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SCSI Fiberoptic Extenders

FEDERAL COMMUNICATIONS COMMISSION
AND
CANADIAN DEPARTMENT OF COMMUNICATIONS
RADIO FREQUENCY INTERFERENCE STATEMENTS

This equipment generates, uses, and can radiate radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio communication. It has been tested and found to comply with the limits for a Class A computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference when the equipment is operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case the user at his own expense will be required to take whatever measures may be necessary to correct the interference.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This digital apparatus does not exceed the Class A limits for radio noise emission from digital apparatus set out in the Radio Interference Regulation of the Canadian Department of Communications.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de classe A prescrites dans le Règlement sur le brouillage radioélectrique publié par le ministère des Communications du Canada.

NORMAS OFICIALES MEXICANAS (NOM) ELECTRICAL SAFETY STATEMENT

INSTRUCCIONES DE SEGURIDAD

1. Todas las instrucciones de seguridad y operación deberán ser leídas antes de que el aparato eléctrico sea operado.

2. Las instrucciones de seguridad y operación deberán ser guardadas para referencia futura.

3. Todas las advertencias en el aparato eléctrico y en sus instrucciones de operación deben ser respetadas.

4. Todas las instrucciones de operación y uso deben ser seguidas.

5. El aparato eléctrico no deberá ser usado cerca del agua—por ejemplo, cerca de la tina de baño, lavabo, sótano mojado o cerca de una alberca, etc.

6. El aparato eléctrico debe ser usado únicamente con carritos o pedestales que sean recomendados por el fabricante.

7. El aparato eléctrico debe ser montado a la pared o al techo sólo como sea recomendado por el fabricante.

8. Servicio—El usuario no debe intentar dar servicio al equipo eléctrico más allá a lo descrito en las instrucciones de operación. Todo otro servicio deberá ser referido a personal de servicio calificado.

9. El aparato eléctrico debe ser situado de tal manera que su posición no interfiera su uso. La colocación del aparato eléctrico sobre una cama, sofá, alfombra o superficie similar puede bloquea la ventilación, no se debe colocar en libreros o gabinetes que impidan el flujo de aire por los orificios de ventilación.

10. El equipo eléctrico deber ser situado fuera del alcance de fuentes de calor como radiadores, registros de calor, estufas u otros aparatos (incluyendo amplificadores) que producen calor.

11. El aparato eléctrico deberá ser connectado a una fuente de poder sólo del tipo descrito en el instructivo de operación, o como se indique en el aparato.

12. Precaución debe ser tomada de tal manera que la tierra fisica y la polarización del equipo no sea eliminada.

13. Los cables de la fuente de poder deben ser guiados de tal manera que no sean pisados ni pellizcados por objetos colocados sobre o contra ellos, poniendo particular atención a los contactos y receptáculos donde salen del aparato.

14. El equipo eléctrico debe ser limpiado únicamente de acuerdo a las recomendaciones del fabricante.

15. En caso de existir, una antena externa deberá ser localizada lejos de las lineas de energia.

16. El cable de corriente deberá ser desconectado del cuando el equipo no sea usado por un largo periodo de tiempo.

17. Cuidado debe ser tomado de tal manera que objetos liquidos no sean derramados sobre la cubierta u orificios de ventilación.

18. Servicio por personal calificado deberá ser provisto cuando:

    A: El cable de poder o el contacto ha sido dañado; u

    B: Objetos han caído o líquido ha sido derramado dentro del aparato; o

    C: El aparato ha sido expuesto a la lluvia; o

    D: El aparato parece no operar normalmente o muestra un cambio en su desempeño; o

    E: El aparato ha sido tirado o su cubierta ha sido dañada.

Contents

1. Specifications

Compliance —	FCC Class A, DOC Class/MDC classe A
Standards —	SCSI: ANSI X3.131 and X3T9.2
Interfaces —	SCSI: Narrow SCSI: IC492 and IC493 models: Differential; IC494 and IC495 models: Single-ended; Fiberoptic: Standard full-duplex
Compatibility —	SCSI: SCSI-1 and Fast SCSI (SCSI-2); Fiberoptic: 50/125-μm or 62.5/125-μm multimode cable
Protocol —	Synchronous or asynchronous
Maximum Data Rate —	SCSI: 10 Megabytes per second (parallel); Fiberoptic: 175 MHz (serial)
Maximum Signal Slew —	5 ns
Maximum SCSI-to-Fiber Conversion Delay —	200 ns
Optical Wavelength —	IC492 and IC495 models: 1300 nm; IC493 and IC494 models: 830 nm
Bit-Error Rate (BER) —	10^{-12} typical
Throughput —	Approximately 225 Kilobytes per second (async) or 4 to 5 Megabytes per second (sync) typical end-to-end

Maximum Distance —

IC492 models:
    From SCSI port to most distant attached device:
    25 m (82 ft.);
    Between fiberoptic ports of Extender pairs:
    600 m (1968 ft.);
IC493 models:
    From SCSI port to most distant attached device:
    25 m (82 ft.);
    Between fiberoptic ports of Extender pairs:
    2000 m (6561 ft., 1.2 mi.);
IC494 models:
    From SCSI port to most distant attached device:
    6 m (19.7 ft.) at 5 MBytes/s or 3 m (9.8 ft.) at
        10 MBytes/s;
    Between fiberoptic ports of Extender pairs:
    2000 m (6561 ft., 1.2 mi.);
IC495 models:
    From SCSI port to most distant attached device:
    6 m (19.7 ft.) at 5 MBytes/s or 3 m (9.8 ft.) at
        10 MBytes/s;
    Between fiberoptic ports of Extender pairs:
    600 m (1968 ft.);

SCSI ID —

None required

Termination —

Internal (can be removed in favor of an external
    terminator):
    IC492, IC493 models: Differential;
    IC494, IC495 models: Single-ended, active

Internal Terminator Power —

1 amp; internal resettable fuse will provide 5 VDC
    at 1 amp

User Controls —

(2) Rear-mounted:
    (1) ON/OFF rocker switch;
    (1) 110-/220-VAC screw-dial

Indicator —

(4) Front-mounted LEDs: Power, Link Active, Bus
    Active, Link Error

Connectors —

Power: (1) IEC 320 male inlet;
SCSI:
    IC492 and IC493 models: (1) 50-pin high-density
        female;
    IC494 and IC495 models: (1) 50-pin Centronics
        female;
Fiberoptic: (2) ST female

Power —

Models with "-A" suffix in product code:
    Through detachable 6-ft. (1.8-m) power cord
        (included) and internal power supply:
            Optimal Input: 110 VAC, 60 Hz;
            Input Range: 99 to 121 VAC, 48 to 65 Hz;
            Input Current Rating: 1.5 amps;
Models with "-AE" suffix in product code:
    Through detachable power cord and internal
        power supply:
            Optimal Input: 220 VAC, 50 Hz;
            Input Range: 198 to 242 VAC, 48 to 65 Hz;
            Input Current Rating: 1.5 amps;
Consumption (all models): 7 watts

MTBF —

200,000 hours

Temperature Tolerance —

32 to 131° F (0 to 55° C)

Humidity Tolerance —

0 to 90% noncondensing

Size —

2.1"H x 6"W x 9.6"D (5.3 x 15.2 x 24.4 cm)

Weight —

3 lb. (1.4 kg)

2. Introduction

2.1 General Overview

The Small Computer Systems Interface (SCSI, pronounced "scuzzy") bus is one of the most popular interfaces for connecting peripheral devices to a computer system. However, the normal maximum cable distance from a computer to a SCSI peripheral is just 6 m (19.7 ft.) for "single-ended" SCSI connections or 25 m (82 ft.) for "differential" SCSI connections.

By using a pair of SCSI Fiberoptic Extenders and fiberoptic cable, you can far exceed these maximum distances: You can connect SCSI components such as disk drives, CD-ROM systems, RAID arrays, tape drives, and laser printers to a computer up to 600 m (1968 ft., with IC492 or IC495 models) or even 2 km (6561 ft., about 1.2 mi., with the IC493 and IC494 models) away, as shown in Figure 2-1 below.

Because the Extenders are completely transparent to your SCSI system, you don't need any additional hardware or software to install or operate them.

Also, as long as they are designed to drive the same distance, you can place a single-ended Extender on one end of a fiber link and a differential Extender on the other end of the link. This lets you attach differential peripherals to a computer with a single-ended interface, or vice versa.
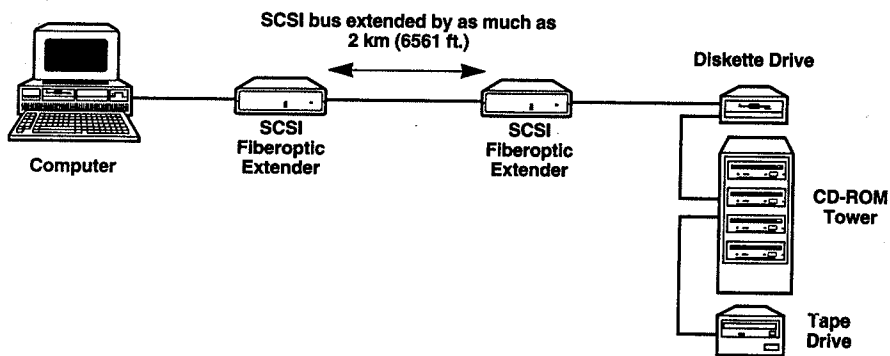

Figure 2-1. Sample application using SCSI Fiberoptic Extenders.

2.2 Features

- Extend SCSI bus by up to *2 kilometers (over 6500 feet)*

- Compatible with both SCSI-1 and Fast SCSI (SCSI-2)

- 10 Megabyte-per-second maximum data rate

- Compatible with synchronous and asynchronous applications

- Transparent to SCSI controllers and peripherals; require no SCSI IDs

- Differential and single-ended units can be paired to convert bus types

- Have standard ST® fiberoptic connectors and are compatible with standard types of fiberoptic cable

- Fiberoptic link is immune to electromagnetic interference

- Internal bus termination ("active" type in single-ended models)

- No software required

- User-installable

The SCSI Fiberoptic Extenders support a maximum SCSI data rate of 10 Megabytes per second in asynchronous or synchronous mode. They support the "Fast SCSI" standard, available in top-of-the-line computers and peripherals. And proprietary switching enables the Extenders to maintain complete SCSI command functionality and remain transparent to the user.

The Extenders conform to ANSI X3.131 and X3T9.2 specifications for device termination. Disconnect and Reselect are fully supported to ensure complete SCSI compatibility. And the Extenders do not require SCSI device addresses (ID numbers).

With a pair of Extenders, not only can you extend a single SCSI chain (a bus with at least one host computer), you can also link two remote SCSI chains as shown in Figure 2-2 on the next page. This enables computer users in far-separated workgroups to share multiple SCSI peripherals. Also, if one Extender in the pair is single-ended and the other is differential, you can even interconnect chains or bus segments of these two types.
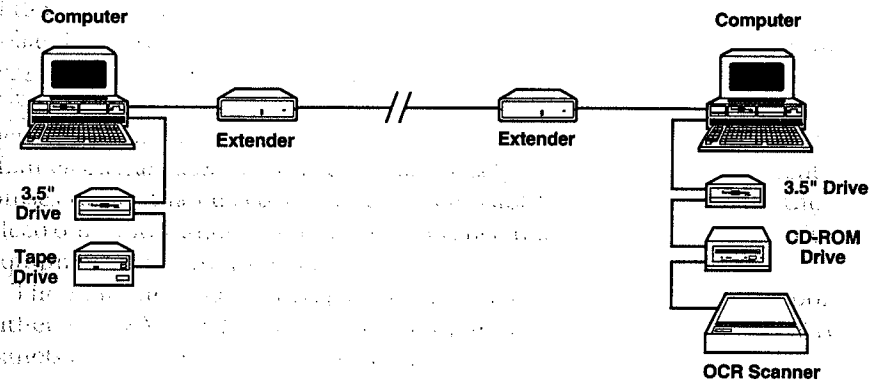
Figure 2-2. Using SCSI Fiberoptic Extenders to link SCSI chains.

Attach the appropriate type of SCSI cable to the SCSI connector (50-pin Centronics® or high-density female) on an Extender's rear panel to connect the Extender to a host or peripheral. The Extenders contain internal differential or active single-ended bus terminators to improve SCSI reliability and performance; you can remove these if your system requires external termination.

You can run a standard duplex fiberoptic cable with ST connectors between local and remote Extender units. Fiber cable is lighter and thinner than electrical cable, so it installs more easily. And, since it carries light pulses rather than electrical signals, fiber cable is not susceptible to the electronic and radio-frequency interference that can be caused by industrial equipment and other devices.

The Extenders have universal IEC 320 male power inlets and support either 110-VAC or 220-VAC operation; use the rotary switch on their rear panels to select the appropriate voltage for your application.

3. Installation

3.1 Unpacking Your Shipment

Check the contents of the shipping carton as you unpack your SCSI Fiberoptic Extender. The package should at least contain:

- (1) SCSI Fiberoptic Extender

- (1) Package of replacement parts consisting of:
  (1) 1.5-Amp input-power fuse
  (1) 110-ohm terminator-network resistor
  With single-ended Extender models only: (1) 1-Amp terminator fuse

- This user's manual

Customers in North America and certain other world regions will also receive an AC power cord. If you didn't receive everything, or if anything arrived damaged, call Black Box immediately.

3.2 Placement

Your SCSI Fiberoptic Extender requires no additional software to operate. The only thing necessary to operate it is a nearby working AC outlet.

You can install the Extender in any position and any location near your SCSI devices that is convenient for you. The only exceptions are:

- You must make sure that the ventilation slots on the sides of the unit get adequate air flow.

- Don't install the unit near any devices that generate (a) excessive heat, such as desk lamps or radiators, or (b) excessive electrical noise, such as motors, fluorescent lights, or compressors—though fiberoptic data transmission would not be affected by this, regular SCSI data transmission would be.

3.3 The Installation Procedure

3.3.1 REMOVING OR REPLACING THE INTERNAL TERMINATORS

If your SCSI system requires that all of your devices be externally terminated, you must open the SCSI Fiberoptic Extenders' chassis and remove or replace their internal terminators. Follow the directions for doing so in **Appendix C**. For a discussion of termination options, see Section 3.3.5.

CAUTION!

Make sure that the SCSI Fiberoptic Extenders are powered OFF and unplugged before you open them.

3.3.2 SELECTING THE LINE VOLTAGE AND ATTACHING THE POWER CORD

The next step in installing your SCSI Fiberoptic Extenders is to tell them what input line voltage to expect. Use the rotary switch on the Extenders' rear panels (one is shown in Figure 3-1 below) to select either 110 VAC (the setting appropriate for North America, Japan, etc.) or 220 VAC (appropriate for Europe, etc.). Make *very* sure that this switch is set correctly before continuing with the installation, or you could damage the Extender.

Now attach the power cords to your Extenders. The cords should have an IEC 320 female outlet at one end, which will fit the Extenders' IEC 320 male inlets. The other end of the cords should have a plug suitable for your type of outlet, but do *not* plug the cords into outlets yet.
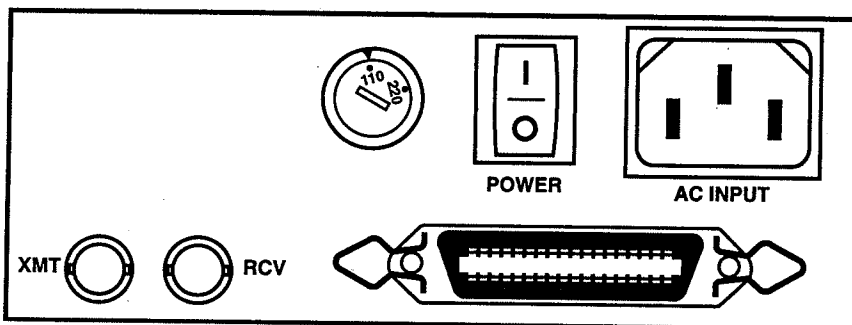

Figure 3-1. The SCSI Fiberoptic Extender's rear panel (single-ended unit shown).

3.3.3 POWERING DOWN THE SYSTEM

Before you insert the SCSI Fiberoptic Extenders into your SCSI system, power down all of the computers and peripherals that will be part of the same SCSI bus as the Extenders. This minimizes the chances that problems or accidental damage will occur.

3.3.4 CONNECTING THE EXTENDERS TO THE SCSI BUS

You may install the SCSI Fiberoptic Extenders at any point on the SCSI bus. They each have a single SCSI connector with locking tabs or clips for secure connections. This port is not computer- or peripheral-specific, so you can connect cable from a computer or SCSI peripheral to it.

Use good cable for your SCSI bus. High-quality shielded SCSI cables will provide a link with the greatest noise immunity, and across the greatest distance, between the Extenders and your other SCSI devices. No matter how good the cable is, however, no SCSI cable connected to the Extender may be longer than 6 m (19.7 ft.) for single-ended models—3 m (9.8 ft.) if you're running at 10 MBytes/s—or 25 m (82 ft.) for differential models. We highly recommend that even differential cable runs be kept to a maximum of 5 or 10 m (16.4 or 32.8 ft.) for optimum system performance.

CAUTION!

Do *not* attach a single-ended Extender to a differential SCSI bus. This could damage the Extender even though it has internal protection.
 Don't attach a differential Extender to a single-ended bus either. The differential models also have internal protection, and the unit would not be damaged by a brief attachment to a single-ended bus, but it could damage the other devices on the bus.

3.3.5 ENSURING PROPER TERMINATION

All SCSI buses must be properly terminated at each end. But because the SCSI Fiberoptic Extenders essentially tie together two SCSI chains that can each be as long as an entire bus, there has to be extra termination on each side of the Extender link in addition to the standard terminators at each end of the bus.

That's a total of four terminators—two on each side of the Extender link. Figure 3-2 on the next page shows the locations of the required terminators. Be careful, though—your system will fail if more than two terminators are installed on either side of the Extender link.
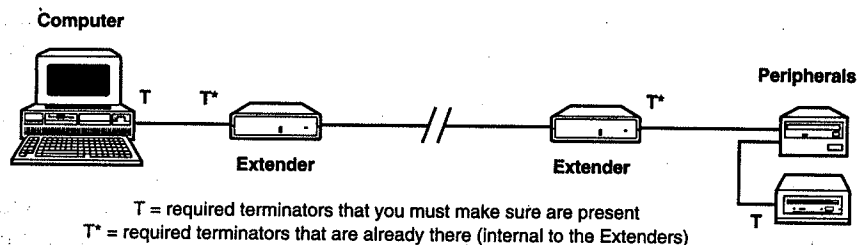
Figure 3-1. Termination in a SCSI Fiberoptic Extender system.

Your SCSI Fiberoptic Extender comes standard with internal terminators that provide the necessary termination on each side of the Extender. However, your application or peripherals might require that you use external terminators with the Extender, in which case you should already have removed or replaced the internal terminators; if you haven't yet, see Section 3.3.1 and Appendix C. (The Extender contains an internal resettable fuse that can provide power—1 amp at 5 volts—to an external terminator. Note that the Extender contains internal protection and will not be affected if other SCSI devices provide terminator power.)

3.3.6 RUNNING FIBEROPTIC CABLE BETWEEN THE EXTENDER PAIR

To be run between a pair of SCSI Fiberoptic Extenders, a fiberoptic cable should be standard full-duplex multimode type with male ST connectors and core/cladding diameter of 50/125-μm or 62.5/125-μm. If the cable you want to use fits this description, examine its ends: Most duplex fiber cable is marked to indicate which fiber connector is transmit (XMT) and which is receive (RCV). Attach the appropriate connectors to the correspondingly labeled ST connectors on the rear panels of the local and remote SCSI Fiberoptic Extenders. Do this for both the local and remote Extender units.

For the link to operate properly, connect the transmit (XMT) port of the local Extender to the receive (RCV) port of the remote Extender and connect the receive (RCV) port of the local Extender to the transmit (XMT) port of the remote Extender.

To identify unmarked fiber connectors, attach both connectors at one end of the cable to the local SCSI Fiberoptic Extender and then briefly plug in the unit and turn it ON. Look at (*not* into!) both connectors at the opposite end of the cable: A faint red light will be visible at the tip of one of the

connectors—the one attached to the transmit fiber. (You might have to turn the room lights down or off to see this.) The transmit-fiber connector should be attached to the receive (RCV) port of the remote Extender unit. Turn OFF and unplug the local Extender when you finish this test.

Take care to keep the fiberoptic connectors and optical components free of dust and dirt. And whenever cables are not atttached to the Extender's ST ports, cover them with the protective plastic caps included with the unit.

If you use low-loss cable with high-quality connectors, you might be able to achieve the maximum distance between units: 600 m (1968 ft.) for the 1300-nm models or 2 km (6561 ft.) for the 830-nm models. (Do *not* install a 1300-nm unit on one end of the fiber link and an 830-nm unit on the other; the units will not function properly and could be damaged. You may, however, install a single-ended unit on one end and a differential unit on the other, as mentioned earlier.) You will probably not be able to run the maximum distance if any of these things is true of your fiberoptic cable:

- It is single-mode rather than multimode (in this case, the link will not actually work at all);

- Its core/cladding diameter is not supported by the Extenders (see the first paragraph of this section);

- It is not terminated properly (that is, the connectors aren't the right type or size, or they're poorly attached, crimped, or polished, etc.); or

- It has been spliced anywhere along its length.

3.3.7 POWERING UP THE SYSTEM

You may now plug in both SCSI Fiberoptic Extenders and turn them ON by moving the Power switch on their rear panels to the "|" position. Check the LINK ACTIVE LEDs on the front panels of both units. If they are both lit, the local and remote units are both powered up and (so far) are communicating properly with each other.

Now power up any SCSI peripherals on the bus, and lastly power up any host computers on the bus. This completes the installation of your SCSI Fiberoptic Extenders; your extended SCSI system should be ready for continuous operation.

4. Operation

4.1 The Front Panel and Its LEDs

Each SCSI Fiberoptic Extender has four LEDs on its front panel, shown in Figure 4-1 below, that give you at-a-glance status information about the unit's operation:

POWER—Lights when the unit is plugged in, turned ON, and receiving AC power.

LINK ACTIVE—Lights when two SCSI Fiberoptic Extenders are powered up and connected to one another with fiberoptic cable.

BUS ACTIVE—Dark when there is no communication on the SCSI bus; flickers (in response to the SCSI interface's BUSY signal) when devices are communicating on the bus.

LINK ERROR—Lights when the integrity of the fiberoptic link dips below specification (data errors have occurred). The SCSI Fiberoptic Extender will logically disconnect itself from the SCSI bus when a Link Error is detected.
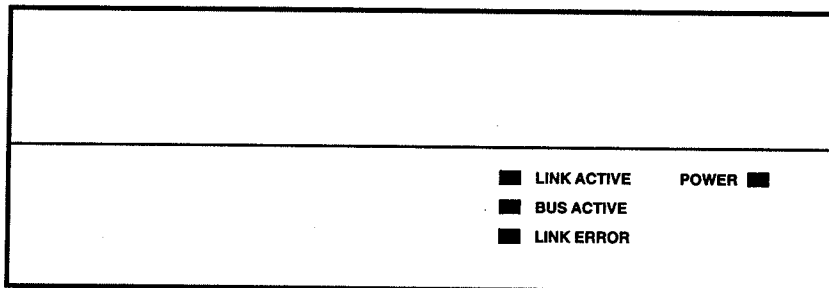

> ■ LINK ACTIVE   POWER ■
> ■ BUS ACTIVE
> ■ LINK ERROR

Figure 4-1. The SCSI Fiberoptic Extender's front panel.

4.2 How the Extenders Work

The local SCSI Fiberoptic Extender converts SCSI data and command information into a serial data stream that's transmitted over a high-speed (175-MHz) fiberoptic interface to the remote Extender. The remote unit decodes the data stream and reconverts it back into proper SCSI signals.

The fiberoptic serial link conforms to the ANSI X3T9.5 encoding scheme specified for FDDI local area networks and is virtually immune to all forms of radio-frequency and electromagnetic interferences (RFI/EMI). It is virtually impossible to tap the link without being authorized or detected.

SCSI-bus signals are routed through proprietary switching logic that enables the Extenders to appear "transparent" to other devices on the bus. Each Extender will logically disconnect itself from the SCSI bus if the fiberoptic link fails or it stops receiving power.

4.3 System Performance

The SCSI Fiberoptic Extenders will support any combination of asynchronous and synchronous SCSI devices on the bus. Overall system performance will depend on the individual data rate and protocol of each SCSI device, plus the overhead of the host computer.

In general, devices connected to an Extender system with a 100-m (305-ft.) fiberoptic link can expect to achieve aggregate data rates of 225 kilobytes per second in asynchronous mode. In synchronous mode, with a byte offset of 8, sustainable data rates of 4 megabytes per second can be expected. A synchronous offset of 16 will provide 5-megabyte-per-second data rates.

4.4 Using a Secondary Channel

The SCSI Fiberoptic Extender supports a maximum "Fast SCSI" data rate of 10 megabytes per second. To ensure optimum system performance, some system configurations might require a secondary SCSI channel to interface with the Extender. In a configuration like the one shown in Figure 4-2 below, the local high-speed peripherals would be on the primary SCSI bus; the secondary bus would be devoted entirely to the Extenders and remote peripherals. Note that the bus that the Extenders are *not* attached to would need to be terminated separately, as shown in the figure.
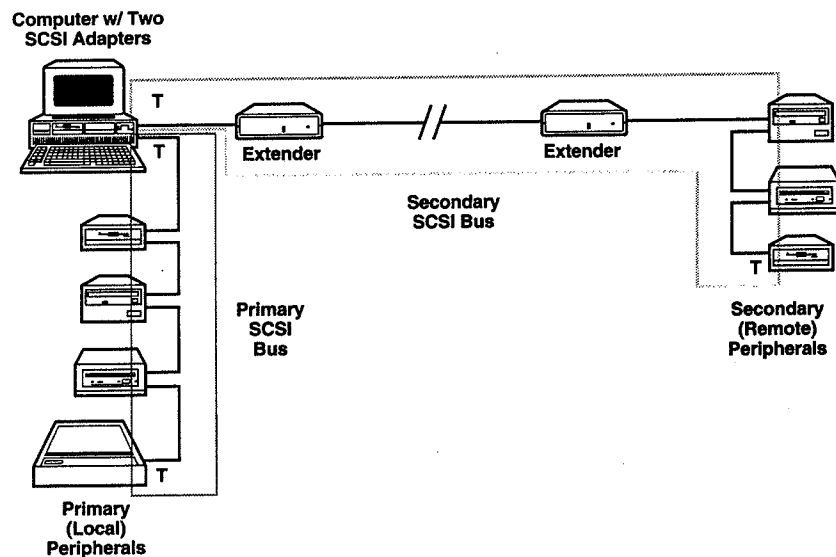

Figure 4-2. A two-channel application (locations of the required terminators are marked by the letter "T").

5. Troubleshooting

5.1 Contacting Black Box

If you determine that your SCSI Fiberoptic Extender is malfunctioning, *do not attempt to alter or repair the unit.* It contains no user-serviceable parts. Call Black Box Technical Support at (412) 746-5500.

Before you do, make a record of the history of the problem. We will be able to provide more efficient and accurate assistance if you have a complete description, including:

- the nature and duration of the problem.

- when the problem occurs.

- the components involved in the problem.

- any particular application that, when used, appears to create the problem or make it worse.

5.2 Shipping and Packaging

If you need to transport or ship your SCSI Fiberoptic Extender:

- Package it carefully. We recommend that you use the original container.

- If you are shipping the Extender for repair, make sure you include its power cord and its bag of replacement parts. If you are returning the Extender, make sure you include everything you received with it. Before you ship, contact Black Box to get a Return Materials Authorization (RMA) number.

Appendix A: Connector Pinouts

A.1 Single-Ended SCSI (50-Pin Centronics) Ports (IC494 and IC495 Models)

The single-ended "narrow" SCSI ports on the IC494 and IC495 versions of the SCSI Fiberoptic Extender are pinned as shown in Table A-1 below.

Table A-1. Pinout Chart for Single-Ended Narrow SCSI Connectors

SIGNAL NAME	PIN NUMBER	SIGNAL NAME	PIN NUMBER
–DB(0)	26	GROUND	1
–DB(1)	27	GROUND	2
–DB(2)	28	GROUND	3
–DB(3)	29	GROUND	4
–DB(4)	30	GROUND	5
–DB(5)	31	GROUND	6
–DB(6)	32	GROUND	7
–DB(7)	33	GROUND	8
–DB(P)	34	GROUND	9
GROUND	35	GROUND	10
GROUND	36	GROUND	11
GROUND	37	GROUND	12
TERMPWR	38	OPEN	13
GROUND	39	GROUND	14
GROUND	40	GROUND	15
–ATN	41	GROUND	16
GROUND	42	GROUND	17
–BSY	43	GROUND	18
–ACK	44	GROUND	19
–RST	45	GROUND	20
–MSG	46	GROUND	21
–SEL	47	GROUND	22
–C/D	48	GROUND	23
–REQ	49	GROUND	24
–I/O	50	GROUND	25

A.2 Differential SCSI (50-Pin High-Density) Ports (IC492 and IC493 Models)

The differential "narrow" SCSI ports on the IC492 and IC493 versions of the SCSI Fiberoptic Extender are pinned as shown in Table A-2 below.

Table A-2. Pinout Chart for Differential Narrow SCSI Connectors

SIGNAL NAME	PIN NUMBER	SIGNAL NAME	PIN NUMBER
GROUND	26	GROUND	1
–DB(0)	27	+DB(0)	2
–DB(1)	28	+DB(1)	3
–DB(2)	29	+DB(2)	4
–DB(3)	30	+DB(3)	5
–DB(4)	31	+DB(4)	6
–DB(5)	32	+DB(5)	7
–DB(6)	33	+DB(6)	8
–DB(7)	34	+DB(7)	9
–DB(P)	35	+DB(P)	10
GROUND	36	DIFFSENS	11
RESERVED	37	RESERVED	12
TERMPWR	38	TERMPWR	13
RESERVED	39	RESERVED	14
–ATN	40	+ATN	15
GROUND	41	GROUND	16
–BSY	42	+BSY	17
–ACK	43	+ACK	18
–RST	44	+RST	19
–MSG	45	+MSG	20
–SEL	46	+SEL	21
–C/D	47	+C/D	22
–REQ	48	+REQ	23
–I/O	49	+I/O	24
GROUND	50	GROUND	25

Appendix B: SCSI Technical Information

B.1 SCSI Basics

This section briefly discusses some of the major topics involved with the SCSI (Small Computer Systems Interface).

SCSI-1

The original specification supported data transfers up to 5 MB per second on an 8-bit-wide parallel data bus. However, the SCSI-1 standards did not solve certain incompatibility problems between host adapters and peripheral devices. The need to improve compatibility, increase transfer rates, and add other features for better performance prompted a review of this specification.

SCSI-2

Improved compatibility and higher transfer rates were provided in this enhancement. The addition of "Wide SCSI" permitted 16 or 32 bits to be transferred in parallel, the latter requiring two cables. "Fast SCSI," which doubled previous maximum data rates, was also added. The new specifications made it possible to achieve synchronous data transfers at up to 10 Megabytes per second for 8-bit buses, 20 MB/s for 16-bit buses, and 40 MB/s for 32-bit buses.

Ultra SCSI (SCSI-3)

The most significant additions in this enhancement were the ability to address up to 32 devices, a 16-bit single-cable data bus, and a serial SCSI protocol. The Ultra SCSI standard has been split into several subdocuments, including the SCSI Parallel Interface (SPI), which is a hardware specification, and the SCSI Interlocked Protocol (SIP), which is a software-link protocol.

Signal Wiring: Single-Ended vs. Differential

The signal wiring used in a SCSI bus has an impact on bus performance. The two wiring techniques generally used for SCSI are called "single-ended" and "differential."

With single-ended wiring, a single wire carries the signal from initiator to target. Single-ended circuitry is not noise-resistant and is generally limited to about 6 meters at data-transfer speeds of 5 MB per second or 3 meters at 10 MB per second.

Differential wiring utilizes two wires for each signal and offers exceptional noise resistance because it does not rely on a common ground. This allows cables up to 25 meters and reliable operation at 10 MB per second or greater. Differential wiring and circuitry is more complex than single-ended and generally tends to be more expensive to implement.

Termination: Passive vs. Active

The majority of problems encountered with SCSI-bus installations are due to unbalanced or improper impedances on the SCSI-bus transmission cables, caused by interactions with and between varying manufacturers' peripheral devices. SCSI uses "terminators" (electrical regulators, if you will) to compensate for the inherent impedance mismatches on SCSI buses, to which several peripheral devices (such as hard drives, CD-ROM drives, scanners, and printers) are typically attached.

"Passive" terminators are the most basic type. They are resistor networks that allow signal voltages to vary with the load and terminator power supplied. This is fine on differential buses, and all differential terminators are by nature passive. It's another story on single-ended buses, however: Passive single-ended terminators are usually supplied with peripherals and frequently do a poor job of balancing bus impedance. The varying voltages they permit result in unstable signals from end to end on the bus and cause data errors. Passive terminators are no longer recommended by ANSI for single-ended SCSI-bus designs.

"Active" terminators, by contrast, add a voltage regulator to the circuit to regulate signal voltages with varying loads and termpower, allowing a consistent signal to be transmitted everywhere on the bus and thereby compensating for varying bus lengths and signal loads. Active termination is now the minimum ANSI-recommended termination for single-ended SCSI buses.

B.2 SCSI Installation Tips

Keep your SCSI chain short. Official SCSI specifications limit a single-ended SCSI chain to no more than 6 meters (19.7 feet) long. Practical experience says the shorter the better. The maximum length you should allow between devices is 3 feet (about 1 meter).

Never assign the same SCSI ID number to two devices on the same bus. SCSI uses these numbers as addresses to ensure that information goes to the correct location. Giving two devices the same address ean result in lost information.

Know that some SCSI-ID numbers may be reassigned. Internal boot-source hard drives are usually set to ID "0," while secondary hard drives are set to "1." Motherboards and host adapters are generally set to ID "7."

Always terminate the first and last devices on the chain. Drives purchased specifically for internal use nearly always arrive with terminators installed. When in doubt, call the vendor you purchased a device from.

If the last device on the chain has two SCSI connectors, attach the cable to one and a terminator to the other. Otherwise, you'll have an open connector that may cause noise on the SCSI chain.

Always turn off the power to your computer and SCSI devices before swapping cables or moving devices around. SCSI cables contain sensitive data-transmission lines and one or more live power wires.

Turn on your SCSI devices before you turn on the computer. Some SCSI devices will not mount if they are not running when you power up your computer. Shutting down your computer first and then the attached SCSI devices allows your system to completely "flush" itself.

B.3 SCSI Signal Descriptions

SCSI requires a total of 18 signals, described below.

BSY (BUSY): A signal that indicates that the bus is being used.

SEL (SELECT): A signal used by an initiator to select a target or by a target to reselect an initiator.

C/D (CONTROL/DATA): A signal driven by a target that indicates whether CONTROL or DATA information is on the DATA BUS. A "true" logic level indicates CONTROL.

I/O (INPUT/OUTPUT): A signal driven by a target that controls the direction of data movement on the DATA BUS with respect to an initiator. A "true" logic level indicates input to the initiator. This signal is also used to distinguish between SELECTION and RESELECTION phases.

MSG (MESSAGE): A signal driven by a target during the MESSAGE phase.

REQ (REQUEST): A signal driven by a target to indicate a request for a REQ/ACK data-transfer handshake.

ACK (ACKNOWLEDGE): A signal driven by an initiator to indicate an acknowledgement for a REQ/ACK data-transfer handshake.

ATN (ATTENTION): A signal driven by an initiator to indicate the ATTENTION condition.

RST (RESET): A signal that indicates the RESET condition.

DB(7 through 0, plus P) (DATA BUS): For narrow SCSI, eight data-bit signals, plus a parity-bit signal, that form a DATA BUS. DB(7) is the most significant bit and has the highest priority during the ARBITRATION phase. Bit number, significance, and priority decrease downward to DB(0). A data bit is defined as "one" when the signal value is "true" and is defined as "zero" when the signal value is "false." The DB(P) bit is used to maintain odd parity.

Appendix C: Removing or Replacing Internal Components

If your application requires that the SCSI Fiberoptic Extenders be externally terminated, or if a surge or other electrical problem damages an Extender's internal terminators or fuses, you might need to remove or replace these components. To do so, take these steps:

1. *If the Extenders are already installed and operating in your system:* Make sure that no one is transmitting data on the SCSI bus across the Extender link. Once this has been verified, turn OFF and unplug the SCSI Fiberoptic Extender pair, then disconnect the two units from their power supplies and from the rest of the SCSI bus. (Even if one unit in the pair is not affected, working on one without deactivating the other will cause a Link Error, and the still-active unit will logically disconnect itself anyway.) We recommend that you also shut down all host computers on the SCSI bus to avoid confusing them.

2. Examine the bottom of the unit you're going to work on. Use a Phillips screwdriver to unscrew the four screws—one in the center of each of the unit's legs, as shown in Figure C-1 on the next page—until they're loose, then remove and set aside the legs.

CAUTION!
Make sure that the SCSI Fiberoptic Extender is powered OFF and unplugged before you open it.

3. Gently separate the two halves of the unit and examine the Extender's circuit board; compare it to the illustration in Figure C-2 (on page 30, for the single-ended models) or C-3 (on page 31, for the differential models) to find any components you need to remove. "F1," close to the bottom of the picture, is the input-power fuse; "F2," at the top left of Figure C-2 only, is the terminator fuse (used in the single-ended models only—the replacement is small and green as opposed to the larger yellow original); and "RN1" through "RN3" (single-ended models) or "RN8" (differential models), at the top of the picture, are the terminators ("resistor networks") themselves.
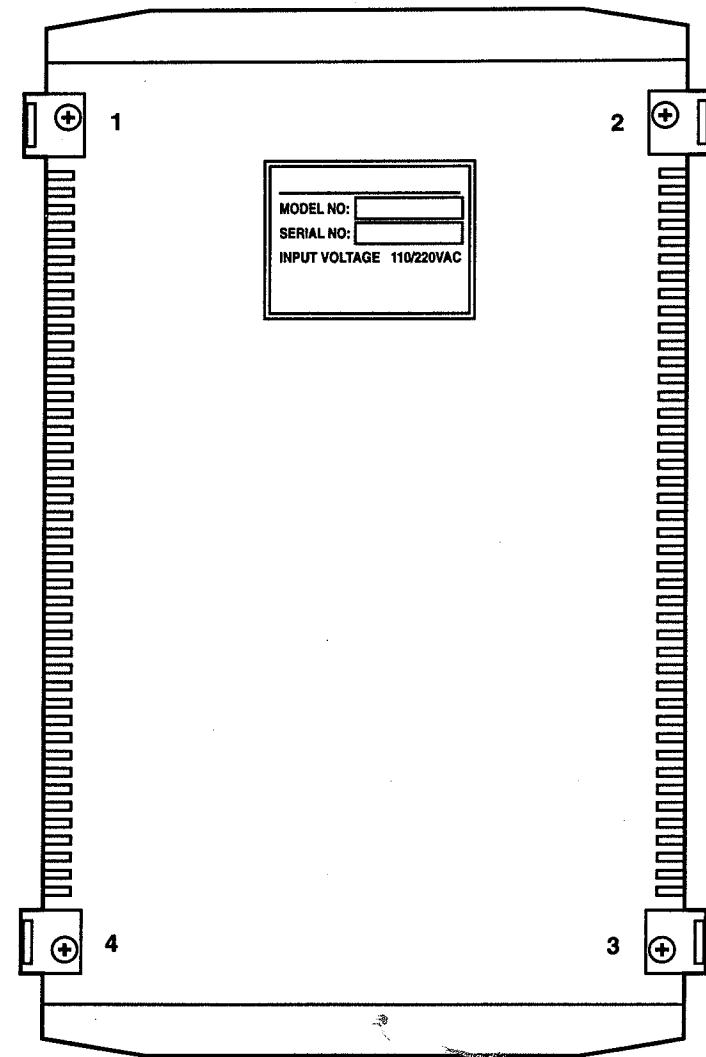
Figure C-1. Locations of the screws that must be removed.
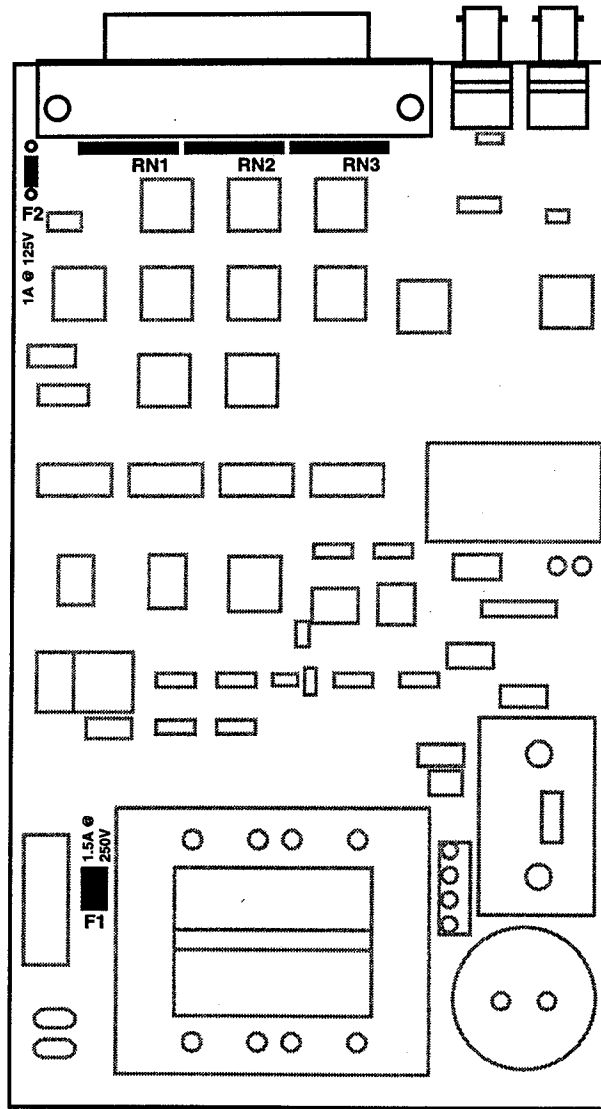
Figure C-2. A single-ended Extender's circuit board.
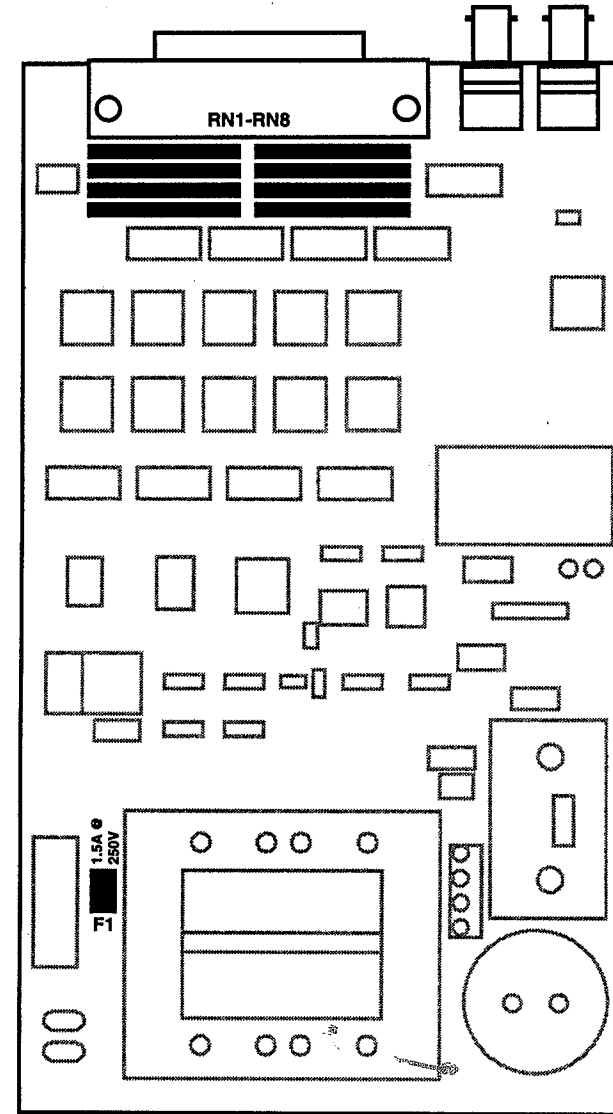
Figure C-3. A differential Extender's circuit board.

4. Remove any of these components that you have to, replacing them if necessary with ones from the bag of replacement parts shipped with the Extender. (If you require more than one replacement terminator, or if you have to replace a component for a second or subsequent time, call Black Box for technical support.)

   To remove or replace the input-power fuse or a terminator, use a chip extractor, tweezers, or a pair of angled needle-nosed pliers to gently slide the old component out of its moorings and slide the new part in.

   The Extender's original terminator fuse is large and resettable: It functions much like a thermostat, and if it opens (blows), turning the Extender OFF and back ON again will close (reset) it. Normally you would not ever need to replace this, but if for whatever reason you should have to, we have provided a replacement. (Note that the substitute fuse is smaller and cannot be reset; if it ever blows, it in turn must be replaced.) Removing and replacing the terminator fuse requires further disassembly of the Extender and some soldering, and should only be attempted by a trained professional; call Black Box for technical support.

5. Put the two halves of the Extender back together, put the unit's legs back on, and screw the four leg-center screws back in.

6. Reconnect the Extender pair to the SCSI bus and to their power supplies.

7. Plug the Extenders back in and turn them ON. Lastly, if you turned OFF any host computers in Step 1, turn them back ON.

This completes the component-replacement procedure.

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