	4 KB
1	1	0	128 KB
1	0	1	512 KB
1	0	0	1 MB
0	1	1	2 MB
0	1	0	4 MB
0	0	1	8 MB

C.10 CSR9 – SCRAMNet+ SC150e Interrupt-On-Error Mask

Bit	Function	Name
0	Transmit FIFO Full mask	M_TX_F_F
1	Transmit FIFO Not Empty mask	M_TX_F_E
2	Transmit FIFO 7/8 Full Mask	M_TX_F_AF
3	Internal 82 bit BIST shift register output	BIST_STREAM
4	Receiver FIFO Full Mask	M_RX_F_F
5	Protocol Violation mask	M_PV
6	Carrier Detect Fail mask	M_CD_FAIL
7	Bad Message mask	M_BM
8	Receiver Overflow mask	M_RX_OVR
9	Transmitter Retry mask	M_RETRY
10	Transmitter Retry - Time-out	M_RETRY_T_O
11	Redundant Transmit/Receive Fault mask	M_FAULT
12	Interrupt on Utility Counter Overflow	M_COUNT_OVR
13	General Purpose Counter/Timer Modes (See below)	M_INC_TRIGS
14	General Purpose Counter/Timer Modes (See below)	M_INC_ERRS
15	Fiber Optic Bypass Not Connected mask	M_FO_BYPASS

General Purpose Counter/Timer Modes

CSR8[9]	CSR9[14]	CSR9[13]	Counter/Timer Modes
0	0	0	Count Errors
0	0	1	Count Triggers (1 & 2)
0	1	0	Transit Time
0	1	1	Network Events
1	1	X	Free Run @ 26.66 ns
1	0	1	1.706 μs\w Trig 2 CLR

C.11 CSR10 – DEC_IGNORE

Bit	Function	Name
0	1 = Non-DEC system 0 = DEC system	DEC_IGNORE
15-1	Reserved	0

C.12 CSR11 – Reserved

A 16-bit, Read Only Systran reserved register.

C.13 CSR12 – SCRAMNet+ SC150e Virtual Paging Register

(Refer to Chapter 54, subsection 5.2.1, and Appendix B, page B-11 for additional information)

Bit	Function	Name
0	Enables Virtual Paging when set	VP
4-1	Always '0'	0
5	Virtual Page Number	VP_A12
6		VP_A13
7		VP_A14
8		VP_A15
9		VP_A16
10		VP_A17
11		VP_A18
12		VP_A19
13		VP_A20
14		VP_A21
15		VP_A22

C.14 CSR13 – SCRAMNet+ SC150e General Purpose Counter Timer

(Refer to Chapter 5, subsection 5.10, and Appendix B, page B-12 for additional information)

Bit	Function	Name
0	Counter/Timer register	RD_COUNT[0]
1	Counter/Timer register	RD_COUNT[1]
2	Counter/Timer register	RD_COUNT[2]
3	Counter/Timer register	RD_COUNT[3]
4	Counter/Timer register	RD_COUNT[4]
5	Counter/Timer register	RD_COUNT[5]
6	Counter/Timer register	RD_COUNT[6]
7	Counter/Timer register	RD_COUNT[7]
8	Counter/Timer register	RD_COUNT[8]
9	Counter/Timer register	RD_COUNT[9]
10	Counter/Timer register	RD_COUNT[10]
11	Counter/Timer register	RD_COUNT[11]
12	Counter/Timer register	RD_COUNT[12]
13	Counter/Timer register	RD_COUNT[13]
14	Counter/Timer register	RD_COUNT[14]
15	Counter/Timer register	RD_COUNT[15]

C.15 CSR14 – Reserved

A 16-bit, Read Only Systran reserved register.

C.16 CSR15 – Reserved

A 16-bit, Read Only Systran reserved register.

C.17 Auxiliary Control RAM (R/W)

Bit	Function	Name
0	Receive Interrupt Enable	RIE
1	Transmit Interrupt Enable	TIE
2	External Trigger 1 (Host Read/Write)*	ET1
3	External Trigger 2 (Network Write)*	ET2
4	HIPRO	HIPRO
7-5	Reserved	0

* User access to Trigger 1 and Trigger 2 is not available on the PMC Card.

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APPENDIX D

CONFIGURATION AIDS

SCRAMNet+ SC150e CONTROL/STATUS REGISTERS REFERENCE SHEET

CSR 0

0	RX ENB
1	TX ENB
2	REDUND LINK TOGGLE
3	HOST INT ENB
4	AUX CTRL RAM ENB
5	INT MEM MASK MATCH
6	OVRD RIE FLAG
7	INT ON ERRORS
8	NET INT ENB
9	OVRD TIE FLAG
10	ENB TX DATA FILTER
11	ENB LOWER 4K FILTER
12	RST TX/RX FIFO
13	RST INT FIFO
14	RST TX FIFO
15	INSERT NODE

CSR 2

0	available to host
1	available to host
2	available to host
3	available to host
4	available to host
5	available to host
6	DSB FO LPBCK
7	ENB WIRE LPBCK
8	DSB HOST TO SM WRT
9	ENB WRT OWN SLOT
10	ENB INT RX OWN SLOT
11	MSG LENGTH LIMIT
12	VAR LENGTH MSGS
13	ENB HIPRO WRITE
14	MULT NATIVE MSGS
15	NO NTWK ERR CRCT

CSR 4

0	always 0
1	always 0
2	RFA 2
3	
4	
5	RX FIFO ADDRESS FIELD
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	RFA 15

CSR 6

0	reserved
1	reserved
2	reserved
3	reserved
4	reserved
5	reserved
6	reserved
7	reserved
8	reserved
9	reserved
10	reserved
11	reserved
12	reserved
13	reserved
14	reserved
15	reserved

ACR

0	RIE
1	TIE
2	EXT TRG 1
3	EXT TRG 2
4	HIPRO ENB
5	reserved
6	reserved
7	reserved

LED STATUS

G	INSERT
G	CARRIER DETECT

CSR 1 (READ RESET)

0	TX FIFO FULL
1	TX FIFO NOT EMPTY
2	TX FIFO 7/8 FULL
3	Always 0
4	INT FIFO FULL
5	PROTOCOL VIOLATION
6	CARRIER DETECT FAIL
7	BAD MESSAGE
8	RX OVERFLOW
9	TX RETRY
10	TX RETRY TIME-OUT
11	REDUND TXRX FAULT
12	GP CTR/TIMER OVRFLO
13	CURRENT LINK FOR USE
14	INTERRUPTS ARMED*
15	FO BYPASS NOT CNCTD

CSR 3

0	NN0
1	
2	NUMBER
3	OF
4	NODES
5	
6	
7	NN7
8	TXID0
9	
10	
11	NODE ID
12	
13	
14	
15	TXID7

CSR 5

0	RFA16
1	
2	RX FIFO
3	ADDRESS
4	(MSW)
5	
6	RFA22
7	reserved
8	reserved
9	reserved
10	reserved
11	reserved
12	reserved
13	reserved
14	RF RETRY
15	INT FIFO NOT EMT

CSR 7

0	reserved
1	reserved
2	reserved
3	reserved
4	reserved
5	reserved
6	reserved
7	reserved
8	reserved
9	reserved
10	reserved
11	reserved
12	reserved
13	reserved
14	reserved
15	reserved

* Write to CSR1 to re-arm interrupts.

	CSR 8
0	AGE & RXID MUX
1	HOLDOFF DISABLE
2	CHP SELECT EEPROM
3	AUX MICROWIRE
4	MICROWIRE DOUT
5	EEPROM PROG ENABLE
6	MICROWIRE CLOCK LN
7	MICROWIRE DOUT DIN
8	INIT ASIC/CSR RESET
9	GP CTR FREE
10	RX INT OVERRIDE
11	MECH SW OVR
12	MEM SIZE
13	MEM SIZE
14	MEM SIZE
15	Reserved

	CSR 10
0	DEC_IGNORE
1	reserved
2	reserved
3	reserved
4	reserved
5	reserved
6	reserved
7	reserved
8	reserved
9	reserved
10	reserved
11	reserved
12	reserved
13	reserved
14	reserved
15	reserved

	CSR 12
0	VIRT PG ENB
1	Always 0
2	Always 0
3	Always 0
4	Always 0
5	VPA 12
6	
7	
8	VIRTUAL
9	PAGE
10	NUMBER
11	
12	
13	
14	
15	VPA 22

	CSR 14
0	reserved
	reserved
	reserved
	reserved
	reserved
	reserved
	reserved
	reserved
	reserved
	reserved
	reserved
	reserved
	reserved
	reserved
	reserved
15	reserved

	CSR 9
0	TX FIFO FULL MASK
1	TX FIFO NOT EMP MASK
2	TX FIFO 7/8 FULL MASK
3	BIST STREAM (R/O)
4	RX FIFO FULL MASK
5	PROTOCOL VIOL MASK
6	CARRIER DETECT FAIL MASK
7	BAD MESSAGE MASK
8	RX OVERFLOW MASK
9	TX RETRY MASK
10	TX RETRY TIME-OUT
11	REDUN TXRX FAULT MASK
12	GP CTR/TIMER OVRFLO
13	UTIL CTR MODES
14	UTIL CTR MODES
15	FO BYPASS NOT CNCTD MASK

	CSR 11
0	reserved
1	reserved
2	reserved
3	reserved
4	reserved
5	reserved
6	reserved
7	reserved
8	reserved
9	reserved
10	reserved
11	reserved
12	reserved
13	reserved
14	reserved
15	reserved

	CSR 13
0	RD COUNT 0
1	
2	
3	
4	GENERAL
5	PURPOSE
6	COUNTER/
7	TIMER
8	REGISTER
9	
10	
11	
12	
13	
14	
15	RD COUNT 15

	CSR 15
0	reserved
1	reserved
2	reserved
3	reserved
4	reserved
5	reserved
6	reserved
7	reserved
8	reserved
9	reserved
10	reserved
11	reserved
12	reserved
13	reserved
14	reserved
15	reserved

SCRAMNet+ SC150e NETWORK CONFIGURATION DATA SHEET

NODE ID	HOST MACHINE	MEMORY ADDRESS & BUS	MEMORY SIZE	CSR ADDRESS & BUS	INT LEVEL	SCRAMNet SERIAL #

GLOSSARY

A16 ----------A type of module that provides or decodes an address on address lines A01 through A15.

A24 ----------A type of module that provides or decodes an address on address lines A01 through A23.

A32 ----------A type of module that provides or decodes and address on address lines A01 through A31.

address-only cycle ----------A DTB cycle that consists of an address broadcast, but no data transfer. The slave does not acknowledge address-only cycles and the master terminates the cycle without waiting for an acknowledgment.

alarm----------Manually resetable latched error condition.

ACR----------auxiliary control RAM. A memory buffer typically used as a data bus width extension for control purposes only. Also referred to as shadow memory .

bad message----------A message error condition reported by a node's receiver circuitry. This condition is automatically corrected by SCRAMNet+ hardware.

block read cycle ----------A DTB cycle used to transfer a block of 1 to 256 bytes from a slave to a master. This transfer is done using a string of 1-, 2-, or 4-byte data transfers. Once the block transfer is started, the master does not release the DTB until all of the bytes have been transferred. It differs from a string of read cycles in that the master broadcasts only one address and address modifier (at the beginning of the cycle.) Then the slave increments this address on each transfer so that the data for the next cycle is retrieved from the next higher location.

block write cycle ----------A DTB cycle used to transfer a block of 1 to 256 bytes from a master to a slave. The block write cycle is very similar to the block read cycle. It uses a string of 1-, 2-, or 4-byte data transfers and the master does not release the DTB until all of the bytes have been transferred. It differs from a string of write cycles in that the master broadcasts only one address and address modifier (at the beginning of the cycle). Then the slave increments this address on each transfer so that the next transfer is stored in the next higher location.

board----------A printed circuit board (PCB), its collection of electronic components, and either one or two 96-pin connectors that can be plugged into the backplane connectors.

broken ring ----------If any of the nodes in a fiber-optic ring loses the ability to retransmit an incoming message, then the ring is "broken."

BURST ----------A protocol where messages are transmitted without error correction to gain higher throughput.

BURST+ ----------Also BURST PLUS. A variable-length message packet size enhancement for the burst protocol. Maximum packet size may be set to either 256 bytes or 1024 bytes plus a 46-bit header.

bus timer----------A functional module that measures the time each data transfer takes on the DTB and terminates the DTB cycle if a transfer takes too long. Without this module, it could wait forever for a slave to respond if the master tries to transfer data to or from a nonexistent slave location. The bus timer prevents this by terminating the cycle.

carrier loss----------A hardware failure reported when the incoming light link has failed because it is too weak or nonexistent in one or both fibers from the preceding node.

CSR----------Control/status register. These registers are used for configuration and control and provide status values that can be interrogated. These registers are located in the computer's address space. Power-up register values are contained in the EEPROM.

data filter ----------A process of comparing a host write to shared memory with contents of the specified memory location to eliminate transmission of redundant data and reduce network traffic.

deterministic ----------Completely predictable message transit time from application to application.

data transfer bus----------One of the four buses provided by the backplane. The data transfer bus allows masters to direct the transfer of binary data between themselves and slaves (data transfer bus is often abbreviated DTB).

data-transfer-bus cycle----------A sequence of level transitions on the signal lines of the DTB that result in the transfer of an address or an address and data between a master and a slave. There are 34 types of data transfer bus cycles.

direct memory access----------(DMA) transfer. An I/O transfer conducted by a device controller which accesses memory directly and, as a result, can transfer a large volume of data without requesting a processor interrupt after each unit amount. Contrast with programmed I/O (PIO) transfer.

device interrupt ----------An interrupt received on interrupt priority levels 20-23. Only devices, controllers, and memories can request device interrupts.

DTB ----------A mnemonic for data transfer bus.

edges ----------Transitions that appear on a signal line.

EEPROM----------The EEPROM stores the initial power-up register values. The EEPROM can be programmed either over the backplane or by most PROM programmers. An EEPROM Initialization (EPI) Program is included in the SYSTRAN software utilities.

falling edge ----------The time during which a signal makes its transition from high to low.

FIFO ----------A data storage method; First In First Out. Also refers to the specific storage area; Transmit FIFO, Interrupt FIFO, etc.

foreign message ----------A message that is in (passing through) a node other than the one of origin.

functional module ----------A collection of electronic circuitry that resides on one board and works together to accomplish a task.

halfword----------Any double byte on even 16-bit boundaries.

insert a node ----------The act of placing a node on a network for the purpose of transmitting and receiving messages.

interrupt ----------An event that changes the normal flow of instruction execution other than an exception or a branch, jump, case or call instruction.

interrupt acknowledge cycle---A DTB cycle, initiated by an interrupt handler, that reads a status/ID from an interrupter. An interrupt handler generates this cycle when it detects an interrupt request from an interrupter and it has control of the DTB.

interrupter----------A functional module that generates an interrupt request on the priority interrupt bus and then provides states/ID information when the interrupt handler requests it.

interrupt handler ----------A functional module that detects interrupt requests generated by interrupters and responds to those requests by asking for status/ID information.

ISR----------interrupt service routine. A routine executed when a device interrupt occurs.

I/O space ----------The regions of host processor physical address space that contain the configuration registers, device control, states registers and data registers. These regions are physically noncontiguous.

latched ----------Data is electrically stored in a circuit until it is needed. A method of coordinating two synchronous events.

locking a page in memory ------Making a page ineligible for either paging or swapping. A page stays locked in physical memory until the operating system specifically unlocks it.

longword ----------Four bytes (32 bits) of data.

loopback----------A method of transmitting to the same node's receivers for testing purposes. Applies to both fiber optic and wire media. Also, a test that loops the outgoing signal back to its source.

master----------A functional module that initiates DTB cycles to transfer data between itself and a slave module.

message packet ----------See packet.

native message----------A message that is received by the node of origin.

node latency----------The time delay at a node before a foreign message can be retransmitted.

packet----------A message that travels on the network. The minimum packet consists of 81 bits and 1 start bit. The packet includes five fields: Source ID (8 bits), Age (8 bits), Control (3 bits), Data Address (21 bits), Data (32 bits), and 9 parity bits; one for every 8 bits.

physical address----------The address used by hardware to identify a location in physical memory or on directly-addressable secondary storage devices (such as disks). A physical memory address consists of a page-frame number and the number of a byte within the page.

PLATINUM----------A protocol where messages are transmitted as fast as the system will allow with error correction enabled.

PLATINUM+----------Also platinum plus. A variable-length message packet size enhancement for the platinum protocol. Maximum packet size may be set to either 256 bytes or 1024 bytes plus a 46-bit header.

priority interrupt bus ----------One of the four buses provided by the backplane. The priority interrupt bus allows interrupter modules to send interrupt requests to interrupt handler modules, and interrupt handler modules to acknowledge these interrupt requests.

PIO ----------programmed I/O transfer. An I/O transfer, primarily conducted by a driver program, that requires processor intervention after each byte or word is transferred. Contrast with Direct Memory Access (DMA) transfer.

protocol violation ----------A signal error at the physical layer (fiber or coax) resulting from noise on the transmission lines or a result of hardware failure. This violation can be any one of the following:

- Missing transition for two clock periods on either line
- Parity error
- Framing error

read cycle ----------A DTB cycle used to transfer 1-, 2-, 3-, or 4-bytes from a slave to a master. The cycle begins when the master broadcasts an address and an address modifier. Each slave captures this address and address modifier, and checks to see if it is to respond to the cycle. If so, it retrieves the data from its internal storage, places it on the data bus, and acknowledges the transfer. Then the master terminates the cycle.

read-modify-write cycle---------A DTB cycle that is used to both read from, and write to, a slave's byte location(s) without permitting any other master to access that location during that cycle. This cycle is most useful in multi-processing systems where certain memory locations are used to control access to certain systems resources, for example, semaphore locations.

requester ----------A functional module that resides on the same board as a master or interrupt handler and requests use of the CTB whenever its master or interrupt handler needs it.

retry ----------A hardware failure condition reported when the first attempt to send a message around the network has resulted in some type of bit error. The originating node will retransmit the message indefinitely until the originating node receives it correctly. Valid only in error correction mode (PLATINUM.)

retry time-out----------A hardware failure condition reported when the first attempt to send a message around the network is not received by the originating node within the time out period specified in CSR5. The originating node will retransmit the message indefinitely until the originating node receives it correctly. Valid only in error correction mode (PLATINUM.)

rising edge ----------The time during which a signal makes its transition from low to high.

Rx ----------Abbreviation for receive or receiver.

SCSI----------Refers to the American National Standard for Information Systems Small Computer System Interface - 1 (X3.131-1986) or the ANSI Small Computer System Interface - 2 (X3.131-1989). This standard defines mechanical, electrical and functional requirements for attaching small computers to each other and to intelligent peripheral devices.

shadow memory----------See Auxiliary Control RAM (ACR)

shared memory (SM) ----------SCRAMNet memory physically located on the network board. This dual-ported memory is accessible by the host and the network. A host WRITE to shared memory results in a transmitted WRITE to all SCRAMNet nodes at the same relative location.

shortword----------16 bits. Also referred to as halfword.

signal mnemonics----------Terms used to identify signal line events. (1) An asterisk following the name of signals that are level-significant denotes the signal is true/valid when the signal is low. (2) A asterisk following the name of signals that are edge-significant denotes the actions initiated by that signal occur on the falling edge.

slave ----------A functional module that detects DTB cycles initiated by a master and, when those cycles specify its participation, transfers data between itself and the master.

slot ----------A position where a board can be inserted into a backplane. If the system has both a J1 and a J2 backplane (or a combination J1/J2 backplane) each slot provides a pair of 96-pin connectors. If the system has only a J1 backplane, then each slot provides a single 96-pin connector. Also, another name for message packet.

system clock driver----------A functional module that provides a 16 MHz timing signal on the utility bus.

time-out ----------Also network time-out. The time written to CSR5 that must elapse before a native message will be retransmitted. The time-out must be a non-zero value.

Tx ----------Abbreviation for transmit or transmitter.

UAT ----------A master that sends or receives data in an unaligned fashion.

utility bus ----------One of the four buses provided by the backplane. This bus includes signals that provide periodic timing and coordinate the power-up and power-down of sequence of the system.

write cycle ----------A DTB cycle used to transfer 1-, 2-, 3-, or 4-bytes from a master to a slave. The cycle begins when the master broadcasts an address and address modifier and places data on the DTB. Each slave captures this address and address modifier, and checks to see if it is to respond to the cycle. If so, it stores the data and then acknowledges the transfer. The master then terminates the cycle.

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