SCRAMNet®+ Network

Media User's Guide

Document No. D-T-MU-MEDIA###-A-0-A7

FOREWORD

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Systran Corporation
4126 Linden Avenue
Dayton, OH 45432-3068 USA
(800) 252-5601 (U.S. only)
(937) 252-5601

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1. INTRODUCTION

1.1 How To Use This Manual

1.1.1 Purpose

This document describes the network cabling hardware accessories for the SCRAMNet+ Network.

1.1.2 Scope

This manual provides information about the Media Access Card (MAC), coaxial cable, fiber-optic cable, the Fiber Optic Bypass Switch, fiber-optic cable performance, and bit-error rate.

This information is intended for systems designers, engineers and network installation personnel. You need at least a systems level understanding of general computer processing, and hardware operation 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.’

1.2 Related Information

SCRAMNet Network Cabinet Kit Hardware Reference (Doc. No. D-T-MR-CABKIT) - A physical and functional description of the Compact and Expanded cabinet kits, including installation.

1.3 Quality Assurance

Systran Corporate policy is to provide our customers with the highest quality products and services. In addition to the physical product, the company provides documentation, sales and marketing support, hardware and software technical support, and timely product delivery. Our quality commitment begins with product concept, and continues after receipt of the purchased product.

Systran’s Quality System conforms to the ISO 9001 international standard for quality systems. ISO 9001 is the model for quality assurance in design, development, production, installation and servicing. The ISO 9001 standard addresses all 20 clauses of the ISO quality system, and is the most comprehensive of the conformance standards.

Our Quality System addresses the following basic objectives:

- Achieve, maintain and continually improve the quality of our products through established design, test, and production procedures.

- Improve the quality of our operations to meet the needs of our customers, suppliers, and other stakeholders.
- Provide our employees with the tools and overall work environment to fulfill, maintain, and improve product and service quality.
- Ensure our customer and other stakeholders that only the highest quality product or service will be delivered.

The British Standards Institution (BSI), the world's largest and most respected standardization authority, assessed Systran's Quality System. BSI's Quality Assurance division certified we meet or exceed all applicable international standards, and issued Certificate of Registration, number FM 31468, on May 16, 1995. The scope of Systran's registration is: "Design, manufacture and service of high technology hardware and software computer communications products." The registration is maintained under BSI QA's bi-annual quality audit program.

Customer feedback is integral to our quality and reliability program. We encourage customers to contact us with questions, suggestions, or comments regarding any of our products or services. We guarantee professional and quick responses to your questions, comments, or problems.

1.4 Technical Support

Technical documentation is provided with all of our products. This documentation describes the technology, its performance characteristics, and includes some typical applications. It also includes comprehensive support information, designed to answer any technical questions that might arise concerning the use of this product. We also publish and distribute technical briefs and application notes that cover a wide assortment of topics. Although we try to tailor the applications to real scenarios, not all possible circumstances are covered.

Although we have attempted to make this document comprehensive, you may have specific problems or issues this document does not satisfactorily cover. Our goal is to offer a combination of products and services that provide complete, easy-to-use solutions for your application.

If you have any technical or non-technical questions or comments, contact us. Hours of operation are from 8:00 a.m. to 5:00 p.m. Eastern Standard/Daylight Time.

- Phone: (937) 252-5601 or (800) 252-5601
- E-mail: support@systran.com
- Fax: (937) 252-1349
- World Wide Web address: www.systran.com

1.5 Ordering Process

To learn more about Systran products or to place an order, please use the following contact information. Hours of operation are from 8:00 a.m. to 5:00 p.m. Eastern Standard/Daylight Time.

- Phone: (937) 252-5601 or (800) 252-5601
- E-mail: info@systran.com
- World Wide Web address: www.systran.com

2. PRODUCT OVERVIEW

2.1 Overview

Cabling a SCRAMNet+ Network involves four hardware elements:

- The specific transmitter and receiver pairs used by SCRAMNet+
- The fiber-optic cable, which comes in various diameters and optical quality, or the optional coaxial cable
- The connectors used to link the cable to the transmitter or receiver. Connectors may also be used to pass the cable through a bulkhead. Connectors also are used to hook separate cables together into one longer cable. However, this causes additional power loss and should be avoided.

2.1.1 Transmitter and Receiver Pairs

The transmitter and receiver pairs provide an interface between the network ring and the SCRAMNet Network node. The fiber-optic transmitter and receiver pairs convert the incoming light signals to electronic signals, and outgoing electronic signals to light signals. The coaxial transmitter and receiver pairs convert incoming 50-ohm terminated single-ended signals to 100 K Emitter Coupled Logic (ECL) differential drive-and-sense signals, and reverses the process for outgoing signals. The transmitter and receiver pairs may be on a MAC depending on the SCRAMNet+ product. The MAC can be configured to completely isolate the node from the network ring.

2.1.2 Network Cabling

The ring topology and bi-polar transmission protocol dictates that there must be two transmitters and two receivers on each network node. This requires two cable pairs connecting each node into the network.

Two types of cable are offered: fiber-optic and coaxial cable. Cabling is chosen based on the distances involved in the application, and whether radio frequency interference (RFI) or electromagnetic interference (EMI) is likely. Fiber-optic cabling will eliminate the effects of this interference on the network, where coaxial cabling will not. Coaxial cable can be used in networks where RFI and EMI are not present in sufficient intensity to interfere.

2.1.3 Connectors

The fiber-optic cable uses the ST® type connector. The coaxial cable uses the SMA type connector.

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3. MEDIA ACCESS CARDS

3.1 Overview

The MAC receives and transmits network messages. There are two types of MAC; fiber-optic and coaxial. The MAC can be used on all SCRAMNet host interface boards, cabinet kit boards, and on the Quad Switch.

3.2 Fiber-Optic MAC

The fiber-optic MAC receiver converts light signals to electronic signals and passes them to the host. The transmitter converts electronic signals to light signals and sends them on to the network.

The fiber-optic MAC is available in standard fiber optic (820 nm wavelength) for short distances and long fiber optic (1300 nm wavelength) for long distances.

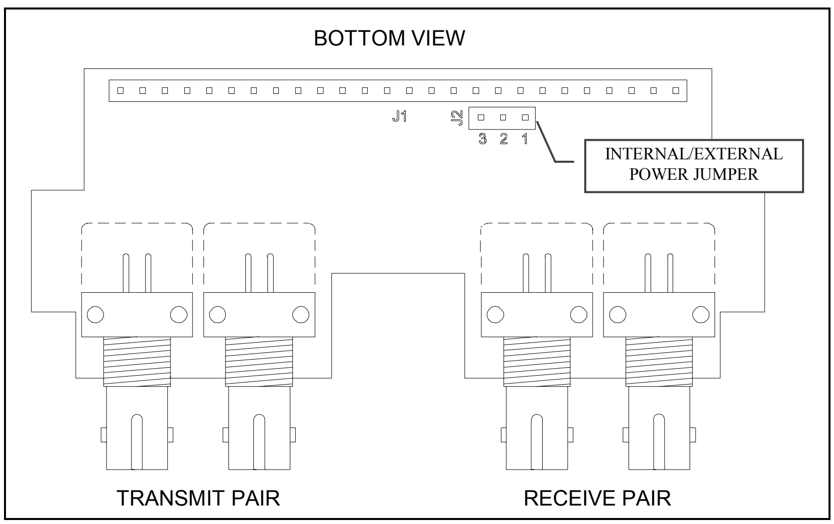


Figure 3-1 Fiber-Optic MAC

This fiber-optic card has two power options; host power and standby or battery power. Jumper J2 in Figure 3-1 controls the power options. Pins 1 and 2 are for normal host power, and pins 2 and 3 are for standby power. The standby or battery power requires external connection via the auxiliary connection on the cabinet-kit board or the host-interface board if no cabinet kit is installed.

3.3 Coaxial MAC

This board receives and transmits messages over coaxial cable. The receive and transmit signals on the host side are 100 K ECL differential-level drive and sense.

The board, shown in Figure 3-2, can be configured to completely isolate the coaxial cables from the host, to connect to common (signal) ground, or to the chassis ground. It can be powered by the host, standby (via the accessory connector), or phantom power. It can also be configured to supply the control signals to the Quad Switch (C version or higher) via phantom levels on the coaxial cables. (This eliminates the need for the auxiliary cable on the Quad Switch.)

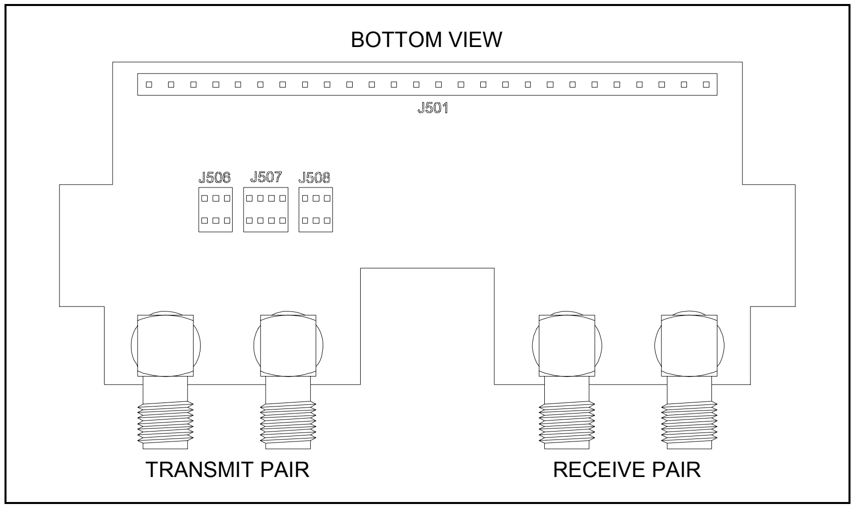
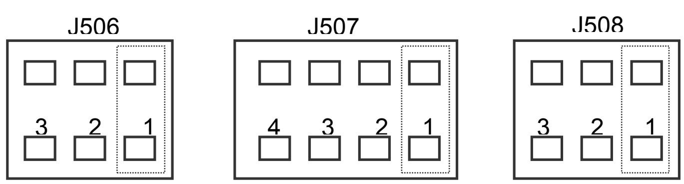


Figure 3-2 Coaxial Media Access Card

3.3.1 Modes of Operation

The jumpers are installed only from one row of the header to the other. Do not install between two pins on the same side of the header.

ISOLATE MODE (Default for nodes)



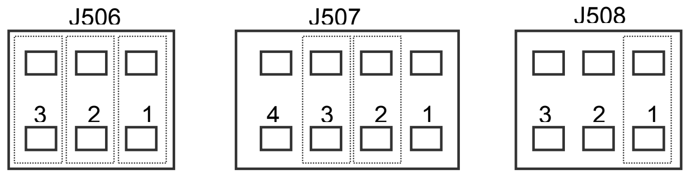
J506 jumper position 1
J507 jumper position 1
J508 jumper position 1

The coaxial outputs are transformer-coupled by high frequency baluns (line-balance converters), and this is the only connection between the host and the cables. This results in very high common-mode rejection and no ground loops between systems.

To tie the shields of the coaxial to circuit common (signal) ground, move the jumper on J506 to position 2.

To tie the shields of the coaxial-to-chassis ground, move the jumper on J506 to position 3.

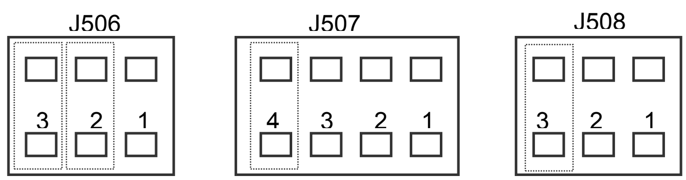
PHANTOM FO_RELAY MODE



Quad Switch End	Host End
J506 jumper position 1	J506 jumper position 2 (for shields-to-circuit common) **OR** J506 jumper position 3 (for shields-to-chassis common)
J507 jumper position 2	J507 jumper position 3
J508 jumper position 1	J508 jumper position 1

The FO_RELAY output is coupled by a lowpass filter to all the coaxial connectors center conductors. This allows this "phantom" signal to be decoupled at the other end of the cables for control purposes. This is used by the Quad Switch ('C' version or higher) to eliminate the need for the accessory cable for control.

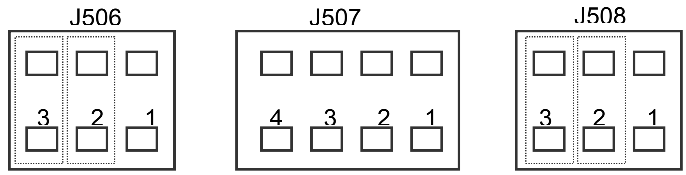
PHANTOM SUPPLY MODE



J506 jumper position 2 (for shields-to-circuit common) **OR**
J506 jumper position 3 (for shields-to-chassis common)
J507 jumper position 4
J508 jumper position 3

The Accessory External power is coupled by a lowpass filter to all the coaxial connectors' center conductors. This allows this "phantom" power to be decoupled at the other end of the cables for powering other devices. The primary purpose is to circulate a "backup" supply for other coaxial MACs that are attached to nodes that may lose power. Effectively, all the Accessory External power supplies of all the powered nodes are paralleled. Each powered node is capable of supplying power to its own MAC plus two others, as a minimum.

BACKUP PHANTOM SUPPLY MODE



J506 jumper position 2 (for shields-to-circuit common) **OR**
J506 jumper position 3 (for shields-to-chassis common)
J507 jumper position none
J508 jumper position 2
J508 jumper position 3

This mode can be used alone or in conjunction with the Phantom supply mode. This mode routes the power coming into the accessory connector from an external supply (possibly a battery supply to the coaxial MAC). This supply will be connected in parallel with others of its type and with the on-node "Accessory External supplies" if this is used in conjunction with the Phantom supply mode.

OTHER MODES

NOTE: There are other possible combinations that may be desired. Contact Systran for assistance because some combinations, other than those above, could be destructive.

3.4 Redundant Operation

Redundant operation requires two sets of MACs with two sets of dual fiber-optic cables connecting all nodes on the network ring. There are four transmitter lines and four receiver lines. This configuration ensures network ring message integrity on a node-to-node basis in the event of the failure of one MAC.

Messages are always sent on both transmitters but only one receiver per node is selected to pull in data from the network to the node. Figure 3-3 shows the redundant transceiver configuration and data flow for the particular link selected. All nodes transmit on T1 and T2. Node A is receiving on R1, Node B on R2, and Node C on R1.

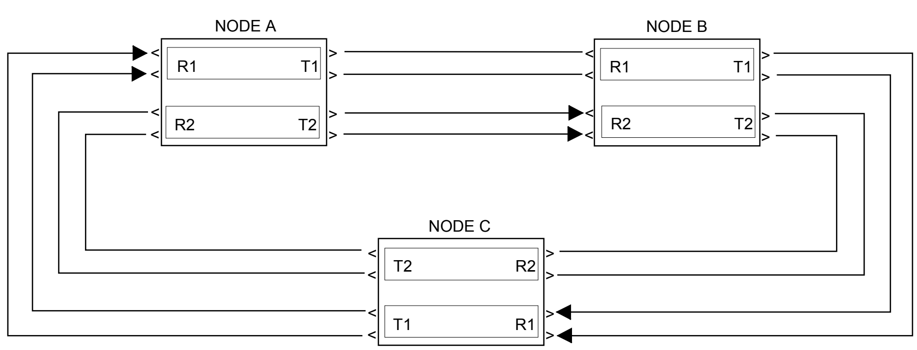


Figure 3-3 Redundant Transceiver Operations

Consider the three-node network configuration shown in Figure 3-3. If node A detects transmission errors from node C or its own receiver is failing, then node A will automatically switch to the alternate receiver. This does not disrupt the transmission to node B since both transmit lines are transmitting to both receivers. Only the receiver on node A is switched. Some incoming data to node A may be initially lost, but will be retransmitted by the originating node when its message does not return within the time-out range if error-correction protocol is used. Nodes B and C will continue to operate on the primary links.

☞ **NOTE**: On power-up, it may be necessary for one node to transmit a message to establish carrier.

Figure 3-4 shows the P2 Cabinet Kit with dual Media Access Cards for redundant operation.

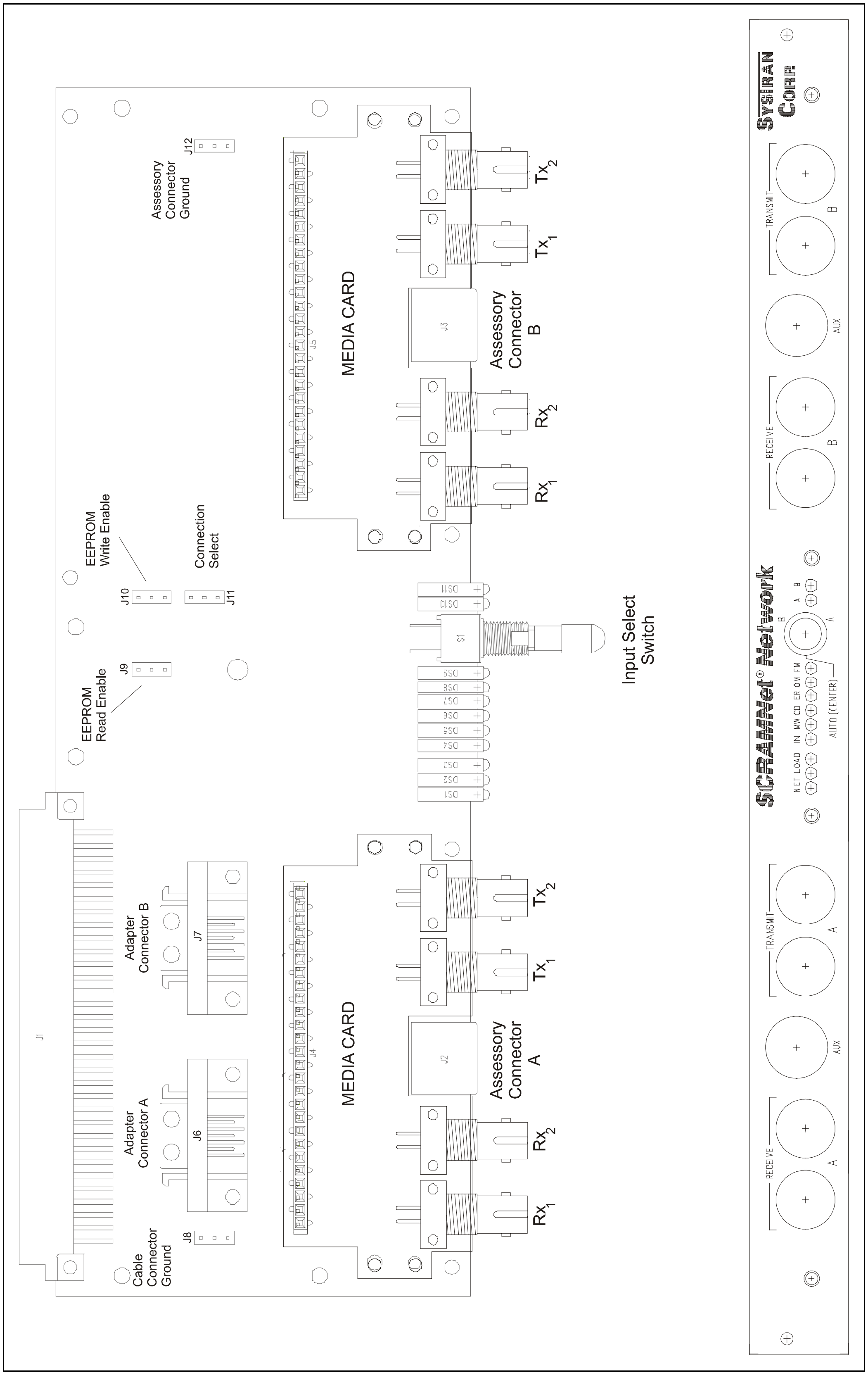


Figure 3-4 Cabinet Kit with Dual Media Access Cards

4. COAXIAL CABLE

4.1 Overview

SCRAMNet+ can use coaxial cables for distances up to 30 meters in environments where RFI/EMI emissions are not prevalent. SCRAMNet+ uses an RG-58U cable with an SMA type connector.

If a coaxial cable SCRAMNet+ installation encounters significant signal errors, then convert to fiber-optic cable. The noise levels are probably too high for safe coaxial cable operation.

4.2 Coaxial Construction

SCRAMNet+ coaxial cable is composed of paired, shielded conductors terminated with SMA connectors. Maximum node separation using coaxial is 30 meters. The recommended coaxial cable is RG-58U.

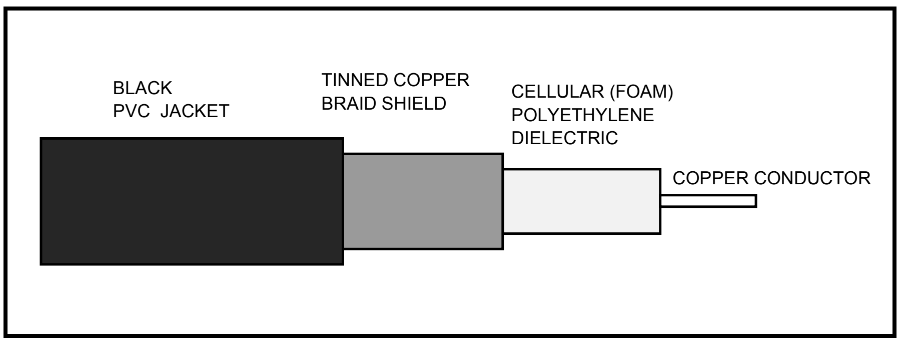


Figure 4-1 Coaxial Construction

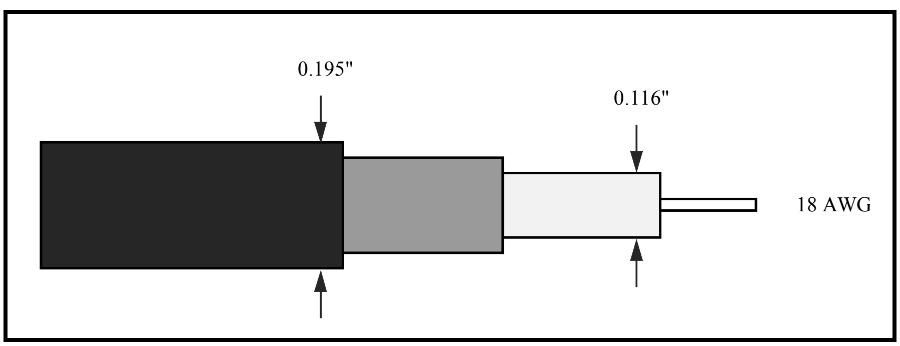


Figure 4-2 Coaxial Dimensions

4.3 Specifications

Requires any coaxial cable capable of a 50-ohm load, RG-58 or better.

4.4 Cable Noise

There are basically three types of noise that may affect the coaxial cabling of a SCRAMNet network:

- Static
- Common Mode
- Crosstalk

4.4.1 Static Noise

This refers to signal distortion due to the electrical fields radiated by a voltage source, which has coupled into the signal-bearing circuit. Simple shielding of the full circuit is a typical means of mitigating this type of interference. It is critical that the shield be continued to, and completely encompasses, the transmitting and receiving ends of the circuit if high levels of noise reduction are required. Effective grounding of the shield is also required. Non-grounded or "floating" shields only partially reduce the effect of the noise. However, it only needs to be grounded at one end to eliminate ground loops, and the coaxial Media Access Card provides for this.

4.4.2 Common Mode

Common mode interference is the result of currents flowing between different potential grounds located at various points within a system. Receivers with very high common-mode rejection ratios minimize this type of interference. The coaxial Media Access Card has a very high common-mode rejection in isolated mode.

4.4.3 Crosstalk

This refers to the superimposition of either pulsed DC or standard AC signals carried on one wire pair to another wire pair in close proximity. The most effective means of mitigation is removing parallel cables to a distance far enough away from each other to eliminate the crosstalk.

4.5 SMA Connector

Figure 4-3 shows the dimensions of the SMA coaxial connector.

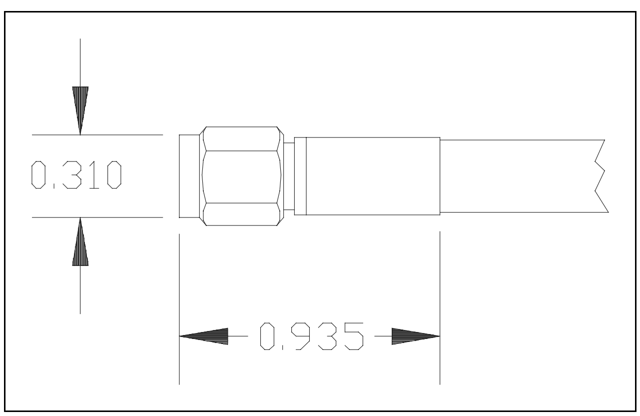


Figure 4-3 SMA Connector

5. FIBER-OPTIC CABLE

5.1 Overview

Fiber-optic cabling is 62.5/125 micron multi-node, with ST connectors. There are three types of fiber-optic cable.

- Commercial-grade cables with ST connectors:
  Standard commercial grade cables designed to interconnect computers within a standard environment (duplex pair)
- Hardened Cables with ST connectors:
  Cables designed for rugged applications. Hardened cables are mud and water immersible (matched pairs).
- Plenum-rated cables with ST connectors:
  Lightguide building cables designed to run within a building environment. Plenum cables are fire resistant with a fluoropolymer jacket and are Plenum listed (duplex pair).

5.2 Fiber Construction

Optical fibers have an all-dielectric construction. The central, circular glass core propagates the optical signal. Core diameters can vary from 10 microns to over 1000 microns. The layer of glass or plastic cladding surrounding the core serves two purposes. First, it protects the core from contamination and damage. Secondly, it causes the light signal to bend back toward the core axis. This bending effect results in a “zigzag” light path or mode. When there are multiple light paths, the fiber-optic cable is referred to as multimode. When the fiber is limited to one path, it is called singlemode fiber.

5.2.1 Multimode Cable

Multimode cable includes both step-index and graded-index fibers. In step-index multimode fiber, the refraction indices between core and cladding are distinctly different. In graded-index multimode fiber, the indices gradually change from the center to the outside of the core. This is made possible through the use of layers, each of which has a slightly greater refraction index. This results in the light rays traveling in the outer layers to travel faster through the core medium than those at the axis. The effect is to produce curved paths and to equalize the propagation times.

5.2.2 Singlemode Cable

Singlemode fiber is constructed with only one path—down the axis. The core of a singlemode fiber must be kept to a diameter of perhaps 10 microns. Singlemode fibers are typically used for long distance runs.

5.2.3 Protective coating

Figure 5-1 and Figure 5-2 show the various layers of the fiber-optic cable construction. The outer layer of a fiber-optic cable is the protective coating. This coating is usually made of epoxy acrylates, and the diameter will vary according to the cable construction. In “loose buffer” cables, the fiber is free to move within a larger diameter tube. Loose buffer cables provide the fibers significant protection from external mechanical forces.

“Tight buffer” cables usually have another buffer over the 500 micron protective coating. Tight buffer cables are generally more flexible, and tend to be smaller in diameter than loose buffer tube cables.

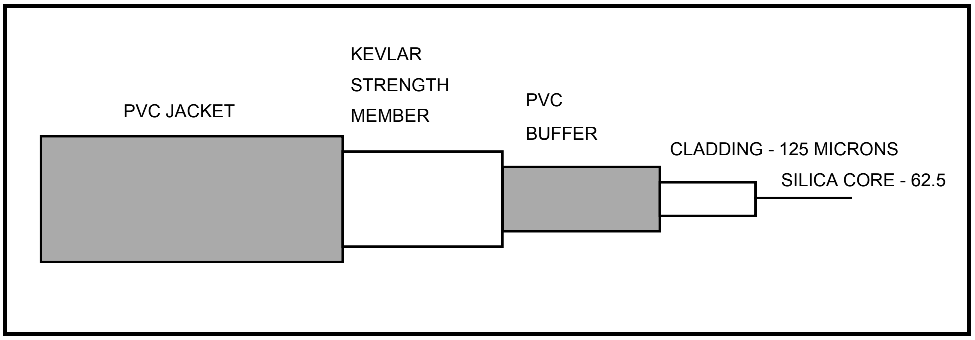


Figure 5-1 Fiber-optic Cable (side view)

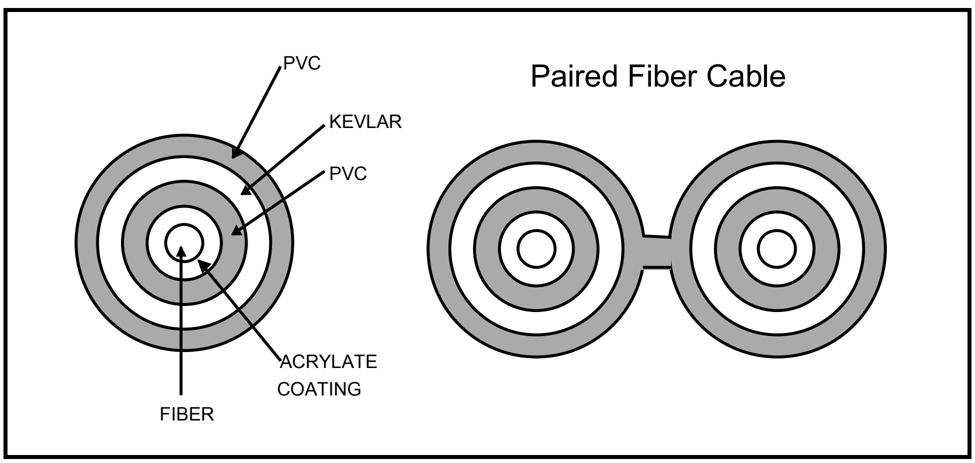


Figure 5-2 Fiber-optic Cable (end view)

5.2.4 Nomenclature

Cladding can vary in diameter from 125 microns to more than 1000 microns. This allows cable to be described in terms of the core-to-cladding ratio. For example, Systran uses 62.5/125 cable. This means the core is 62.5 microns, and the cladding is 125 microns.

5.3 Specifications

All power ratings are given in dB referenced to 1 microwatt and are average. To convert to peak-to-peak power, add 3 dB.

5.3.1 Standard Link Fiber-Optic Specifications

Fiber-optic Transmitter:
Agilent HFBR1414T
(12 dB to 19 dB into 62.5/125)

Fiber-optic Receiver:	**Rev. A1***	**Rev. B1 or Higher****
Agilent HFBR2416T		
Min power budget:	10 dB	10 dB
Max power to break squelch:	2.0 dB	N/A
Min power to break squelch:	-0.6 dB	N/A
Max power to squelch:	-0.5 dB	N/A
Min power to squelch:	-3.0 dB	N/A
(with 62.5/125 mm fiber)		

Connectors for Receivers and Transmitters: ST

5.3.2 Long Link Fiber-Optic Specifications

Fiber-optic Transmitter:
Agilent HFBR1312T
(10.5 dB to 15.5 dB into 62.5/125)

Fiber-optic Receiver:	**Rev. A1***	**Rev. B1 or Higher****
Agilent HFBR2316T		
Min power budget:	9.4 dB	9.5 dB
Max power to break squelch:	1.1 dB	N/A
Min power to break squelch:	-3.5 dB	N/A
Max power to squelch:	-1.4 dB	N/A
Min power to squelch:	-6.0 dB	N/A
(with 62.5/125 mm fiber)		

Connectors for Receivers and Transmitters: ST

* Rev A1 MAC
** Rev B1 MAC or higher, or SC150e

Commercial grade fiber-optic cable ordered through Systran is the Optical Cable Corporation ULTRA FOX multimode cable, and is described by the diagrams on the following pages. Other fiber-optic cable varieties such as radiation hardened and plenum are also available. Contact Systran for further details on the non-commercial grade cables.

Fiber-optic Cable Specifications

Fiber Characteristics	• Fiber Type	Multimode 62.5/125 microns	
	• Operating Wavelength	850 nm	1300 nm
	• Maximum Attenuation	3 dB/km	1 dB/km
	• Minimum Bandwidth	160 MHz-km	500MHz-km
Technical Specification	• *UL* Listed	1990 National Electrical Code 770-51(b) 770-53(b)	
	• Jacket Material	Polyvinyl Chloride	
	• Buffer Material	Polyvinyl Chloride	
	• Strength Member	KEVLAR	
	• Operating Temperature	-40°C to +85°C	
	• Storage Temperature	-55°C to +85°C	
	• Minimum Bend Radius	5 cm - loaded 3 cm - no load	
	• Operating Relative Humidity	8 to 80%	
	• Storage Relative Humidity	5 to 100%	
	• Cable Outside Diameter	0.12 x 0.26 inches (3.0 x 6.5 mm)	
	• Cable Weight	11 pounds/1000 feet	

5.3.3 Fibre-Optic Cables

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

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

H-PR-WST2XXXX-0

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.

5.4 Cleaning

It is important that 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.

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 Access 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 cable ends.

5.5 Fiber-optic Connectors

The function of the fiber-optic cable connector is to align fibers for propagation fiber-to-fiber, fiber-to-source, or fiber-to-detector. The function of the coaxial connector is to provide proper electrical contact.

A splice can be used for permanent fiber-to-fiber mating. However, splices are not recommended.

5.5.1 Connector Requirements

The following are the requirements for an effective fiber-optic cable connector:

- Low signal loss—signal attenuation through the connector
- Repeatability—obtaining the same signal quality for each re-connection
- Low rotational variation—The accuracy in rotational alignment of the cores of the segments being connected
- Durability—The amount of degradation over time
- Low optical return loss—Smooth finish and cleanliness of the cable ends reduce the Fresnel Reflection
- Environmental stability—How the connector works in variations of temperature, humidity, altitude, and physical stress
- Low cost
- Fast, easy installation.

5.5.2 ST Connector

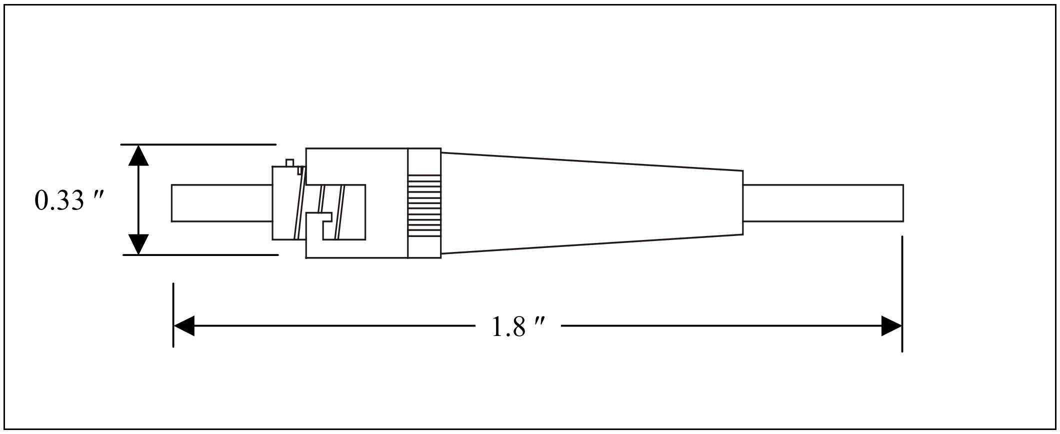


Figure 5-3 ST Connector – 3M Model 6100

Specifications
• Loss: 0.4 dB average for 62.5/125 micron fiber
• Optimal Temperature: -55°C to 85°C
• Cable Retention: 50 pounds minimum

Features
• Fully compatible with all other ST Connector hardware
• Corrosion resistant hardware
• 3 mm OD cable options

6. FIBER OPTIC BYPASS SWITCH

6.1 Overview

This section addresses the functionality, specifications, configurations and uses of a Fiber Optic Bypass Switch in a SCRAMNet+ fiber-optic ring.

SCRAMNet+ uses a bi-polar transmission protocol that requires two optical transmitters and two optical receivers. Hence there are two fiber-optic lines for receiving and two for transmitting, all of which are ST style receptacles. The bypass switch has ST style receptacles on the network side of the ring and ST style male connectors on the node side.

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.

6.2 Functionality

The SCRAMNet+ 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 6-1 describes a ring configuration using 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 6-1 were to lose power or chose not to be included in the ring, then those two nodes would be bypassed.

6.3 Benefits

The bypass switch provides a higher system fault tolerance by automatically “going around” unpowered nodes in the fiber-optic network ring. The software control on powered nodes enables the bypass switch to redistribute network resources according to the needs of different real-time applications.

Some ring configurations choose not to have all nodes up and running. In these situations, the bypass switch automatically routes traffic around the unpowered node. This eliminates the need to reconnect fiber-optic cables based upon a particular configuration’s needs. When previously unused nodes are included in the ring, they can be switched in by software control.

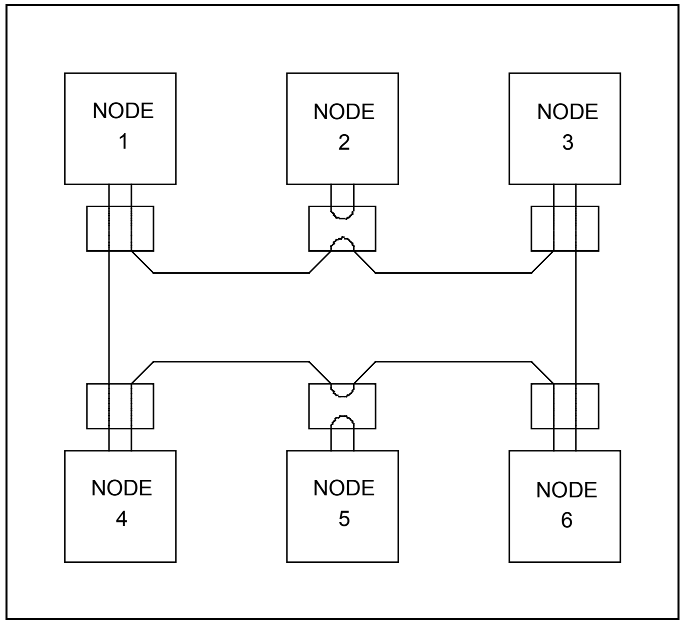


Figure 6-1 Ring with Bypass Switches

Powered nodes can be selectively switched in or out of the network ring by software control. This allows great flexibility in the sharing and allocation of resources in the ring.

6.4 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 switch in place when the node was powered down, there would be no means to receive or transmit incoming network data. Consequently, 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 present.

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. Figure 6-2 describes the fiber-optic path and data flow for the bypass state.

6.5 Inserted Mode

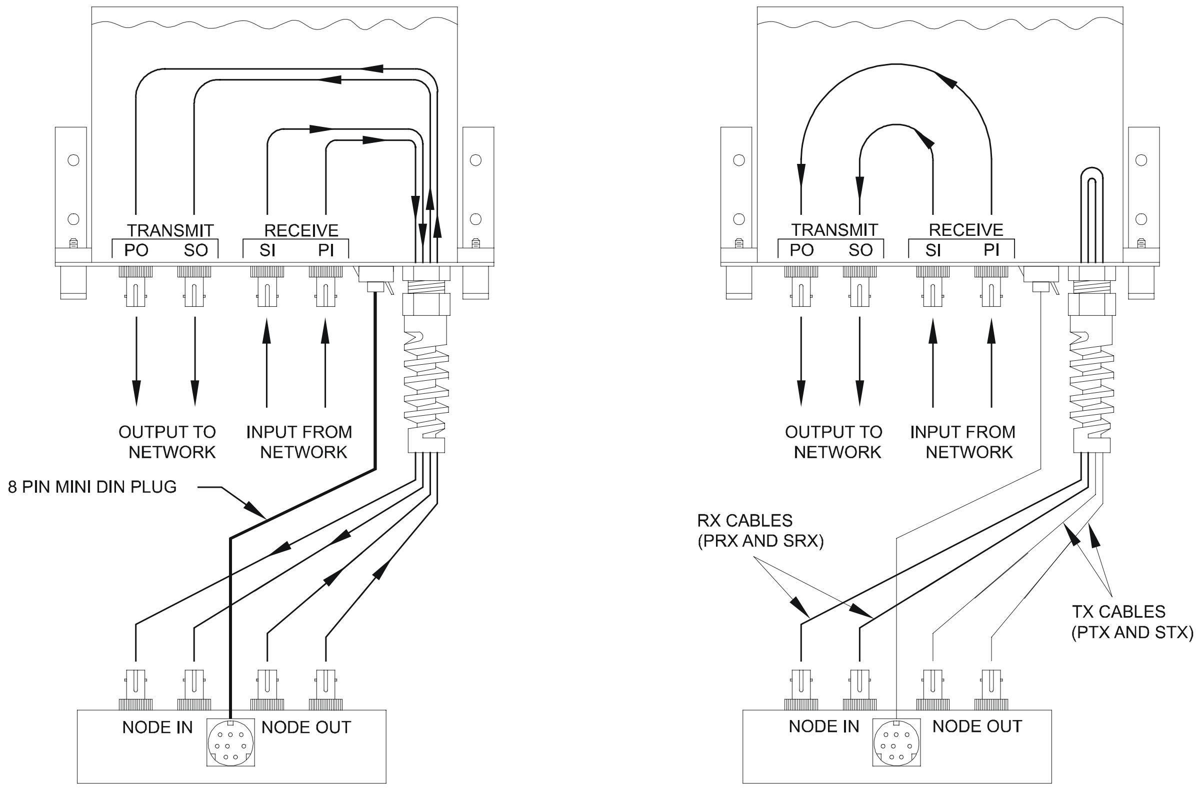
When a node is powered up, the switch is automatically in the bypass state by default. With power at the node, the bypass switch is under software control. By setting a bit in one of the SCRAMNet+ node’s control registers, the switch can be placed in the “inserted” mode. The control signals are passed by an electrical connection between the node and the bypass switch using the 8-pin mini-DIN connector provided.

When the bypass 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 is illuminated during this state. Figure 6-2 describes the fiber-optic path and data flow for the inserted state.

6.6 Considerations

The light-power budget should be considered when using bypass switches in the fiber-optic ring. Bypass switches, cable connectors and the fiber-optic cables themselves all dissipate the light as it travels from the source to the destination. There must be enough light-power remaining at the destination point to be interpreted by the receiver. See Chapter 7, PERFORMANCE, for more detailed information.

Each node acts as a booster when re-transmitting the incoming network data. If three or four contiguous bypassed nodes are each separated by long lengths of cable, then the light-power loss may be great enough so that there is too little light power to be received. The Fiber Optic Bypass Switches each carry a 2 dB loss for the light-power budget. Coupled with the 3.75 dB/km cable loss, this can deplete the 12 dB light-power budget, when several contiguous switches are in the bypass state in a given network.



INSERTED STATE (POWER ON)

BYPASS STATE (POWER OFF)

SPECIFICATIONS

OPTICAL PERFORMANCE

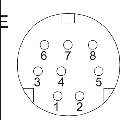
INSERTION LOSS	1.1 DB TYPICAL, 1.8dB MAXIMUM. 1.4 DB TYPICAL, 2.1 DB MAXIMUM.
LOOPBACK LOSS	5 DB MAXIMUM.
SWITCHING TIME (POWER LOSS TO POINT THAT RELIABLE DATA TRANSFERS OCCUR)	5 MILLISECONDS TYPICAL, 10 MILLISECONDS MAXIMUM.
OPTICAL CROSS-TALK	-45dB MAXIMUM (FOTP-42).
MECHANICAL SHOCK	30 G'S ON 3 AXES, PER FOTP-14.
VIBRATION TOLERANCE	15 G'S ON 3 AXES, PER FOTP-11.
ALLOWABLE LENGTH DIFFERENCE BETWEEN PRIMARY AND SECONDARY DATA PATHS IN "INSERT" OR "BYPASS" STATE	LESS THAN 6" (.76NS) MEASURED BY SYSTRAN SKEWMETER IN "BYPASS" MODE AT PTX AND STX TO PRX AND SRX. ALSO TX INNER AND OUTER CON' TO RX INNER AND OUTER CON'.
ALLOWABLE SPLICES IN DATA PATH	NONE ON "NEW" UNITS (REPAIRS ON CASE BY CASE BASIS AS CUSTOMER REQUIRES)
DURABILITY	ONE MILLION CYCLES MINIMUM.
OPERATING TEMPERATURE	-10°C TO +65°C
STORAGE TEMPERATURE	-30°C TO +70°C

ELECTRICAL PERFORMANCE

SWITCHING VOLTAGE	3.5 VDC MINIMUM VOLTAGE TO SWITCH THE RELAY
SWITCHING CURRENT (SYSTRAN USES 2 RELAYS IN PARALLEL)	160 MA MAXIMUM AT 5.0 VDC
CONNECTOR	8 PIN MINI DIN PLUG

RECEPTACLE PIN ASSIGNMENTS

1	PRIMARY/SECONDARY SWITCH GROUND
2	NO CONNECT/RESERVED
3	PRIMARY/SECONDARY SWITCH POSITIVE
4	NO CONNECT/RESERVED
5	NO CONNECT/RESERVED
6	NO CONNECT/RESERVED
7	NO CONNECT/RESERVED
8	NO CONNECT/RESERVED



SWITCH LEGEND

PI = PRIMARY IN	PTX = PRIMARY TRANSMIT
SI = SECONDARY IN	STX = SECONDARY TRANSMIT
PO = PRIMARY OUT	PRX = PRIMARY RECEIVE
SO = SECONDARY OUT	SRX = SECONDARY RECEIVE

NOTES:
1. INSERTION LOSS MEASUREMENTS ARE BASED ON FOTP 34, METHOD B - LONG LAUNCH AND METHOD A - SHORT LAUNCH (RESPECTIVELY).
2. UNIT CONFIGURED USING ST CONNECTOR RECEPTACLES AND ST CONNECTOR PLUGS.
3. LED WILL BE "ON" WHEN IN INSERTED STATE (POWER "ON").

SYSTRAN CORPORATION 4126 LINDEN AVE. SUITE 100 DAYTON, OHIO 45432	SIZE A	DWG. NO. A-D-PR-FORELAY-6X	REV. -
		FILE: FORELAY6X2.DWG	SHEET 2 OF 4

Figure 6-2 Fiber Optic Bypass Switch Connections

7. PERFORMANCE

7.1 Overview

There are a number of ways power losses can occur in a network. For fiber-optic cable these include absorption, dispersion, return loss, connector attenuation, and mismatched fiber losses. Absorption and dispersion are the two primary causes of attenuation in optical fibers.

7.2 Fiber-optic Cable

7.2.1 Light-Power Budget

The primary factor in fiber-optic cabling is the power budget of the optical transmitter-receiver pair. “Power budget” is a term used to describe the loss of signal (power) allowed from the transmitter to the receiver, before some specific bit-error rate might be exceeded. A 10^{-9} bit-error rate (BER) is an industry-accepted standard for a good data link. However, the SCRAMNet+ network is designed for a bit-error rate of less than 10^{-15}.

The SCRAMNet+ Network uses a transmitter and receiver pair with a total optical power budget. This number is calculated based on worst-case parameters, and thus a system designed within this budget will experience a much better bit-error rate. This figure assumes use of 62.5/125 fibers.

FIBER OPTIC BYPASS SWITCH

Some of this budget will also be used if there are additional connectors or the node is operated with the optional Fiber Optic Bypass Switch. Loss for each switch is 2.0 dB maximum which reduces the remaining budget. Another 2.0 dB must be taken from the budget if a switch is installed in the receiving node. (See the Design Example at the end of this technical note). If more bypass switches are used external to the computer (i.e., patch bay) these losses must also be taken from the budget.

☞

NOTE: Several switches or connectors in series may not have a total loss as large as the sum of the individual losses. For a large number of switches or connectors, power meters should be used to obtain actual measurements.

CONNECTORS

Power loss over connectors can be caused by rotational variation, poor connectability, or Fresnel Reflection (return loss).

In high bit-rate systems, the return loss can be a major source of bit-error rate problems. The reflected light interferes with the laser light in the chip and can be a source of noise.

Table 7-1 Typical Connector Losses

Multimode:		
	SMA	0.5-1.5 dB
	ST	0.3-0.6 dB
	FDDI	0.3-1.0 dB
	ALL	0.3-2.0 dB
Singlemode:		
	Biconic	0.5-1.0 dB
	FC/PC	0.2-0.8 dB
	Rotary	0.1-0.5 dB

Connecting a smaller fiber-optic cable to a larger fiber-optic cable will result in minimal losses, perhaps only 0.3 dB. However, connecting larger fiber to smaller will result in substantial losses.

POWER INPUT

The minimum average input power to the receiver to guarantee the 10^{-9} BER is -1.5 dBμW. To guarantee 10^{-15} BER, average input power must be at least -0.4 dBμW.

CLEANING

It is important that the ends of the fiber-optic cable be kept clean. Cables are shipped with rubber boot covers over the ceramic tips. Keep these in place whenever the cables are not connected to a transmitter or receiver. If an exceptional amount of light-power loss is experienced, inspect the cables for cleanliness and breaks or excessive bends. Fiber-optic cleaning pads are available to remove minor contaminants such as dust.

7.2.2 Bandwidth-Length Budget

There are also power losses due to the way light disperses as it propagates through the fiber. The parameter used to quantify these losses is bandwidth-length. For instance, a 400 MHz-km fiber is good for a sine wave of 400 MHz for 1 km, or 200 MHz for 2 km, or 100 MHz for 4 km, and so on. Typically this parameter is measured using a laser.

When used with an LED emitter such as SCRAMNet+ uses, another parameter comes into play—“chromatic dispersion”. The LED emits a wider spectrum of light wavelengths than the laser. Since the different wavelengths of light propagate at different speeds, these arrive at the receiver at different times. The effect of this dispersion is to reduce the 160 MHz-km multimode 62.5/125 fibers to 50 MHz-km. The SCRAMNet+ Network needs to have at least 150 MHz bandwidth in the cable. This limits the 850 nm transmitter driven cables to approximately 300 meters in length. For the 1300 nm transmitter driven cables, the maximum is approximately 3500 meters. However, approach these limits with caution, as cable manufacturers do not typically define chromatic dispersion bandwidth.

7.2.3 Signal Skew

Another area to consider which is unique to the SCRAMNet+ Network is signal skew between the accumulated delay or skew between an active node's two fibers. For reliable data recovery by the receiver, there must be less than 1 ns skew. This can normally be accomplished by making sure there are no more than eight inches difference in the length of the two fiber paths. (An active node is one in which neither wire loopback nor optic loopback is active.)

Systran's Skew Meter is available for loan or purchase. It is used to evaluate differences in length between two transmit or receive fiber-optic cables. To obtain a Skew Meter call Systran Technical Support at (937) 252-5601. Part numbers for the Skew Meter are:

H-AS-CSKEWMTR-10 (COAX)
H-AS-CSKEWMTR-20 (STD FO MAC)
H-AS-CSKEWMTR-30 (LONG LINK FO MAC)

NOTE: Propagation delay is approximately 5 ns per meter of fiber.

In the event the Skew Meter detects the skew in a cable, the skew must be adjusted toward zero. The skew can be changed by either cutting off a piece of the longer conductor and installing a new connector or by connecting a short extender to the shorter conductor. If a short extender is needed, fiber-optic extender cables are available in lengths in multiples of 5 cm (~ 2 in). The part number for the fiber-optic extender cable is:

H-PR-WST1XXXX-0

The "XXXX" section of the order number represents the length of the fiber-optic extender cable ordered. See Table 6-2 for examples of order numbers for the fiber-optic extender cable.

Table 7-2 Examples Of Fiber-optic Extender Cable Order Numbers

CABLE LENGTH	ORDER NUMBER
5 cm (~ 2 in)	H-PR-WST105R0-0
10 cm (~ 4 in)	H-PR-WST110R0-0
1 m (~ 3.28 ft)	H-PR-WST11000-0

DESIGN EXAMPLE

Two nodes are connected 925 feet apart by a two-piece connected fiber-optic cable and fiber-optic bypass switches installed at each end. Two pieces of cable are used for example purposes only. Using one 925-foot cable would eliminate the 1.0 dB loss for the connector.

1. Check light-power budget:

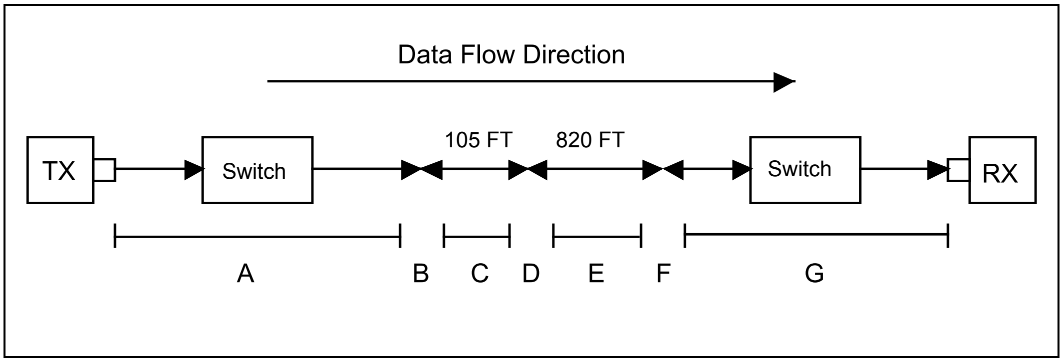


Figure 7-1 Data Flow

Code	Link Element	Attenuation (Power Loss)
A	Bypass Switch	2.00
B	Connector	1.00
C	105 ft. (0.032 Km)	0.10
D	Connector	1.00
E	820 ft. (0.25 Km)	0.75
F	Connector	1.00
G	Bypass Switch	2.00
		Total Attenuation* 7.85 dB

* 7.85 dB power loss is acceptable since it is less than the 10.0 dB light-power budget.

2. Check bandwidth-length budget:

0.28 km x 150 MHz = 42 MHz-km required
(Acceptable since 42 MHz-km is less than the 50 MHz-km maximum)

The design example is based on average data and is useful as a guideline. It should be noted that the only sure method of determining these values is to assemble the system and then measure the losses with an optical power meter.

7.3 Coaxial Cable

Discussion of bit-error rates for coaxial cables is not appropriate. Bit-error rate is a function of signal-to-noise ratio. Since the noise level at the SCRAMNet+ node is known, and the fiber-optic cable is immune to noise (RFI/EMI), it is possible to calculate a bit-error rate because it simply becomes a factor of signal strength. With coaxial cable, the noise is not constant because the cable is affected by the RFI/EMI prevalent in the installed environment. Since that noise level cannot be guaranteed, an estimate of bit-error rate for coaxial cables cannot be provided. However, the same BER/signal-to-noise ratios still apply.

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8. BIT-ERROR RATE

8.1 Overview

The bit-error rate of a fiber-optic SCRAMNet+ link is a function of the signal-to-noise ratio at the receiver. Because SCRAMNet+ has been specifically designed with a very favorable signal-to-noise ratio, it offers a reliable and error-free solution to problems associated with high speed, real-time data communications.

Bit-error rates are a very important consideration for real-time system architects. The lower the bit-error rate, the better the performance and reliability of the overall system. According to the current industry standards, a 10^{-9} bit-error rate is generally considered to be acceptable for a “good” data link. However, at the speeds at which the SCRAMNet+ Network operates, this could result in a bit error every 6.67 seconds!

For this reason, the SCRAMNet+ Network was designed for a bit-error rate of less than 10^{-15}, in even the most demanding installations. Many design features and extra performance margins were incorporated into SCRAMNet+ in order to achieve this level of safety and performance. At 150 Mbps and 100% bandwidth, this rate could result in a single-bit error for every 1,851 hours of operation, or approximately every 78 days. If errors in excess of this rate are found in actual systems in operation, it indicates a problem with damaged cables, cabling conventions, or other component failure.

8.1.1 Signal-to-noise Ratio

The rate at which bit errors are generated on the SCRAMNet+ Network is a function of the signal-to-noise ratio at the input of the fiber-optic receivers. The bit-error rate will increase as network “noise” increases or as the “signal” strength decreases.

The source of noise in many network environments is the effect of electromagnetic interference (EMI) on the wire cabling between nodes. This is one reason for using fiber-optic cables with the SCRAMNet+ Network. The SCRAMNet+ fiber-optic media is generally immune to noise created by EMI. Thus, the only source of noise is the random noise produced by the semiconductors in the receiver, plus any noise induced by the circuitry and environment surrounding the fiber-optic receiver.

Every practical design step has been taken to reduce internal circuit noise and to shield against external environmental noise. Through actual measurement in the laboratory at Systran, it has been determined that noise at the SCRAMNet+ receiver in a normal electronic environment is 0.08 μW RMS.

The function relating the signal-to-noise ratio to the bit-error rate is such that a very small increase in signal strength dramatically reduces the bit-error rate. The strength of the signal at the receiver is dependent on the launched power, and losses of the fiber-optic link.

Because these factors vary for each installation, measuring light power with an average-power meter is the most accurate way of determining the signal strength at the receivers. Since the output of the optical transmitters has a 50% average duty cycle, multiply the reading from the meter by two to obtain “peak power.”

Prior to installation, theoretical calculations must be used. When calculating the received power, tolerances in component specifications must be considered. Generally, calculations using minimum, maximum, and typical specifications should be made to provide accurate insight into the range of possibilities.

8.1.2 Calculations

When the signal strength at the receiver is known, Tables 8-1 and 8-2 are used. Table 8-1 is arranged by µW. Table 8-2 is arranged by dbµW. They are the same for either the 820 nm optics or the 1300 nm optics.

When the signal strength of the outputs are not known, the minimum can be assumed, and Table 8-3 (820 nm) or Table 8-4 (1300 nm) can be used. Table 8-3 assumes a minimum average output of 12 dBµW and Table 8-4 assumes a 10.5 dBµW average output.

As an example, a 1300 nm link with 1500 meters of cable, a Fiber Optic Bypass Switch on each end, and four connector splices has a signal loss of 16 dB (See note 1). Looking in Table 8-4 we find the bit-error rate to be 1.3E-4 errors/bit. This assumes 6 dB loss per kilometer of cable, 1.5 dB per switch and 1 dB per splice.

Once the link is installed, the actual light received will probably be much higher because the power budget method assumes the lowest launched energy, and worst-case losses for optic components. If the light launched was typical (15.5 dBµW) and the fiber components attenuated the light by the 16 dB, then the measured received light would be -0.5 µw resulting in an acceptable rate of 1.9E-8 If the optics are better than their worst-case by only 2 dB total, the rate will improve to 3.3E-18.

A more common link may only be 30 meters of cable, a Fiber Optic Bypass Switch at each end, and two connector splices. This link has a signal loss of 5.2 dB. The low loss of this link is off the chart with a bit-error rate of less than 10^{-21}.

8.1.3 Tables

These notes apply to all four tables:

1. S/N ratio is based on a receiver input noise of 0.8 µW RMS.
2. BER was computed from S/N ratio by the following formulas:
   For S/N less than 10: BER=10**(1.5-.75 * S/N)
   For S/N greater than 10: BER=10**(9-1.5 * S/N)
   where S = Signal is in peak µW, and N = Noise is in µW RMS

   These hold well up to a S/N ratio of 16 (BER 1E-15). Above this they become increasingly pessimistic. (Indicates worse BER than will actually be achieved.)
3. After some limit, other factors will influence BER more than the receiver.
4. Mean hours and years between errors assumes 100% bandwidth utilization.

Table 8-1 Bit-Error Rate Calculation Table 1

Measured Average Power μW	Peak Power μW	Peak Power dBμW	Receive Input Noise r μW	BER Errors/Bit	S/N Ratio 0.08	Mean Hrs. Between Errors Hrs.	Mean yrs. Between Errors Yrs.
-2.52	0.48	-3.187588	0.08	1.0E-03	6	1.9E-09	2.1E-13
-2.44	0.56	-2.51812	0.08	1.3E-04	7	1.4E-08	1.6E-12
-2.36	0.64	-1.9382	0.08	1.8E-05	8	1.0E-07	1.2E-11
-2.28	0.72	-1.426675	0.08	2.4E-06	9	7.8E-07	8.9E-11
-2.2	0.80	-0.9691	0.08	1.0E-06	10	1.9E-06	2.1E-10
-2.12	0.88	-0.555173	0.08	3.2E-08	11	5.9E-05	6.7E-09
-2.04	0.96	-0.177288	0.08	1.0E-09	12	1.9E-03	2.1E-07
-1.96	1.04	0.170333	0.08	3.2E-11	13	5.9E-02	6.7E-06
-1.88	1.12	0.49218	0.08	1.0E-12	14	1.9E+00	2.1E-04
-1.8	1.20	0.791812	0.08	3.2E-14	15	5.9E+01	6.7E-03
-1.72	1.28	1.0721	0.08	1.0E-15	16	1.9E+03	2.1E-01
-1.64	1.36	1.335389	0.08	3.2E-17	17	5.9E+04	6.7E+00
-1.56	1.44	1.583625	0.08	1.0E-18	18	1.9E+06	2.1E+02
-1.48	1.52	1.818436	0.08	3.2E-20	19	5.9E+07	6.7E+03
-1.4	1.60	2.0412	0.08	1.0E-21	20	1.9E+09	2.1E+05

Table 8-2 Bit-Error Rate Calculation Table 2

Measured Average Power dBμW	Peak Power dBμW	Peak Power μW	Receiver Input Noise μW	BER Errors/Bit	S/N Ratio	Mean Hrs. Between Errors Hrs.	Mean Yrs. Between Errors Yrs.
-6.5	-3.5	0.45	0.08	2.3E-03	5.6	8.0E-10	3.3E-13
-6.0	-3.0	0.50	0.08	5.9E-04	6.3	3.2E-09	3.6E-13
-5.5	-2.5	0.56	0.08	1.3E-04	7.0	1.5E-08	1.7E-12
-5.0	-2.0	0.63	0.08	2.2E-05	7.9	8.3E-08	9.5E-12
-4.5	-1.5	0.71	0.08	3.2E-06	8.8	5.8E-07	6.6E-11
-4.0	-1.0	0.79	0.08	3.6E-07	9.9	5.1E-06	5.8E-10
-3.5	-0.5	0.89	0.08	1.9E-08	11.1	9.5E-05	1.1E-08
-3.0	0	1.00	0.08	1.8E-10	12.5	1.0E-02	1.2E-06
-2.5	0.5	1.12	0.08	9.2E-13	14.0	2.0E+00	2.3E-04
-2.0	1.0	1.26	0.08	2.5E-15	15.7	7.5E+02	8.5E-02
-1.5	1.5	1.41	0.08	3.3E-18	17.7	5.7E+05	6.5E+01
-1.0	2.0	1.58	0.08	1.9E-21	19.8	9.6E+08	1.1E+05
-0.5	2.5	1.78	0.08	4.5E-25	22.2	4.1E+12	4.7E+08
0	3.0	2.00	0.08	3.9E-29	24.9	4.8E+16	5.4E+12
0.5	3.5	2.24	0.08	1.1E-33	28.0	1.8E+21	2.0E+17
1.0	4.0	2.51	0.08	8.0E-39	31.4	2.3E+26	2.6E+22
1.5	4.5	2.82	0.08	1.4E-44	35.2	1.3E+32	1.5E+28
2.0	5.0	3.16	0.08	5.1E-51	39.5	3.6E+38	4.1E+34
2.5	5.5	3.55	0.08	3.0E-58	44.4	6.2E+45	7.1E+41
3.0	6.0	3.98	0.08	2.3E-66	49.8	8.2E+53	9.3E+49
3.5	6.5	4.47	0.08	1.8E-75	55.8	1.0E+63	1.2E+59

Table 8-3 Bit-Error Rate Calculation Table 3

Signal Loss dB	Transmitted Peak Pwr dBμW	Received Peak Pwr dBμW	Received Power μW	Receiver Input Noise μW	S/N Ratio	BER Errors/Bit	Mean Hrs. Between Errors Hrs.	Mean Yrs. Between Errors Yrs.
10.0	15.00	5.00	3.16	0.08	39.5	5.1E-51	3.6E+38	4.1E+34
10.5	15.00	4.50	2.82	0.08	35.2	1.4E-44	1.3E+32	1.5E+28
11.0	15.00	4.00	2.51	0.08	31.4	8.0E-39	2.3E+26	2.6E+22
11.5	15.00	3.50	2.24	0.08	28.0	1.1E-33	1.8E+21	2.0E+17
12.0	15.00	3.00	2.00	0.08	24.9	3.9E-29	4.8E+16	5.4E+12
12.5	15.00	2.50	1.78	0.08	22.2	4.5E-25	4.1E+12	4.7E+08
13.0	15.00	2.00	1.58	0.08	19.8	1.9E-21	9.6E+08	1.1E+05
13.5	15.00	1.50	1.41	0.08	17.7	3.3E-18	5.7E+05	6.5E+01
14.0	15.00	1.00	1.26	0.08	15.7	2.5E-15	7.5E+02	8.5E-02
14.5	15.00	0.50	1.12	0.08	14.0	9.2E-13	2.0E+00	2.3E-04
15.0	15.00	0.00	1.00	0.08	12.5	1.8E-10	1.0E-02	1.2E-06
15.5	15.00	-0.50	0.89	0.08	11.1	1.9E-08	9.5E-05	1.1E-08
16.0	15.00	-1.00	0.79	0.08	9.9	3.6E-07	5.1E-06	5.8E-10
16.5	15.00	-1.50	0.71	0.08	8.8	3.2E-06	5.8E-07	6.6E-11
17.0	15.00	-2.00	0.63	0.08	7.9	2.2E-05	8.3E-08	9.5E-12
17.5	15.00	-2.50	0.56	0.08	7.0	1.3E-04	1.5E-08	1.7E-12
18.0	15.00	-3.00	0.50	0.08	6.3	5.9E-04	3.2E-09	3.6E-13
18.5	15.00	-3.50	0.45	0.08	5.6	2.3E-03	8.0E-10	9.1E-14

Table 8-4 Bit-Error Rate Calculation Table 4

Signal Loss dB	Transmitted Peak Pwr dBμW	Received Peak Pwr dBμW	Received Power μW	Receiver Input Noise μW	S/N Ratio	BER Errors/Bit	Mean Hrs. Between Errors Hrs.	Mean Yrs. Between Errors Yrs.
8.5	13.50	5.00	3.16	0.08	39.5	5.1E-51	3.6E+38	4.1E+34
9.0	13.50	4.50	2.82	0.08	35.2	1.4E-44	1.3E+32	1.5E+28
9.5	13.50	4.00	2.51	0.08	31.4	8.0E-39	2.3E+26	2.6E+22
10.0	13.50	3.50	2.24	0.08	28.0	1.1E-33	1.8E+21	2.0E+17
10.5	13.50	3.00	2.00	0.08	24.9	3.9E-29	4.8E+16	5.4E+12
11.0	13.50	2.50	1.78	0.08	22.2	4.5E-25	4.1E+12	4.7E+08
11.5	13.50	2.00	1.58	0.08	19.8	1.9E-21	9.6E+08	1.1E+05
12.0	13.50	1.50	1.41	0.08	17.7	3.3E-18	5.7E+05	6.5E+01
12.5	13.50	1.00	1.26	0.08	15.7	2.5E-15	7.5E+02	8.5E-02
13.0	13.50	0.50	1.12	0.08	14.0	9.2E-13	2.0E+00	2.3E-04
13.5	13.50	0.00	1.00	0.08	12.5	1.8E-10	1.0E-02	1.2E-06
14.0	13.50	-0.50	0.89	0.08	11.1	1.9E-08	9.5E-05	1.1E-08
14.5	13.50	-1.00	0.79	0.08	9.9	3.6E-07	5.1E-06	5.8E-10
15.0	13.50	-1.50	0.71	0.08	8.8	3.2E-06	5.8E-07	6.6E-11
15.5	13.50	-2.00	0.63	0.08	7.9	2.2E-05	8.3E-08	9.5E-12
16.0	13.50	-2.50	0.56	0.08	7.0	1.3E-04	1.5E-08	1.7E-12
16.5	13.50	-3.00	0.50	0.08	6.3	5.9E-04	3.2E-09	3.6E-13
17.0	13.50	-3.50	0.45	0.08	5.6	2.3E-03	8.0E-10	9.1E-14

GLOSSARY

active node ------------------------ A network node which is in neither wire loopback nor optic loopback mode.

balun -------------------------------- A line-balance converter.

bipolar transmission protocol--- Dictates there must be two transmitters and two receivers on each network node.

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.

cabinet kit-------------------------- An interface board that provides fiber-optic or coax-cable access to the node's network connections while maintaining the shielding of the chassis.

cable noise------------------------- Interference on a coaxial cable. This may include static, common mode, and/or crosstalk.

chromatic dispersion------------- An LED emits a wider spectrum of light wavelengths than the laser. Since the different wavelengths of light propagate at different speeds, these arrive at the receiver at different times. The effect of this dispersion is to reduce the 160 MHz-km multimode 62.5/125 fibers to 50 MHz-km.

cladding ---------------------------- A layer of glass or plastic surrounding the glass core that protects the core from contamination and damage, and causes the light signal to bend back toward the core axis. Cladding can vary in diameter from 125 microns to more than 1000 microns.

coaxial cable ---------------------- Coaxial cable is composed of paired, shielded conductors terminated with SMA connectors.

commercial grade ---------------- Commercial grade fiber-optic cable ordered through Systran is the Optical Cable Corporation ULTRA FOX multimode cable.

common mode -------------------- Interference that results from currents flowing between different potential grounds located at various points within a system.

crosstalk---------------------------- The superimposition of either pulsed DC or standard AC signals carried on one wire pair to another wire pair in close proximity.

ECL --------------------------------- Emitter coupled logic.

EMI --------------------------------- Electromagnetic interference.

Fiber Optic Bypass Switch------ 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. The Fiber Optic Bypass Switch automatically mends a broken ring by offering an alternative route for the fiber-optic message to travel. Some ring configurations choose not to have all nodes up and running. In these situations, the bypass switch automatically routes traffic around the unpowered node.

fiber-optic cable ------------------ Optical fibers have an all-dielectric construction. The central, circular glass core propagates the optical signal. Core diameters can vary from 10 microns to over 1000 microns. Systran fiber-optic cable is 62.5/125-micron multi-node cabling with ST connectors. This may be commercial grade, hardened, or plenum-rated cable.

Fresnel Reflection---------------- Light signal return loss. The reflected light interferes with the laser light in the chip and can be a source of noise. In high bit-rate systems, the return loss can be a major source of bit-error rate problems.

hardened cable --------------------- Hardened cables are mud and water immersible (matched pairs).

inserted mode ---------------------- The node is enabled to transmit data onto the ring and receive data from the ring.

isolate mode ----------------------- A network node is excluded from transmitting or receiving data on the network ring.

LED --------------------------------- Light-emitting diode.

light-power budget -----------------Bypass switches, cable connectors and the fiber-optic cables themselves all dissipate the light as it travels from the source to the destination. There must be enough light-power remaining at the destination point to be interpreted by the receiver. The loss of signal (power) allowed from the transmitter to the receiver, before some specific bit-error rate might be exceeded.

MAC -------------------------------- Media access card. The interface between the network ring and the network node. It converts incoming light signals to electronic signals and outgoing electronic signals to light signals.

multimode fiber-------------------- When there are multiple light paths, the fiber-optic cable is referred to as multimode.

network node ---------------------- The host computer network interface.

network ring ----------------------- ring topology.

phantom power -------------------- The Accessory External power is coupled by a lowpass filter to all the coaxial connectors' center conductors.

phantom signal--------------------- The FO_RELAY output is coupled by a lowpass filter to all the coaxial connectors center conductors.

phantom supply-------------------- This mode routes the power coming into the accessory connector from an external supply (possibly a battery supply to the coaxial Media Access Card).

plenum-rated cable---------------- Fire resistant fiber-optic cable with a fluoropolymer jacket and are Plenum listed (duplex pair).

Quad Switch----------------------- An electronic switching center for various SCRAMNet network nodes. It provides up to five fiber-optic or coaxial connections (ports). The data source connected to each port can be switched in or 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.

redundant operation--------------- Requires two sets of Media Access Cards with two sets of dual fiber-optic cables connecting all nodes on the network ring. There are four transmitter lines and four receiver lines.

RFI ---------------------------------- Radio frequency interference.

signal skew ------------------------- The accumulated delay between an active node's two fiber-optic cables. For reliable data recovery by the receiver, there must be less than 1 ns skew.

singlemode fiber------------------- When the fiber is limited to one path, it is called singlemode fiber.

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