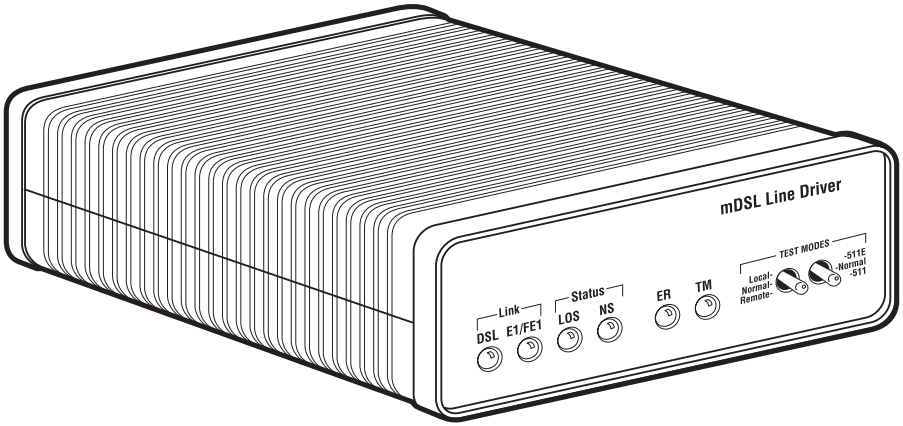
BLACK BOX®
NETWORK SERVICES

NOVEMBER 2001
ME0005A-G703

2-Wire Short-Range DSL Line Driver (mDSL) G.703



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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 of Subpart B 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.

EUROPEAN UNION DECLARATION OF CONFORMITY

This equipment complies with the requirements of the European EMC Directive 89/336/EEC.

CE

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.

TRADEMARKS USED IN THIS MANUAL

Any trademarks mentioned in this manual are acknowledged to be the property of the trademark owners.

Contents

1. Specifications

Clocking Modes: Network (G.703)

DTE Rate: All 64-kbps increments from 64 to 2048 kbps

Diagnostics: V.52-compliant (511/511E) pattern generator and detector with error injection mode; Remote loopback (toward DSL line) and local loopback (toward G.703 network) control by a single front-panel switch

Transmission Line: Single twisted-pair

Line Coding: CAP (Carrierless Amplitude and Phase Modulation)

Line Rates (DSL Line): 144, 272, 400, 528, 784, 1040, 1552, and 2064

Line Interface: Transformer-coupled, 1500-VAC isolation

mDSL Physical Connection: RJ-45, 2-wire, polarity insensitive pins 4 and 5

G.703/G.704 Specific

Interface: Dual coaxial female 75 ohm or RJ-45 female 120 ohm

Line Rate: 2.048 Mbps

Line Coding: AMI or HDB3 (selectable); HDB3 is the default

Line Framing: G.703 (unframed) or G.704/G.732 (framed)

Isolation: 1500 Vrms

Physical Connection: Pin 1 RX Data +, pin 2 RX Data -, pin 4 TX Data +, pin 5 TX Data -

Indicators: DSL Link (green active), E1/FE1 Link (red active), LOS (E1 loss of framing, red active), NS (No signal DSL link, red active), ER (CRC error during normal operation, bit error during pattern-generator test, flashing red), TM (Test mode enabled, active yellow)

Configuration: Externally accessible DIP switches or SNMP managed through mDSL Rack Card

Power: 5 VDC from external desktop power supply, 100 to 240 VAC, 50 to 60 Hz (universal input), 10 W

Size: 1.6"H x 4.1"W x 6"D (4.1 x 10.4 x 15.2 cm)

Weight: 0.58 lb. (0.26 kg)

2. Introduction

2.1 Description

The mDSL Line Driver extends G.703/G.704 service over multi-rate symmetric digital subscriber line technology. Multi-rate DSL delivers the maximum bit rate that a twisted-pair line can accommodate at these extended distances. ISPs, CLECs, and corporate enterprises can terminate G.703/G.704 (E1) service and either extend nx64 G.703/G.704 service or provide a remote serial connection to a router or switch when paired with an mDSL Line Driver V.35 or X.21 (ME0005A-V35 or ME0005A-X21).

As the mDSL Line Driver receives data from an E1 line, it extracts the E1 clock and delivers smooth clock and data to the remote DSL modem over a two-wire DSL span. In a network-extension application, a remote Line Driver delivers nx64kbps to 2-Mbps G.703 data and clocking to an external piece of equipment with an E1 interface. In a network termination application, a remote ME0005A-V35 or ME0005A-X21 accepts this data and clock stream and provides nx64kbps data to customer premise equipment with a V.35 or X.21 interface.

As a symmetric DSL NTU, ME0005A-G703 offers the same data rates in both directions over a single pair of regular telephone lines using Carrierless Amplitude and Phase (CAP) modulation. Equipped with both 75-ohm (dual coax) and 120-ohm (RJ-45) terminations, the ME0005A-G703 is easy to configure and install. DSL line connection is via an RJ-45 jack. The mDSL Line Driver is powered by a 100- to 240-VAC universal power supply.

2.2 Features

- Multi-rate symmetric DSL.
- Supports DTE speeds from 64 kbps to 2.048 Mbps.
- 2-wire operation.
- 120-ohm (RJ-45) and 75-ohm (dual coax) G.703/G.704 terminations.
- 2-Mbps G.703 clear channel (unframed) or nx64 G.704 (framed) operation.
- SNMP manageable as the CP (Customer Premises) modem when connected to an mDSL Rack Card.
- Selectable AMI or HDB3 Line Coding.
- LED indicators for DSL Link, E1/FE1 Link, LOS, TM, ER, and NS.

3. Configuration

The mDSL Line Driver is equipped with two sets of eight DIP switches. This chapter describes switch locations and explains all possible configurations.

3.1 Configuring the Hardware DIP Switches

The 16 external switches are grouped into two eight-switch sets, and they're externally accessible from the underside of the mDSL Line Driver (see Figure 3-1).

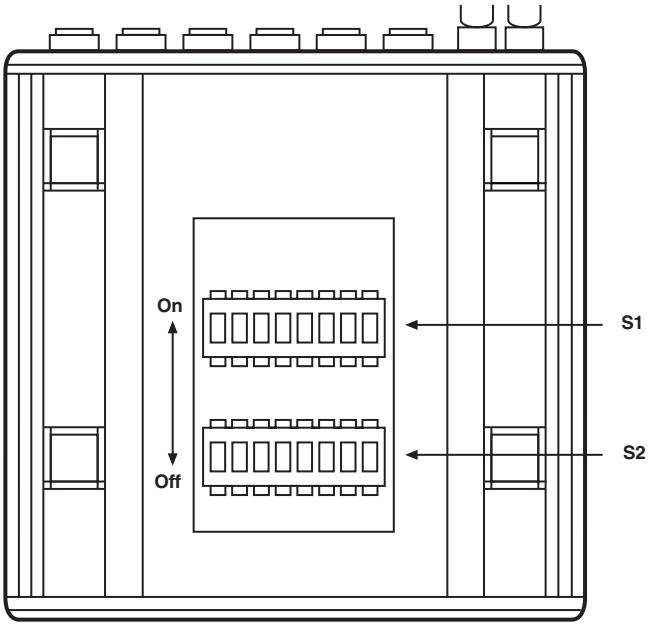

Figure 3-1. Underside of the mDSL Line Driver, showing the location of the DIP switches.

The two sets of DIP switches on the underside of the mDSL Line Driver are called S1 and S2. As Figure 3-2 shows, the orientation of all DIP switches is the same with respect to the ON and OFF positions.

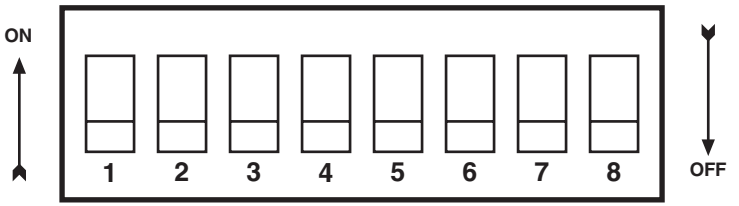

Figure 3-2. Close-up of the configuration switches (all sets are identical in appearance).

3.1.1 DIP-Switch S1

Switches S1-1 through S1-8 may be used to configure CO/CP operation, line framing and coding, and CRC-4 operation. Default settings of S1 switches are shown in Table 3-1.

Table 3-1. S1 summary.

Position	Function	Factory Default	
S1-1	CO/CP Setting	On	CP Mode
S1-2	Line Coding	Off	HDB3
S1-3	CRC-4 Enable	Off	Disabled
S1-4	Reserved	Off	
S1-5	Reserved	On	
S1-6	Reserved	Off	
S1-7	Reserved	On	
S1-8	Reserved	Off	

Switch S1-1: CO/CP

Use Switch S1-1 to configure the CO (located at the Central Office or G.703/G.704 demarcation point) or CP (located at the Customer Premises) mode of the ME0005A-G703.

Table 3-2. Configuring the CO or CP.

S1-1	CO/CP Mode
Off	CO = located at the Central Office
On	CP = located at the Customer Premises

CO/CP Configuration:

The ME0005A-G703 does not use clock mode settings as described in other Black Box mDSL products. Instead, the ME0005A-G703 will always recover the clocking from the G.703/G.704 network and use this clock to send data across the DSL span to the remote DSL modem, which will use the incoming clocking to send data out to the G.703/G.704 network. Therefore, one unit must be set for CO mode (located at the G.703 demarcation), and the other unit must be set for CP mode (located at the customer premises). This type of clocking method was employed for two reasons:

1. To allow two independent networks to use the modems as independent clocking paths.

2. To allow the user to independently specify the timing source for the network based on external equipment.

CO/CP and using the ME0005A-G703 with other Black Box mDSL modems

Other Black Box mDSL Line Drivers allow the option of specifying the clock mode, but not the CO/CP designation. This is already done internally within the unit. When connecting a ME0005A-G703 to an mDSL Line Driver other than an ME0005A-G703, determine the source of the system clock and then determine the ME0005A-G703's CO/CP designation based upon Table 3-3.

Table 3-3. CO/CP.

mDSL Rack Card Clock Mode	mDSL Rack Card Designation	mDSL Line Driver G.703 Setting Required
External	CO	CP
Internal	CO	CP
Receive Recover	CP	CO

NOTE

In each DSL modem pairing, one unit must act as the CO unit and the other must act as the CP unit.

Switch S1-2: Line Coding

Use Switch S1-2 to configure the G.703/G.704 network line coding. The line coding must be the same line coding prescribed by the NAP (Network Access Provider). Most applications will use HDB3.

Table 3-4. Line coding.

S1-2	Line Framing & Coding
Off	HDB3
On	AMI

Line Coding Options:

- High-Density Bipolar 3 (HDB3): In HDB3 coding, the transmitter deliberately inserts a bipolar violation when excessive zeros in the data stream are detected. The receiver recognizes these special violations and decodes them as zeros. This method enables the network to meet minimum pulse density requirements. Use HDB3 unless AMI is required in your application.
- Alternate Mark Inversion (AMI): AMI coding does not inherently account for ones density. To meet this requirement, you should make sure that the data inherently meets pulse density requirements.

Switch S1-3: CRC-4 Multiframe

CRC-4 Multiframe uses Time Slot zero to carry CRC-4 information. When CRC-4 is enabled (ON), the unit synchronizes to the CRC-4 multiframe protocol.

Table 3-5. CRC-4 multiframe.

S1-3	Option
Off	Disabled
On	Enabled

NOTE

When the DTE rate is set to 2048 kbps, the ME0005A-G703 transmits user data on all 32 timeslots, ignoring framing information. In this case, Switch S1-3 will need to be in the disabled (Off) position.

Switches S1-4, S1-5, S1-6, S1-7, and S1-8: Reserved

Switches S1-4, S1-5, S1-6, S1-7, and S1-8 are reserved for factory use. They must remain in the default configuration except when using the Plug-and-Play feature.

Table 3-6. Reserved switches.

S1-4	S1-5	S1-6	S1-7	S1-8	Default Setting
Off	On	Off	On	Off	Only Valid Setting

3.1.2 DIP-Switch S2

Use the eight DIP switches in Switch S2 to enable the DTE connection rate. Table 3-7 summarizes default positions of DIP-switch S2. Detailed descriptions of each switch follow the table.

Table 3-7. S2 summary.

Position	Function	Factory Default
S2-1	DTE Rate	Off
S2-2	DTE Rate	Off
S2-3	DTE Rate	On
S2-4	DTE Rate	On
S2-5	DTE Rate	On
S2-6	DTE Rate	Off
S2-7	Reset Software Defaults	On Normal Operation
S2-8	Transmit Data Sample Point	On Normal Operation

2048 kbps

Switches S2-1 through S2-6: DTE Rate

Use Switch S2-1 through S2-6 to set the DTE bit rate.

Table 3-8. DTE rate switch settings.

S2-1	S2-2	S2-3	S2-4	S2-5	S2-6	DTE Rate (kbps)
Off	Off	On	On	On	On	64
On	On	Off	On	On	On	128
Off	On	Off	On	On	On	192
On	Off	Off	On	On	On	256
Off	Off	Off	On	On	On	320
On	On	On	Off	On	On	384
Off	On	On	Off	On	On	448
On	Off	On	Off	On	On	512
Off	Off	On	Off	On	On	576
On	On	Off	Off	On	On	640
Off	On	Off	Off	On	On	704
On	Off	Off	Off	On	On	768
Off	Off	Off	Off	On	On	832

Table 3-8 (continued). DTE rate switch settings.

S2-1	S2-2	S2-3	S2-4	S2-5	S2-6	DTE Rate (kbps)
On	On	On	On	Off	On	896
Off	On	On	On	Off	On	960
On	Off	On	On	Off	On	1024
Off	Off	On	On	Off	On	1088
On	On	Off	On	Off	On	1152
Off	On	Off	On	Off	On	1216
On	Off	Off	On	Off	On	1280
Off	Off	Off	On	Off	On	1344
On	On	On	Off	Off	On	1408
Off	On	On	Off	Off	On	1472
On	Off	On	Off	Off	On	1536
On	On	Off	Off	Off	On	1600
Off	On	Off	Off	Off	On	1664
On	Off	Off	Off	Off	On	1728
Off	Off	Off	Off	Off	On	1792
On	On	On	On	On	Off	1856
Off	On	On	On	On	Off	1920
On	Off	On	On	On	Off	1984
Off	Off	On	On	On	Off	2048

NOTE

The actual line rate of the Line Driver is determined by the selection of the DTE rate. To see the line rate associated with various DTE rates, refer to the distance charts in Appendix A.

Switch S2-7: Reset Software Defaults

Switch S2-7 allows you to reset the software-configured factory defaults. This will only be needed when using the Managed Micro Rack SNMP/HTTP Card (part number RM261C-SNMP) to SNMP manage your units. For more information, please refer to the *Managed Micro Rack SNMP/HTTP Users' Manual*.

Table 3-9. Reset software defaults.

S2-7	Setting
On	Normal Operation
Off	Reset

Switch S2-8: Transmit Data (TD) Sampling Point

Table 3-10. Transmit data sampling point.

S2-8	Setting	Description
On	Normal	TD sampled on the falling edge of the mDSL Line Driver Transmit Clock (TC)
Off	Invert	TD sampled on the rising edge of the mDSL Line Driver Transmit Clock

3.2 Plug-and-Play

The Plug-and-Play feature allows ISPs, carriers, and PTTs to quickly upgrade the link speed for a customer without requiring a visit to re-configure the Customer Premise (CP) mDSL Line Driver. This feature also allows service providers to set up all of the configurations at the Central Office (on the rack cards) before installing the standalone units, saving time spent configuring or re-configuring DIP switches.

NOTE

Plug-and-play is only available with Black Box's other managed mDSL products, such as the ME0004C.

The Plug-and-Play feature allows you to configure the DTE rate (bandwidth allocation; see Switches S2-1 through S2-6) of the CP unit from the rack card at the Central Office (CO). The standalone unit at the Customer Premise (CP) site will automatically configure itself to the DTE rate (bandwidth allocation) of the rack card. Other configuration parameters remain in the default setting.

Follow the instructions below to activate Plug-and-Play between CO (mDSL Rack Card, ME0004C) and CP (mDSL Line Driver, ME0005A) units:

1. Set the mDSL Rack Card (CO) to either internal or external clocking mode as defined by the application.

2. Set the mDSL Line Driver (CP) to "Plug-and-Play CP" by setting S1 and S2 DIP switches in the ON position as described in Figure 3-3.

Figure 3-3. Typical plug-and-play application.

When the CO and CP units connect over DSL, the CP will enter a predefined default configuration (receive recovered clocking). During the negotiation process between the units, the CO unit will configure the DTE rate/line rate on the CP unit as defined by the settings of the CO unit. When additional bandwidth is required, only the configuration of the CO unit should be changed. This feature gives ISPs, LECs, and PTTs the ability to provision bandwidth on an as-needed basis to customers.

The Plug-and-Play application will also work in an HTTP/SNMP managed system using the Managed Micro Rack SNMP/HTTP Card (part number RM261C-SNMP) with mDSL Rack Cards installed in Black Box's 2U rack system. In this application, the system administrator can configure the entire rack through the Network Management Station (NMS) before the standalone (CP) units are installed. For more information on HTTP/SNMP management, please refer to the *Managed Micro Rack SNMP/HTTP Card Users' Manual.*

4. Installation

Once the mDSL Line Driver is properly configured, it is ready to connect to the twisted-pair interface, to the serial port, and to the power source. This chapter describes how to make these connections.

4.1 Connecting the G.703 Network

The Power, G.703/G.704, and DSL Line connections are located on the Line Driver's rear panel. Figure 4-1 shows the location of each of these ports.

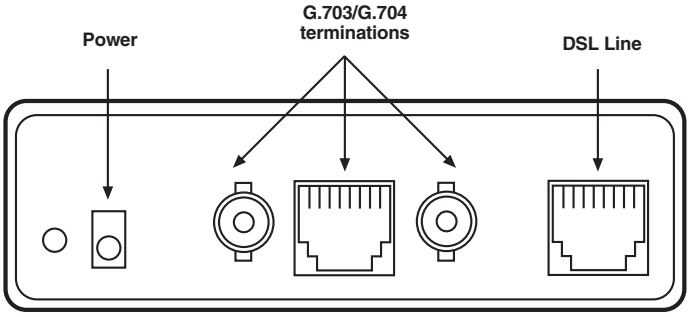

Figure 4-1. Rear panel.

4.2 Jumper Configuration

The mDSL Line Driver has four jumpers (two position headers): JP1, JP4, JP5, and JP6. These jumpers are used to select input or output impedance matching between the module and external line, and to employ either BNC or RJ-45 interface. Figure 4-2 shows the top view of the printed circuit board (PCB) and the location of the jumpers.

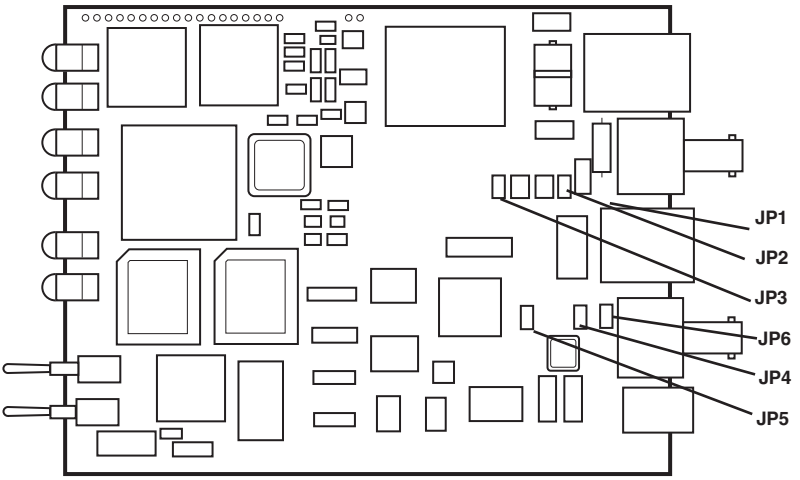

Figure 4-2. Top view, showing the location of JP1–JP6.

The following is a description of the jumper settings with respect to the rear-panel connectors.

1. For a 75-ohm connection (coax), insert JP1, JP4, JP5, and JP6 (default).
2. For a 120-ohm connection (RJ-45), remove JP1, JP4, JP5, and JP6.

4.2.1 Connect Twisted Pair (120 ohm) to a G.703 Network

The ME0005A-G703 is equipped with a single RJ-48C jack for connections to a 120-ohm twisted-pair G.703/G.704 network interface. If your G.703/G.704 network terminates via RJ-48C, use Figure 4-3 and Table 4-1 to make the proper connections. The connector pinout and signals are shown in Figure 4-3.

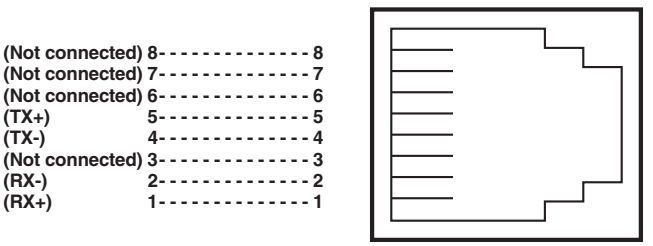

Figure 4-3. 120-ohm RJ-48C G.703 interface.

Use the following connection diagram to connect the 120-ohm G.703/G.704 network channel.

Table 4-1. RJ-45 cable (8-wire).

mDSL Line Driver Signal	Pin #	G.703/G.704 Network Signal
RX+	1 ----------	TX+
RX-	2 ----------	TX-
TX+	5 ----------	RX+
TX-	4 ----------	RX-
Shield	3 ----------	Shield
Shield	6 ----------	Shield

4.2.2 Connect Dual Coaxial Cable (75 ohm) to a G.703 Network

The ME0005A-G703 is also equipped with dual female BNCs (TX and RX) for connection to a 75-ohm dual-coax G.703 network interface. If your G.703/G.704 network terminates via dual coaxial cable, use Figure 4-4 to make the proper connections. The connector pinout and signals are shown in Figure 4-4.

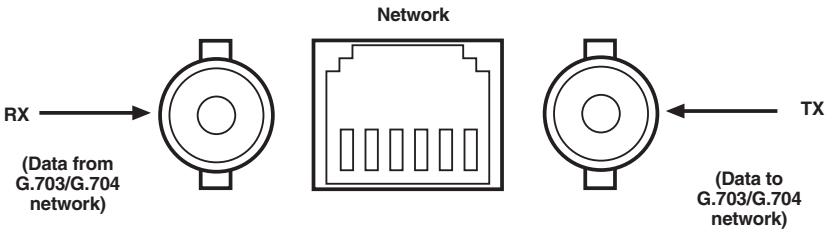

Figure 4-4. 75-ohm dual coaxial G.703 interface.

NOTE

The outer conductor of the coax cables are isolated from system earth ground.

4.3 Connect Twisted Pair to DSL Interface

The ME0005A-G703 supports communication between two DTE devices at distances to 5 miles (8 km) over 24-AWG (0.5-mm) twisted-pair wire. Two things are essential:

1. These units operate as a pair. Both units at the end of the twisted-pair DSL span must be set for the same DTE rate.

2. To function properly, the mDSL Line Driver needs one twisted pair of metallic wire. This twisted pair must be unconditioned, dry, metallic wire, between 19 (0.9 mm) and 26 AWG (0.4 mm); the higher number gauges will limit distance. Standard dial-up telephone circuits, leased circuits that run through signal equalization equipment, or standard, flat modular telephone type cable are not acceptable.

The RJ-45 connector on the mDSL Line Driver's twisted-pair interface is polarity insensitive and is wired for a two-wire interface. The signal/pin relationships are shown in Figure 4-5.

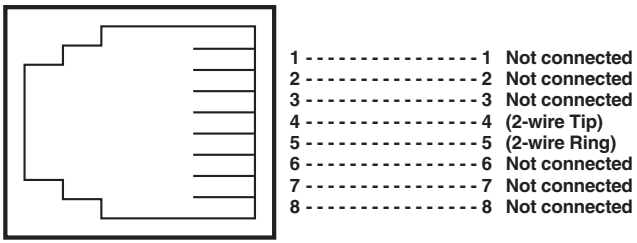

Figure 4-5. Twisted-pair line interface.

4.4 Power Connection

The mDSL Line Driver uses a 5-VDC, 2-A 100- to 240-VAC universal input power supply (center pin is +5V). The power supply has a male IEC 320 power entry connector. This power supply connects to the mDSL Line Driver via a barrel jack on the rear panel.

The Line Driver powers up as soon as it is plugged into an AC outlet—there is no power switch.

WARNING

There are no user-serviceable parts in the mDSL Line Driver's power supply. Only qualified service personnel should replace the fuse. Contact Black Box Technical Support at 724-746-5500 for details.

5. Operation

Once the mDSL Line Driver is properly configured and installed, it should operate transparently. This chapter describes power-up, reading the LED status indicators, and using the built-in loopback test modes.

5.1 Power-Up

Before you apply power to the mDSL Line Driver, first be sure that you have read **Chapter 4**. Also make sure that the unit is connected to the appropriate power source.

5.2 LED Status Indicators

The mDSL Line Driver features six front-panel LEDs that monitor power, the DTE signals, network connection, and test modes. Figure 5-1 shows the location of each LED. Following Figure 5-1 is a description of each LED's function. See also **Appendix B**.

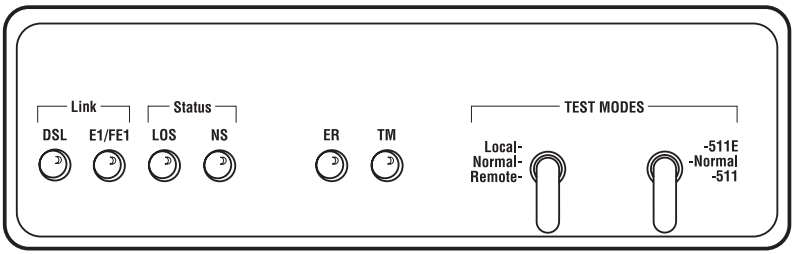

Figure 5-1. Front panel.

- DSL Link: (Active Green) Solid green (On) indicates that the end-to-end DSL Framer Link is up, signifying that the link across the DSL span is active. The DSL Link LED is Off when the link is down.
- E1/FE1 Link: (Active Green) Solid green (On) indicates a valid E1 connection.
- LOS: (Active Red) The Loss of Sync indicates that the unit has lost synchronization with the incoming signal. This may happen when there is a framing mismatch or a loss of signal. In unframed mode, the LOS LED monitors the status of the transmit clock.

- NS: (Active Red) The No Signal LED glows red to indicate that the local mDSL Line Driver is not connected with the remote mDSL Line Driver.
- ER: (Flashing Red) Blinks ON/OFF after a 511/511E test has timed out. See **Section 5.3.3** for more information.

- flashes once to indicate that a CRC error has occurred (during normal operation) or bit errors have occurred (during 511/511E tests).
- Only at power up, blinks once every 200 ms if the DTE rate is set to unsupported settings.

- TM: (Active Yellow) glows yellow to indicate that the ME0005A-G703 has been placed in Test Mode. The unit can be placed in test mode by the local user or by the remote user. The TM LED will flash for 400 msec when a valid packet is received from the Managed Micro Rack SNMP/HTTP Card (part number RM261C-SNMP).

5.3 Test Modes

The mDSL Line Driver offers two proprietary loopback test modes. It also has a built-in V.52 BER test-pattern generator to evaluate the condition of the modems and the communication link. These tests can be activated physically from the front panel.

5.3.1 Overview

Figure 5-2 shows the major elements used in the loopback and pattern tests available in the mDSL Line Driver. Each block has several functions. Following Figure 5-2 are descriptions that show how the elements are used during test modes.

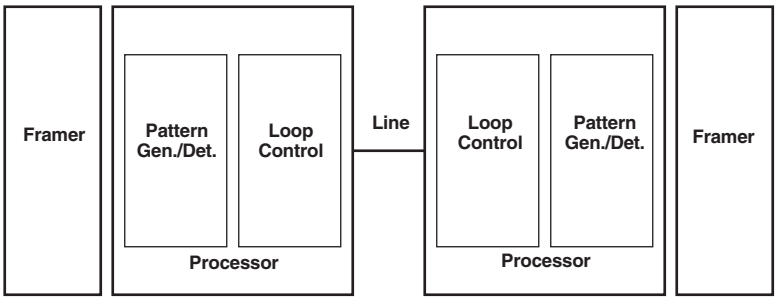

Figure 5-2. Two mDSL Line Drivers communicating over the DSL span.

- Framer: The framer is used to determine the status of the line. In normal operation, the framer transmits and expects to receive framed packets from the far end. If the framer receives framed packets from the far end, the DSL Link LED will be active. If framed packets are not received, the DSL Link LED will be inactive. The restart procedure uses this information to determine if a valid connection is made (cable disconnect, poor cable quality, etc). In normal data mode, if the box receives four seconds of unframed packets it will restart the box and begin trying to re-establish a connection with the far end. The distinction between framed packets and unframed packets becomes important when we discuss the pattern generator.

- Pattern Gen./Det.: This part of the processor generates and detects the 511/511E patterns. When transmitting 511 patterns, the information is unframed (because it originates after the framer) and is intended to be evaluated only by another processor. If the units are in data mode and the pattern generator is enabled on one end of the link, the far end will begin receiving unframed packets and assume that the line has gone down. During test modes, we force the pattern generator to time out before it can cause the link to be killed.

- Loop Control: This part of the processor is used to control loopbacks. In a local loop, the data is looped back towards the local DTE (G.703/G.704). In a remote loop, the data is looped back to the line, but it is also allowed to pass through to the framer and to the remote DTE (G.703/G.704).

5.3.2 Restart Procedure and Timeouts

The restart procedure is in place to allow the units to re-establish a connection after the framer begins seeing unframed packets. Table 5-1 shows the amount of time the framer must see consecutive unframed packets before the unit will restart and try to establish a new line connection. The reason that there are different restart times will become apparent after reading the rest of the document. The 511/511E timeout shown refers to the amount of time the 511/511E pattern will be valid. At the end of this time the pattern will automatically turn itself off and the normal data path will be re-established. The ER LED will flash, indicating to you that the test has timed out. The ER LED will stop flashing once the 511/511E switch is placed into the normal position.

Table 5-1. Test mode timing.

Item	Elapsed Time (seconds)
Startup	50
Data Mode	4
511/511E Generator Enabled	60 (The generator will stop after 45 seconds.)
Remote End of an RDL	60
511/511E Timeout	45 (The pattern generator will automatically turn off after 45 seconds. The ER LED will flash until you turn off the 511/511E switch.)

Symbol Indicators

☐ This symbol designates the origination or the termination of a data path. The direction of the arrow connected distinguishes the two data paths.

☒ This symbol designates an invalid data path. If there is data present, it should be ignored.

5.3.3 Loops and Patterns

The following section describes the test modes used in the mDSL Line Driver. At the bottom of each test mode, a figure is included to show the data path.

Local Loop

There are two different modes of operation for a local loop, depending on the status of the units at the time that the local loop is initiated. If the units are not linked (NS LED on) and the local loop is initiated (either by the front-panel switch or the DTE interface), the unit will enter mode 1. If the units are linked (NS LED off), then the unit will enter a mode 2 local loop.

A mode 1 local loop is shown in Figure 5-3. When the local loop is initiated (either by the front-panel switch or the DTE interface), the loop will be activated within the local processor. The data present at the local DTE interface will be looped back to the local DTE by the loop control block within the processor. Any data present on the line or at the far-end DTE interface is invalid. The remote unit will remain

in the startup mode (NS LED on, DSL Link LED stays off), until the local unit is taken out of the local loop mode. After the local loop is deselected, the units will both be in startup mode and the link will be established.

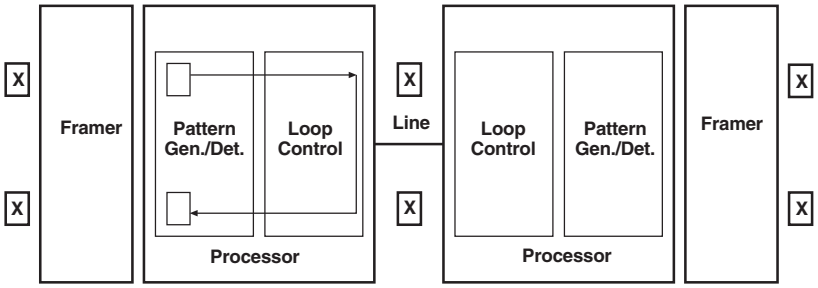

Figure 5-3. Local loop mode 1.

A mode 2 local loop is shown in Figure 5-4. When the local loop is initiated (either by the front-panel switch or the DTE interface), two separate loop paths will be started. In the first path, data presented to the local DTE interface will be looped back to the local DTE within the framer. In the second path, data presented at the far-end DTE will be transmitted to the local DTE and then looped back within the local DTE loop-control block with the processor. After the local loop is deselected, the units will be placed back into data mode and the normal data paths will be re-established.

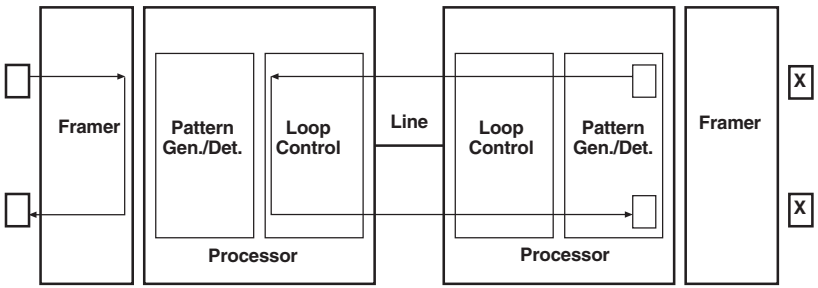

Figure 5-4. Local loop mode 2.

Local Loop with 511/511E

When the unit is placed into a mode 1 local loop and the 511/511E pattern generator is activated, the local pattern generator begins sending out a 511/511E pattern to the loop control block. The loop control block will loop this data back to the 511/511E pattern detector block, which will evaluate the data for errors. Because the 511/511E pattern generator is contained within the processor, the data is unframed so the framer will begin seeing unframed packets. The framer receives this unframed data and cannot distinguish this information from a line disconnection (this would cause the units' restart procedure to start). What we have done to allow this mode to work is to add timeouts for the pattern generators. When the 511/511E is initiated, the line restart procedure is changed to one minute. The 511/511E pattern will timeout after 45 seconds. So if the 511/511E is turned on during a local loop, the restart procedure is set to one minute, but the 511/511E pattern will time out after 45 seconds, allowing the framer to begin seeing framed packets (and not restart the box).

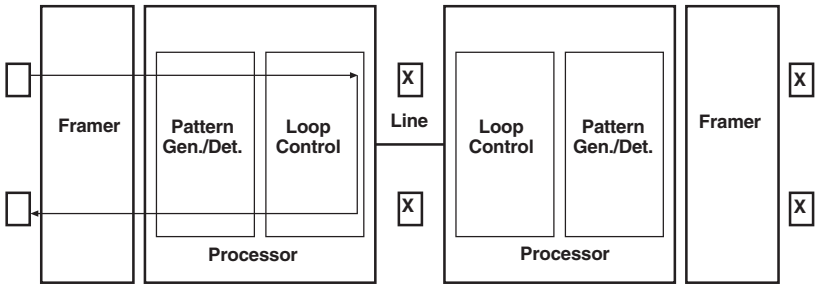

Figure 5-5. Local loop mode 1 with 511/511E.

After the 511/511E pattern times out, the ER LED will begin flashing. It will remain this way until the pattern-generator switch is turned off. Note that the data at the local DTE and the remote DTE are not valid. Because the data is unframed there is no way for the framer to send this data out to the DTE. This is an important distinction because other units will send out the 511 pattern.

When the unit is placed into a mode 2 local loop, the 511/511E pattern generator on the local unit is unavailable for transmission. Figure 5-6 displays the 511/511E pattern generator, showing that data-path connections are not available. The 511/511E pattern generator is still available on the remote unit. For more information on the proper operation of this pattern generator, please refer to the *Remote Digital Loop with 511/511E* section.

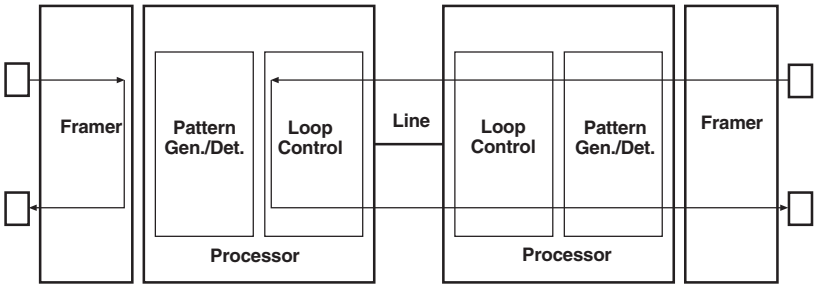

Figure 5-6. Local loop mode 2 with 511/511E.

Remote Digital Loop

The Remote Loop uses the EOC channel (an out-of-band signaling channel) to establish the remote link. Upon the RDL switch being thrown or DTE initiation, a RDL_ON Request signal is sent to the remote unit. The remote unit then responds with an RDL Acknowledge command, and the link is established. Data originates at the local DTE and is looped at the remote processor back to the local DTE. Note that the data is also passed through to the remote DTE and is not squelched. When a remote unit enters RDL, it changes its restart timeout to one minute (the reason will be explained in the *RDL with 511/511E* section). If the line is disconnected, the local unit will restart (NS LED activated) after 4–6 seconds, but the remote unit will wait for one minute before it restarts. Note that the transmit data at the remote DTE is ignored. When the switch is thrown or the DTE removes the RDL request, the local unit will transmit an RDL_OFF request to the remote unit. The local unit will keep its TM LED active until this request has been completely sent out. If the switch is thrown again before the completion of the termination phase, the switch will be ignored until it is placed back into the normal position.

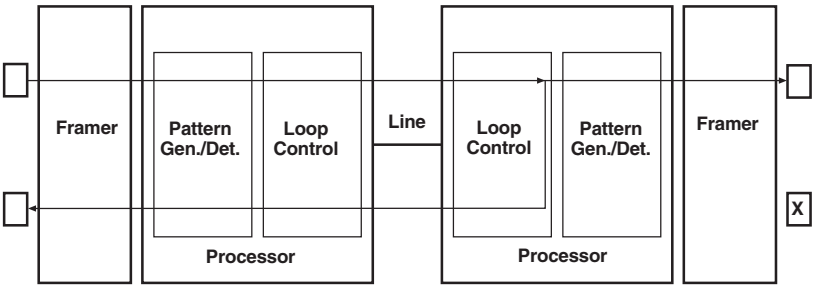

Figure 5-7. Remote loop.

Remote Digital Loop with 511/511E

The Remote Digital Loop with 511/511E is shown in Figure 5-8. After RDL is established, the remote unit's restart timer is set to one minute. This was done because when the 511/511E generator is started on the local unit, the remote framer will see unframed packets. The remote unit cannot distinguish the 511/511E pattern from the line being disconnected, so the restart timer has been lengthened to allow the pattern generator to function. Once the 511/511E test is started, the local unit changes its restart timer to one minute. The pattern originates within the processor and is sent to the remote unit. It is then looped back to the Local unit where it is evaluated for errors. After 45 seconds, the pattern generator will timeout and stops sending the pattern. The ER LED will begin blinking until the user turns off the 511/511E switch.

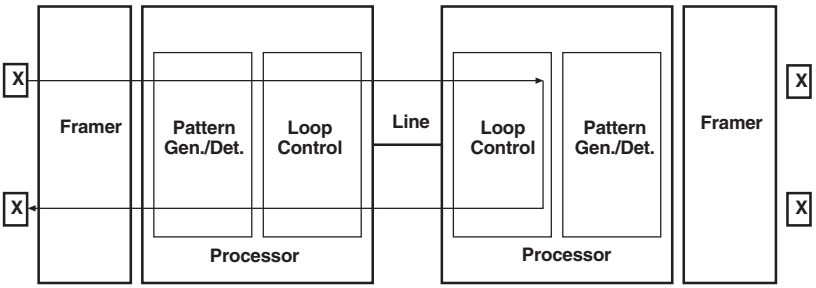

Figure 5-8. Remote loop with 511/511E.

Data Mode with 511/511E Pattern Generators

When the units enter data mode, you can turn on the 511/511E pattern generators on both ends of the link. Once a 511/511E pattern is selected on one end of the link, the pattern generator will begin transmitting unframed 511/511E through the line to the remote end. A possible problem with this test can occur due to the restart procedure. Once the local 511/511E is turned on, the remote unit begins receiving an unframed 511 pattern. If the remote unit does not turn on the 511/511E pattern generator within four seconds, the remote unit will restart and enter the startup mode. Note that once the 511/511E pattern generator is started, the restart timer is changed to one minute (only on the unit that has the pattern enabled). If both units enable the 511/511E pattern within four seconds of each other, both units will be transmitting and receiving the 511/511E pattern. Both framers are now receiving unframed data and will restart after one minute. The 511/511E pattern generators will timeout after 45 seconds, re-enabling the normal data path. The ER LED will begin flashing until the user terminates the test.

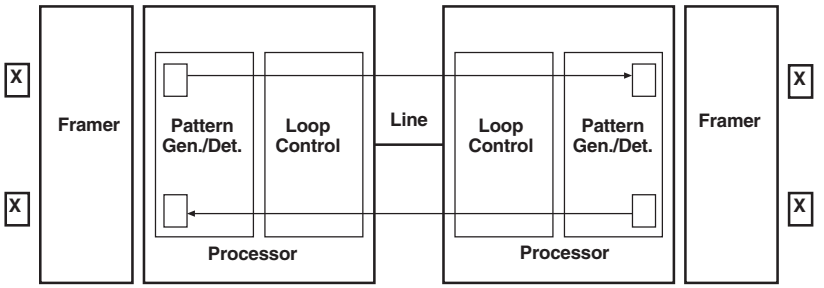

Figure 5-9. Data mode with 511/511E.

5.3.4 Using the V.52 (BER) Test-Pattern Generator

To use the V.52 BER tests in conjunction with the remote digital loopback tests (or with local line loopback tests), follow these instructions:

1. Locate the 511/511E toggle switch on the Line Driver's front panel and move it DOWN. This activates the V.52 BER test mode and transmits a 511 test pattern into the loop. If any errors are present, the local modem's red ER LED will blink sporadically.

2. If the above test indicates no errors are present, move the V.52 toggle switch UP, activating the 511E test with errors present. If the test is working properly, the local modem's red ER LED will blink. A successful 511E test will confirm that the link is in place, and that the mDSL Line Driver's built-in 511 generator and detector are working properly.

NOTE

The above V.52 BER tests can be used independently of the remote digital loopback tests. This requires two operators: (one) to initiate and monitor the tests at the local Line Driver and (one) to do the same at the remote Line Driver. In this case, the test pattern sent by each Line Driver will not be looped back, but will be transmitted down the line to the other Line Driver. While one operator initiates the test, the other operator monitors for errors.

Appendix A. Transmission Distance Charts

Table A-1. Transmission distance mDSL Line Driver, no crosstalk.

Line Rate (kbps)	DTE Rates (kbps)	26 AWG (0.4 mm)			24 AWG (0.5 mm)		
		ft.	mi.	km	ft.	mi.	km
144	64, 128	21,400	4	6.5	30,700	5.8	9.4
272	192, 256	20,300	3.8	6.2	30,600	5.8	9.3
400	320, 384	18,600	3.5	5.7	29,100	5.5	8.9
528	448, 512	17,400	3.3	5.3	26,100	4.9	8
784	576, 640, 704, 768	15,800	3	4.8	22,600	4.3	6.9
1040	832, 896, 960, 1024	15,500	2.9	4.7	22,100	4.2	6.7
1552	1088–1536	13,600	2.6	4.2	19,200	3.6	5.9
2064	1600–2048	12,200	2.3	3.7	17,200	3.3	5.2

Table A-2. Transmission distance mDSL Line Driver, crosstalk (49 adjacent CAP pairs).

Line Rate (kbps)	DTE Rates (kbps)	26 AWG (0.4 mm)			24 AWG (0.5 mm)		
		ft.	mi.	km	ft.	mi.	km
144	64, 128	16,992	3.2	5.2	25,000	4.7	7.6
272	192, 256	15,088	2.9	4.6	22,000	4.2	6.7
400	320, 384	13,264	2.5	4	20,000	3.8	6.1
528	448, 512	12,300	2.3	3.8	18,000	3.4	5.5
784	576, 640, 704, 768	10,216	1.9	3.1	14,000	2.7	4.3
1040	832, 896, 960, 1024	8417	1.6	2.6	12,000	2.3	3.7
1552	1088–1536	7107	1.4	2.2	10,000	1.9	3.1
2064	1600–2048	5920	1.1	1.8	8000	1.5	2.4

Appendix B. LED Descriptions

	Power On	DSL Link	Link Brk	Brk 10s	RDL	RDL + 511
E1/FE1	Green*	Green*	Green*	Green*	Green*	Green*
LOS	Red*	Red*	Red*	Red*	Red*	Red*
DSL Link	Off	Green*	Off	Off	Green*	Off
NS	On	Off	Off	On	Off	Off
ER	Off	Off	Off	Off	Off	Off
TM	Off	Off	Off	Off	On	On
E1/FE1	Green*	Green*	Green*	Green*	Green*	Green*
LOS	Red*	Red*	Red*	Red*	Red*	Red*
DSL Link	Off	Green	Off	Off	Green	Off
NS	On	Off	Off	On	Off	Off
ER	Off	Off	Off	Off	Off	Off
TM	Off	Off	Off	Off	On	On

	With DTE Connected		
	Mark	Space	Data
E1/FE1	Green*	Green*	Green*
LOS	Red*	Red*	Red*
DSL Link	Green*	Green*	Green*
NS	Off	Off	Off
ER	Off	Off	Off
TM	Off	Off	Off
E1/FE1	Green*	Green*	Green*
LOS	Red*	Red*	Red*
DSL Link	Green	Green	Green
NS	Off	Off	Off
ER	Off	Off	Off
TM	Off	Off	Off

Green* = Green if a valid 10BASE-T connection is detected.

Red* = Red if a loss of sync on the E1 signal is detected.

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