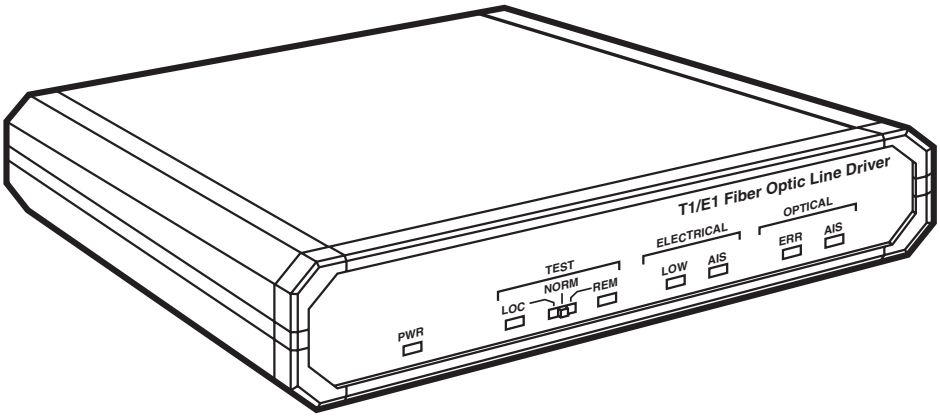
BLACK BOX®
NETWORK SERVICES

SEPTEMBER 2000

MT650A-ST MT651A-ST MT652AE-FC
MT650AE-ST MT651AE-ST MT653A-ST-D48
MT650C MT651C

T1/E1 Fiberoptic Line Drivers

(T1/E1 FOLDs)



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FEDERAL COMMUNICATIONS COMMISSION, INDUSTRY CANADA, AND EUROPEAN UNION 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 Industry Canada.

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

EN 55022 Warning: This is a Class A product. In a domestic environment, this product might cause radio interference, in which case the user might be required to take adequate measures to correct the interference.

EUROPEAN UNION TELECOMMUNICATION SAFETY STATEMENT

The safety status of each of the E1 and T1 ports on the T1/E1 Fiberoptic Line Driver is declared to be SELV (Safety Extra Low Voltage) according to EN 41003.

SAFETY WARNING

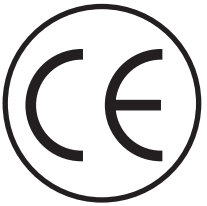
Always observe standard safety precautions during the installation, operation, and maintenance of this product. Only qualified and authorized service personnel should perform adjustments to, maintenance of, or repairs of this instrument. No adjustments, maintenance, or repairs should be done by operators or users.

EUROPEAN UNION DECLARATION OF CONFORMITY

The manufacturer declares that the T1/E1 Fiberoptic Line Driver conforms to these standards:

- EMC standard EN 55022 (1994), "Limits and methods of measurement of radio disturbance characteristics of information technology equipment"
- EMC standard EN 50082-1 (1992), "Electromagnetic compatibility - Generic immunity standards for residential, commercial, and light industry"
- Safety standard EN 60950 (1992/93), "Safety of information technology equipment, including electrical business equipment"

This equipment herewith complies with the requirements of the European EMC Directive 89/336/EEC and the Low Voltage Directive 73/23/EEC.



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 objectos 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: Objectos 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.

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Contents

Chapter Page

1. Specifications

Compliance — EMI/RFI: CE (EN 55022, EN 50082-1); FCC Part 15 Subpart J Class A, IC Class/classe A;
Safety: EN 60950, EN 41003

Interfaces — Electronic: Either 100-Ω balanced T1, 120-Ω balanced E1, or 75-Ω unbalanced E1, user-selectable; with Card models, unbalanced E1 requires special adapter—call for technical support;
Optical:
MT650, MT652, and MT653 models: 1300-nm single-mode;
MT651 models: 850-nm multimode

Zero Suppression — B8ZS when set to T1, HDB3 when set to E1

Output Power — –18 dBm

Receiver Sensitivity — For a BER of 10^{-9}:
MT650, MT652, and MT653 models: –40 dBm;
MT651 models: –38 dBm

Dynamic Range — 28 dB

Maximum Budget —
MT650, MT652, and MT653 models:
22 dB over 9/125–µm single-mode fiber cable;
MT651 models:
20 dB over 62.5/125–µm multimode fiber cable

Data Rate — T1: 1.544 Mbps;
E1: 2.048 Mbps

Maximum Distance — MT650, MT652, and MT653 models: 23.6 miles (38 km);
MT651 models: 3.1 miles (5 km)

User Controls — (1) Front-mounted slide switch for test mode;
All others mounted on main board (internal):
(1) Jumper block for interface type;
(1) Jumper and (3) DIP switches for grounding control and signal-loss handling

Diagnostic — Dry-contact-closure alarm on various DB15 pins (standalone models) or RackNest DB25 pins (card models) for signal or power loss; minimum switching current 1 amp; see **Section 5.3** for details

Indicators — (6) or (7) Front-mounted LEDs: Power, local loopback, remote loopback, and various error conditions; see Figure 5-1 and Table 5-1 in **Section 5.1** for details

Connectors — Standalone models (all rear-mounted):
(1) DB15 female for balanced T1 or E1 I/O and for dry-contact alarm;
(2) BNC female for unbalanced E1 I/O;
For fiberoptic link:
MT652AE-FC: (2) FC female;
All other models: (2) ST female;
For power:
MT653A-ST-D48: (1) Standard 3-pin female;
All other models: (1) IEC 320 male inlet;
Card models:
(2) Front-mounted ST female for fiberoptic link;
Rear-mounted card-edge male linked to connectors on rear of RackNest 2/14:
(1) 5-position terminal block for balanced T1 or E1;
(1) DB25 female for dry-contact alarms;
Special plug-in adapter required for unbalanced E1—call for technical support

Temperature Tolerance — 32 to 122˚F (0 to 50˚C)

Humidity Tolerance — Up to 90% noncondensing

Overvoltage Protection — AC/DC overvoltage circuits are connected through transformers to transmit and receive lines

Fuses — MT650A-ST and MT651A-ST:
0.2 A, 250 V;
MT650AE-ST, MT651AE-ST, and MT652AE-FC:
0.1 A, 250 V

Power — Input:
MT650A-ST and MT651A-ST:
108 to 132 VAC at 47 to 63 Hz from AC source through included detachable input cord;
MT650AE-ST, MT651AE-ST, and MT652AE-FC:
207 to 253 VAC at 47 to 63 Hz from AC source through included detachable input cord;
MT650C and MT651C:
From RackNest 2/14 in which they're installed;
MT653A-ST-D48:
–48 VDC at 130 mA, nominal, from –48 VDC source through detachable cord (not included except for connector elements)
Consumption for all models: 6 watts maximum

Size — Standalone models: 1.75"H (1U) x 7.6"W x 9.6"D (4.4 x 19.4 x 24.3 cm);
Card models: 6.2"H x 0.9"W x 9"D (15.7 x 2.3 x 22.9 cm)

Weight — Standalone models: 2.4 lb. (1.1 kg);
Card models: 0.8 lb. (0.3 kg)

2. Introduction

2.1 Overview

The T1/E1 Fiberoptic Line Driver (T1/E1 FOLD) is used for transmission of T1 (1.544 Mbps) and E1 (2.048 Mbps) data over multimode or single-mode fiberoptic media. The FOLD is transparent to T1 and E1 framing, and can transmit data using any framing pattern with HDB3 or B8ZS coded signals.

The FOLD converts the T1/E1 electrical signal into an optical signal using an infrared LED transmitter. At the opposite end of the fiber, the optical signal is converted back into an electrical signal and amplified to the required level. Automatic Gain Control (AGC) circuits are used to accommodate various distances. The FOLD uses a Phase Locked Loop (PLL) circuit to recover data and clock from the signal. The FOLD provides three user-selectable electronic-interface options:

- 100-Ω terminated balanced T1,
- 120-Ω terminated balanced E1, or
- 75-Ω terminated unbalanced E1.

The rear panels of the standalone FOLD models feature both a DB15 connector (for the balanced interfaces) and dual BNC connectors (for the unbalanced E1 interface). Internal jumpers enable the input/output ports to be grounded or floating as necessary.

Diagnostic features include LED status indicators, all-ones signaling (AIS) alarm generation, and an optional dry-contact alarm triggered by link failure.

Because the FOLDs communicate with each other over fiberoptic cable, they have these advantages:

- Immunity to electrical interference such as EMI, RFI, spikes, and differential ground loops.
- Protection from sparking and lightning.
- A secure link in hazardous or hostile environments.

The MT650, MT652, and MT653 models of the FOLD have a 1300-nm single-mode interface. The MT651 models have an 850-nm multimode fiberoptic interface.

The FOLD's electrical interfaces meet the requirements of AT&T PUB 62411 and ITU G.703 for T1, and of ITU G.823 for E1. Different models of the FOLD use either 115 VAC, 230 VAC, or –48 VDC power. The unit comes in a compact standalone case that can be placed on a desktop or shelf, or can be mounted in a 19-inch rack (using a separately available rackmount kit).

2.2 How It Works

The T1/E1 FOLD provides a simple and reliable way to transmit full-duplex T1 or E1 signals over fiberoptic cable. Figures 2-1 and 2-2 show useful applications for this.

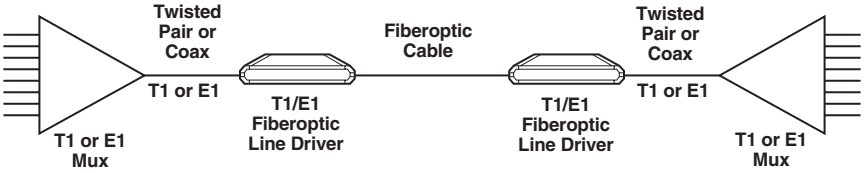

Figure 2-1. FOLD-and-mux application.

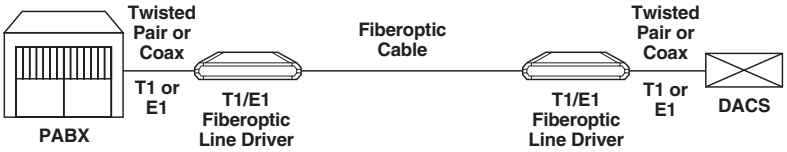

Figure 2-2. FOLD-and-PABX application.

Each FOLD receives T1 or E1 signals and equalizes them to overcome electrical-link distortion. The FOLD then converts these electrical signals into optical signals that it transmits across fiberoptic cable to its counterpart at the remote site. The remote FOLD uses a high-sensitivity pre-amplifier and an AGC (Automatic Gain Control) circuit to receive the optical signal. The output of the receiver is applied to the clock-recovery and data-regeneration circuit, which in turn applies it to the circuit that drives its electrical (T1 and E1) interfaces.

Speaking of the electrical interfaces, they fully comply with all applicable ITU standards, including G.703, G.824, G.921, and G.935. The T1 interface operates at 1.544 Mbps and uses B8ZS encoding. The E1 interface operates at 2.048 Mbps and uses HDB3 encoding.

Figure 2-3 is a block diagram of the FOLD's circuitry.

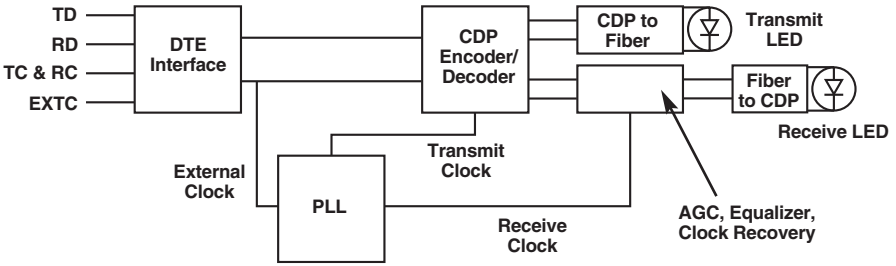

Figure 2-3. Block diagram of the FOLD.

3. Standalone Installation

Standalone models of the T1/E1 Fiber Optic Line Driver can be either placed on a desktop or mounted in a 19" rack with separately available rackmount kits. This chapter describes how to configure and install these models.

If you have any problems during your installation, refer to the troubleshooting instructions in **Chapter 6**. For instructions on configuring and installing card models of the FOLD, see **Chapter 4**.

3.1 Unpacking and Placement

1. After unpacking the FOLD, inspect the unit for damage. If you notice any, call Black Box immediately. For the card models, the package should contain the FOLD itself and this user's manual. The MT653A-ST-D48 will also contain a DC power-supply connector kit; AC-powered standalone models will also contain a power cord.

2. The location where you install AC-powered models of the FOLD should be within 5 feet (1.5 m) of a grounded source (outlet) capable of furnishing the FOLD model's rated voltage (115 or 230 VAC). In order to prevent a fire hazard, the negative power-supply line must pass through a fuse or circuit breaker.

   DC-powered models of the FOLD must be installed in a place where they can be connected to a –48-VDC power source. This power source must be adequately isolated from the site's AC power system.

   For all models of the FOLD, the installation location's ambient temperature should be between 32 and 122°F (0 and 50°C) and the relative humidity should not be greater than 90% non-condensing.

3.2 Configuration

WARNING—HIGH VOLTAGE!

Only authorized and qualified service personnel should ever access the interior of the FOLD or work with its internal components.

To avoid accidental electric shock, always disconnect the FOLD from the power line and from all data lines before accessing its interior.

Line voltages are present inside the FOLD when it's connected to power or data lines. Moreover, external conditions such as lightning strikes and power surges can cause potentially lethal voltages to appear on those lines.

Any adjustment, maintenance, and repair of the FOLD while it's still powered ON should be avoided as much as possible and should be carried out only by a skilled person who is aware of the hazard involved.

Keep in mind that capacitors inside the FOLD might still be charged even after the FOLD has been disconnected from its power source.

You don't need to configure the FOLD if these default settings are appropriate for your application:

- Balanced E1.
- E1 signal ground connected to the FOLD's chassis ground.
- "All ones signal" transmitted across fiber link in response to signal loss.

If you need to change these settings—in order to run T1 rather than E1, for example—take these steps to configure the FOLD:

1. If the FOLD is connected to a power source, disconnect it.

2. Unscrew the two rear-panel screws far enough to loosen the FOLD's rear plate from the rest of the case. Then use the screws as knobs and slide out the FOLD's circuit board as if it were a drawer.

3. Consult Figure 3-1 on the next page and **Sections 3.2.1** through **3.2.4** to identify the FOLD's board-mounted configuration controls and move them to your desired positions.

4. Slide the FOLD's circuit board back in and retighten the screws.

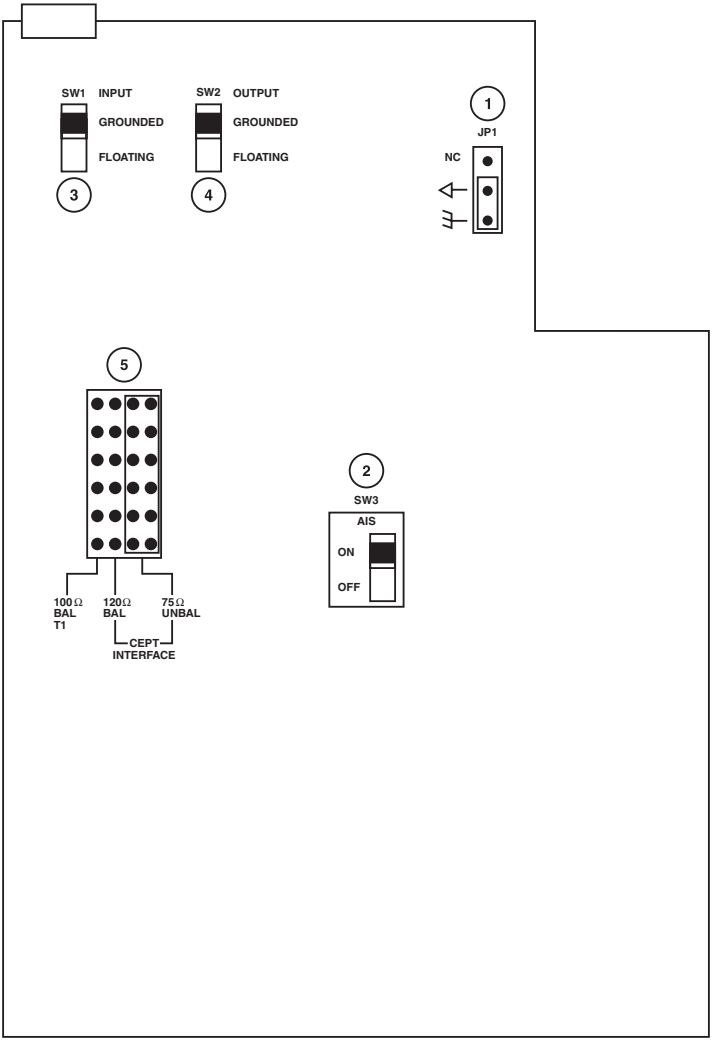

Figure 3-1. Locations of internal controls.

① See **Section 3.2.1**.

② See **Section 3.2.2**.

③, ④ See **Section 3.2.3**.

⑤ See **Section 3.2.4**.

3.2.1 JP1: Signal/Chassis Grounding

Depending on how you set jumper JP1 (item 1 in Figure 3-1), the FOLD connects ("⏚") or disconnects ("N.C.") its chassis ground from T1/E1 signal ground. The factory-default setting is for the two grounds to be connected.

WARNING!

Setting the jumper to "N.C." may render the FOLD unsafe for connection to unprotected T1 or E1 networks in some locations where permanent excessive voltages are present on the lines.

3.2.2 SW3: AIS

When the AIS DIP switch SW3 (item 2 in Figure 3-1) is set to ON (the default setting), the FOLD sends an "all ones signal" (AIS) across the fiberoptic link if it detects either (a) low or no signal on its T1/E1 interface or (b) high error rates on its fiberoptic interface. This signal will cause the remote FOLD to light its OPTICAL AIS LED, alerting operators there of the problem at the other site. If you don't want the FOLD to send this signal across the fiber link, move this switch to the OFF setting.

3.2.3 SW1 and SW2: Interface Grounding

If you will be using the FOLD's balanced T1 or E1 interface, keep Input and Output DIP switches SW1 and SW2 (items 3 and 4 in Figure 3-1) both set to their factory-default "Floating" setting. (In this setting, the shields of the IN and OUT BNC connectors on the rear panel are isolated from the FOLD's chassis ground.) If you will be using the FOLD's unbalanced E1 interface, move both of these switches to the "Grounded" setting to connect the BNC shields to the FOLD's chassis ground.

3.2.4 Jumper Block: Interface Type

Move the jumper on the interface-type jumper block (item 5 in Figure 3-1) as necessary to select one of the FOLD's three interface options:

- Set it to "100 Ω BAL T1" (the block on the left-hand row of posts) to select balanced T1 I/O on the FOLD's DB15 connector.
- Set it to "120 Ω BAL—CEPT INTERFACE" (the block on the middle row of posts, the default setting) to select balanced E1 I/O on the FOLD's DB15 connector.
- Set it to "75 Ω BAL—CEPT INTERFACE" (the block on the right-hand row of posts) to select unbalanced E1 I/O on the FOLD's BNC connectors.

3.3 Rackmounting (Optional)

The standalone FOLD models can be installed in 1U (1.75", 4.4 cm) of vertical space in a standard 19" rack. To mount either a single FOLD or two FOLDs side by side, you'll need the RM523 rackmount kit, which consists of one long bracket, two short brackets, two side rails, and some screws and washers.

WARNING

Disconnect the FOLD(s) from any power source before performing any of the following procedures.

3.3.1 Rackmounting a Single FOLD

The parts of the rackmount kit that you'll use to mount a single FOLD, other than screws and washers, are the long bracket and one of the short brackets. Take these steps, referring to Figure 3-2:

1. Attach the two brackets to the side walls of the FOLD's case: the short bracket to the left side and the long bracket to the right side. To fasten each bracket, use two of the included screws and flatwashers. Insert the screws into the side wall's two front holes (nuts are already in place inside of the wall) and tighten them.

2. Use four screws (*not included*)—two for each bracket—to fasten the brackets to the side rails of your 19" rack.

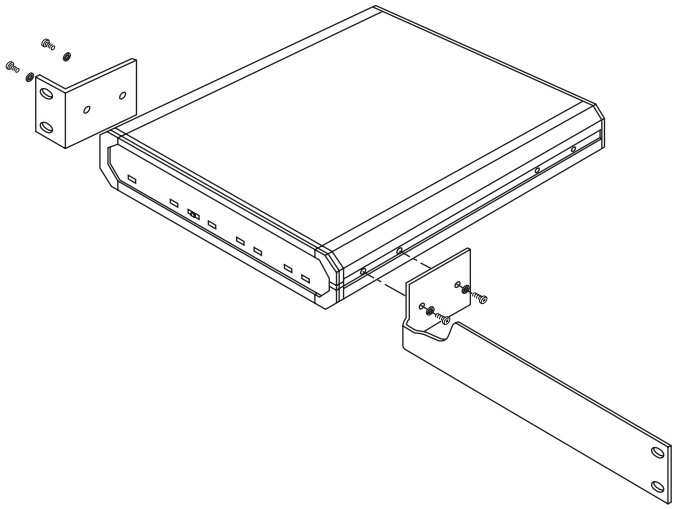

Figure 3-2. Putting together the rackmount assembly for a single FOLD.

3.3.2 Rackmounting Two FOLDs Side by Side

The parts of the rackmount kit that you'll use to mount two FOLDs side by side, other than screws and washers, are the two short brackets and the two side rails. Take these steps, referring to Figures 3-3 and 3-4 on the next page:

1. Take the two side rails and eight of the included screws and washers (four screws and washers for each rail). Attach the first rail to the left side of one FOLD's case; attach the second one to the right side of the other FOLD's case. Make sure to attach the rails so that one has the narrow flange facing outward and the other has the wide flange facing outward.

2. Using two more of the included screws and washers for each bracket, attach a short bracket to the other side of each FOLD's case (the side that *doesn't* have a rail attached to it).

3. Fasten the two FOLDs together by sliding one side rail inside the other so that the two rails interlock.

4. Put the included plastic caps on the ends of the joined rails to protect the rail ends and prevent the FOLDs from sliding.

5. Use four screws (*not included*)—two screws for each side—to fasten the FOLDs' rackmount assembly to the side rails of the 19" rack.

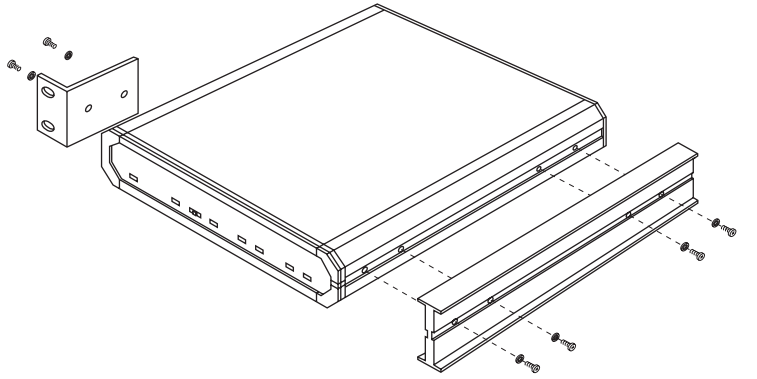

Figure 3-3. Attaching the rail and bracket to one of the two FOLDs.

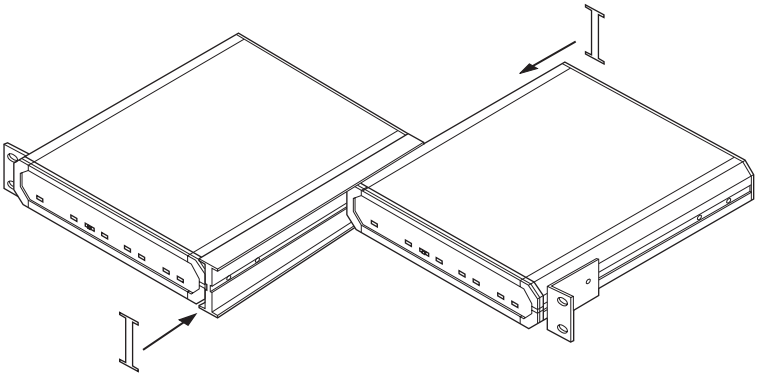

Figure 3- 4. Finishing the rackmount assembly for a pair of FOLDs.

3.4 Connecting Data Cables

You are now ready to attach data cabling to your FOLD. As you do so, refer to Figures 3-5 and 3-6 on the next page.

3.4.1 Fiberoptic Connections

Two fiberoptic ST® or FC connectors marked TX and RX are located on the FOLD's rear panel. Remove the protective caps from these connectors and store them in a safe place for later use. Connect the transmit fiber to the connector marked TX and the receive fiber to the connector marked RX. At the remote unit, the transmit fiber must be connected to RX and the receive fiber to TX.

3.4.2 T1 or E1 Cable Connections

If you are using the FOLD's balanced T1 or E1 interface, plug the T1 or E1 cable into the DB15 female connector on the FOLD's rear panel. You might need to adapt or reterminate your existing cable to do this, especially if the cable will also be carrying dry-alarm signals (see **Section 5.3**); refer to Table 3-1 on the next page for the pinout of the FOLD's DB15 connector.

If you are using the FOLD's unbalanced E1 interface, plug your coaxial E1 cables into the two BNC connectors marked "IN" and "OUT" on the FOLD's rear panel. The "IN" connector is for E1 data coming into the FOLD for transmission across the fiber link. The "OUT" connector is for E1 data received on the fiber link and going out of the FOLD to the local equipment.

NOTES

Make only SELV (Safety Extra Low Voltage) connections to the FOLD's T1 and E1 ports.

***Never* attach cables to both the DB15 connector and the coaxial connectors at the same time.**

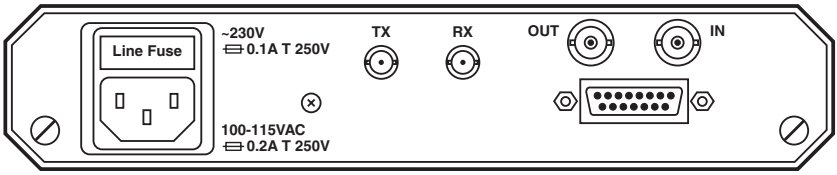

Figure 3-5. Rear panel of the AC-powered FOLD models.

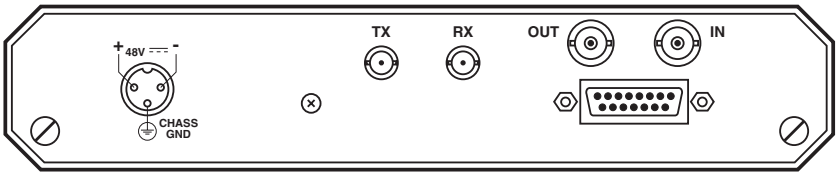

Figure 3-6. Rear panel of the MT653A-ST-D48.

Table 3-1. Pinout of DB15 Connector

Data-Transfer Pins

Pin	Designation	Function
1	Send Data (Tip)	Transmit Data A (input to FOLD)
9	Send Data (Ring)	Transmit Data B (input to FOLD)
3	Receive Path (Tip)	Receive Data A (output from FOLD)
11	Receive Path (Ring)	Receive Data B (output from FOLD)

Alarm Pins

Pins	Function
8 and 7	Minor alarm, normally closed
8 and 15	Minor alarm, normally open
6 and 5	Major alarm, normally closed
6 and 13	Major alarm, normally open

3.5 Connecting Power

Follow the procedure in the **Section 3.5.1** to connect power to an AC-powered FOLD model. To connect power to the DC-powered MT653A-ST-D48 model, follow the procedure in **Section 3.5.2**.

3.5.1 AC Power

The AC-powered models of the FOLD come with a 5-ft. (1.5-m) power cord terminated with a standard 3-prong plug. Attach the female end of this cord to the FOLD's IEC 320 male power inlet. Plug the other end of the cord into a standard grounded utility-power (mains) outlet.

The FOLD, which has no power switch, will begin operating immediately. Its POWER LED will light and will remain lit as long as the FOLD continues to receive power. (At startup some of the FOLD's other LEDs might light—this only indicates that the remote FOLD and/or the local T1 or E1 device[s] aren't yet operating. These LEDs will go dark when all of the system's equipment is up and running.)

To power down the FOLD later, unplug its power cord from the utility-power outlet. Never power down the FOLD by disconnecting the power cord from the FOLD while leaving the cord plugged into the utility-power outlet.

WARNING!

Make sure that the FOLD's ground terminal is connected to an outlet's site-ground contact with the included power cord or some other cord that has a ground conductor. Do *not* compromise the FOLD's protective grounding by using extension cords that don't have a ground conductor, or by plugging the FOLD into an outlet without a ground contact.

This is because, for the sake of your personal protection, the FOLD must *always* be grounded. Any interruption of the grounding conductor—either inside or outside the FOLD—or disconnection of the ground terminal can make the FOLD dangerous.

Replace the FOLD's fuses only with fuses rated for the same current and voltage (these ratings are labeled on the FOLD's rear panel). Do *not* short-circuit fuse holders. Whenever it's likely that a fuse has blown or that its protective action has been impaired, the FOLD must be made inoperative and secured against any unintended operation.

3.5.2 DC Power (MT653A-ST-D48 Only)

The DC-powered MT653A-ST-D48 model of the FOLD has a standard 3-pin male power connector on its rear panel (see Figure 3-6 in **Section 3.4** and Figure 3-7 here).

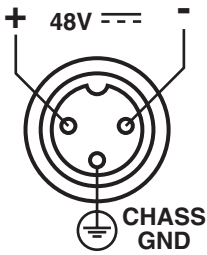

Figure 3-7. Standard 3-pin male DC connector.

The FOLD comes with a kit that you can use to assemble a matching female connector for the power-supply cord that will be attached to the FOLD, if that cord is not yet terminated or has some other kind of connector on it.

- If your power-supply cord already has a compatible connector, just verify that its voltage polarity matches what the FOLD requires.
- If not, terminate the wires of your power-supply cord with the FOLD's connector kit, being careful to match the voltage polarity shown in Figure 3-8. Note that the solder side of the connector is shown in those illustrations. Figure 3-9 shows how everything should fit together.

WARNING!

Reversing the wire-voltage polarity can seriously damage the FOLD!

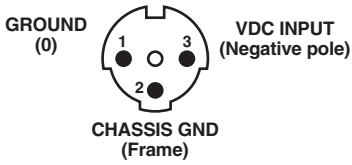

Figure 3-8. Cord connector (female) voltage polarity (solder side shown).

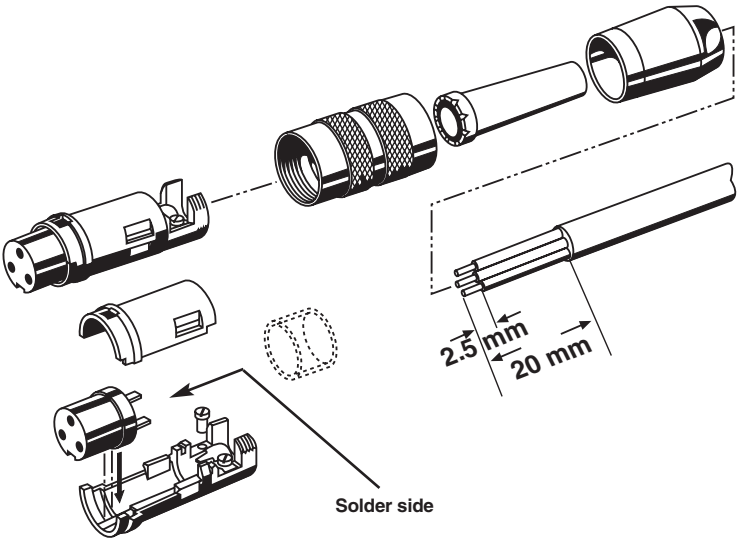

Figure 3-9. Cord-connector assembly.

4. Card Installation

4.1 Overview of the RackNest 2/14

The MT650C and MT651C are card models of the T1/E1 Fiber Optic Line Driver designed to fit in the RackNest 2/14 rackmountable card cage. Refer to the Nest's manual for more information about it than this chapter can provide.

The RackNest 2/14 can host one or two power supplies and up to 14 plug-in cards of any compatible type. These cards communicate with two sets of connectors on the RackNest's rear panel: For each card, a snap-in five-position terminal block handles balanced T1 or E1 communication and a DB25 female connector handles dry-contact alarms. (To support unbalanced E1, you'll need a special non-included adapter with BNC female connectors for each card. Call Black Box Technical Support for details.)

As Figure 4-1 shows, the terminal block has two XMT terminals for the transmit pair of balanced T1/E1 wires and two RCV terminals for the receive pair of wires, plus a terminal for an optional ground connection.

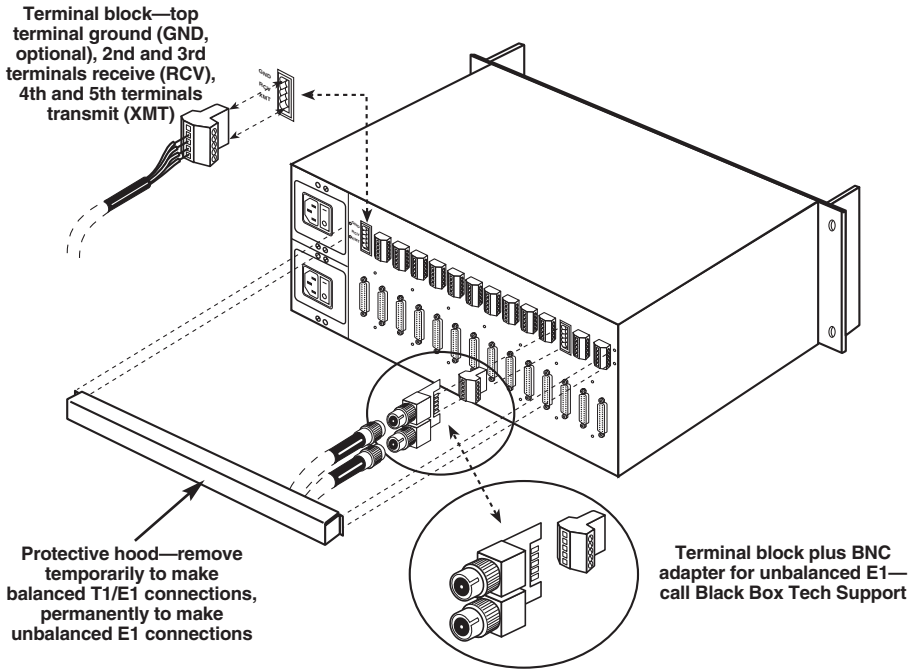

Figure 4-1. The rear of the RackNest 2/14.

The 115-VAC RackNest 2/14 (our product code RM110A) uses the PS1000A power supply, which accepts 115-VAC input power. The 230-VAC RackNest 2/14 (RM110AE) uses power supply PS1000AE, which accepts 230-VAC input power. Each of these power supplies consists of a power-line transformer, a fuse, and an operating switch. The 115-VAC Nest can also be ordered with dual power supplies (RM110A-2PS); either of these power supplies can be hot-swapped if it fails.

All power-regulating circuitry for the RackNest 2/14 is located on the installed cards. Each card has two fuses which protect the entire system against power failure if any one card short-circuits. Primary power needed is 115 or 230 VAC (±10%), 47 to 63 Hz, at up to 24 VA.

Figure 4-2 shows the front of the RackNest, including the power supplies.

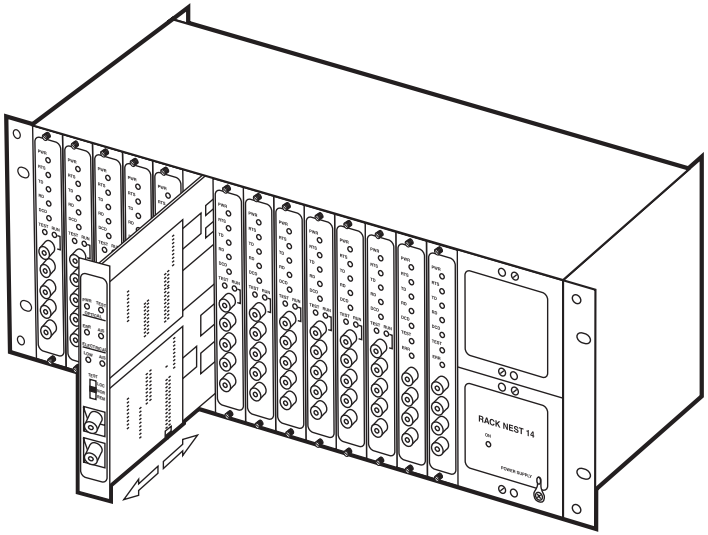

Figure 4-2. The front of the RackNest 2/14.

4.2 Configuration

WARNING—HIGH VOLTAGE!

Only authorized and qualified service personnel should ever access the FOLD Card or work with its board-mounted components.

Never attempt to work with the FOLD Card while it is installed in the RackNest 2/14, especially when the RackNest is powered. See the Warning notice on page 13 for more information.

To avoid accidental electric shock, always remove the FOLD Card from the RackNest before working with it.

Line voltages are present on the FOLD Card when it's installed in a "live" RackNest 2/14. Moreover, external conditions such as lightning strikes and power surges can cause potentially lethal voltages to appear on those lines.

Any adjustment, maintenance, and repair of the FOLD Card while it's under power should be avoided as much as possible and should be carried out only by a skilled person who is aware of the hazard involved.

Keep in mind that capacitors on the FOLD Card might still be charged even after the Card has been removed from the RackNest.

To configure the FOLD Card, consult Figure 4-3 on the next page and **Sections 4.2.1** through **4.2.3** to identify the FOLD's board-mounted configuration controls and move them to your desired positions. (If the Card is installed in the RackNest 2/14, remove it by loosening the top and bottom screws and sliding it out of the Nest chassis.)

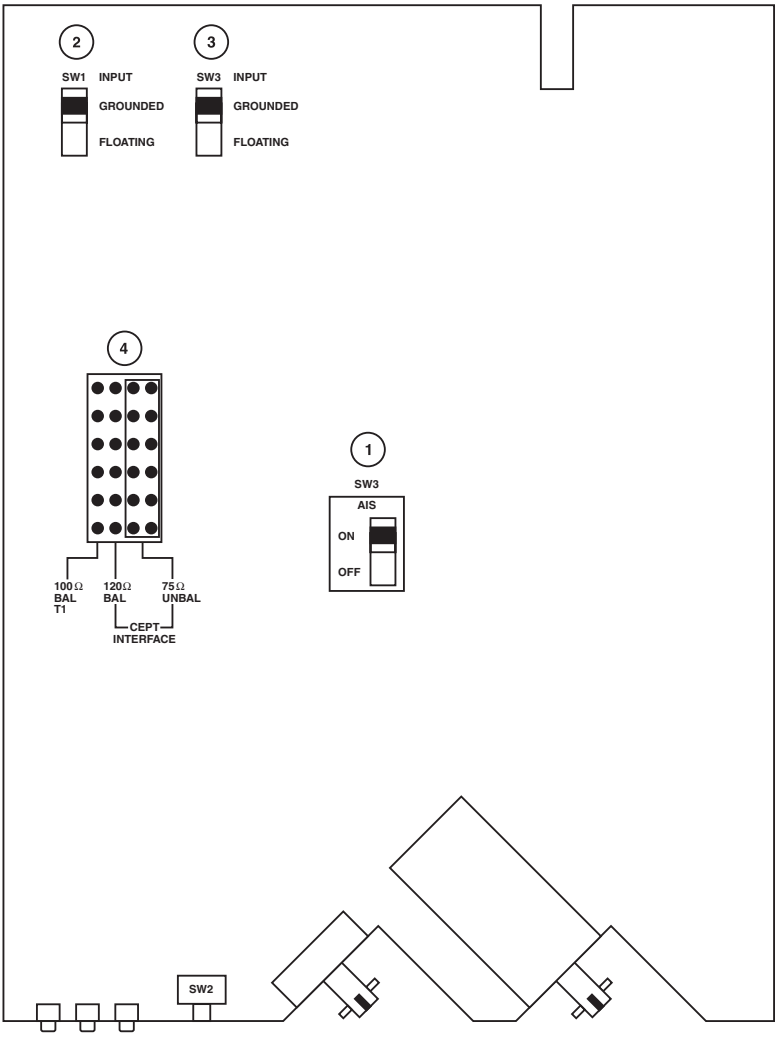

Figure 4-3. Locations of board-mounted controls.

① See **Section 4.2.1**.

②, ③ See **Section 4.2.2**.

④ See **Section 4.2.3**.

4.2.1 SW3: AIS

When the AIS DIP switch SW3 (item 1 in Figure 4-3) is set to ON (the default setting), the FOLD sends an "all ones signal" (AIS) across the fiberoptic link if it detects either (a) low or no signal on its T1/E1 interface or (b) high error rates on its fiberoptic interface. This signal will cause the remote FOLD to light its OPTICAL AIS LED, alerting operators there of the problem at the other site. If you don't want the FOLD to send this signal across the fiber link, move this switch to the OFF setting.

4.2.2 SW1 and SW2: Interface Grounding

If you will be using the FOLD's balanced T1 or E1 interface, keep Input and Output DIP switches SW1 and SW2 (items 2 and 3 in Figure 4-3) both set to their factory-default "Floating" setting. (In this setting, the shields of the IN and OUT BNC connectors on the rear panel are isolated from the FOLD's chassis ground.) If you will be using the FOLD's unbalanced E1 interface, move both of these switches to the "Grounded" setting to connect the BNC shields to the FOLD's chassis ground.

4.2.3 Jumper Block: Interface Type

Move the jumper on the interface-type jumper block (item 4 in Figure 4-3) as necessary to select one of the FOLD's three interface options:

- Set it to "100 Ω BAL T1" (the block on the left-hand row of posts) to select balanced T1 I/O on the FOLD's DB15 connector.
- Set it to "120 Ω BAL—CEPT INTERFACE" (the block on the middle row of posts, the default setting) to select balanced E1 I/O on the FOLD's DB15 connector.
- Set it to "75 Ω BAL—CEPT INTERFACE" (the block on the right-hand row of posts) to select unbalanced E1 I/O on the FOLD's BNC connectors.

4.3 Installing the Card

When you have finished configuring the FOLD Card, take these steps to install it in the RackNest 2/14:

1. Slide the Card into the Nest, matching its top and bottom edges with the upper and lower rails of the chosen Nest slot. Note the number of this slot—they're labeled, left to right, "C1" through "C14"—because later you'll need to attach your T1 or E1 cable to the connector with the same number on the back of the Nest.

2. When the Card is fully inserted, push the bottom of the Card into the Nest a little farther to make sure that the Card is fully inserted in the card-edge socket at the back of the slot.

3. Lastly, tighten the two screws at the top and bottom of the Card.

4.4 Connecting Data Cables

You are now ready to attach data cabling to your FOLD. As you do so, refer to Figure 4-1 in **Section 4.1** and Figure 4-4 on the next page.

4.4.1 Fiberoptic Connections

Two fiberoptic ST or FC connectors marked TX and RX are located on the FOLD Card's front panel. Remove the protective caps from these connectors and store them in a safe place for later use. Connect the transmit fiber to the connector marked TX and the receive fiber to the connector marked RX. At the remote unit, the transmit fiber must be connected to RX and the receive fiber to TX.

4.4.2 T1 or E1 Cable Connections

Note the number ("C1" through "C14") of the slot the FOLD Card is installed in. Attach your T1 or E1 cable to the 5-position terminal block on the rear of the RackNest with the corresponding number ("M1" through "M14"):

- Unscrew and remove the hood flange on the rear of the Nest. If you are using the FOLD's balanced T1 or E1 interface, attach the T1 or E1 cable's transmit wires—the ones carrying data that should be *input* to the Card for transmission out of the fiberoptic link—to the TX terminals. Attach the cable's receive wires—those carrying data that should be *output* from the Card, having been received from the fiberoptic link—to the RX terminals. (The Card isn't sensitive to polarity.) Attach any ground wire to the topmost (ground) terminal *on one end of the cable only*. Reattach the Nest's hood flange when you're done.

- In order to use the FOLD's unbalanced E1 interface, you'll need to permanently remove the Nest's hood flange and install a special adapter with BNC connectors (not included) in that slot's terminal block, as shown in Figure 4-1 in **Section 4.1**. Call Black Box Technical Support for details.

4.4.3 Dry-Contact Alarm Connections (Optional)

Note the number ("C1" through "C14") of the slot the FOLD Card is installed in. Attach a dry-contact alarm cable to the DB25 female connector on the rear of the RackNest with the corresponding number ("M1" through "M14").

The DB25 pins that carry the alarm signals are listed in Table 4-1 on the next page. If your dry-contact alarm equipment has DB25 connectors and can create an alarm circuit on any combination of DB25 pins, you might be able to use a 25-wire RS-232 style cable to attach it to the RackNest's DB25 connector. It's far more likely, though, that you'll need a special cable. Please call Black Box Technical Support for assistance.

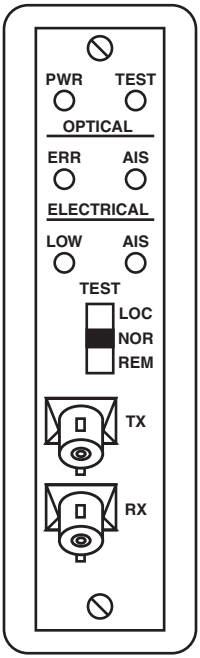

Figure 4-4. Front panel of FOLD Card models.

Table 4-1. Pinout of DB25 Connector

Pins	Function
10 and 22	Minor alarm, normally closed
10 and 21	Minor alarm, normally open
13 and 25	Major alarm, normally closed
13 and 24	Major alarm, normally open

4.5 Powering Up the System

AC power should be supplied to the RackNest 2/14 through a standard power cord run between the AC socket on the rear of the Nest's power-supply module—an IEC 320 male power inlet which contains an integral fuse—and a standard, grounded, easily accessible AC outlet. (If your Nest is an RM110A or RM110A-2PS, you can use the power cord[s] supplied with it; if your Nest is an RM110AE, use a power cord appropriate for your site's mains outlets.)

The Nest begins operating and supplying power to the installed Cards as soon as it is plugged into a mains outlet, and will continue operating until it is unplugged.

5. Operation

5.1 Front-Panel Components

Figure 5-1 shows the front panels of the standalone and card versions, respectively, of the T1/E1 Fiberoptic Line Driver. Table 5-1 on the next page lists the functions of the numbered front-panel indicators and the lettered TEST control.

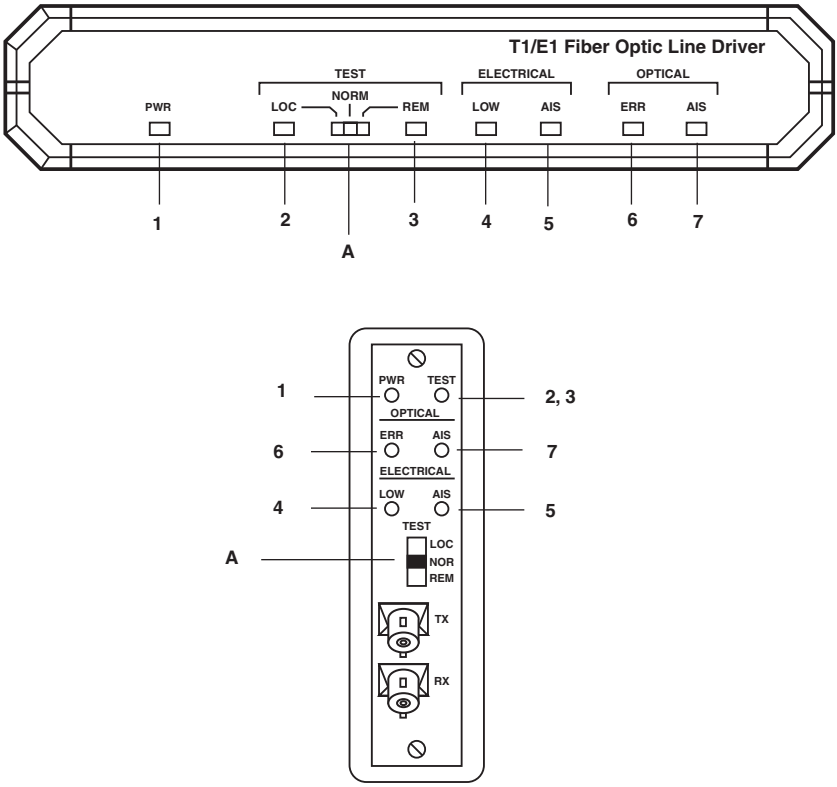

Figure 5-1. Front panels of the FOLD.

Table 4-1. Functions of Indicators and TEST Control

Item	Indicator/Control	Function
1	POWER	ON when the FOLD Card is powered.
2	TEST LOC (Standalone) TEST (Card)	ON when the FOLD is in local loopback mode.
3	TEST REM (Standalone) TEST (Card)	ON when the FOLD is in remote loopback mode, or when the local FOLD sends a remote loopback pattern to the remote FOLD.
4	ELECTRICAL LOW	ON when T1 or E1 interface input is below G.703 electrical levels.
5	ELECTRICAL AIS	ON when an “all ones string” is received at the T1 or E1 interface.
6	OPTICAL ERR	ON when Bit Error Rate of the received signal from the optical interface is 10^{-6} or worse.
7	OPTICAL AIS	ON when an “all ones string” is received at the optical interface.
A	TEST Switch	NORM or NOR—Normal operation of the FOLD, LOC—Activate local loopback, REM—Activate remote loopback

5.2 General Operation

After you follow the directions in **Chapter 3** or **4** for installing and powering the FOLD, it is designed to start operating immediately and to continue operating unattended indefinitely. Further operator intervention should only be required if:

- the FOLD needs to be reconfigured because its operating requirements have changed;
- an error occurs or an alarm is received (see **Section 5.3**);
- diagnostic testing needs to be done (see **Section 5.4**); or
- the FOLD system stops operating correctly (see **Chapter 6**).

5.3 Error Indicators and Alarms

The FOLD's four ERR and AIS LEDs will sometimes light when you start up the FOLD system. This is normal—it only indicates that the remote FOLD and/or the local T1 or E1 equipment isn't operating yet. When the system is fully powered, these LEDs should go out. If the LEDs light later, after the FOLD has been operating normally for some time, it might mean that something has gone wrong:

- If the red ELECTRICAL LOW LED lights, the input at the FOLD's T1 or E1 interface has dropped below normal G.703 electrical levels. This probably means that either the T1/E1 cable has been broken or disconnected or the T1/E1 equipment has crashed, has lost power, or is malfunctioning.
- If the yellow ELECTRICAL AIS LED lights, an "all ones signal" has been received at the T1 or E1 interface. This might mean that your T1/E1 equipment is malfunctioning.

CAUTION!

In some systems, FF hex (solid binary ones) is transmitted as filler by the T1 or E1 equipment when no data is being received from other devices, and this can cause the FOLD's AIS LEDs to light and its alarms to go off. In such situations, you should either disable AIS (see Sections 3.2.2 **and** 4.2.1**) or use a different character (FE hex, for example) as filler.**

- If the red OPTICAL ERR LED lights, the bit error rate (BER) at the FOLD's fiberoptic interface has reached 10^{-6} or worse; that is, at least one in every million bits is corrupt. This probably means that either the fiber cable has been broken or disconnected or the remote FOLD has lost power or is malfunctioning.

- If the yellow OPTICAL AIS LED lights, an "all ones signal" has been received at the fiberoptic interface. This might mean that the T1/E1 equipment connected to your remote FOLD is malfunctioning—but see the Caution notice on the previous page.

If you want to, you can also connect dry-contact alarm equipment to the FOLD. It supports both normally open and normally closed alarms, and it has a minimum switching current of 1 amp. The FOLD's major alarms are triggered by the same conditions that cause the ELECTRICAL LOW and OPTICAL ERR LEDs to light; its minor alarms are triggered by the same "all ones signals" that cause the AIS LEDs to light.

You can attach alarm equipment to the alarm circuitry of standalone models of the FOLD through the DB15 female connector on its rear panel, using different pins than the balanced T1 and E1 interfaces use (refer to Table 3-1 in **Section 3.4.2**). You can attach such equipment to the alarm circuitry of card models of the FOLD through the DB25 female connector on the rear of the RackNest 2/14 that's electrically connected to the card (refer to Table 4-1 in **Section 4.4.3**). You will probably need special cables to do this; please call Black Box Technical Support to discuss your application.

5.4 Diagnostics: Loopback Testing

The FOLD supports a pair of V.54-compliant loopback tests with which you can check its electrical and fiberoptic interfaces. Use a bit-error-rate tester (BERT)—either external or internal to your T1/E1 equipment—to compare the data sent to the FOLD against the data that comes back.

To check the electrical (T1 or E1) interface only, move the front-panel TEST switch to the LOC position. This triggers a local loopback test whose data flow looks like Figure 5-2:

- The TEST LOC (standalone models) or TEST (card models) LED lights.
- The FOLD ignores all data coming in on its optical interface.
- It continues to transmit data out of its fiberoptic interface, but it transmits the same data back out of its T1 or E1 port at the same time.

When you're finished testing, move the TEST switch back to the NORM (standalone) or NOR (card) position.

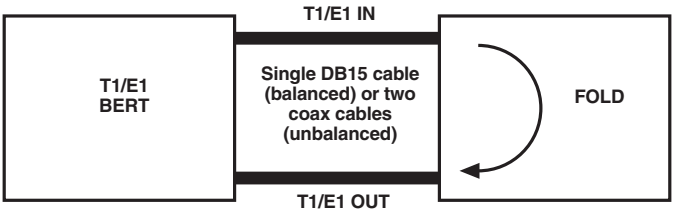

Figure 5-2. Local loopback.

To check the both the electrical (T1 or E1) interface *and* the optical interface, move the front-panel TEST switch to the REM position. This triggers a remote loopback test whose data flow looks like Figure 5-3:

- The TEST REM (standalone models) or TEST (card models) LED lights.
- The local FOLD causes the remote FOLD to go into remote loopback. The remote FOLD lights its TEST REM or TEST LED.
- The remote FOLD ignores all data coming *in* on its electrical (T1 or E1) interface.
- It continues to transmit data *out* of its electrical interface, but it transmits the same data back out of its fiberoptic port at the same time.

When you're finished testing, move the TEST switch back to the NORM (standalone) or NOR (card) position.

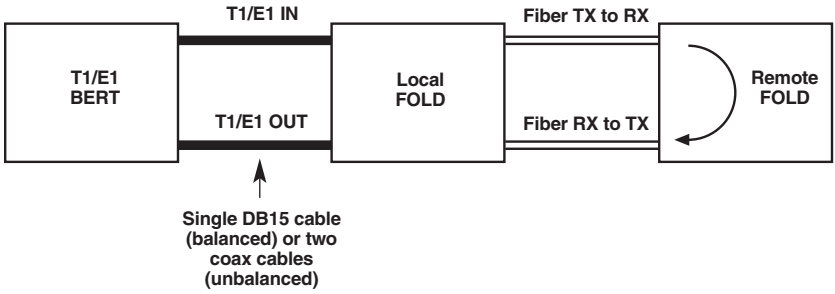

Figure 5-3. Remote loopback.

6. Troubleshooting

If anything ever seems to go wrong with the T1/E1 Fiber Optic Line Driver, check **Section 6.1** to see whether any of the listed symptoms match what you're experiencing. If so, try the recommended fixes. Also keep in mind that you can do loopback testing on the FOLD system (see **Section 5.4**) to try to diagnose and isolate problems. If your difficulty isn't listed in **Section 6.1**, or if the recommended actions fail to solve the problem, call Black Box as directed in **Section 6.2**.

6.1 Things to Try

Symptom	Possible Causes	Corrective Measures
POWER LED is OFF.	The FOLD is not receiving power.	Make sure that its power cord is securely plugged in on both ends and that it's connected to a working power source.
	The FOLD has blown a fuse.	Replace the blown fuse with a new one with the same rating.
	The FOLD is malfunctioning.	Call Black Box Technical Support.
ELECTRICAL LOW LED is ON.	The T1 or E1 cabling from the FOLD to the local equipment is improperly connected, improperly wired, or broken.	Make sure that any local T1/E1 cables and adapters are securely connected, properly wired, and intact.
	The signal output of the local T1/E1 equipment does not meet G.703 electrical levels.	Make sure the equipment is ON and operating properly. If it is, boost its signal to G.703-compliant levels.
	The wrong interface is selected.	Verify that the FOLD is using the correct interface; see **Section 3.4** (standalone) or **4.3** (card).
	The FOLD is malfunctioning.	Call Black Box Technical Support.

Symptom	Possible Causes	Corrective Measures
ELECTRICAL AIS LED is ON.	The attached T1 or E1 equipment is sending an "all ones signal."	Make sure that the equipment is operating properly and, if it is, that it's transmitting something other than continuous strings of ones. Refer to **Section 5.3**.
	The FOLD is malfunctioning.	Call Black Box Technical Support.
OPTICAL ERR LED is ON.	The fiber cabling between the FOLDs is improperly connected or broken.	Make sure that the fiberoptic cables are running TX to RX and RX to TX, and that they (and any splices or adapters) are securely connected and intact.
	The link budget of the fiberoptic link has been exceeded.	Measure the link's optical loss end to end. If it exceeds specifications (see **Chapter 1**), you'll need to reduce it: make the link shorter, eliminate as many connectors and splices as possible, etc.
	The FOLD is malfunctioning.	Call Black Box Technical Support.
OPTICAL AIS LED is ON.	The T1 or E1 equipment attached to the remote FOLD is sending an "all ones signal."	Make sure that the equipment is operating properly and, if it is, that it's transmitting something other than continuous strings of ones. Refer to **Section 5.3**.
	The remote FOLD detected an ELECTRICAL LOW condition.	(See the entries for "ELECTRICAL LOW LED is ON" on the previous page.)
	The FOLD is malfunctioning.	Call Black Box Technical Support.

Symptom	Possible Causes	Corrective Measures
TEST LOC LED is ON.	The FOLD is in local loopback test mode.	See **Section 5.4**. To resume normal operation, move its TEST switch back to the NOR or NORM position.
	The FOLD is malfunctioning.	Call Black Box Technical Support.
TEST REM LED is ON.	The FOLDs is in remote loopback test mode.	See **Section 5.4**. To resume normal operation, make sure that the TEST switches of both the local and remote FOLDs are set to the NOR or NORM position.
	The FOLD is malfunctioning.	Call Black Box Technical Support.
Major alarm has been triggered.	The FOLD has detected an ELECTRICAL LOW or OPTICAL ERR condition.	See **Section 5.4** and the entries for “ELECTRICAL LOW LED is ON” and “OPTICAL ERR LED is ON” on the preceding pages.
Minor alarm has been triggered.	The FOLD is receiving an “all ones signal.”	See **Section 5.4** and the entries for “ELECTRICAL AIS LED is ON” and “OPTICAL AIS LED is ON” on the preceding pages.

6.2 Calling Black Box

If you determine that your FOLD is malfunctioning, *do not attempt to alter or repair the unit.* It contains no user-serviceable parts. Call Black Box Technical Support at 724-746-5500.

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 (including your T1 or E1 equipment, T1/E1 cables, and your fiber cabling);
- any particular application that, when used, appears to create the problem or make it worse; and
- the results of any testing you've already done.

6.3 Shipping and Packaging

If you need to transport or ship your FOLD:

- Package it carefully. We recommend that you use the original container.
- If you are returning the FOLD, make sure you include everything you received with it. Before you ship the product back to us for any reason, contact Black Box to get a Return Authorization (RA) number.

DISCLAIMERS

The manufacturer and its agents make no representation or warranty of the fitness of the T1/E1 Fiber Optic Line Driver to be used for any other purpose than those specifically mentioned in this manual.

Neither the manufacturer nor its agents shall be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort or any legal theory.

NOTES

1000 Park Drive • Lawrence, PA 15055-1018 • 724-746-5500 • Fax 724-746-0746