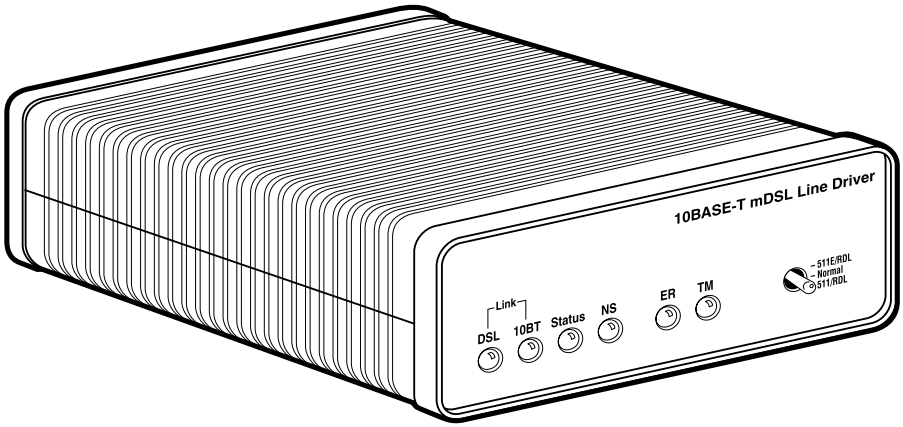
NOVEMBER 2001
ME0005A-10BT

2-Wire Short-Range DSL Line Driver (mDSL)



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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 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.

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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.

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Contents

1. Specifications

1.1. General

Clocking Modes: Internal or Receive Recovered

DTE Rate: All 64-kbps increments from 64 to 2304 kbps

Diagnostics: V.52-compliant (511/511E) pattern generator and detector with error injection mode and Remote Loopback control by a single front-panel switch

Configuration: Externally accessible DIP switches or SNMP/HTTP managed through the Managed Micro Rack SNMP/HTPP Card (part number RM261C-SNMP)

Transmission Line: Single twisted-pair (2 wires)

Line Coding: CAP (Carrierless Amplitude and Phase Modulation)

Line Rates (DSL Line): 144, 272, 400, 528, 784, 1040, 1552, 2064, 2320 kbps

Line Interface: Transformer coupled, 1500-VAC isolation

Indicators: The following LEDs are displayed on the front panel:
DSL Link (Green Active): DSL Link active;
10BT Link (Green Active): Valid Ethernet connection;
Status (Flashing Yellow): Status indication from the Ethernet port;
NS (Red Active): No signal on DSP Link;
ER (Flashing Red): CRC error during normal operation, bit error during pattern-generation test;
TM (Active Yellow): Test Mode Enabled

Connectors: (2) RJ-45

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

Size: 1.6"H x 4.7"W x 5"D (4.1 x 11.9 x 12.7 cm)

Weight: 0.58 lb. (0.26 kg)

1.2 Ethernet Specifications

Connector: RJ-45, 10BASE-T 802.3 Ethernet

Protocol: PPP (RFC 1661) with Bridging Control (RFC 1638)

Address Aging: Entries are deleted after 8 minutes of inactivity

Frame Latency: 1 frame

Frame Buffer: 512 frames

Ethernet Physical Connection: Pin 1 TD Data +, Pin 2 TD Data -, Pin 3 RD Data +, Pin 6 RD Data +, Pins 4, 5, 7, 8 no connection

2. Introduction

2.1 Description

The 2-Wire Short-Range Line Driver (mDSL) is a multi-rate DSL modem that provides seamless MAC Layer connectivity between two peered 10BASE-T LANs. Enterprise users no longer need to hassle with a bridge and a CSU/DSU or recurring leased-line costs. The mDSL Line Driver allows you to add additional nodes to a LAN that has reached its maximum distance limits or separate high-traffic areas of a LAN. The Line Driver connects peered LANs and automatically forwards and receives LAN broadcasts, multicasts, and frames across a 2-wire DSL span. The Line Driver supports PPP (RFC 1661) and BCP (RFC 1638).

The Line Driver features include loopback diagnostics, inband SNMP/HTTP remote management capabilities using plug-and-play, and externally accessible configuration switches. As a symmetric DSL modem, the Line Driver offers the same data rates in both directions over a single pair of regular telephone lines using Carrierless Amplitude and Phase (CAP) modulation. The Line Driver connects to the DSL line via an RJ-45 jack. The Line Driver is powered by a universal (100 to 240-VAC) power supply.

2.2 Features

- Provides MAC Level Data Link (Layer 2) connection between two peered 10BASE-T Ethernet LANs.
- Operates transparently to higher level protocols such as TCP/IP, DECnet™, NetBIOS, and IPX™.
- PPP (Point-to-Point Protocol, RFC 1661) with Bridge Control Protocol (RFC 1638).
- Automatically learns, loads, and removes MAC addresses.
- Point-to-point connectivity over 2-wire mDSL up to 10 km.
- Plug-and-play slave.
- HTTP/SNMP manageable as CP (Customer Premises) unit with ME0004C rack card as the central office unit.
- Internal or receive recovered clocking between units.
- LED indicators for 10BASE-T Link, DSL Link, Status, No Signal, Error, and Test Mode.

3. PPP Operational Background

PPP is a protocol used for multiplexed transport over a point-to-point link. PPP operates on all full-duplex media. It's a symmetric peer-to-peer protocol, which can be broken into three main components:

1. A standard method to encapsulate datagrams over serial links.
2. A Link Control Protocol (LCP) to establish, configure, and test the data-link connection.
3. A family of Network Control Protocols (NCPs) to establish and configure different network layer protocols.

In order to establish communications over a point-to-point link, each end of the PPP link must first announce its capabilities and agree on the parameters of the link's operation. This exchange is facilitated through LCP Configure-Request packets.

Once the link has been established and optional facilities have been negotiated, PPP will attempt to establish a network protocol. PPP will use Network Control Protocol (NCP) to choose and configure one or more network layer protocols. Once each network layer protocol has been configured, datagrams from the established network layer protocol can be sent over the link. The link will remain configured for these communications until explicit LCP or NCP packets close the link down, or until some external event occurs.

The PPP Bridging Control Protocol (BCP), defined in RFC 1638, configures and enables/disables the bridge protocol on both ends of the point-to-point link. BCP uses the same packet exchange mechanism as the Link Control Protocol (LCP). BCP is a Network Control Protocol of PPP, and bridge packets may not be exchanged until PPP has reached the network layer protocol phase.

Applications

In situations where a routed network requires connectivity to a remote Ethernet network, the interface on a router can be configured as a PPP IP half-bridge. The serial line to the remote bridge functions as a Virtual Ethernet interface, effectively extending the router's serial-port connection to the remote network. The bridge device sends bridge packets (BPDUs) to the router's serial interface. The router will receive the Layer 3 address information and will forward these packets based on its IP address.

Figure 3-1 shows a typical Cisco® router with a serial interface configured as a PPP half-bridge. The router serial interface uses a remote device that supports PPP bridging to function as a node on the remote Ethernet network. The serial interface on the Cisco router will have an IP address on the same Ethernet subnet as the bridge.

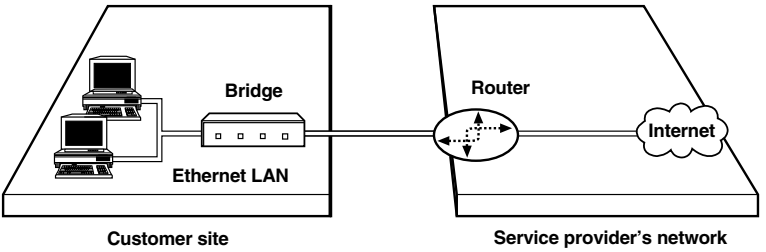

Figure 3-1. Cisco router with serial interface, configured as a PPP half-bridge.

For example, the customer site is assigned the addresses 192.168.1.0/24 through 192.168.1.1/24. The address 192.168.1.1/24 is also the default gateway for the remote network. The above settings remove any routing/forwarding intelligence from the CPE. The associated Cisco configuration will set serial interface (s0) to accommodate half-bridging for the example in Figure 3-1.

4. Configuration

There are two modes of operation for the Line Driver: Plug-and-Play and self-configuration. Both are described in this chapter.

4.1 Plug-and-Play

The Plug-and-Play feature allows ISPs, carriers, and PTTs to quickly upgrade the link speed to configure the Customer Premise (CP) 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.

The Plug-and-Play feature allows you to configure the DTE rate (bandwidth allocation, see Switches S3-1 through S3-6) 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-10BT) 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 all S2 and S3 DIP switches in the OFF position as described in Figure 4-1.

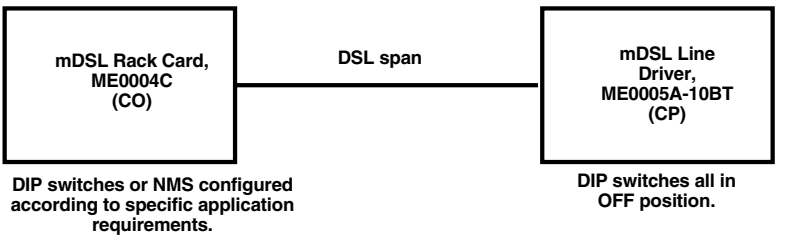

Figure 4-1. Typical plug-and-play application.

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 a Managed Micro Rack (part number RM260). 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 the HTTP/SNMP management, please refer to the *Managed Micro Rack SNMP/HTTP Card Users' Manual*.

4.2 Configuring the Hardware DIP Switches

The mDSL Line Driver has two sets of eight DIP switches. This section describes switch locations and explains all settings.

The 16 external switches are grouped into two eight-switch sets, and they're externally accessible from the underside of the Line Driver, as shown in Figure 4-2.

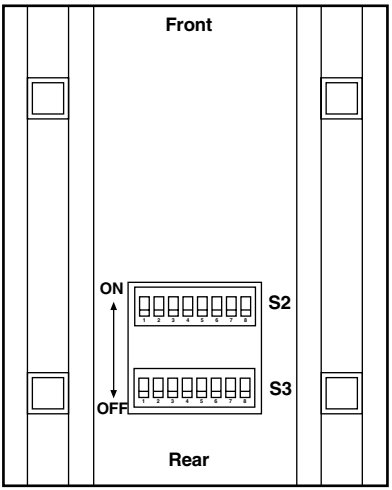

Figure 4-2. Underside of the mDSL Line Driver, showing the location of the DIP switches.

The two sets of DIP switches on the underside of the mDSL Line Driver are called S2 and S3. As Figure 4-3 shows, the orientation of all DIP switches is the same with respect to ON and OFF positions.

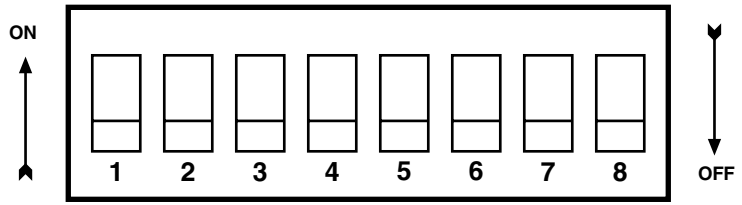

Figure 4-3. Close-up of configuration switches (all sets are identical in appearance).

4.2.1 Configuration DIP-Switch S2

The only setting for S2 is for clocking mode between the mDSL Line Drivers. All other switches are reserved for factory use and must remain in the default configuration. Default settings are shown in Table 4-1.

Table 4-1. S2 summary.

Position	Function	Factory Default
S2-1	Reserved	Off
S2-2	Reserved	Off
S2-3	Reserved	Off
S2-4	Reserved	Off
S2-5	Reserved	Off
S2-6	Clock Mode	On } Receive Recover
S2-7	Clock Mode	Off
S2-8	Reserved	Off

Switch S2-1, S2-2, S2-3, S2-4, S2-5, and S2-8

These switches are reserved for factory use and must remain in the factory-default settings as shown in Table 4-1.

Switches S2-6 and S2-7: Clock Mode

Use Switches S2-6 and S2-7 to configure internal or receive recover (clocking derived from the remote mDSL Line Driver across the DSL span) settings. One Line Driver (typically the CO, or "Central Office" unit) will be set for internal clock. The remote Line Driver (typically the CP, or Customer Premises unit) will be set for receive recover clocking. See Table 4-2.

Table 4-2. Clock mode.

CO/CP Unit	S2-6	S2-7	Clock Mode	Description
CO	On	On	Internal	Line Driver generates internal, crystal-controlled timing.
CP	On	Off	Receive Recover	Line Driver receives its timing from the CO unit over the DSL span.

4.2.2 Configuration DIP-Switch S3

Use the DIP switches in Switch S3 to set the DTE Rate (for LAN bandwidth allocation), the transmit data sampling point, and to reset the unit to its software default settings. Table 4-3 summarizes default positions of DIP-switch S3. Detailed descriptions of each switch follow the table.

Table 4-3. S3 summary.

Position	Function	Factory Default	
S3-1	DTE Rate	On	768 kbps
S3-2	DTE Rate	Off	
S3-3	DTE Rate	Off	
S3-4	DTE Rate	Off	
S3-5	DTE Rate	On	
S3-6	DTE Rate	On	
S3-7	Reset Software Defaults	On	Normal Operation
S3-8	Reserved	On	

Switch S3-1 through S3-6: DTE Rate

Use Switch S3-1 through S3-6 to provision bandwidth to the LAN in 64-kbps increments up to 2.304 Mbps. Peak bandwidth utilization on the local domain on an Ethernet LAN runs typically between 15% to 20% (1.5 Mbps to 2 Mbps) of the maximum bit rate of 10 Mbps. Traffic between LANs typically runs even lower — between 2% to 7% (200 kbps to 700 kbps) of the maximum bit rate depending upon application and environmental conditions. This is the amount of traffic that will run across the DSL span.

Set Switches 3-1 through S3-6 to allocate bandwidth based upon expected LAN-to-LAN traffic rates. As an example, set applications with low LAN-to-LAN bandwidth content between 64 kbps and 576 kbps. Applications with high-bandwidth LAN-to-LAN content should be set between 576 kbps and 2.304 Mbps as required.

Table 4-4. Bandwidth settings.

S3-1	S3-2	S3-3	S3-4	S3-5	S3-6	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
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

Table 4-4 (continued). Bandwidth settings.

S3-1	S3-2	S3-3	S3-4	S3-5	S3-6	DTE Rate (kbps)
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
On	On	Off	On	On	Off	2112
Off	On	Off	On	On	Off	2176
On	Off	Off	On	On	Off	2240
Off	Off	Off	On	On	Off	2304

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 the Appendix.

Switch S3-7: Reset Software Defaults

Use Switch S3-7 to reset the software-configured factory defaults. This feature is applicable only using the Managed Micro Rack SNMP/HTTP Card (part number RM261C-SNMP) to SNMP through the mDSL Line Driver central office to manage your units. For more information, please refer to the *Managed Micro Rack SNMP/HTTP Card Users' Manual.*

Table 4-5. Reset software defaults.

S3-7	Setting
On	Normal Operation
Off	Reset

Switch S3-8: Reserved

Switch S3-8 is reserved for factory use and must remain in the On position.

5. Installation

When the mDSL Line Driver has been properly configured, it may be connected to the DSL twisted-pair interface, the 10BASE-T Ethernet Interface, and the power source. This section describes these connections.

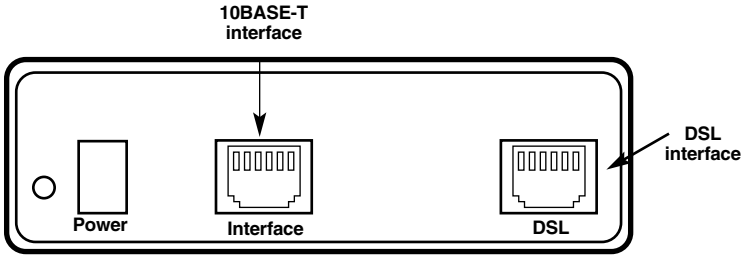

Figure 5-1. Connectors on the mDSL Line Driver.

5.1 Connecting the DSL Interface

The mDSL Line Driver supports communication between 10BASE-T hubs or workstations at distances to 5 miles (8 km) over 24 AWG (0.5 mm) twisted-pair wire. There are two requirements for installing the mDSL Line Driver:

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 5-2.

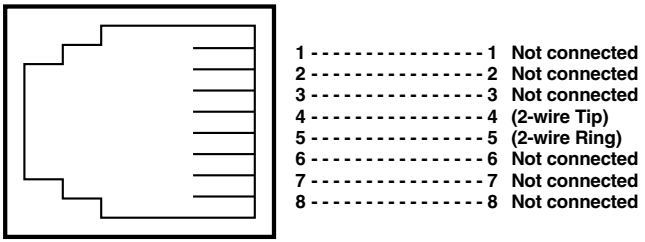

Figure 5-2. Twisted-pair line interface.

5.2 Connecting the 10BASE-T Ethernet Port to a PC (DTE)

The 10BASE-T interface is configured as DTE (Data Terminal Equipment). If the mDSL Line Driver is to connect to another DTE device such as a 10BASE-T network interface card, construct a 10BASE-T crossover cable and connect the wires as shown in Figure 5-3.

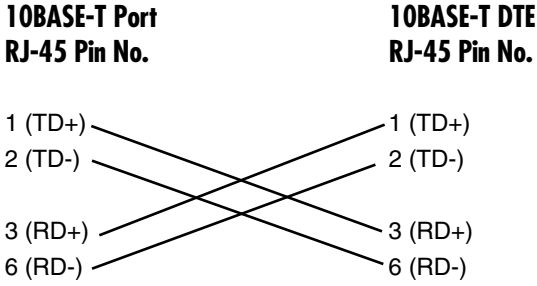

Figure 5-3. Ethernet port to PC connections.

5.3 Connecting the 10BASE-T Ethernet Port to a Hub (DCE)

The 10BASE-T interface is configured as DTE (Data Terminal Equipment), just like a 10BASE-T network interface card in a PC. Therefore, it "expects" to connect to a 10BASE-T hub using a straight-through RJ-45 cable. Use Figure 5-4 to construct a cable to connect the 10BASE-T interface to a 10BASE-T hub.

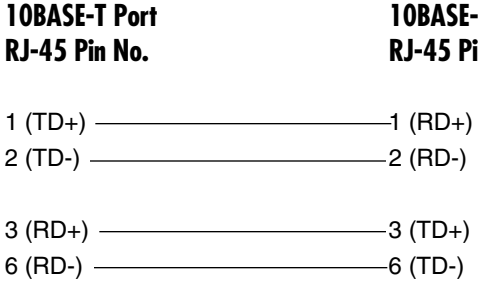

Figure 5-4. Port-to-hub connections.

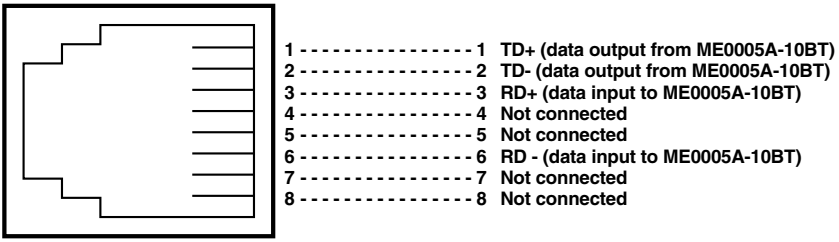

Figure 5-5. Ethernet RJ-45 connector pinout.

5.4 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 Line Driver via a barrel jack on the rear panel.

WARNING

There are no user-serviceable parts in the Line Driver's power supply. Contact Black Box Technical Support at 724-746-5500 for details.

6. Operation

When the mDSL Line Driver has been properly configured and installed, it should operate transparently. This section describes power-up, LED status monitors, and the built-in loopback test modes.

6.1 Power-Up

Before applying power to the Line Driver, please read **Section 5.4** and make sure that the unit is connected to the appropriate power source.

6.2 LED Status Indicators

The mDSL Line Driver features six front-panel LEDs that monitor connections on the DSL and 10BASE-T links, signaling, error, and test modes. Figure 6-1 shows the location of each LED. Descriptions of each LED follow Figure 6-1.

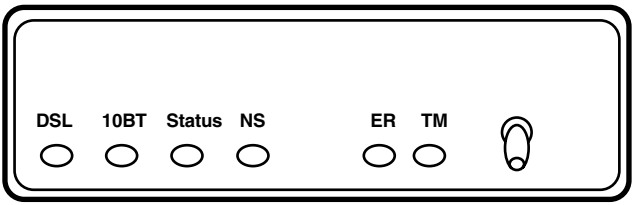

Figure 6-1. Front panel of the Line Driver.

- 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.

- Status: Blinks yellow from one to eleven times to indicate system status. Each pulse pattern is separated by a 2-second "off" period. Greater pulse patterns have higher priority (buffer saturation has greater priority than an empty MAC table). Valid system statuses are:

1 pulse =	system status is okay
2 pulses =	no MAC entries in the MAC Address Table
3 pulses =	Clear to Send (CTS) or Carrier Detect (DCD) from base unit are not asserted

4 pulses =	Line Driver's buffer is saturated
5 pulses =	WAN receive frame(s) too large
6 pulses =	WAN receive frame(s) not octet aligned
7 pulses =	WAN receive frame(s) aborted
8 pulses =	Detected WAN receive frame(s) with CRC
9 pulses =	Detected LAN receive frame(s) too large
10 pulses =	Detected LAN receive frame(s) not octet aligned
11 pulses =	Detected LAN receive frame(s) with bad CRC

- 10BT Link: (Active Green) Solid green indicates that the 10BASE-T Ethernet interface has detected a valid SQE heartbeat, signifying a valid 10BASE-T connection.

- NS: (Active Red) Solid red indicates that the Digital Signal Processors (DSPs) are not linked.

- ER: (Active Red) Flashing red indicates CRC Errors on DSL (Framer) side if DSL Link is active or if bit errors are received during loop/BER test. ER flashes once to indicate a CRC error (during normal operation) or bit errors (during Remote Loopback 511/511E tests).

- TM: (Active Yellow) Solid Yellow indicates an Active Test Mode. The unit may be placed in test mode by the local user or by the remote user.

Table 6-1. LED status, local Line Driver.

	Local					
	10BASE-T	DSL	Status	NS	ER	TM
Power On	Green*	Off	Flashing	On	Off	Off
DSL Link	Green*	Green	Flashing	Off	Off	Off
Link Brk	Green*	Off	Flashing	Off	Off	Off
Brk +10s	Green*	Off	Flashing	On	Off	Off
RDL	Green*	Green	Flashing	Off	Off	On
RDL +511	Green*	Off	Flashing	Off	Off	On

Table 6-2. LED status, remote Line Driver.

	Remote					
	10BASE-T	DSL	Status	NS	ER	TM
Power On	Green*	Off	Flashing	On	Off	Off
DSL Link	Green*	Off	Flashing	Off	Off	Off
Link Brk	Green*	Off	Flashing	Off	Off	Off
Brk +10s	Green*	Off	Flashing	On	Off	Off
RDL	Green*	Off	Flashing	Off	Off	On
RDL +511	Green*	Off	Flashing	Off	Off	On

Link Brk = DSL link broken

Brk +10s = 10 seconds following link break

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

6.3 Test Modes

The mDSL Line Driver offers a proprietary Remote Loopback test mode. It also has a built-in V.52 BER test-pattern generator to evaluate the communication status between units. Activate this test mode by toggling the Test Mode switch on the unit's front panel.

6.3.1 Overview

Figure 6-2 shows the major elements used in the loopback and 511 pattern tests available in the mDSL Line Driver. Each block has several functions. Following Figure 6-2 are descriptions of the elements during Test Modes.

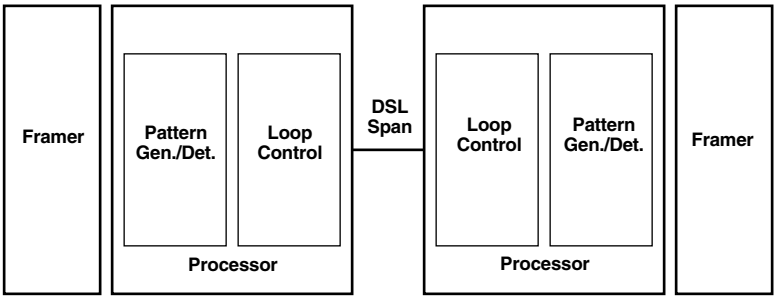

Figure 6-2. Block diagram: two mDSL Line Drivers communicating over the DSL span.

- Framer: The framer determines 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 turn on. If framed packets are not received, the DSL Link LED will turn off. 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 the remote mDSL Line Driver. 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 transmitting data 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, the pattern generator is forced to time out before it can cause the DSL link to go down.

- Loop Control: This part of the processor is used to control Remote Loopback test mode. In a remote loop, the 511/511/E data is looped back to the line and to the remote unit over the DSL span.

6.3.2 Restart Procedure and Timeouts

The restart procedure is in place to allow the Line Drivers to re-establish a connection after the framer begins seeing unframed packets. Table 6-3 shows the amount of time the framer must see consecutive unframed packets before the Line Driver 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 the user that the test has timed out. The ER LED will stop flashing once the 511/511E switch is placed into the normal position.

Table 6-3. 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.)

6.3.3 Loops and Patterns

The following section describes the Remote Loopback/BER test modes.

Remote Digital

When Remote Loop/511 or Remote Loop/511/E is enabled via the front-panel switch, the remote unit's restart timer is set to one minute. This is because when the 511/511E generator is initiated on the local unit, the remote framer begins seeing unframed packets. The remote Line Driver 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 Line Driver changes its restart timer to one minute. The pattern originates within the processor and is sent to the remote Line Driver. It is then looped back to the local Line Driver 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 you turn off the 511/511E switch.

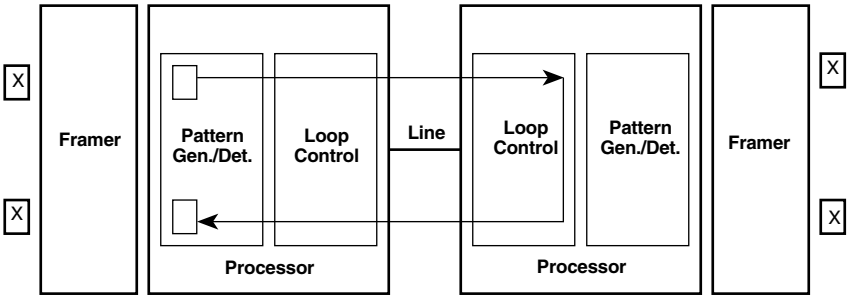

Figure 6-3. Remote Digital loop.

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.

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

To use the V.52 BER tests in conjunction with the Remote Digital Loopback tests, follow these instructions:

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

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

Appendix. Transmission Distance Charts

Table A-1. Transmission distance, 26 to 20 AWG.

Line Rate (kbps)	DTE Rates (kbps)	26 AWG (0.4 mm)			24 AWG (0.5 mm)			22 AWG (0.6 mm)			20 AWG (0.8 mm)		
		ft.	mi.	km	ft.	mi.	km	ft.	mi.	km	ft.	mi.	km
144	64, 128	21,400	4	6.5	30,700	5.8	9.4	42,980	8.1	13.1	55,260	10.5	16.8
272	192, 256	20,300	3.8	6.2	30,600	5.8	9.4	42,840	8.1	13.1	55,080	10.4	16.8
400	320, 384	18,600	3.5	5.7	29,100	5.5	8.9	40,740	7.7	12.4	52,380	9.9	16
528	448, 512	17,400	3.3	5.3	26,100	4.9	8	36,540	6.9	11.1	46,980	8.9	14.3
784	576–768	15,800	3	4.8	22,600	4.3	6.9	29,380	5.6	9	38,420	7.3	11.7
1040	832–1024	15,500	2.9	4.7	22,100	4.2	6.7	28,730	5.4	8.8	37,570	7.1	11.5
1552	1088–1536	13,600	2.6	4.2	19,200	3.6	5.9	24,960	4.7	7.6	32,640	6.2	10
2064	1600–2048	12,200	2.3	3.7	17,200	3.3	5.2	22,360	4.2	6.8	29,240	5.5	8.9
2320	2112–2304	11,500	2.2	3.5	15,800	3	4.8	20,540	3.9	6.3	26,860	5.1	8.2

Table A-2. Transmission distance, 19 to 16 AWG.

Line Rate (kbps)	DTE Rates (kbps)	19 AWG (0.9 mm)			18 AWG (1 mm)			16 AWG (1.2 mm)		
		ft.	mi.	km	ft.	mi.	km	ft.	mi.	km
144	64, 128	64,470	12.2	19.7	70,610	13.4	21.5	90,784	17.2	27.7
272	192, 256	61,200	11.6	18.7	70,380	13.3	21.5	90,488	17.1	27.6
400	320, 384	52,900	10	16	66,930	12.7	20.4	86,053	16.3	26.2
528	448, 512	49,590	9.4	15.1	60,030	11.3	18.3	77,181	14.6	23.5
784	576–768	42,940	8.1	13.1	51,980	9.8	15.8	67,974	12.9	20.7
1040	832–1024	41,990	7.9	12.8	50,830	9.6	15.5	66,470	12.6	20.3
1552	1088–1536	34,580	6.5	10.5	44,160	8.4	13.5	57,748	10.9	17.6
2064	1600–2048	30,960	5.9	9.4	39,560	7.5	12.1	51,732	9.8	15.8
2320	2112–2304	28,440	5.4	8.7	36,340	6.9	11.1	47,522	9	14.5

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