SCRAMNet® Network

QUAD SWITCH
User Manual

Document No. C-T-MU-QUADSW##-A-0-A8

FOREWORD

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FCC

This product is intended for use in industrial, laboratory or military environments. This product uses and emits electromagnetic radiation which may interfere with other radio and communication devices. The user may be in violation of FCC regulations if this device is used in other than the intended market environments.

CE

Please note: As a component part of another system, this product has no intrinsic function and is therefore not subject to the European Union CE EMC directive 89/336/EEC.

TABLE OF CONTENTS

APPENDICES

FIGURES

TABLES

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HOW TO USE THIS MANUAL

0.1 Scope

This document is a user manual for the **SCRAMNet** Quad Switch.

This document provides a physical and operational description of the **SCRAMNet** Quad Switch Network switching Center.

This information is intended for systems designers, engineers and network installation personnel.

The reader should have at least a systems-level understanding of general computer processing, memory and hardware operation.

0.2 Organization

This document is divided into three sections: Introduction, Installation and Operation.

1.0 Introduction:.....A description of the product.
2.0 Installation:.....Procedures for configuring and installing the Quad Switch.
3.0 Operation:.....A discussion of how the Quad Switch works.

0.3 Appendices

A - Configuration Aids

B - Specifications

C - Glossary

0.4 Related Documentation

EIA Standard for EIA-485. To obtain a copy, write to:

ELECTRONICS INDUSTRIES ASSOCIATION
Engineering Department
1722 Eye Street NW
Washington, DC 20006

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1.0 INTRODUCTION

1.1 The SCRAMNet Network

The **SCRAMNet** Network is a real-time communications network, based on a replicated, shared memory concept. Each computer on the network has access to its own local copy of the **SCRAMNet** shared memory which is updated over a high-speed, serial-ring network. It is optimized for the high-speed transfer of data among multiple, real-time computers attached to the network. These computers, with their **SCRAMNet** adapter boards, are called network nodes. Each computer, or node, is solving a portion of the same real-time problem.

As a network grows, the management of the network also increases. The Quad Switch provides a fast, efficient means of switching nodes and sub-rings in and out of the primary ring.

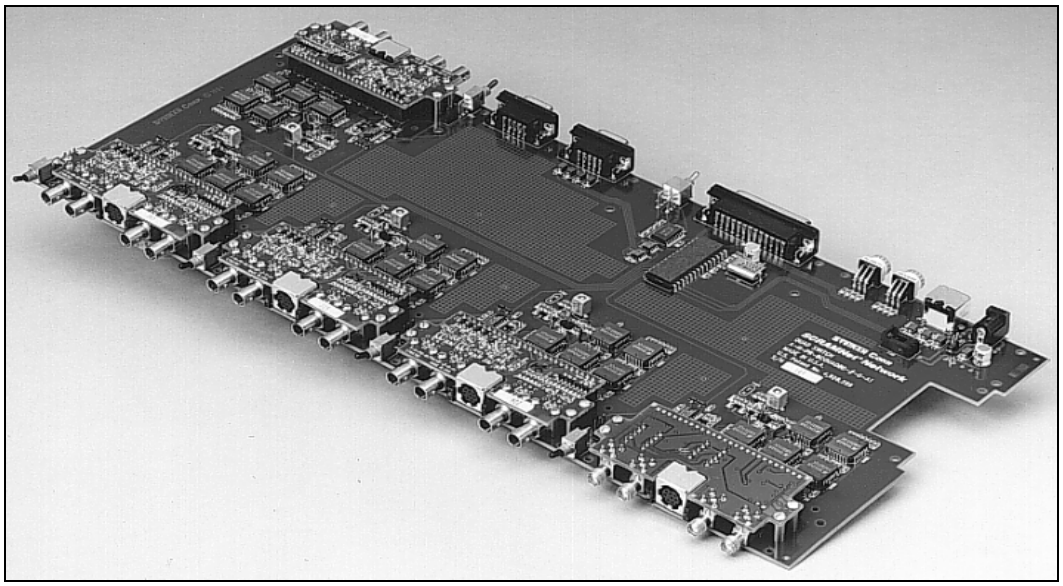

Figure 1-1 Quad Switch

1.2 What is the Quad Switch?

The Quad Switch is primarily an electronic switching center for the various components of **SCRAMNet, SCRAMNet-LX**, and **SCRAMNet+** Network installation.

As seen in Figure 1-1, the Quad Switch provides dynamic configuration of up to five fiber-optic or coaxial connections, called ports. The data source connected to each port can be switched in or switched out of the network ring. The Quad Switch extends the functions of the **SCRAMNet** passive optical bypass switch, fiber-optic repeater and long-link converter.

1.3 How Does it Work?

The Quad Switch has a single logical internal ring and 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 (See Figure 1-2).

Each Quad Switch port may be connected to a node, a ring, or another Quad Switch.

Each port consists of a Media Card, a Manual Switch, Carrier Detect function, an Auxiliary Connector, and two LED indicators. The Quad Switch itself has a Serial Interface for RS-232 or RS-422/485.

1.3.1 Media Card

Each port uses a Media Card with fiber-optic or coaxial transmitters and receivers. A Media Card can be coax for links up to 30 meters, standard fiber-optic for links up to 300 meters, and long-link fiber-optic links up to 3,500 meters. Each port may be configured with any of these Media Cards.

1.3.2 Manual Switch

The Manual Switch can be in either the INCLUDE ENABLE or ISOLATE position. In the INCLUDE ENABLE position it makes it possible, if all the other control inputs affecting that port are enabled, for the port to be in the INCLUDE state. In the ISOLATE position, it guarantees the port will be in the ISOLATE state.

1.3.3 Carrier Detect (CD)

Carrier is an electronic signal transmitted by a node. If no carrier is detected by the Media Card receiver, the port is automatically put in the ISOLATE state. If a carrier is detected and all the other control inputs affecting that port are enabled, the port will be in the INCLUDE state. There is an “IGNORE CD” jumper option to permit connection of a port to another Quad Switch. See paragraphs 2.5.2 and 3.4 for more details.

1.3.4 Auxiliary Connection

If a **SCRAMNet** node is connected to the port and is using the Auxiliary Connection, the port can detect the power state of the node. If it detects power, and all the other control inputs affecting that port are enabled, the port switches to the INCLUDE state. This permits the node to transmit and receive network data via the internal ring.

A **SCRAMNet** node may be physically attached to a port so that its state affects the port switching function. The **SCRAMNet** node can disable the Auxiliary Connection control input and force the port into the ISOLATE state. If the node is connected but it is not powered up or is in loopback mode, the port will be isolated from the internal ring and cannot transmit or receive network data via the internal ring.

If there is no **SCRAMNet** node connected to the Auxiliary Connector, the port assumes the node is present and the Auxiliary Connection control input defaults to an enabled condition. The other control inputs must also be enabled before the node can attain an INCLUDE status.

1.3.5 LED Indicators

Each port has two associated status LED indicators for INCLUDE and CARRIER DETECT (CD). The CD indicator is on whenever the port detects and locks onto a valid

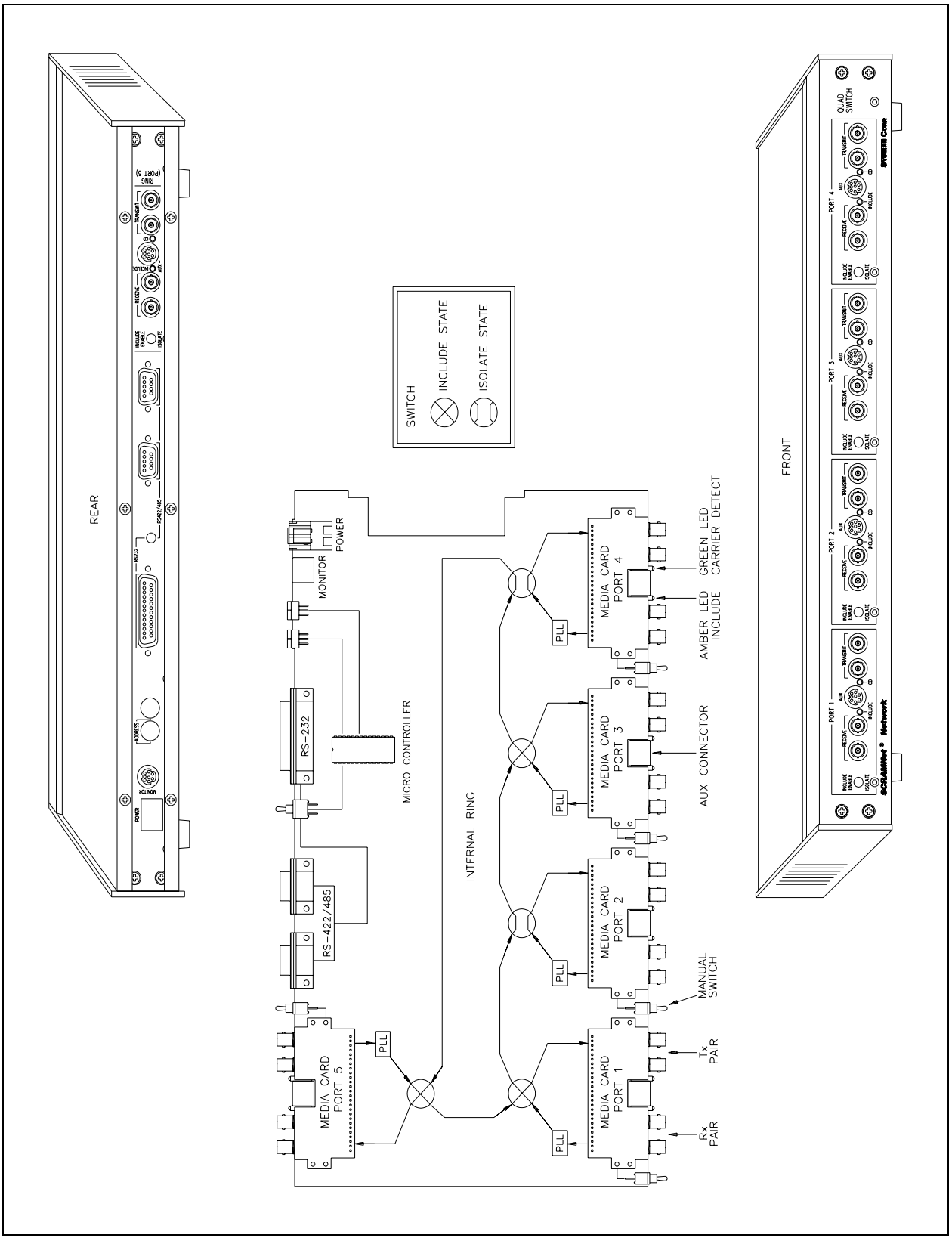

Figure 1-2 Quad Switch Layout

carrier signal on the receive link. The INCLUDE LED is on whenever the port is included in the Quad Switch internal ring.

1.3.6 Serial Interface

The Quad Switch can be controlled through the installed serial port. A toggle switch is used to select either RS-232 or RS-422/485. The RS-485 is the multi-drop version of RS-422. Up to 256 Quad Switches can be controlled over a single RS-485 serial link.

There are two mechanical rotary switches for setting the Serial Interface address located at the rear of the Quad Switch cabinet.

A micro-controller in the Quad Switch communicates with the serial interface. A host computer can place a port in the ISOLATE state by sending the Quad Switch a message packet with instructions to ISOLATE the port. If no host is connected to the Serial Interface, the Serial Interface control input is enabled for all ports. If all the other controls affecting that port are enabled, the port will switch into the INCLUDE state.

1.3.7 Port Communication States

Data received by each port is either included in the internal ring or isolated from the internal ring depending on the states of a port's four control input sources: Manual Switch, Carrier Detect(NOTE 1), Serial Interface, and Auxiliary Connection. If all four control input sources are enabled, the port will be in the INCLUDE state. If a port is in the INCLUDE state, it has access to the internal ring and any sub-ring or node attached to it. If a port is in the ISOLATE state (as a result of one or more control input sources being disabled) it is isolated from the internal ring.

If a sub-ring is attached to one of the ports, that sub-ring may be isolated from outside inputs as desired. If a node is attached to one of the ports, it may be isolated for loopback testing or to keep it out of the global ring.

Node addresses must be unique relative to the global ring before the sub-ring is included in the internal ring. If a duplicate node address exists, a message packet will be prematurely removed from the ring preventing downstream nodes from receiving the data.

INCLUDE STATE

If (1) the Manual Switch is in the INCLUDE ENABLE position, (2) a carrier is detected on the node receiver(NOTE 1), (3) the Serial Interface is enabled, and (4) the Auxiliary Connection is enabled; only then will the port be switched to the INCLUDE state and be included in the Quad Switch internal ring. If any one of these inputs is disabled, the port is in the ISOLATE state.

In the INCLUDE state, data received by the port receiver pair will be resynchronized and retransmitted to the internal ring. The signal is enhanced because the Quad Switch ports also function as repeaters. In the INCLUDE state, data received from the internal ring is sent out the transmitter of this port. Note in Figure 1-2 that ports 1, 3 and 5 are in the INCLUDE state.

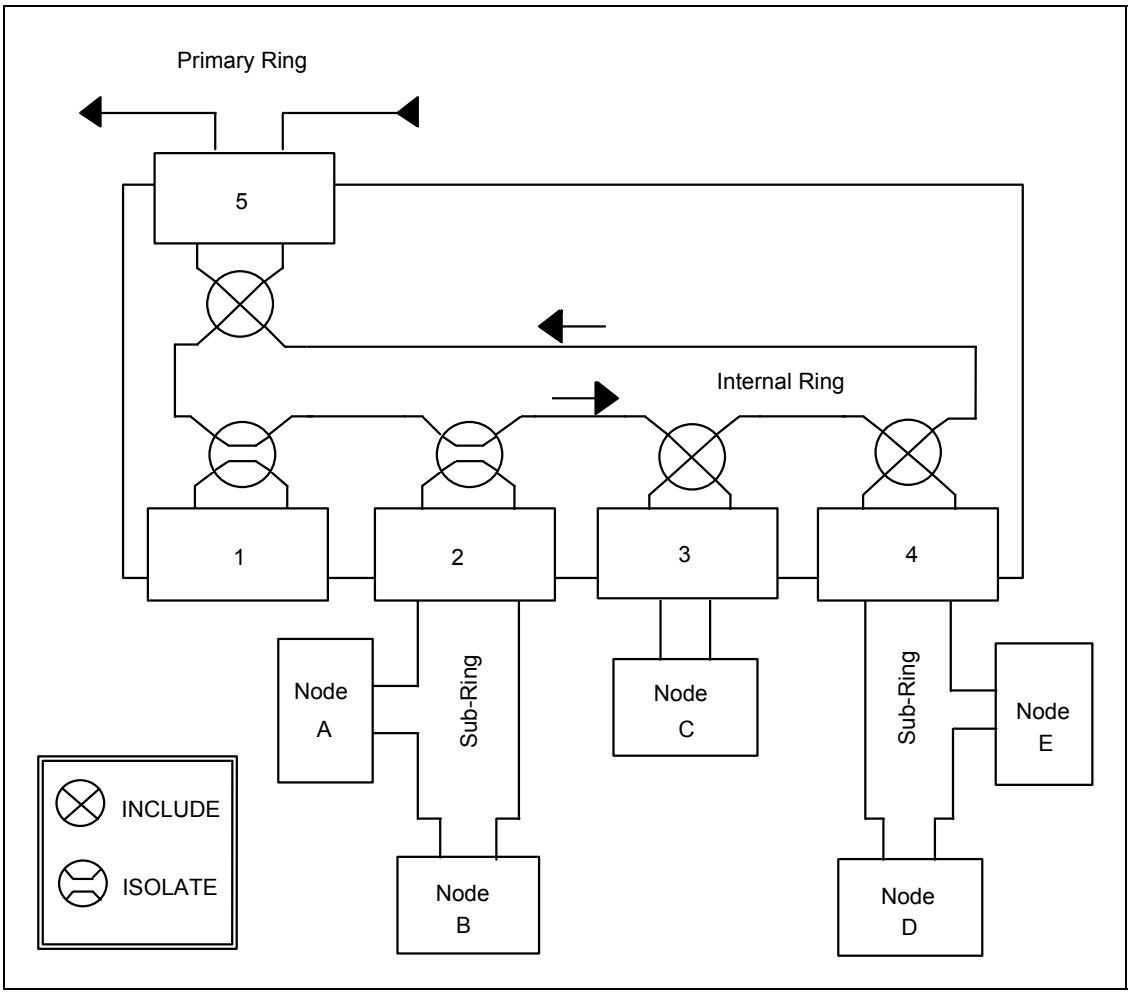

Figure 1-3 Quad Switch States

ISOLATE STATE

If the port is not in the INCLUDE state, it is in the ISOLATE state. When the port is in the ISOLATE state it is isolated from the internal ring. The data signal received by the port is re-synchronized and immediately reflected back out the transmitter of this port. The data is not written to the internal ring. Any data on the internal ring is passed on to the next port. Note in Figure 1-3 that ports 1 and 2 are in the ISOLATE state and ports 3, 4 and 5 are in the INCLUDE state.

1.3.8 Port Configuration

Typically, port 5 is defined as the "main" port and ports 1 through 4 as sub-ports. This allows four small rings to become part of a large ring. This can be configured dynamically. Each of the five ports operate as peers, therefore any port could be the main ring port. The data flow on the internal ring is counter-clockwise.

The ports are numbered from left to right. Ports 1 through 4 are on the front, and port 5 is at the rear of the switch cabinet. Each port has a two position toggle switch and 5 external connection points. Four of the connection points are for the Tx and Rx fiber optic or coax cable pairs. The fifth connection point is an Auxiliary Connector to permit a network node to effect control over the port communication state.

Each port has a jumper connection used to select “USE CD” or “IGNORE CD” depending on how the port will be used. If the port is to be connected to another Quad Switch, the “IGNORE CD” option must be set(NOTE 1).

1.3.9 Data Flow

Examine the data flow shown in Figure 1-3. Ports 1 and 2 are in ISOLATE state and are therefore bypassed. Data entering the Quad Switch port 5 travel the internal ring to port 3 where the data is received by Node C. The data is retransmitted and is passed to the sub-ring on port 4. Node D and E receive and retransmit the data. The data returns to the internal ring and exits port 5 to the primary ring.

NOTE 1: If the port is connected to another Quad Switch, Carrier Detect must be ignored by setting jumper JX05 (X = Port number) to IGNORE CD.

2.0 INSTALLATION

2.1 Table Model

The Quad Switch table model may be placed on any flat surface or table top. The Quad Switch is 16.88" wide, 1.68" high and 7.58" deep, including fiber-optic or coaxial connectors.

2.2 Rack Model

The Quad Switch may be mounted in a 19" rack. Specially designed rails are employed that allow the unit to be mounted flush or recessed 3". This 3" recess allows space for fiber-optic or coax connectors when a door is used on the cabinet. Figure 2-2 shows the rack model in comparison to the table model.

2.3 Fiber Optic Connections

Node, sub-ring and primary-ring fiber-optic cables are connected to the receive and transmit pair connectors of the Media Card at the desired port.

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

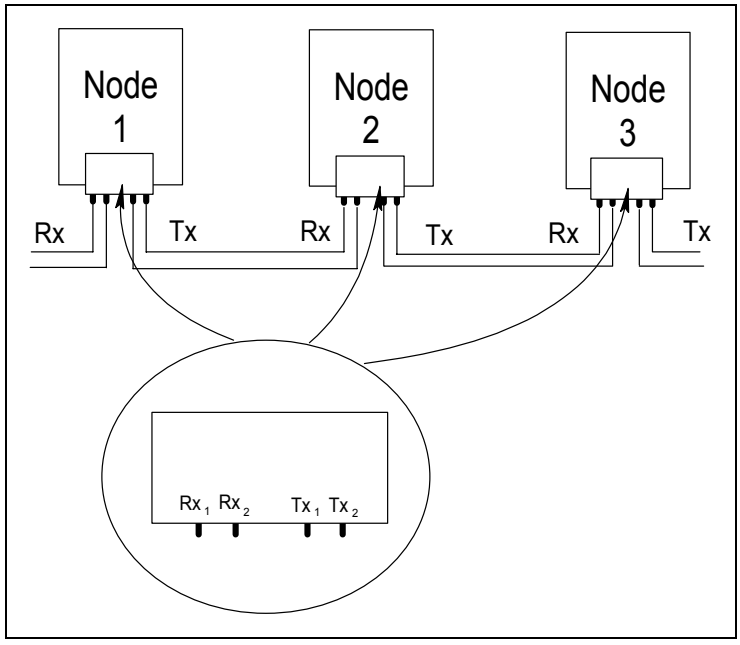

Figure 2-1 Fiber Optic Connections

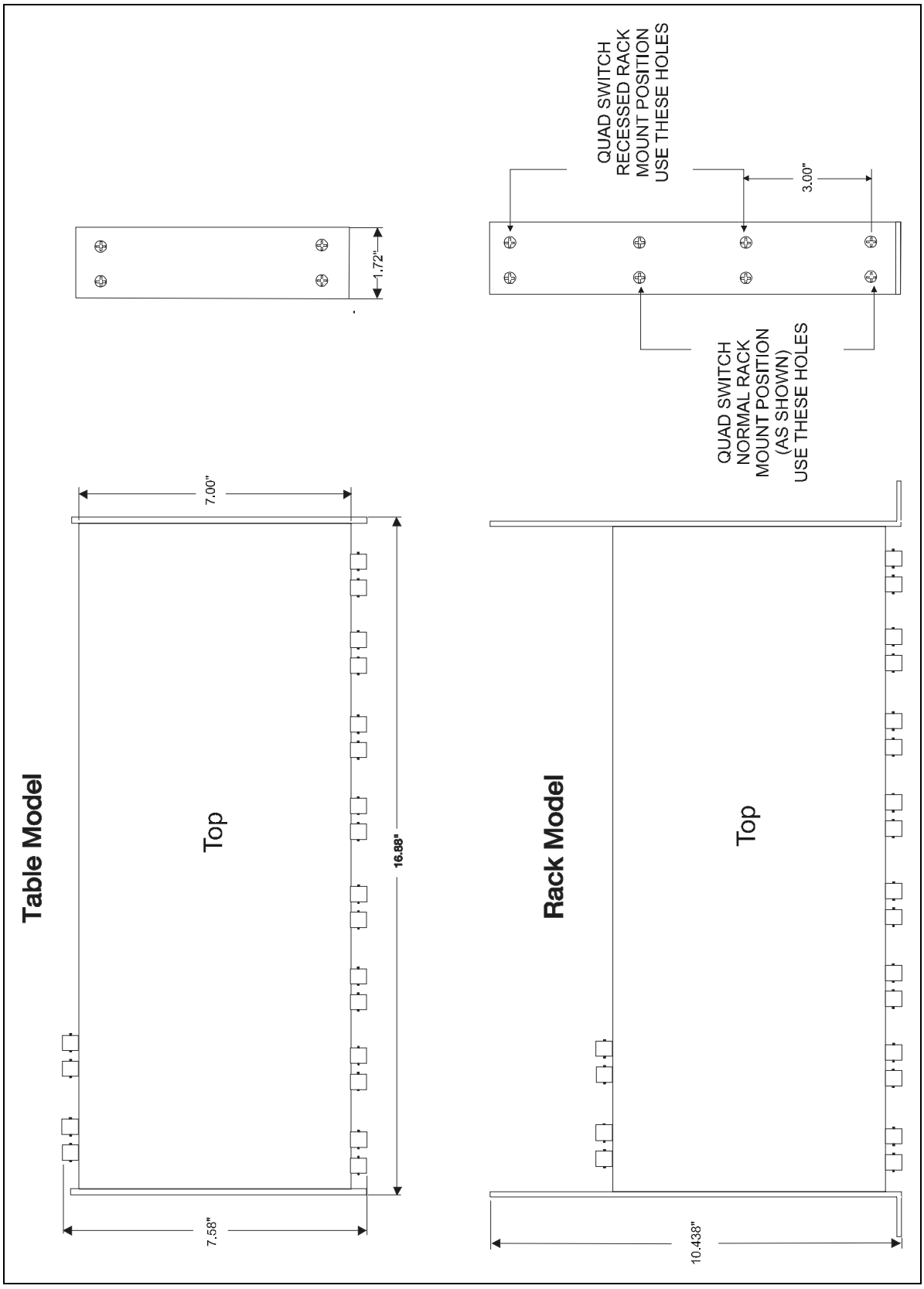

Figure 2-2 Quad Switch Models

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 Media Card 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 the cable ends.

2.4 Auxiliary Connection

A **SCRAMNet** node may be connected to the port via the Auxiliary Connection. The node exercises control over the port communication state by setting Control/Status Register CSR1[15] ON or OFF. A software program will be required to access the node control/status registers. If the **SCRAMNet** node is not connected, the Quad Switch Auxiliary Connector control input defaults to "enabled".

2.5 Port Activation

Ports connected to a node or ring must have all control-input sources listed below enabled in order to switch the port into the Quad Switch internal ring:

- Manual Switch
- Carrier Detect (Factory set to "USE CD")
- Auxiliary Connection (defaults to enable if not connected)
- Serial Interface (defaults to enable if not connected)

2.5.1 Manual Switch

The two-position Manual Switch is used to either isolate the port from the internal ring (ISOLATE) or to enable the port to be included in the internal ring (INCLUDE ENABLE).

NOTE: Moving the Manual Switch to the INCLUDE ENABLE position will not automatically include the port in the internal ring. All the port-control inputs must be enabled to make that occur: Manual Switch, Carrier Detect, Auxiliary Connection, and the Serial Interface.

2.5.2 Carrier Detect

The port phase lock loop (PLL) circuit is used to detect proper signal reception. It detects a missing or failed transmitter and automatically isolates the port from the internal ring. If a suitable carrier is detected, the Carrier Detect control input is enabled and the Carrier Detect LED comes on.

If port number 'X' is to be connected to another Quad Switch, set jumper JX05 to "IGNORE CD". Port number 'X' may be 1 through 5. (See Figure 2-3).

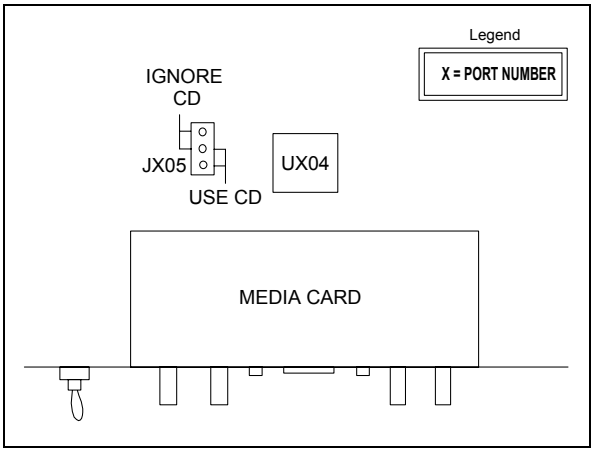

Figure 2-3 Carrier Detect Jumper Connection

2.5.3 Multiple Quad Switch Configuration

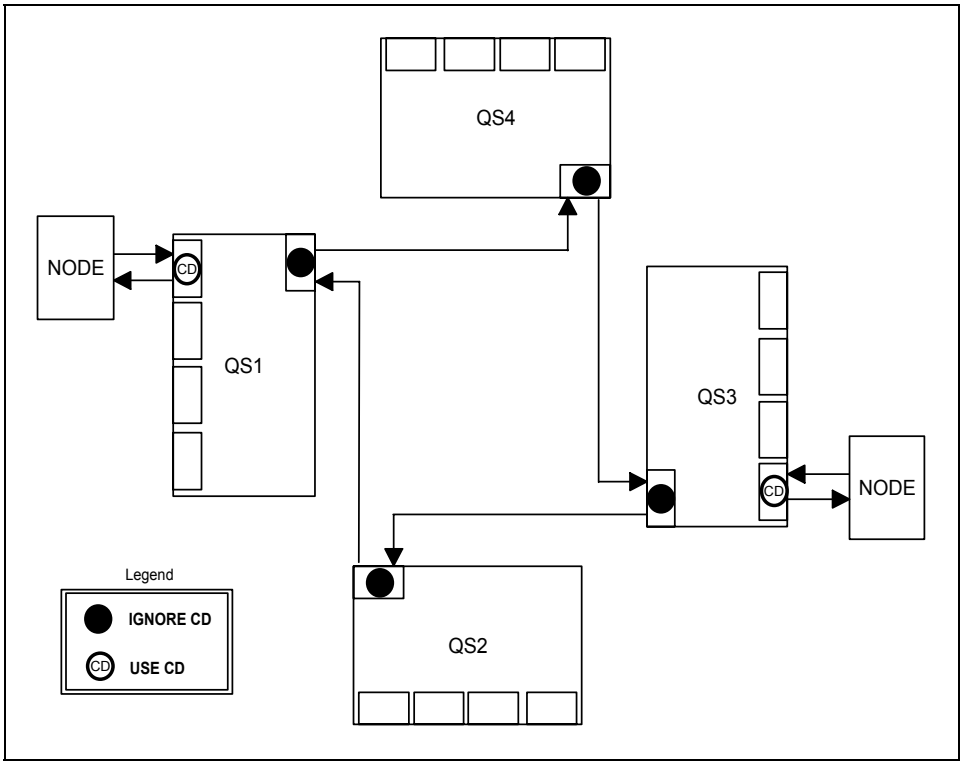

Figure 2-4 Multiple Quad Switch Connections

If Quad Switches are to be connected between ports as described in Figure 2-4, ensure the Carrier Detect jumper connection is set for "IGNORE CD" for those ports.

NOTE: Ensure there is at least one inserted node for every two Quad Switches to remove phase jitter. The extremely low bit error rate of the **SCRAMNet** Network (10^{-21}) will begin to increase if there are more than two consecutive Quad Switch units (ten ports) between on-line **SCRAMNet** nodes.

2.5.4 Serial Interface

A host computer may be connected to the RS-232 or RS-422/485 serial interface port. Additionally, Quad Switches may be daisy-chained off the RS-422/485 serial port. Move the toggle switch to the RS-232 or the RS-422/485 position, as appropriate.

HOST COMPUTER SERIAL INTERFACE

A host computer will require a software program to communicate with the Quad Switch. Section 3, paragraph 3.6 contains information for this type of operation.

DAISY-CHAIN QUAD SWITCHES

Up to 32 Quad Switches may be connected via the RS-422/485 Serial Interface if the total length, including all drops, is less than 100 feet. Up to 256 Quad Switches may be daisy-chained using repeaters*. Set unique addresses into the mechanical address switches for each Quad Switch.

* For more information on daisy-chaining off the EIA RS-422/485 Serial Interface, refer to the *EIA 485 Standard*.

2.6 Troubleshooting

2.6.1 Carrier Detect

Problem:	Carrier Detect LED will not come on.
Solution:	Check the node/sub-ring connection to the port receiver pair. If the connection appears good, then trace the cable back to the node connected to the port. This node should be generating the carrier received by this port. Carrier transmission is only assured after this node has transmitted one message. Also, each node receives carrier from the previous node. In the Quad Switch, each port receives carrier from the previous port.
Problem:	Random blinking of the CD LED in a port connected to other Quad Switches. (See Figure 2-4).
Solution:	This is normal. As soon as one port is INCLUDED and can transmit data around the entire ring INCLUDING other Quad Switches, this will go away.

2.6.2 Port Isolation

Under any configuration, removal of the network cables from the port receiver connections will cause a loss of carrier to that port. This should force the port into the ISOLATE state. If this does not happen, the Quad Switch needs to be serviced.

Problem:	Port will not Isolate from internal Ring.

Solution: Check the amber LED on the port. If it is on, the port is connected to the Internal Ring. Place the port two-position manual switch in the ISOLATE position. If the amber LED is still on, the Quad Switch needs to be serviced.
If the port cannot be forced into ISOLATE state by the Serial Interface, please re-read the section on the Serial Interface Communication, page 3-4. This is only an issue if there is a Host attached to the Serial Interface attempting to isolate a port. If no Host system is attached to the Serial Interface, the Quad Switch assumes the Serial Interface control input is in an enabled condition.
If the Auxiliary Connection is being used to ISOLATE the port, check the software on the node connected to the Auxiliary Connector. If a node is not attached to the Auxiliary connector, the port Auxiliary Connection control input will default to INCLUDE ENABLE.

2.6.3 INCLUDE State

Problem: Port will not include itself in the Quad Switch internal ring.
Solution: For the port to include itself in the internal ring, four conditions must be true:

- **The port Rx pair must have a carrier. Check the green LED on the port. If it is not on, there is no carrier at the port Rx pair. If this is the case, check the transmitter at the other end of the cable from the port Rx pair. This node is not producing carrier.**
- **The port Manual Switch must be in the INCLUDE ENABLE position.**
- **The port Auxiliary Connector control input must be enabled by the attached node. If no node is attached, it will default to an enabled condition.**
- **The Serial Interface control input will default all ports to an enabled condition. If there is nothing attached to the Serial Interface, it will stay in this mode. If a Host is attached, then some ports may have been forced into the ISOLATE state.**

  To ensure all port Serial Interface control inputs are enabled, remove any serial communication lines from the serial interface, then turn the Quad Switch off and back on. When it powers up, the Serial Interface control input for all ports will be enabled. They will remain constant as long as the Serial Interface is not in use.

3.0 OPERATION

3.1 Electronic Switching

A port can be added or removed in less than one microsecond. This is over 10,000 times faster than mechanical optical bypass switches. This means that no more than two network message packets will be affected during the switching action.

The Quad Switch is designed so that a port will be switched into the ring if all the switching controls are enabled. The Manual Switch, Carrier Detect*, Auxiliary Connector, and Serial Interface must all agree that the port should be connected with the ring before it can switch to the INCLUDE state. Any one of the switching controls can cause the port to be switched into the ISOLATE state.

Two things always occur regardless of how the information is routed:

- Re-transmission—The port Carrier Detect Phase Lock Loop (PLL) will acquire the signal and the signal will be re-synchronized before being re-transmitted. This means the port could be viewed as a directional repeater.
- Transparency—The network packet is not changed in any way, and there is negligible delay for reception and transmission.

3.2 Operational States

Operationally, the switch can be viewed as five ports. Each of these ports share a single logical internal ring on the Quad Switch. There are only two states any port can be in: INCLUDE or ISOLATE. Different ports can be in different states.

INCLUDE

If a port is in the INCLUDE state, an attached node or sub-ring is inserted into the Quad Switch internal ring. To be in the INCLUDE state means that:

- A valid carrier is detected on the port receive pair*
- The Manual Switch is in the INCLUDE ENABLE position
- If a host is connected to the Serial Interface, the Serial Interface control input is enabled, and
- If the node is physically connected to the port via the Auxiliary Connection, that control input is enabled.

* If the port is connected to another Quad Switch, Carrier Detect must be ignored by setting jumper JX05 (X = Port number) to IGNORE CD.

EXAMPLE:

Assume ports 1 through 4 have small local rings connected to them. If ports 1 and 3 were in the INCLUDE state, they would be considered as one combined ring. If ports 1 through 4 were in the INCLUDE state, they would be considered as a single, larger ring. Port 5 typically connects the primary ring to the Quad Switch internal ring, and therefore to the local rings of ports 1 through 4. However, port 5 operates exactly the same as ports

1 through 4. The only difference is the physical location at the back of the Quad Switch cabinet.

ISOLATE

In the ISOLATE state, the port is switched out of the Quad Switch internal ring. Any data received by the port is transmitted back to its source and is not inserted into the internal ring. Disabling any one of the port control inputs can put the port in the ISOLATE state.

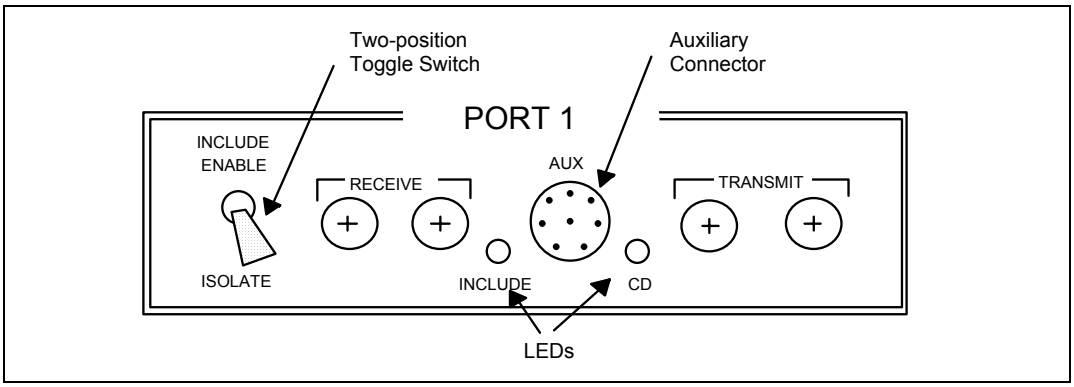

Figure 3-1 Quad Switch Port

3.3 Manual Switch Control

Each Quad Switch port has a two-position toggle switch as shown in Figure 3-1 at the left. In the INCLUDE ENABLE position the port is eligible to be included in the internal ring. In the ISOLATE position the port is isolated from the internal Quad Switch ring.

EXAMPLE

A node is attached to port 1. Tx_1 and Tx_2 from the node are connected to Rx_1 and Rx_2 of the port. There is no node-control cable attached to the Auxiliary Connection for that port, and there is no host connected to the Quad Switch Serial Interface. If the Manual Switch for port 1 is moved to the INCLUDE ENABLE position, and a valid carrier is detected by the port's PLL, the CARRIER DETECT LED and the INCLUDE LED will come on and data received from the attached node will be inserted into the internal ring.

If the Manual Switch is moved to the ISOLATE position, the INCLUDE LED will go off and data received from the attached node will be re-transmitted back to that node.

3.4 Carrier Detect

If the port does not detect a carrier, the CARRIER DETECT LED, shown in Figure 3-1 as "CD", will not come on, the port will automatically switch to the ISOLATE state, and the node will no longer have access to the Quad Switch internal ring.

NOTE: It may be necessary to send the first message on the ring before the Quad Switch "comes on."

If a valid carrier is detected, the CARRIER DETECT LED will come on and the control input will be enabled (See paragraph 3.2 for INCLUDE criteria).

CAUTION: A port set to "IGNORE CD" must be connected to a node or another Quad Switch. If there is no connection, the port can still be included in the internal ring. In this case, data on the internal ring will be lost when it attempts to transmit through the "open" port.

3.5 Auxiliary Connection

The Auxiliary Connection is labeled "AUX" in Figure 3-1. A **SCRAMNet** node can have software control over its Quad Switch port's communication state through a node

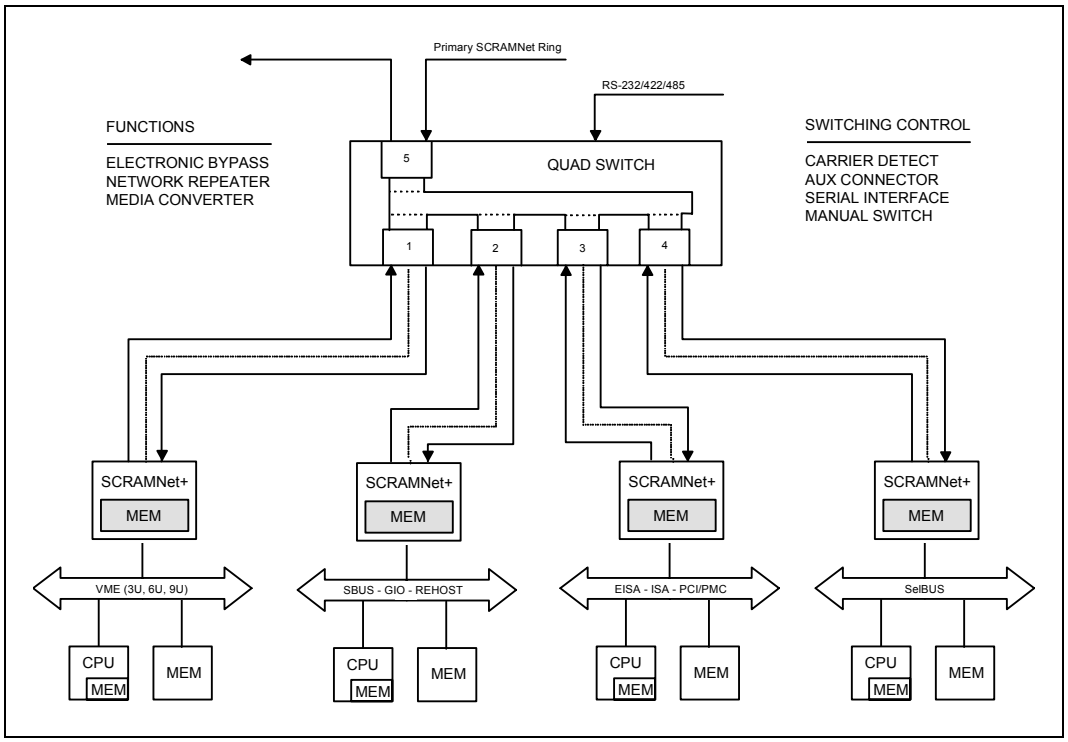

Figure 3-2 Quad Switch Connections

control cable attached to the port Auxiliary Connection. The Auxiliary Connection is represented by the dashed lines in Figure 3-2. The switch can detect the power state of the node, and the node can detect the presence of the switch via pin #3.

The **SCRAMNet** Control/Status Register (CSR) 1, bit 15 is used to communicate with the Quad Switch. If that bit is OFF, the signal sent to the Quad Switch is low and the Auxiliary Connection control input is disabled. This results in the port being forced into the ISOLATE state. If CSR1, bit 15 is set ON, the signal sent to the Quad Switch is high and the control input is enabled. If and when all other control inputs for that port are enabled, the port will then be placed in the INCLUDE state.

If the node-control cable is not connected to the port Auxiliary Connection, the switch Auxiliary Connection control input defaults to the "enabled" condition. In this way, a switch can continue to operate without the node-control cable. However, without the cable, the node does not have software control over the switch.

3.6 Serial Interface Communication

The Quad Switch can be controlled by a host computer via the RS-232 or RS-422/485 Serial Interface. RS-485 is a multi-drop version of RS-422. The option for RS-232 and RS-422/485 is switch selectable as shown in Figure 3-3 The RS-485 connection permits Quad Switches to be daisy-chained.

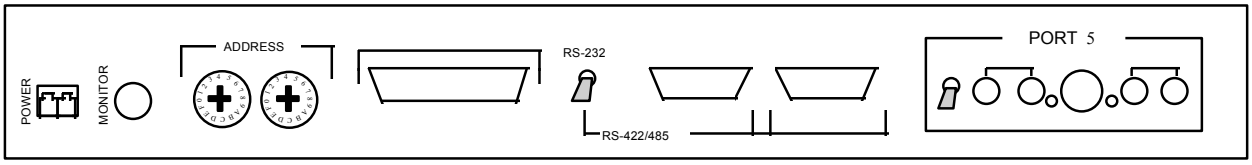

Figure 3-3 Serial Interface Communication

Up to 32 Quad Switches can be controlled over the RS-485 serial link without using a repeater if the total length, including all drops, does not exceed 100 feet. Up to 256 Quad Switches can be controlled using repeaters.

A micro-controller in the Quad Switch reports status, and performs the switching actions commanded over the Serial Interface.

3.6.1 Quad Switch Addresses

The address for serial interface communications is set using two hexadecimal rotary switches. These switches are on the rear plate as shown in Figure 3-3 This permits communication to a specific Quad Switch in a multi-drop configuration. The two switches permit addressing up to 256 Quad Switches. The example in Table 3-1 shows the address for a Quad Switch set to C3 *hex*.

Table 3-1 Serial Interface Addressing

Switch	Left				Right			
BITS	7	6	5	4	3	2	1	0
BINARY	1	1	0	0	0	0	1	1
HEX	C				3			

3.6.2 Micro-Controller

The micro-controller communicates with the host via the standard RS-232/422/485 serial interface. A three-byte message packet is transmitted to the switch to determine how the switch will be configured by the micro-controller and to request status information. By sending CONTROL packets, the switch can then be dynamically reconfigured from a remote location.

The micro-controller reports the status and performs switching functions as directed by the host.

Figure 3-4 shows how the micro-controller initializes the ports and the status variables.

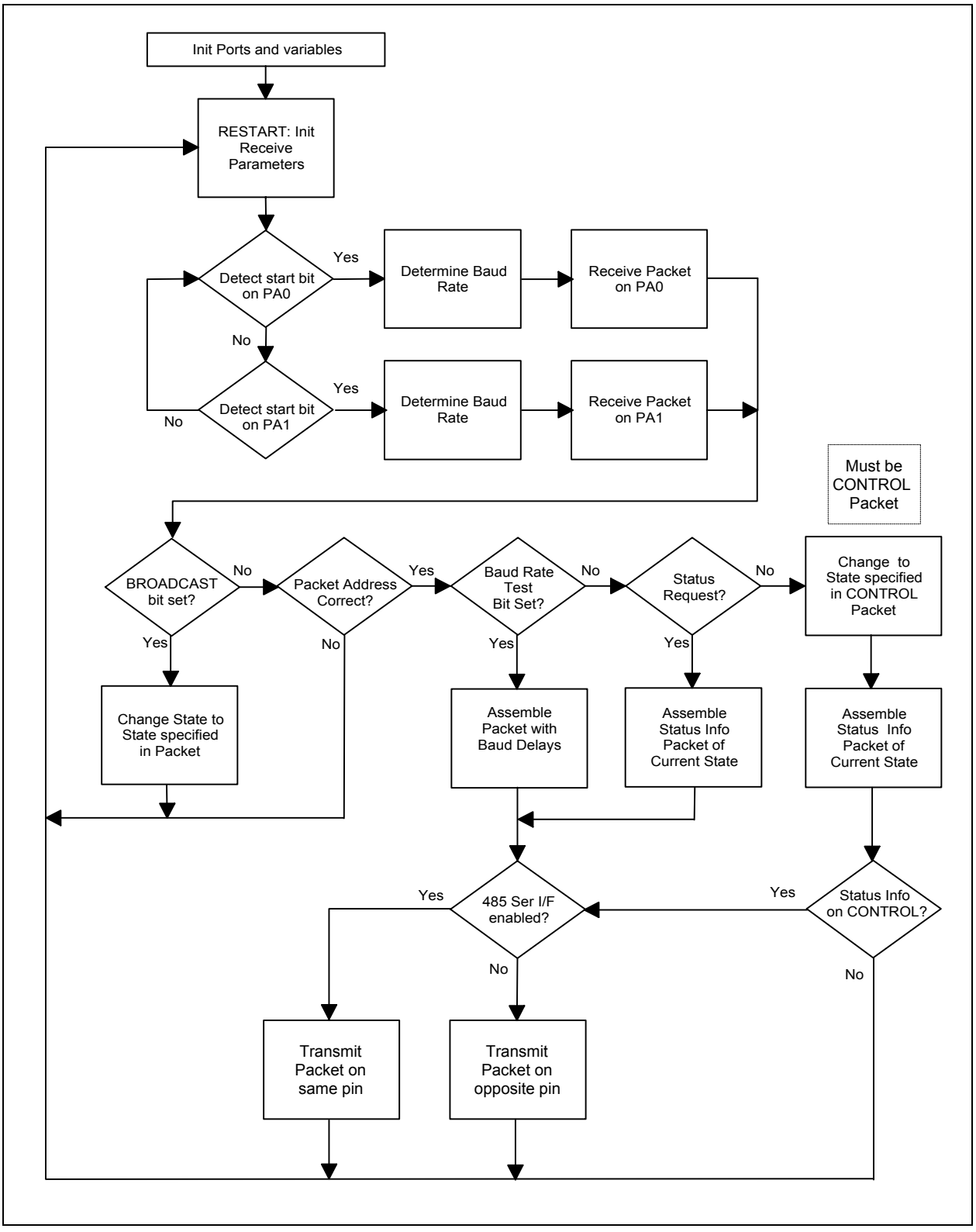

Figure 3-4 Serial Interface Packet Reception and Transmission

RESTART: INITIALIZE RECEIVE PARAMETERS

Detect Start Bit. The RS-232 (2-wire) line to the Micro-Controller is kept in a high state. The Micro-Controller looks for the signal on each input line (PA0 and PA1) to go low which means a message packet has been received.

The message packet can be any of the following:

- Broadcast - sends initialization states and communication mode.
- Baud Rate Test
- Status Request (READ) - requests current state.
- Control Packet (WRITE) - sends control states and communication mode.

Broadcast. Change state as specified.

Baud Rate Test. Factory use only.

Status Request. Assemble Status Info packet and transmit.

Control Packet. Change to state specified. Assemble Status Info Packet. Check for Status Info on Control, and transmit.

3.6.3 Packet Types

The Quad Switch may receive either of two packets: CONTROL or STATUS REQUEST. The Quad Switch responds with a STATUS INFO packet. These packets are defined in Table 3-2

Table 3-2 Packet Type Definition

Type	Definition
CONTROL/STATUS REQUEST	The CONTROL/STATUS REQUEST packet causes the Quad Switch to transmit the current status back to the HOST without affecting the state of any of the ports.
STATUS INFO	This packet is generated in response to a STATUS REQUEST packet. It can optionally be generated by a CONTROL packet if STATUS INFO ON CONTROL is set in BYTE 2.

Each packet consists of three bytes. Refer to Tables 3-3, 3-4, and 3-5 on pages 3-8 through 3-10 for detailed descriptions. The Host must transmit these three bytes to the Quad Switch rapidly. If there is more than 7 ms spacing between bytes in the packet, the switch will time out and reset the receiver. This also means that the Host can be assured the Quad Switch receiver is ready if 7 ms has elapsed since the end of the previous activity. This is only necessary if the Quad Switch has received an error such as a partial packet or an unsupported baud rate and is going to time out.

The bit descriptions in the CONTROL/STATUS REQUEST and the STATUS INFO packets presented in the flow chart on page 3-5 are in the order in which they are evaluated by the Quad Switch during reception.

STATUS INFO PACKET

The STATUS INFO packet is the only message generated by the Quad Switch. This message contains the ISOLATE/INCLUDE state for each port as described in Table 3-5.

NOTE: There is a firmware consideration which may affect STATUS INFO messages from the Quad Switch. There is no delay between the bytes in the three-byte packet that is returned. This may overrun older serial chips such as the 8250 because there is only a single byte Rx buffer. The host should use one of the lower baud rates if this happens. One alternative is to use a more advanced serial controller such as the 16550. This has a 16-byte Tx and a 16-byte Rx buffer. By using this chip, the switch can be operated at 19,200 bps by virtually any IBM compatible personal computer.

Table 3-3 Host to Switch Packets

CONTROL/STATUS REQUEST Packet - BYTE 1: HOST to SWITCH		
Bit	**Name**	**Definition**
7	COMMAND	STATUS REQUEST = 1, CONTROL= 0
6	LOCAL/BROADCAST	LOCAL = 1, BROADCAST = 0
5 - 1	SERIAL INTERFACE CONTROL INPUT PORT 5 - PORT 1	INCLUDE ENABLE = 1 ISOLATE = 0
0	AUTO BAUD BIT = 1	Must be a '1' for automatic baud rate detection to work. Will detect 19200, 9600, 4800 and 2400

CONTROL/STATUS REQUEST Packet - BYTE 2: HOST to SWITCH		
Bit	**Name**	**Definition**
7 - 6	Communications type and STATUS INFO (SI) packet generation	Bit 7 Bit 6 Ser I/F Definition 0 0 232/422 No SI on CONTROL 0 1 485 No SI on CONTROL 1 0 485 SI on CONTROL 1 1 232/422 SI on CONTROL
5	Baud Check = 0	Test Bit
4 - 0	Always zero	Reserved

CONTROL/STATUS REQUEST Packet - BYTE 3: HOST to SWITCH		
Bit	**Name**	**Definition**
7 - 0	SWITCH ID	Switch address used in local transmission

Table 3-4 Message Packet Bit Definitions

Byte/Bit	Applies To	Name	Definition
BYTE 1, bit 7:	C/SR & SI	COMMAND	Indicates whether the switch is receiving a CONTROL or a STATUS REQUEST packet.
BYTE 1, bit 6:	C/SR	LOCAL/ BROADCAST	If set, the address contained in BYTE 3 is ignored and the packet is treated as though the address were correct and the packet type were CONTROL. There is no STATUS INFO packet returned by the switch regardless of the COMMUNICATION TYPE bits.
BYTE 1, bits 5-1:	C/SR SI	SERIAL INTERFACE CONTROL INPUT	This works like the Manual Switch. A '1' enables the port Serial Interface Control Input "switch". A '0' disables the port Serial Interface Control Input and forces the port into ISOLATE state. These bits are ignored in a STATUS REQUEST packet. The STATUS INFO packet reflects the Serial Interface Control Input status. A '1' is INCLUDE ENABLE, A '0' indicates ISOLATE.
BYTE 1, bit 0:	C/SR & SI	AUTOBAUD	This must be set to a '1' in all packets for automatic baud rate detection. Baud rates supported include 19200, 9600, 4800 and 2400. The Quad Switch will transmit the STATUS INFO packet at the same baud rate as the CONTROL/ STATUS REQUEST received packet. This bit need only be set in the first byte of the packet.
BYTE 2, bits 7,6:	C/SR	COMMUNICATION TYPE and STATUS INFO Packet Generation	These two bits differentiate between • RS-232/422 and RS-485 • STATUS INFO ON CONTROL - only used when a CONTROL package is sent to determine if a STATUS INFO packet should automatically be transmitted by the Quad Switch Serial Interface. • NO STATUS INFO ON CONTROL. If a STATUS REQUEST is sent, a STATUS INFO packet will be returned regardless. These bits are only used when a STATUS INFO packet is going to be generated. They tell the micro-controller how to transmit the STATUS INFO packet.
BYTE 2, bit 5:	C/SR SI	BAUD RATE TEST BIT RESERVED	This bit is used for AUTOBAUD rate testing at the factory. When set, it returns the internal timing delays of the software synthesized serial interface. For use this bit must be a '0'. Not used.
BYTE 2, bits 4-0:	C/SR SI	RESERVED PORT STATUS	Set = '0' These bits are only valid in a STATUS INFO packet. A '1' indicates the port is in the INCLUDE state, a '0' indicates ISOLATE.
BYTE 3, bits 7-0:	C/SR & SI	ADDRESS	These are the Quad Switch address bits. All Quad Switches that receive a packet without the correct address in BYTE 3 will ignore the packet. The only exception occurs when the BROADCAST bit is set. In this case, see BYTE 1, bit 6 above.

Legend: C/SR - Control/Status Request Packet SI - Status Information Packet

Table 3-5 Switch to Host Packets

STATUS INFO Packet - BYTE 1: SWITCH to HOST		
Bit	**Name**	**Definition**
7	COMMAND	Unchanged, transmitted as is
6	1	Forced = 1 in firmware
5 - 1	SERIAL INTERFACE CONTROL INPUT PORT 5 - PORT 1	INCLUDE ENABLE = 1 ISOLATE = 0
0	AUTO BAUD BIT = 1	Must be a '1' for automatic baud rate detection to work. Will detect 19200, 9600, 4800 and 2400

STATUS INFO Packet - BYTE 2: SWITCH to HOST			
Bit	**Name**	**Definition**	
7 - 5	RESERVED	Not used	
4 - 0	PORT STATE PORT 5 - PORT 1	STATE	DESCRIPTION
		0	ISOLATE
		1	INCLUDE

STATUS INFO Packet - BYTE 3: SWITCH to HOST		
Bit	**Name**	**Definition**
7 - 0	SWITCH ID	Unchanged, transmitted as is

3.7 Status LED's

Each node connection has two status LED indicators for INCLUDE and CARRIER DETECT as described in Table 3-6.

The green CARRIER DETECT LED will come on whenever the Phase Lock Loop (PLL) detects and locks onto a valid carrier signal on its receive link.

The amber INCLUDE LED will come on whenever the node is actually included in the Quad Switch ring.

Table 3-6 LED Definitions

LED	Definition
CARRIER DETECT (CD)	Will come on whenever the PLL detects and locks onto a valid carrier signal on its receive link
INCLUDE	Will come on whenever the node is included in the internal ring of the Quad Switch

3.8 Sample Communication

This is an example of a communications sequence with a Quad Switch at address 0xC0.

Objective: (1) Check the status of all the ports
(2) Force all ports into the ISOLATE state.

1. A STATUS REQUEST packet (Figure 3-5, column 1) is sent to the Quad Switch by the host. A STATUS INFO message packet (Figure 3-5, column 2) is generated by the Quad Switch micro-controller in response to the CONTROL packet indicates the port status.

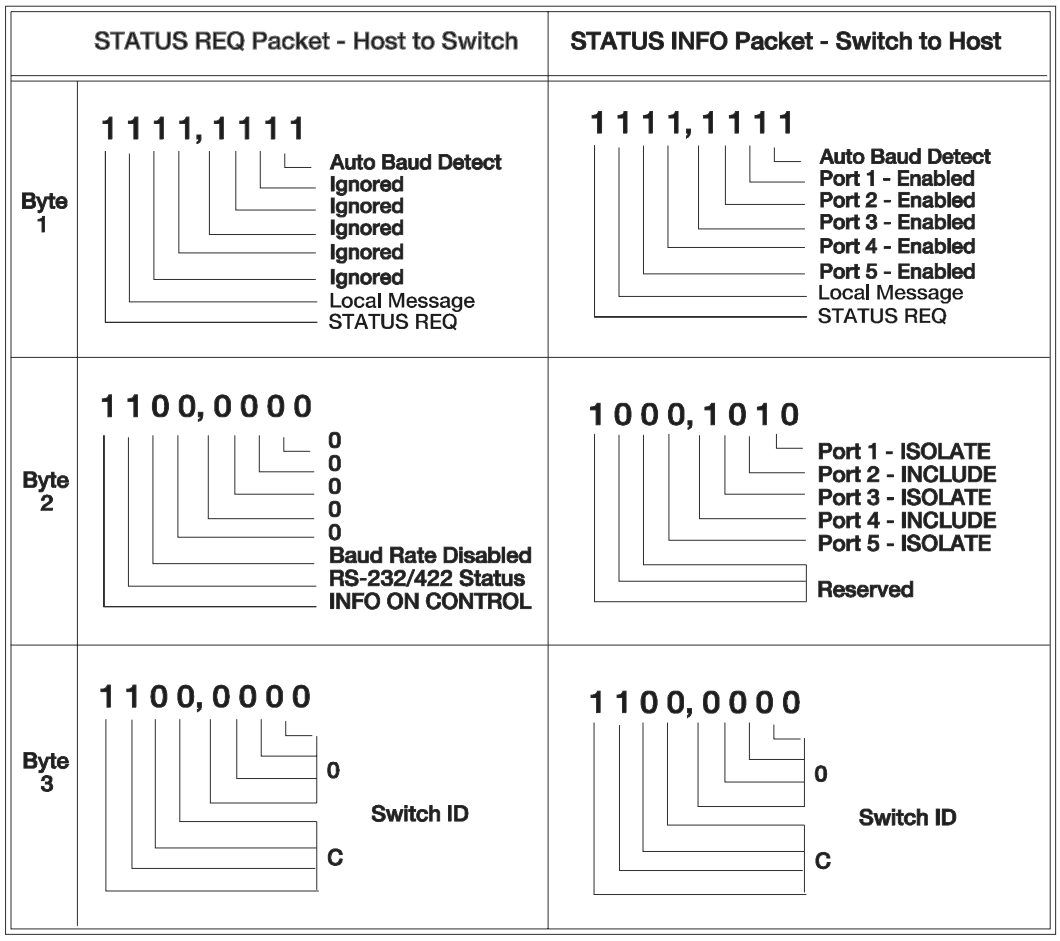

Figure 3-5 Status Request and Response

The STATUS INFO packet, byte 2, shows ports 1, 3, and 5 in ISOLATE state, and ports 2 and 4 in the INCLUDE state. Note that Byte 1, bits 5 - 1 all show “Enabled”. This means that the Serial Interface Control Input bit for each port is enabled.

2. A CONTROL packet (Figure 3-6, column 1) is sent to the Quad Switch by the host disabling the Serial Interface Control Input and forcing all ports into ISOLATE state. A STATUS INFO message packet (Figure 3-6, column 2) generated by the Quad Switch micro-controller in response to the CONTROL packet indicates the changes.

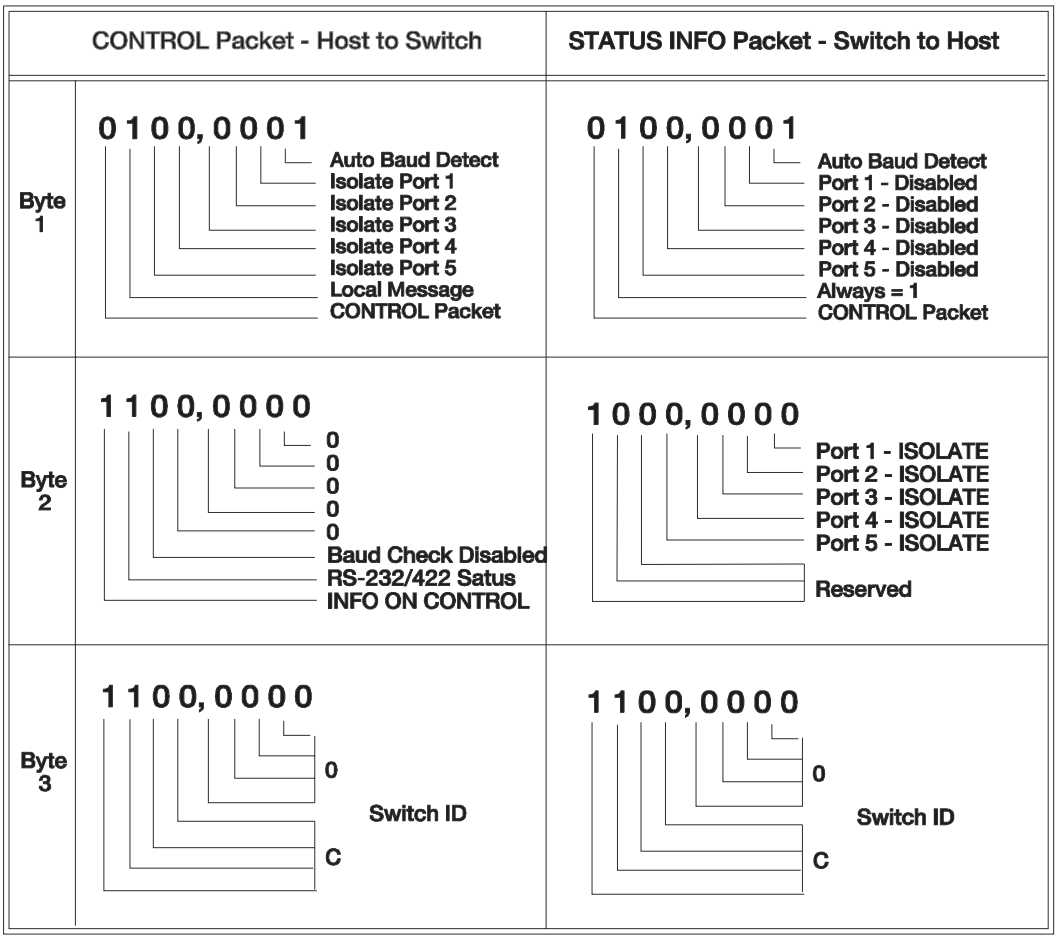

Figure 3-6 Control Packet and Response

The CONTROL packet, byte 1, dictates that all ports be placed in the ISOLATE state.

The STATUS INFO packet, byte 2, indicates the action completed. Note that Byte 1 reflects that the Serial Interface Control Input bit for each port has been disabled.

NOTE: Packet byte 1 stays the same except that bit 6 will always be a '1' in the STATUS INFO packet. Byte 3 does not change.

APPENDIX A
CONFIGURATION AIDS

QUAD SWITCH ID:		SERIAL INTERFACE HOST ID:		
PORT #	PORT #	PORT #	PORT #	PORT #
CONTROLLING NODE #	CONTROLLING NODE #	CONTROLLING NODE #	CONTROLLING NODE #	CONTROLLING NODE #
NODES ON PORT RING	NODES ON PORT RING	NODES ON PORT RING	NODES ON PORT RING	NODES ON PORT RING

APPENDIX B
SPECIFICATIONS

TABLE OF CONTENTS

FIGURES

TABLES

B.1 General Specifications

Hardware Compatibility:	**SCRAMNet Classic** node, **SCRAMNet-LX** node, **SCRAMNet+** node
Physical Dimensions:	
Cabinet:	1.68" x 16.88" x 7" (44.45 mm x 431.8 mm x 177.8 mm)
Rack:	Standard 1.75" high w/side rails:
flush	(16.88" x 7"), or 3" recess (16.88" x 7")
Cabinet w/Quad Switch	1.68" x 16.88" x 7.58"
Weight:	3.7625 lbs
Electrical Requirements:	+5 VDC, 6 Amps
Temperature Range:	
Storage:	-50° to +70° C (-58° to 158° F)
Operating:	-30° to +70° C (-22° to 158° F)
Humidity Range:	
Storage:	10% to 90% (non-condensing)
Operating:	10% to 90% (non-condensing)
Switch Latency:	1.56 ms to 12.5 ms depending on baud rate
Switching Time:	10 ns
Phase Lock Loop(PLL)	
Acquisition Time:	1 μs

B.2 Media Card

The Media Card is the interface between the **SCRAMNet-LX/+** support circuitry and the transmission medium: optical fiber or coaxial cables. The Media Cards are available with either fiber optic or coaxial connectors.

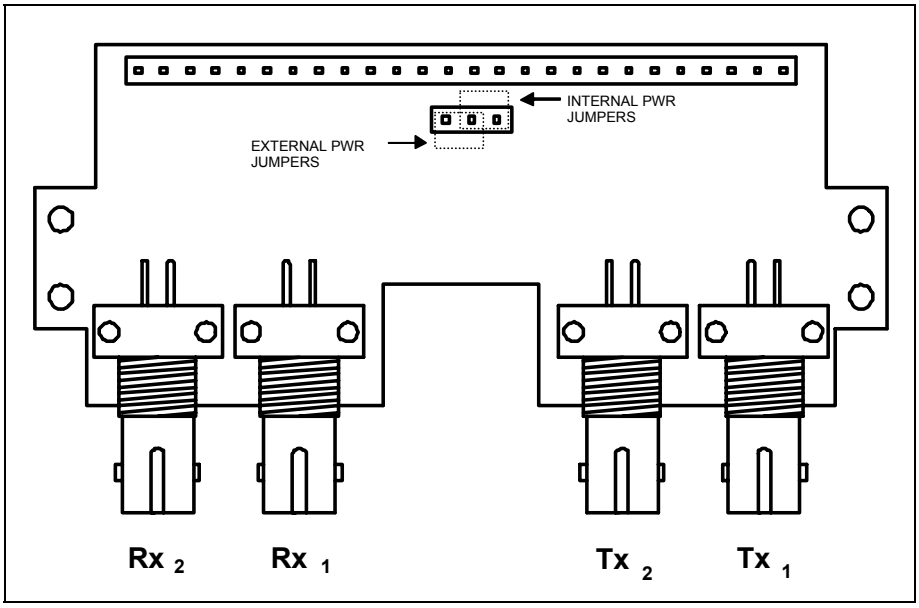

Figure B-1 Fiber Optic Media Card (bottom view)

The **SCRAMNet-LX/+** Support Circuitry supplies the same signal to the Media Card, regardless of the transmission medium supported by the Media Card. The Media Card converts the generic signal from the **SCRAMNet-LX/+** Support Circuitry to one appropriate for the transmission medium.

B.2.1 Internal/External Power Jumpers

The internal position is the normal position and results in the Media card being powered from the host power.

The external position results in power being supplied to the Media Card via a pin on the auxiliary connector. This is useful for those applications where a backup supply is desirable to keep the Media Card powered and the ring intact.

B.3 Node Control Cable

The node control cable is an off-the-shelf cable with an 8-pin circular mini-DIN connector at both ends. It is directly compatible with the Auxiliary Connector of the **SCRAMNet-LX/+** node adapter. A special cable is available from SYSTRAN Corporation that allows the Quad Switch to operate with the optical bypass connector of existing **SCRAMNet Classic** nodes. The order number is A-D-AS-C6T08XXX-10. The "XXX" depends on the length required.

B.4 Auxiliary Connector

The Auxiliary Connector is a standard 8-pin DIN connection. One Aux Connector is located at each port.

Table B-1 Auxiliary 8-pin Connector

Pin	Definition*
1	GND
2	Not used
3	Fiber Optic Relay Drive and Sense
4	Not used
5	INCLUDE (used to sense powered host)
6	Not used
7	Not used
8	Not used

* Apply signal names only to Quad Switch

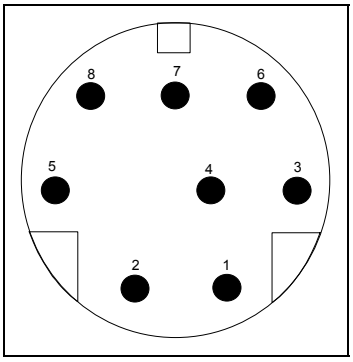

Figure B-2 Aux Connection

NOTE: The diagram is shown looking into the "female" connector on the Quad Switch board.

B.5 RS-232 Connector

The RS-232 connector is a standard 25-pin DIN connection. Only pins 1 - 3 are used.

Table B-2 RS-232 25-Pin Connector

Pin	Definition
1	GND
2	Tx
3	Rx

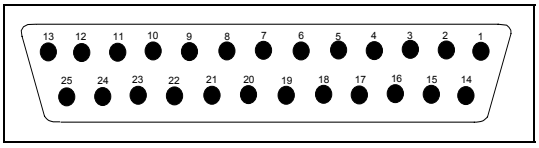

Figure B-3 25-Pin Connector

NOTE: The diagram is shown looking into the "female" connector on the Quad Switch board.

B.6 RS-485 Connector

The RS-422/485 connection requires a 9-pin DIN connector. Only pins 1, 4, 5, 8 and 9 are used.

Table B-3 RS-422/485 9-Pin Connector

Pin	Definition
1	Signal GND
4	Rx(+)
5	Rx(-)
8	Tx(+)
9	Tx(-)

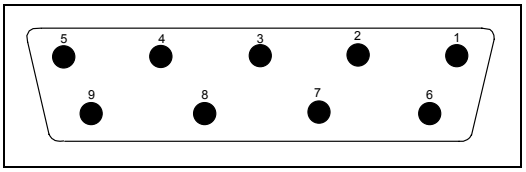

Figure B-4 RS-422/485 Connection

NOTE: The diagram is shown looking into the "female" connector on the Quad Switch board.

B.7 Power Connection

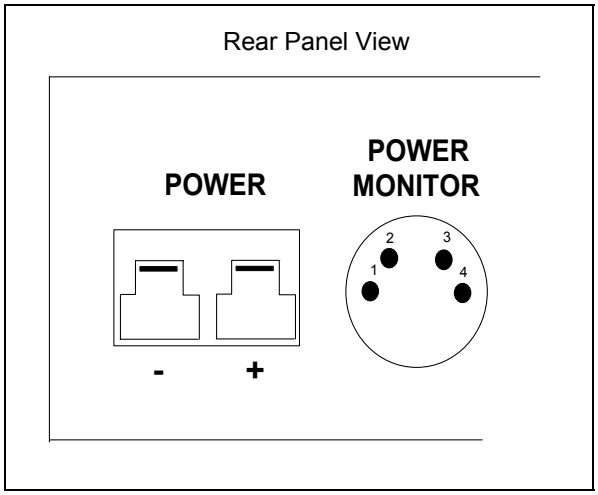

Figure B-5 Quad Switch Power Connection

Power is +5 volts DC.

The hermaphroditic power connector is SYSTRAN part number AHPRHS021X1##0A1, METHODE-2000-302-200.

NOTE: The diagram is shown looking into the "female" connector on the Quad Switch board.

The Power Monitor is reserved for future implementation.

B.8 Part Number

The Quad Switch part number is in the format: H-AS-QSWabcde-X_1X_2, where relative positions a - e represent ports 5, 1, 2, 3, and 4, in that order. The following options apply to any of the five ports:

0	No Media Card
1	Coax Media Card
2	Standard FO Media Card
3	Long Link FO Media Card

The last two positions are defined as follows:

X_1	Quad Switch Type 1 - Populated circuit card only 2 - Mounted in box*
X_2	Variations/Modifications

* The external box is light gray and has silk screened labels for ports and connections. It contains a cooling fan.

Example: **H-AS-QSW12222-20**

This is a Quad Switch with a coaxial Media Card in port 5, and Fiber Optic Media Cards in ports 1, 2, 3 and 4. The Quad Switch is mounted in an external box.

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APPENDIX C
GLOSSARY

auxiliary connection---------- The 8-pin connection on a Quad Switch port used to connect the Quad Switch with the **SCRAMNet** node host computer. This connection allows the **SCRAMNet** node, via the host, to exercise software control over the Quad Switch port.

daisy-chain ---------- The connection of Quad Switches in series via their RS-422/485 serial interfaces.

INCLUDE state ---------- A port in the INCLUDE state is a participant in the Quad Switch internal ring. Data received from the attached node or sub-ring is inserted into the internal ring. Data received from the internal ring is transmitted out the port to the node or sub-ring.

hermaphroditic connector ---------- A connector in which both mating parts are exactly alike at their mating surfaces. Also known as a “sexless” connector.

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

internal ring---------- The connection of the five ports within the Quad Switch results in an internal ring. This is accomplished via the printed circuit board of the Quad Switch. Each of the five ports may be included or isolated from the internal ring depending on the state of the port.

ISOLATE state ---------- The state of a Quad Switch port that excludes the port from the internal ring. Data passed on the internal ring bypasses the port. Data received from a node or sub-ring is retransmitted back to the source.

logical ring ---------- The network ring configuration resulting from connection of one or more physical ring networks. The Quad Switch internal ring is part of the logical ring.

loopback mode ---------- A method of transmitting to the same node’s receivers for testing purposes. Applies to both fiber optic and coaxial media.

media card ---------- An electronic **SCRAMNet-LX** network device with either fiber optic or coaxial cable Receive/Transmit capabilities.

Node ---------- A **SCRAMNet** network board physically attached to the network and potentially able to communicate.

phase lock loop (PLL)---------- Circuitry contained in each Quad Switch port logic which detects proper transmission on its receiver pair. The PLL allows the port to re-synchronize and retransmit the pair of received signals, performing the function of a repeater. The PLL detects and locks onto a carrier signal on the receiver pair.

Port ---------- One of the physical, external connections to the Quad Switch. The Quad Switch has five network Media Card connections, one RS-232 serial connection, and one RS-422/485 serial connection. Each network port also has an Auxiliary Connection to accommodate a node control cable, two LED indicators for Carrier Detect and INCLUDE State, and a manual switch used to place the port in ISOLATE state or INCLUDE ENABLE state.

quad switch ---------- A switching center used to dynamically configure active **SCRAMNet** Classic and **SCRAMNet-LX** ring(s). The Quad Switch:

- Has five network Media Card connections
- Can be managed by a host via an RS-232 or RS-422/485 serial interface.
- Has an internal ring with access to five external ports.
- Can be connected to other Quad Switches.

sub-ring ---------- A ring of two or more nodes which may be connected to any Quad Switch port. One ring may be considered the primary ring and others as subordinate or sub-rings. A sub-ring is a complete network and may be removed from the primary ring.

INDEX