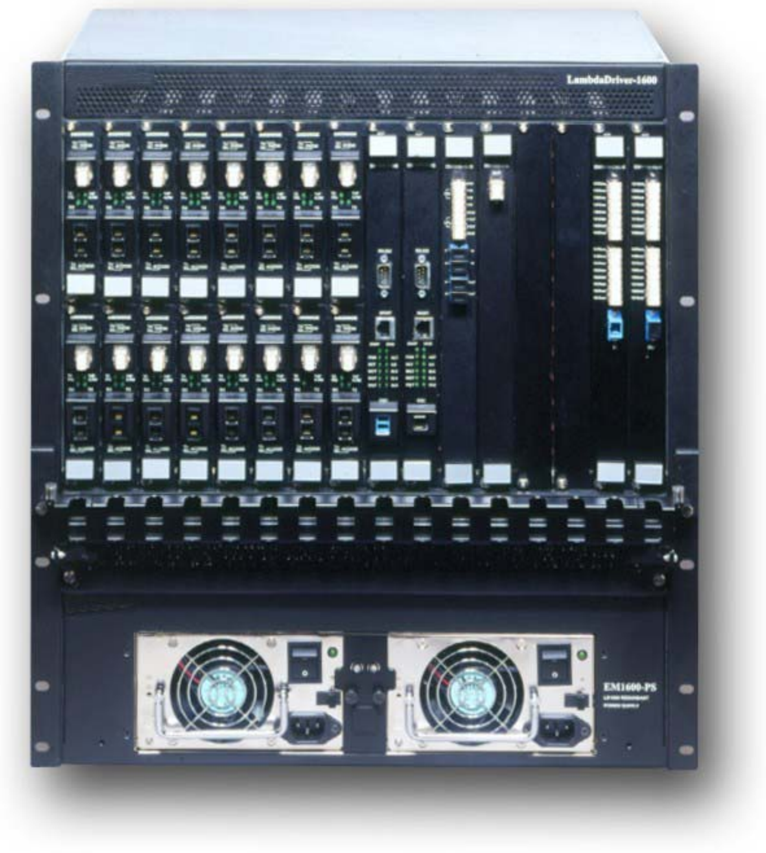
LambdaDriver

Wavelength Division Multiplexer

Model 1600

User Manual



Standards Compliance

This equipment is certified to UL 1950; CSA 22.2 No 950; FCC Part 15 Class B; CE-89/336/EEC, 73/23/EEC.

FCC Notice

WARNING: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct for the interference at his own expense.

The user is cautioned that changes and modifications made to the equipment without approval of the manufacturer could void the user's authority to operate this equipment.

It is suggested that the user use only shielded and grounded cables when appropriate to ensure compliance with FCC Rules.

Disclaimer

MRV reserves the right to make changes to any *technical specifications* in order to improve reliability, function, or design.

MRV reserves the right to modify the *equipment* at any time and in any way it sees fit in order to improve it.

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Contact Information

For customer support, you can:

- Contact your local MRV representative
- E-mail us at InternationalSupport@mrv.com
- Visit our MRV Web site at http://www.mrv.com

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About this Manual

Audience

This manual is intended for the use of network administrators who wish to apply, install, setup, operate, manage, and troubleshoot the LambdaDriver Wave Division Multiplexer Model 1600. The network administrator is expected to have working knowledge of:

- Networking
- Multiplexers

Latest Revision

The latest revision of the user manual can be found at the following Web site:

`ftp.international.mrv.com/support/tech_data`

Related Documents

- *Release Notes for LambdaDriver 1600* (produced if warranted): Contains information not found in the User Manual and/or overriding information.
- *MegaVision User Manual:* Describes how to manage the LambdaDriver 1600 and other MRV SNMP manageable products using MRV's *MegaVisionWEB*® Web-Based Network Management application.

Organization

This manual is organized into the following:

Safety Requirements – specifies the safety requirements that must be met at all times.

Chapter 1: Overview – provides a general introduction to the LD1600 noting its key features, advantages, architecture, components, etc.

Chapter 2: Applications – presents typical networks built round the LD1600s.

Chapter 3: Installation – shows how to mount, network connect, and hardware configure the LD1600.

Chapter 4: Startup, Setup, and Operation – describes how to start up, set up (by software), and monitor operation of the LD1600.

Chapter 5: CLI Management – describes software-controlled configuration, monitoring, and control of the LD1600 through its CLI.

Appendix A: Software Upgrading/Downloading – provides a detailed procedure for upgrading/downloading software to the LD1600.

Appendix B: Troubleshooting – is a guide for troubleshooting the LD1600 on the operative level.

Appendix C: RLB Test – describes the diagnostic procedure Remote Loopback Test.

Appendix D: Cable Wiring – shows the wiring for modem and null-modem RS-232 cables and for Ethernet straight and cross cables.

Appendix E: Cleaning Optical Connectors – describes a recommended procedure for cleaning optical connectors.

Appendix F: Modem Setup and Installation – describes how to set up and install a dial-up modem via which the LD1600 can be managed from a remote station.

Appendix G: Replacing a Module – shows how to replace a network module, power supply module, and SFP module.

Appendix H: Servicing the Fan Module – gives the procedure for cleaning/replacing the fan module.

Appendix I: Redundancy Protection Network Topologies – describes network topologies with different levels of redundancy.

Appendix J: Product Specification – provides technical specifics on the LD1600 that are useful.
Appendix K: Small Form-factor Pluggables (SFPs) – provides general information on SFPs that can be installed in LD1600 modules.

Typographical Conventions

The typographical conventions used in this document are as follows:

Convention	Explanation
`Courier`	This typeface represents information provided *by* the system.
`Courier Bold`	This typeface represents information provided *to* the system.
Italics	This typeface is used for emphasis.
Enter	This format represents the key name on the keyboard or keypad. If two keys are to be pressed together the key names are shown together, e.g., **Ctrl** **A**.
	This icon represents important information.
	This icon represents risk of personal injury, system damage, or data loss.

Acronyms

ALS	Automatic Laser Shutdown
APD	Avalanche PhotoDiode
APR	Automatic Power Reduction
ARP	Address Resolution Protocol
ATM	Asynchronous Transfer Mode
BER	Bit-Error Rate
BO	Branch Office
CLI	Command Line Interpreter
CO	Central Office
CTS	Clear To Send
CWDM	Coarse Wavelength-Division Multiplexing
dB	deciBel
DCD	Data Carrier Detect
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
DWDM	Dense Wavelength-Division Multiplexing
ESCON	Enterprise System CONnection
FDB	Filtering/Forwarding Data Base
GBIC	GigaBit Interface Converter
GFF	Gain Flattening Filters
Gnd	Ground
GUI	Graphical User Interface
I/O	Input/Output

IP	Internet Protocol
ISP	Internet Service Provider
ITU	International Telecommunications Union
LAN	Local Area Network
LIN	Link Integrity Notification
MAN	Metropolitan Area Network
MDI	Media Dependent Interface
MDIX	Media Dependent Interface with cross-wiring
NMS	Network Management Station
OA	Optical Amplifier
OADM	Optical Add-Drop Multiplexer
OSC	Optical Service Channel
PING	Packet Inter-Network Groper
PLL	Phase-Locked Loop
RARP	Reverse ARP
RI	Ring Ignore
RLB	Remote LoopBack
RMON	Remote MONitoring
RTS	Request To Send
RxD	Receive Data
SDH	Synchronous Digital Hierarchy
SFP	Small Form-factor Pluggable
SNMP	Simple Network-Management Protocol
SONET	Synchronous Optical Network
STM	Synchronous Transfer Mode
TDM	Time-Division Multiplexer/Multiplexing
TE	Terminal Equipment
TELNET	(dial-up) TELephone NETwork (connection protocol)
TFTP	Trivial-File Transfer Protocol
TLB	Trunk LoopBack
TxD	Transmit Data
UPS	Uninterruptible Power Supply
URL	Universal Resource Location
WAN	Wide Area Network
WDM	Wavelength-Division Multiplexing

Safety Requirements

⚠	**Caution!** To reduce risk of electrical shock, equipment damage, and fire and to maintain proper operation, ensure that the safety requirements stated hereunder are met!

Before Installing

Power Ensure that *all* power to the LD1600 is cut off. Specifically, disconnect all LD1600 power cords from the power source/s (line/mains).

Inspection Ensure by inspection that no part of the LD1600 is damaged.

Covers Leave the protective covers (e.g., dust caps on optical connectors, etc.) on the LD1600 at all times except when it is to be installed.

Site Reserve one of the following sites for the LD1600:

– 482 x 511 or 11.5U[1] x 299 mm^3 (19 x 20.1 or 11.5U x 11.8 in^3) space in a 19-inch rack,

or

– Flat, stable, non-conductive static-free surface.

Before Powering On

Blank Panels Ensure that vacant slots of the LD1600 are covered with Blank Panels. (This protects the user against electrical shock and the LD1600 against harmful physical intrusion, and increases operation reliability by assuring circulation of sufficient cooling air throughout the LD1600.)

Temperature Operate the LD1600 only at a location where the ambient temperature is in the range 0 to 45 ^{o}C (32 to 113 ^{o}F).

Humidity Operate the LD1600 only at a location where the ambient humidity is non-condensing and less than 85%.

Dust Ensure that the site for the LD1600 is dust-free. (Less than 1,000,000 particles per cubic meter or 30,000 particles per cubic foot is OK.)

Cooling Air Ensure that the air-flow around the LD1600 and through the air vents is not obstructed. In addition, ensure that there is a clearance of at least 25 mm (1 inch) between the air vents and nearby objects.

Power Ensure that the power to the LD1600 is:

AC: 100 to 120 Vac, 60 Hz ***or*** 200 to 240 Vac, 50 Hz

DC: -48 to -60 Vdc.

Power Cords The ac power cords of the LD1600 must have the following specifications:

In the USA and Canada

UL approved and CSA certified flexible 3-conductor power cord having individual conductor wire of gauge #18 AWG and length not exceeding 4.5 m (15 ft). The power cord terminations should be NEMA Type 5-15P (3-prong,

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[1] 1U = 1¾ inch or 44.45 mm

one prong for earthing) at one end and an IEC appliance inlet coupler at the other end.

Any of the following types of power cords are acceptable:
G, S, SE, SJ, SJE, SJO, SJOO, SJT, SJTOO, SO, SOO, SP-3, SPE-3, SPT-3, ST, STO, STOO, SV, SVE, SVO, SVT, SVTO, SVTOO, W.

In all other countries

Flexible 3-conductor power cord approved by the cognizant safety organization of the country. The power cord must be Type HAR (harmonized), with individual conductor wire having cross-sectional area 0.75 sq. mm. The power cord terminations should be a suitably rated earthing-type plug at one end and an IEC appliance inlet coupler at the other end. Both of the power cord terminations must carry the certification label of the cognizant safety organization of the country.

During Operation

Do not connect or disconnect cables and/or power cords during lightning strikes or thunderstorms.

Servicing

All servicing must be carried out only by *qualified* service personnel. Before servicing, ensure that *all* power to the LD1600 is cut off!

Chapter 1 Overview

Function

LD1600 is a multi-functional modular wavelength-division multiplexer that can operate using DWDM and CWDM technologies. It can create as many as sixteen virtual fibers (channels[2]) on a *single* physical fiber. Each virtual fiber is fully independent of the others and can carry data at the same rate as a dedicated physical fiber.

Advantages

The capability to create several virtual fibers on a *single* physical fiber enables *additional* services to be conveniently and simply provisioned on *existing* fiberoptic links – without the need to add fibers.

The LD1600 is a high-speed, quick, easy, and secure solution for efficient bandwidth upgrade of existing fiber infrastructures. It can incorporate existing equipment, simultaneously supports and is transparent to multiple communication protocols, provides high throughput and efficiency (having no inherent lapse times), and allows for simply executed add-on future expansion.

Features

- Metro, access, and campus network applicability
- Handles multiple protocols concurrently
- Supports mixed data speeds
- Transparent to network topology and protocols
- Point-to-point, ring, star, and multi-point network topologies
- Maximizes fiber utilization while simplifying network design and reducing cost
- Optics-only channels – no electro-optic or opto-electric conversions
- Scalable design for up to 16 independent channels with no Interruption-of-Service
- 8 Mbps to 2.7 Gbps data rates per channel
- ITU-T G.694.1 standard grid of cooled lasers with 0.8 nm (100 GHz) or 1.6 nm (200 GHz) spacing for ***D***WDM
- ITU-T G.694.2 standard grid with 20 nm spacing for ***C***WDM
- Add, drop, and pass-through functionality
- System and fiberoptic cabling redundancy protection option
- Standard-compliant Protective Automatic Laser Shutdown (ALS/APR) mechanism.
- Protective Link Integrity Notification (LIN) mechanism.
- RLB and LLB testability
- WDM I/O Signal Power Monitoring of local and remote LD1600s
- Full modularity
- All modules hot-swappable and plug-installable
- Performance and error monitoring by *MRV's* MegaVision ® Web-based SNMP management application, SNMP manager, TELNET station, and craft/ASCII terminal (e.g., VT100 terminal/emulator)
- Hot-swappable SFP interface transceivers for Transponder, ESCON, and GM2 modules.
- Mountable in 19-inch rack

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[2] Data, voice, and video carrier wavelengths.

Application

LD1600 is applied as a campus, access, or MAN solution for high-speed concurrent transfer of voice, data, and video of different bandwidths and protocols on a single pair of fibers. For various application configurations, refer to *Chapter 2 Applications*.

Single-fiber cables can be used for full-duplex operation by allocating two channels (pair of *virtual* fibers).

Installation

The LD1600 is installed simply by *plugging* it into *existing* infrastructures.

Operation

Operation is autonomous once the LD1600 is powered on.

The operation status can be monitored on the Front Panel LEDs *or* with management tools described in the section *Management*.

Management

The LD1600 can be custom set up and managed with any one or more of the following:

- MRV's Web-based network management application *MegaVision*®
- MRV's *MegaVision Configurator* and *Demo*.
  MegaVision Configurator is a fully featured MegaVision Web-based element manager for configuring and monitoring a single device in a real network environment. MegaVision Demo is a comprehensive simulator of the MegaVision real-device network management application. To run this application, no password is required.
  The Configurator can be downloaded for free from:
  ftp.international.mrv.com/support/tech_data/MegaVision/mvconf
- SNMP NMS
- MIB browser
- TELNET station
- Craft terminal (asynchronous ASCII terminal, e.g., VT100 terminal or emulator).

Architecture

LD1600 is architectured as a scalable system that can be expanded and enhanced simply by inserting pluggable modules.

The basic LD1600 consists of a chassis and the following modules: Mux and Demux (1 each) or OADM (1); Transponders (1 per virtual fiber); Power Supply (1).

LD1600 can be scaled up by inserting the following modules: Additional Transponders (up to 16); ESCONs (1 per physical or virtual fiber), Management (1); Service (1); 1+1 Protection (1); OA[3] (1 or 2); GM2 Gigabit Ethernet Multiplexers (1 per physical or virtual fiber), Redundant Power Supply (1).

The chassis and modules are described in the section *Components*.

[3] Each OA module can increase the operating distance by roughly 30 km (20 mi), depending on the fiberoptic cable attenuation.

Components

Chassis

Overview

The chassis is a host for up to *twenty-four* pluggable network modules and up to two pluggable power supplies, and contains WDM support functionality. It can support various combinations of network modules to offer a wide range of applications.

Features

- *Twenty-four* network module slots + two power supply slots
- 19-inch rack-mountable

Layout

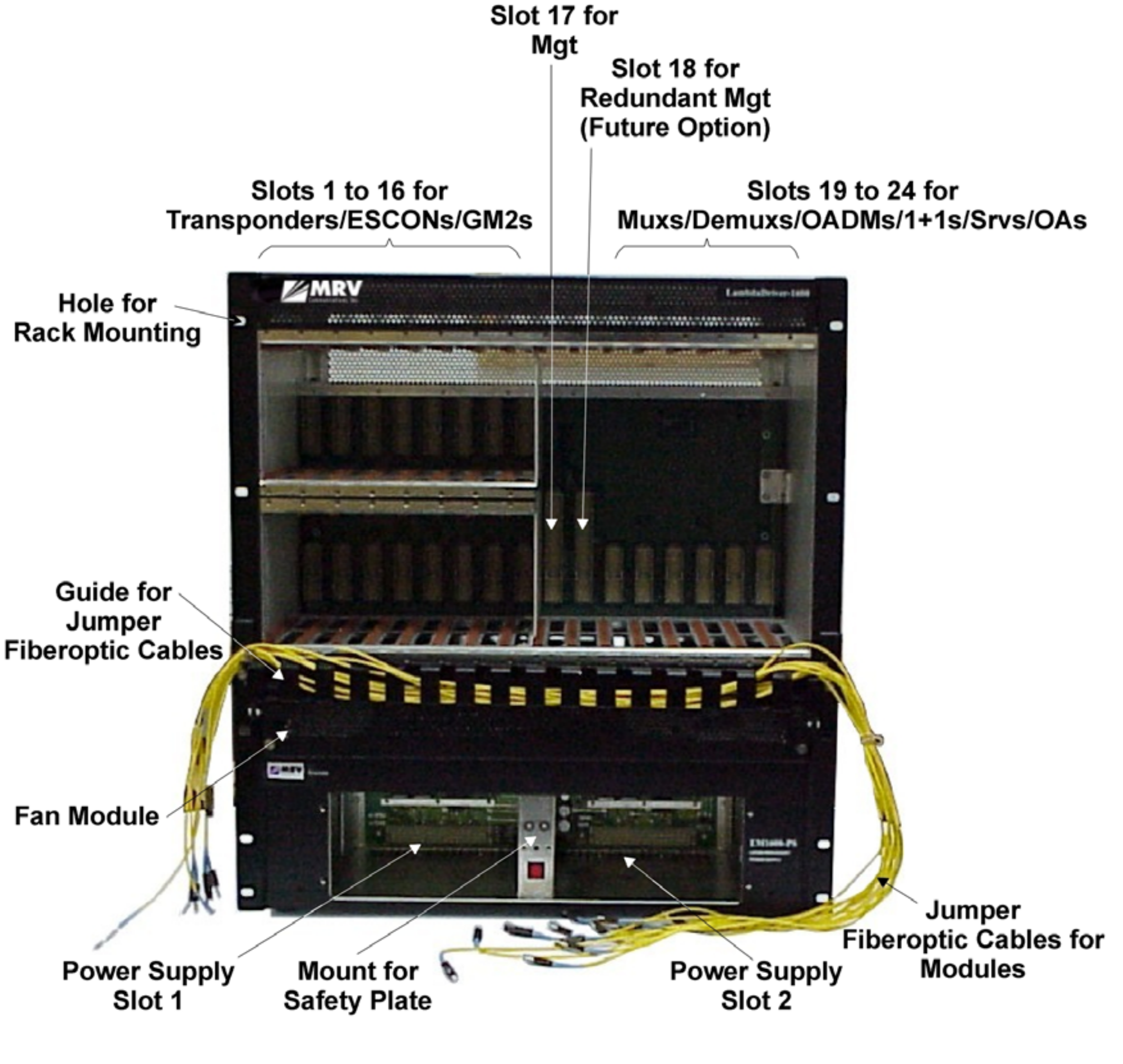

Figure 1: LD1600 Chassis Layout

Transponder Module

Overview

The Transponder module serves as an interface between the CWDM/DWDM network and an access unit port, converting data-carrier wavelength into the access unit port's operating wavelength, which may be 850 nm, 1310 nm, or 1550 nm.

It can be configured to drive any data-centric protocol whose data rate is in the range 8 Mbps to 2.7 Gbps completely transparently across a WDM network. A few examples of such data-centric protocols are: Fast Ethernet, Gigabit Ethernet, T1, E1, SONET/SDH, ESCON, Fibre Channel, OC-24, OC-48.

A transponder has the **Automatic Laser Shutdown** (**ALS/APR**) function. ALS/APR is a special algorithm-&-sensor mechanism that regularly checks link integrity on the access *and* trunk (WDM) side. If either of the links is broken (when for e.g., the fiberoptic cable on the access *or* trunk side is disconnected), the LD1600 performs Automatic Laser Shutdown (ALS/APR) on the WDM link. As a result, power is reduced to the safety level. After the links are reestablished, the LD1600 automatically reactivates the laser.

The **Link Integrity Notification** (**LIN**) feature notifies Terminal Equipment of link failure by cutting off laser power on the access side whenever no power is received from the WDM side, and vice versa. Specifically, power at the transponder **WDM TX** port is cut off when no power is received at the **ACCESS RX** port. Also, power at the transponder **ACCESS TX** port is cut off when no power is received at the **WDM RX** port. LIN is permanently enabled.

RLB Testability provides a simple cost-effective means of performing a diagnostic test on the WDM network. Details are given in Appendix C.

Signal Power Monitoring enables the display of WDM input and output signal power in dBm by invoking the CLI command **`get-card-wdm-power`**, described on page *186*.

Y-cable connectivity enables terminal equipment without redundant interfaces to be integrated into redundancy protection WDM networks – see Appendix I for application examples.

The transponder access interface can be fitted with any vendor SFP. The SFP completely specifies the properties of the interface to the terminal equipment, namely, protocol, carrier wavelength, fiber type, and operating range. This endows the transponder with flexible connectivity to terminal equipment and minimizes cost of investment on upgrades and deviations since to change any one or more of the interface properties, only the SFP, and not the whole transponder module, needs to be replaced.

*C*WDM SFPs have the following single module applications, all 3R[4]-based:

CWDM Repeater – used as an intermediate node for boosting the signal to cover internode distances of over 100 km. It operates at a specific wavelength.

CWDM Wavelengths Converter – used in "inter-ring nodes" for transparent connection of specific services between two rings.

CWDM-to-DWDM Converter – used at DWDM-CWDM demarcation points for seamless connection of CWDM links to a DWDM backbone.

Transponders are available in various models, described in the section *Models* on page *24*. The dual transponder model (TM2-SFP/xx) consists of ***two*** transponders on one physical card that is just 1 slot in size. Each such transponder can be linked to *any* other transponder (that has the same operating wavelength). The two transponders can be set to operate independently of each other or in mutual redundancy mode. Accordingly, a single LD1600 chassis fitted with 16 dual transponders can serve as:

– ***Two independent*** multiplexer systems, each consisting of *16* full-duplex WDM channels
or

– *One* multiplexer system consisting of *16* full-duplex WDM channels and having ***mutual redundancy protection*** among the transponders!

– *One* multiplexer system consisting of ***32*** full-duplex WDM channels!

Transponder model TM-DXFP has an especially wide frequency bandwidth that is used for 10.3 Gbps Ethernet or 9.95 Gbps OC-192/STM-64 communication.

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[4] Reshape, re-time, re-transmit.

A Transponder module is required for each WDM channel.

Figure 21 to *Figure 28* and *Figure 90* to *Figure 95* show how Transponder modules can be applied.

Features

- All data rates in the range 8 Mbps to 2.7 Gbps supported.
- 3R functionality for *high* data rates; 2R functionality for *medium* data rates
- Standard-compliant Protective Automatic Laser Shutdown (ALS/APR) mechanism.
- Protective Link Integrity Notification (LIN) mechanism.
- RLB testability
- WDM I/O Signal Power Monitoring of local and remote LD1600s
- Transmission, reception, and temperature indicators
- Operation control by hardware or software
- Access interface (receptacle) can host any vendor SFP meeting the MSA SFF-8074i standard for flexible connectivity to terminal equipment.
- SFF-8472 digital diagnostics support for SFP
- SNMP manageable
- Y-cable connectivity for redundancy protection
- Installable in all LambdaDriver chassis
- Hot-swappable
- 1-slot size for single as well as dual transponders.
- Pluggable

Models

No.	Model	Description
1	TM-CSFP/xx	CWDM technology. Data Rate of channel in the range 8 Mbps to 2.7 Gbps. Operating distance up to 85 km without regeneration. Wavelength in the range 1470 to 1610. SFP Access port. Fixed WDM ports fitted with Mu (MiniSC) connectors. SFF-8472 Digital diagnostics. Standard G.652/G.655 fibers.
2	TM-DSFP/xx	DWDM technology. Data Rate of channel in the range 8 Mbps to 2.7 Gbps. Operating distance up to 100 km without regeneration. Channel number in the range 21 to 59. SFP Access port. Fixed WDM ports fitted with Mu (MiniSC) connectors. SFF-8472 Digital diagnostics. Standard G.652/G.655 fibers.
3	TM-DL4SFP/xx	DWDM technology. Data Rate of channel in the range 8 Mbps to 2.7 Gbps with low dispersion. Operating distance up to 400 km using EDFA optical amplifiers without compensators. Channel number in the range 21 to 59. SFP Access port. Fixed WDM ports fitted with Mu (MiniSC) connectors. SFF-8472 Digital diagnostics. Standard G.652/G.655 fibers.
4	TM2-SFP/xx	CWDM and DWDM technology. Data Rate of channel in the range 8 Mbps to 2.7 Gbps. Operating distance up to 80 km without regeneration. Dual transponder occupying 1 slot. The transponders can be set to operate independently of each other or in mutual redundancy mode. SFP WDM and Access ports. SFF-8472 Digital diagnostics. Standard G.652/G.655 fibers.
5	TM-DXFP/xx	DWDM technology. Data Rate of channel is 10 Gbps (10.3 Gbps Ethernet or 9.95 Gbps OC-192/STM-64). Operating distance up to 80 km without regeneration. XFP Access ports fitted with LC connectors. Occupies 1 slot. Fixed WDM ports fitted with Mu (MiniSC) connectors. SFF-8472 Digital diagnostics. Standard G.652/G.655 fibers.

Layout

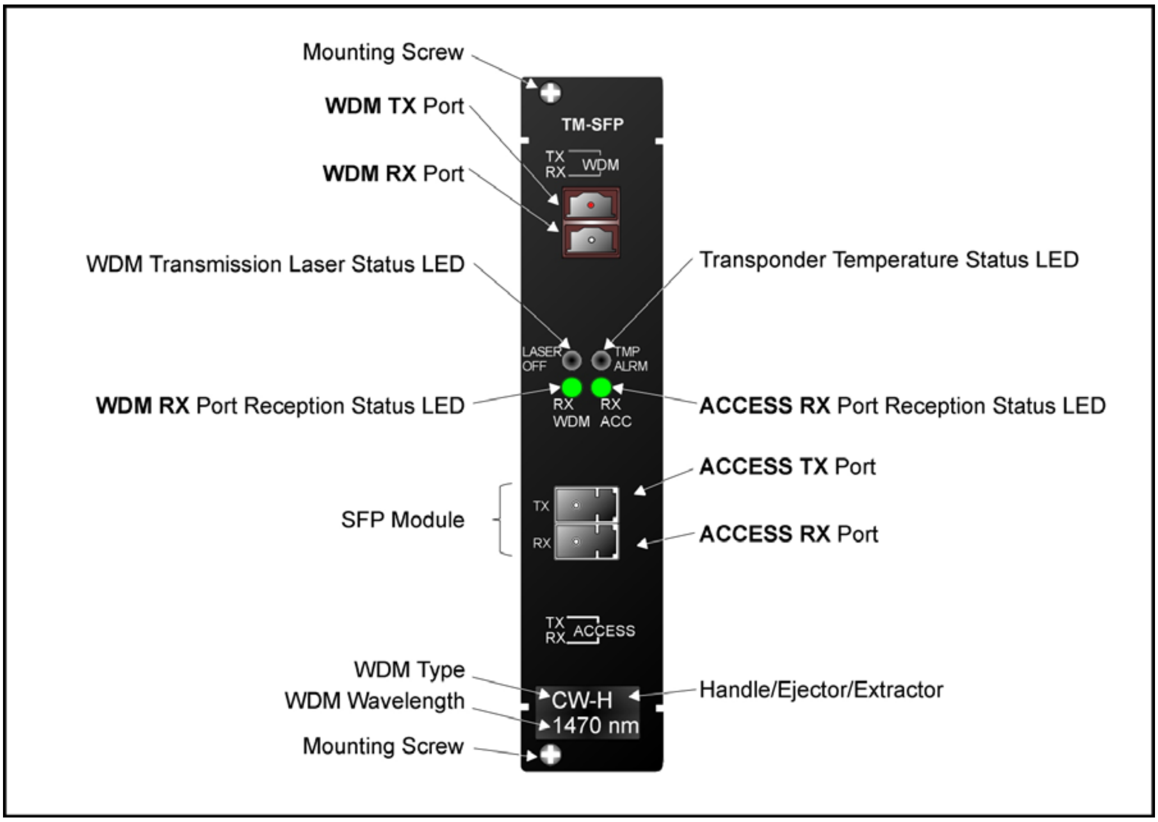


Figure 2: TM-SFP Single Transponder Module Layout

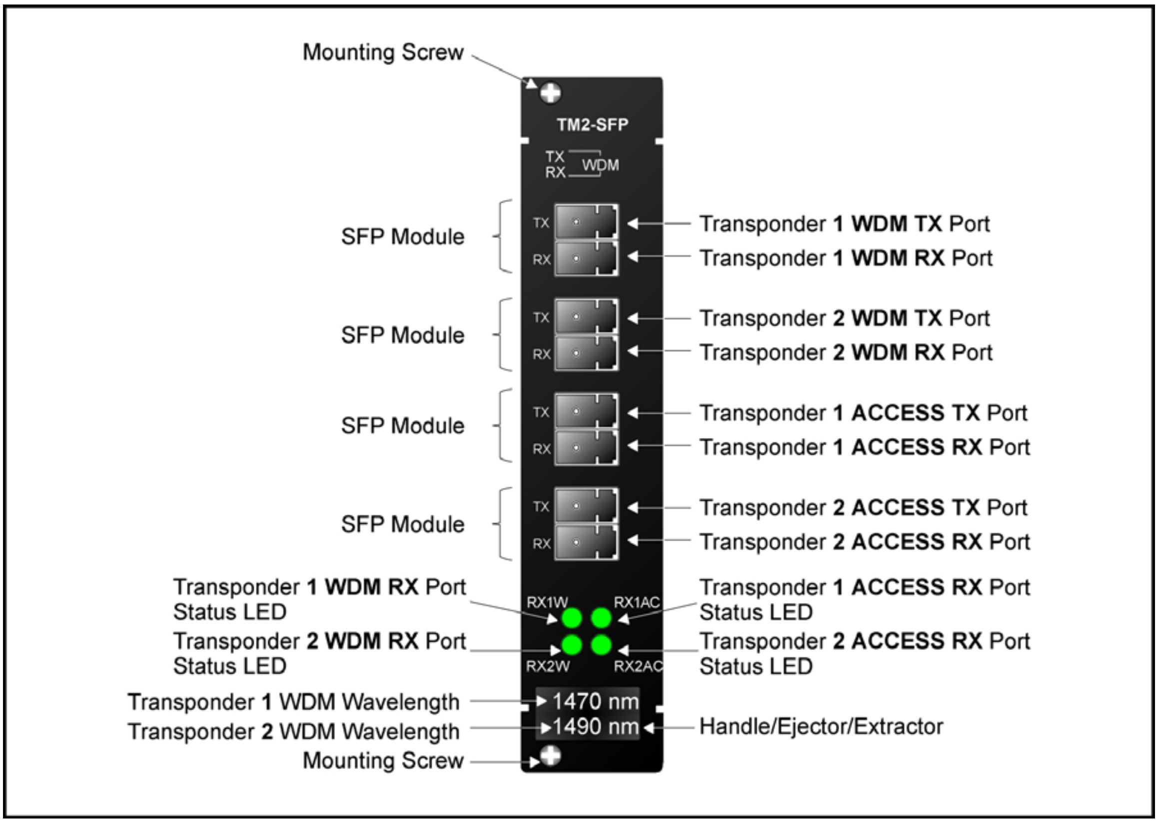


Figure 3: TM2-SFP Dual Transponder Module Layout

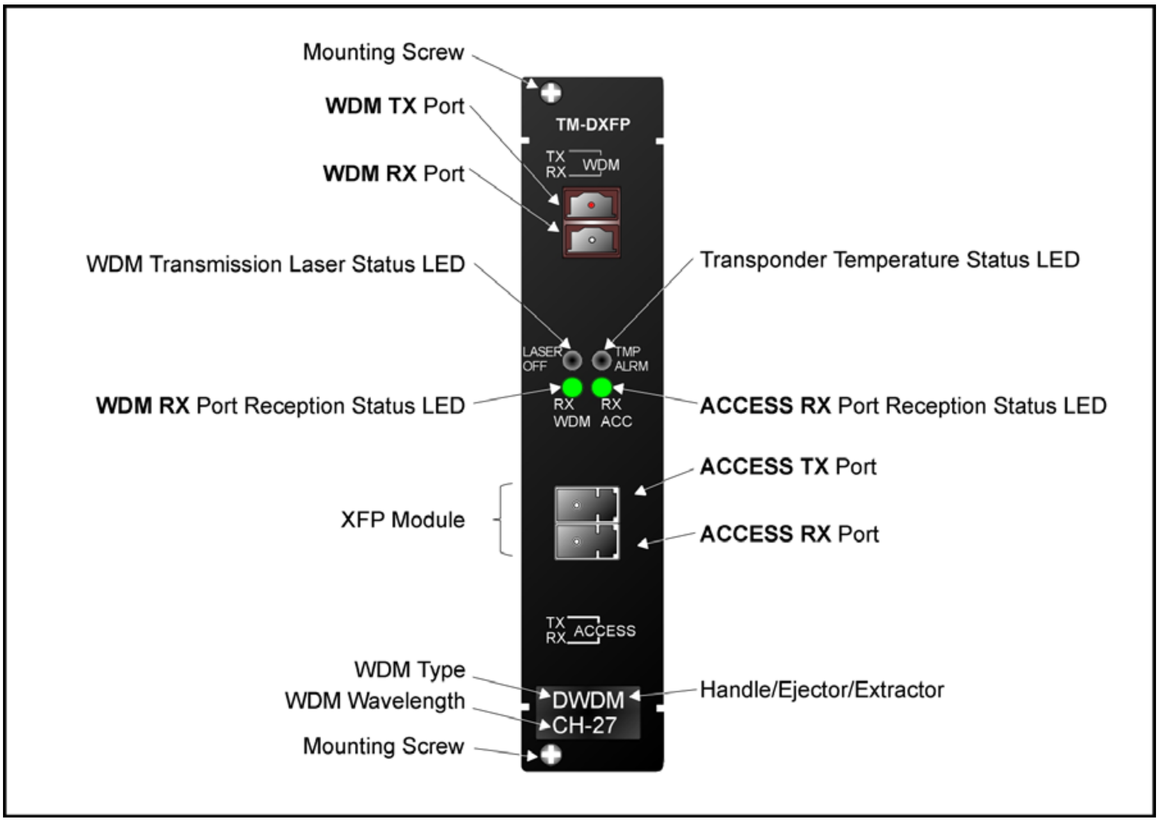


Figure 4: TM-DXFP 10 Gbps Transponder Module Layout

Product Specification

TM-SFP and TM2-SFP

Parameters	**Values**
Data Rate Range	8 Mbps to 2.7 Gbps
WDM TX Port (WDM Transmit Port)	
Purpose:	Connection to Mux **TX** port or OADM **ADD** port
Grid	
CWDM:	ITU-T G.694.2
DWDM:	ITU-T G.694.1
Transmitter Output Power	
CWDM:	+1.5 dBm ± 0.5 dBm
DWDM:	+3 dBm ± 0.5 dBm
Transmission Dispersion Penalty for Transponder-to-Mux/Demux module connection (Max)	2 dB
Cable Fiber Length (max):	
Outband	
TM-SFP to TM-SFP	100 km (62.1 mi)
TM2-SFP to TM2-SFP	Per the *local* TM2-SFP WDM SFP transmitter output power, *remote* TM2-SFP WDM SFP receiver sensitivity, and power loss due to other elements in the signal path – see Rule *18*, page *108.*
Inband	
Transpopnder to Mux or OADM (in same LD1600)	1 m (~ 3 ft)
Local Mux or OADM to *Remote* Mux or OADM (between two LD1600s)	
TM-SFP to TM-SFP	100 km (62.1 mi)
TM2-SFP to TM2-SFP	Per the *local* TM2-SFP WDM SFP transmitter output power, *remote* TM2-SFP WDM SFP receiver sensitivity, and power loss due to other elements in the signal path – see Rule *18*, page *108.*
Cable Type:	Singlemode 9/125 μm

Cable Connectors:	MiniSC (MU)
WDM RX Port (WDM Receive Port)	
Purpose:	Connection to Mux **RX** port or OADM **DROP** port
Grid	
CWDM:	ITU-T G.694.2
DWDM:	ITU-T G.694.1
Receiver Sensitivity at **WDM RX** Port (Max)	
1.25 Gbps:	- 32 dBm ± 1 dBm
2.5 Gbps:	- 27 dBm ± 1 dBm
APD Overload for Transponder-to-Mux/Demux module connection (Max)	- 5 dBm
Cable Fiber Length (max):	
Outband	
TM-SFP to TM-SFP	100 km (62.1 mi)
TM2-SFP to TM2-SFP	Per the *remote* TM2-SFP WDM SFP transmitter output power, *local* TM2-SFP WDM SFP receiver sensitivity, and power loss due to other elements in the signal path – see Rule *18*, page *108.* (The *cable* length is the smaller of the fiber lengths for the **WDM TX** Port and **WDM RX** Port.)
Inband	
Transponder to Mux or OADM (in same LD1600)	1 m (~ 3 ft)
Remote Mux or OADM to *Local* Mux or OADM (between two LD1600s)	
TM-SFP to TM-SFP	100 km (62.1 mi)
TM2-SFP to TM2-SFP	Per the *remote* TM2-SFP WDM SFP transmitter output power, *local* TM2-SFP WDM SFP receiver sensitivity, and power loss due to other elements in the signal path – see Rule *18*, page *108.* (The *cable* length is the smaller of the fiber lengths for the **WDM TX** Port and **WDM RX** Port.)
Cable Type:	Singlemode 9/125 µm
Cable Connectors:	MiniSC (MU)

ACCESS TX Port (Access Transmit Port)	
Purpose:	Connection to access unit receive port or ESCON SFP **RX** port
Cable *Fiber* Length (max):	Per the transponder access SFP output power and access unit receiver sensitivity – see Rule *17*, page *107*.
Cable Type:	Per the SFP (fiberoptic or copper)
Cable Connectors:	Per the SFP
ACCESS RX Port (Access Receive Port)	
Purpose:	Connection to access unit transmit port or ESCON SFP **TX** port
Cable *Fiber* Length (max):	Per the access unit output power and transponder access SFP receiver sensitivity – see Rule *17*, page *107*.
Cable Type:	Per the SFP (fiberoptic or copper)
Cable Connectors:	Per the SFP
LEDs	
LASER OFF (ALS/APR):	WDM transmission laser status
TMP ALRM:	Temperature status
WDM RX:	WDM port reception status
ACC RX:	Access port reception status
Mounting	Handle/ejector/extractor Posidrive screws (two)
Physical Dimensions (W x H x D):	26.93 mm (1.06 in) x 130.7 mm (5.145 in) x 227.5 mm (8.956 in)
Weight (max):	0.7 kg (1.5 lb)

TM-DXFP

Parameters	**Values**
Data Rate Range	10 Gbps
WDM TX (WDM Transmit Port)	
Purpose:	Connection to Mux **TX** port or OADM **ADD** port
Grid (DWDM)	ITU-T G.694.1
Transmitter Output Power	0 dBm
Transmission Dispersion Penalty for Transponder-to-Mux/Demux module connection (Max)	2 dB
Carrier Wavelength	1530 to 1565 nm
Cable Fiber Length (max):	
Outband	100 km (62.1 mi)
Inband	
Transpopnder to Mux or OADM (in same LD1600)	1 m (~ 3 ft)
Local Mux or OADM to *Remote* Mux or OADM (between two LD1600s)	100 km (62.1 mi)
Cable Type:	Singlemode 9/125 µm
Cable Connectors:	MiniSC (MU)
WDM RX Port (WDM Receive Port)	
Purpose:	Connection to Mux **RX** port or OADM **DROP** port
Grid (DWDM)	ITU-T G.694.1
Receiver Sensitivity at **WDM RX** Port (Max)	-23 dBm
APD Overload for Transponder-to-Mux/Demux module connection (Max)	- 8 dBm
Carrier Wavelength	1530 to 1565 nm
Cable Fiber Length (max):	
Outband	100 km (62.1 mi)
Inband	
Transpopnder to Mux or OADM (in same LD1600)	1 m (~ 3 ft)

Local Mux or OADM to *Remote* Mux or OADM (between two LD1600s)	100 km (62.1 mi)
Cable Type:	Singlemode 9/125 µm
Cable Connectors:	MiniSC (MU)
ACCESS TX Port (Access Transmit Port)	
Purpose:	Connection to access equipment receive port
Cable *Fiber* Length (max):	
XFP-10GD-LR	10 km
XFP-10GD-SR	2 km
Cable Type:	Singlemode 9/125 µm
Cable Connectors:	Per the SFP (usually LC)
ACCESS RX Port (Access Receive Port)	
Purpose:	Connection to access equipment transmit port
Cable *Fiber* Length (max):	
XFP-10GD-LR	10 km
XFP-10GD-SR	2 km
Cable Type:	Singlemode 9/125 µm
Cable Connectors:	Per the SFP (usually LC)
APD Overload for Transponder-to-Mux/Demux module connection (Max)	- 2 dBm
LEDs	
LASER OFF (ALS/APR):	WDM transmission laser status
TMP ALRM:	Temperature status
WDM RX:	WDM port reception status
ACC RX:	Access port reception status
Mounting	Handle/ejector/extractor Posidrive screws (two)
Physical Dimensions (W x H x D):	26.93 mm (1.06 in) x 130.7 mm (5.145 in) x 227.5 mm (8.956 in)
Weight (max):	0.55 kg (1.21 lb)

Appendix K lists some of the available SFPs.

Mux Module

Overview

The Mux module multiplexes egress data coming over WDM channels[5] onto a single physical fiber. 16-channel, 32-channel, and 64-channel CWDM as well as DWDM Mux modules are available. The modules are passive and use optics only for their operation.

Figure 21, Figure 22, *Figure 25*, and *Figure 27* show how Mux modules can be applied.

Features

- No electric power grounding or protection needed
- No opto-electric transducers used
- No EMI/RFI either to or from the Mux
- Scalable in increments of 1 port
- Hot-swappable
- 1-slot size for up to 16 access ports
- Pluggable

[5] WDM channels carry data from one LambdaDriver to another.

Layout

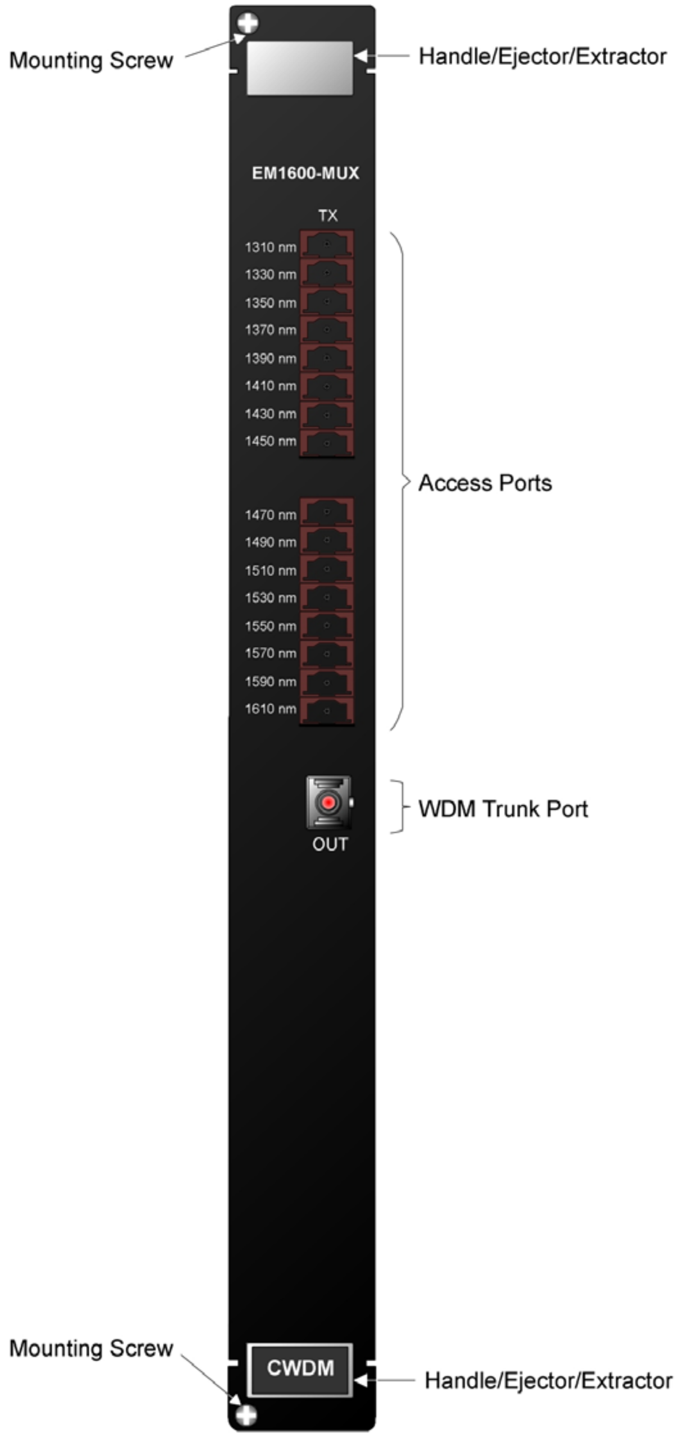


Figure 5: Mux Module Layout

Product Specification

Parameters	Values
OUT Port (WDM Transmit Port)	
Purpose:	Connection to Mux **OUT** port, Demux **IN** port, OADM **IN** port, Service **MUX** port, or 1+1 **MUX** port
Power Attenuation (CWDM or DWDM)	
	<table><tr><th rowspan="2">Trunk Width</th><th colspan="2">Attenuation (dB)</th></tr><tr><th>Mux</th><th>Mux-Demux Pair</th></tr><tr><td>4-Channel</td><td>1.8</td><td>3.4</td></tr><tr><td>8-Channel</td><td>3</td><td>4.5</td></tr><tr><td>16-Channel</td><td>5.4</td><td>6.5</td></tr></table>
Cable Length (max):	Per the lowest power output of all the modules in the LD1600. If a Transponder is connected to a Mux, the cable length depends on whether the technology is CWDM or DWDM and on channel bandwidth (Data Rate Range) – see Transponder *Product Specification*. If an ESCON or GM2[6] is connected to a Mux, refer to ESCON *Product Specification* and *GM2 Product Specification*.
Cable Type:	Singlemode 9/125 μm
Cable Connector	SC
TX Ports (Access Transmit Ports)	
Purpose:	Connection to Transponder **WDM TX** ports, ESCON SFP **TX** ports, or GM2 **TRUNK TX** ports
Power Attenuation (CWDM or DWDM)	
4-Channel	1.8 dB
8-Channel	3 dB
16-Channel	5.4 dB
Cable Length (max):	1 m (~ 3 ft)
Cable Type	Singlemode 9/125 μm
Cable Connectors	MiniSC (MU)
Mounting	Handle/ejector/extractor Posidrive screws (two)

[6] GM2 is 2-Gigabit-Ethernet Multiplexer module

Physical Dimensions (W x H x D)	26.93 mm (1.06 in) x 263.4 mm (10.37 in) x 227.5 mm (8.956 in)
Weight (max)	1.2 kg (2.65 lb)

Demux Module

Overview

A Demux module demultiplexes ingress[7] data coming over WDM channels onto a single physical fiber. 16-channel, 32-channel, and 64-channel CWDM as well as DWDM Demux modules are available. The modules are passive and use optics only for their operation.

Figure 21, Figure 22, *Figure 23*, *Figure 25*, *Figure 26*, and *Figure 27* Demux modules can be applied.

Features

- No electric power grounding or protection needed
- No opto-electric transducers used
- No EMI/RFI either to or from the Demux
- Scalable in increments of 1 port
- Hot-swappable
- 1-slot size for up to 16 access ports
- Pluggable

[7] Data entering the LD1600.

Layout

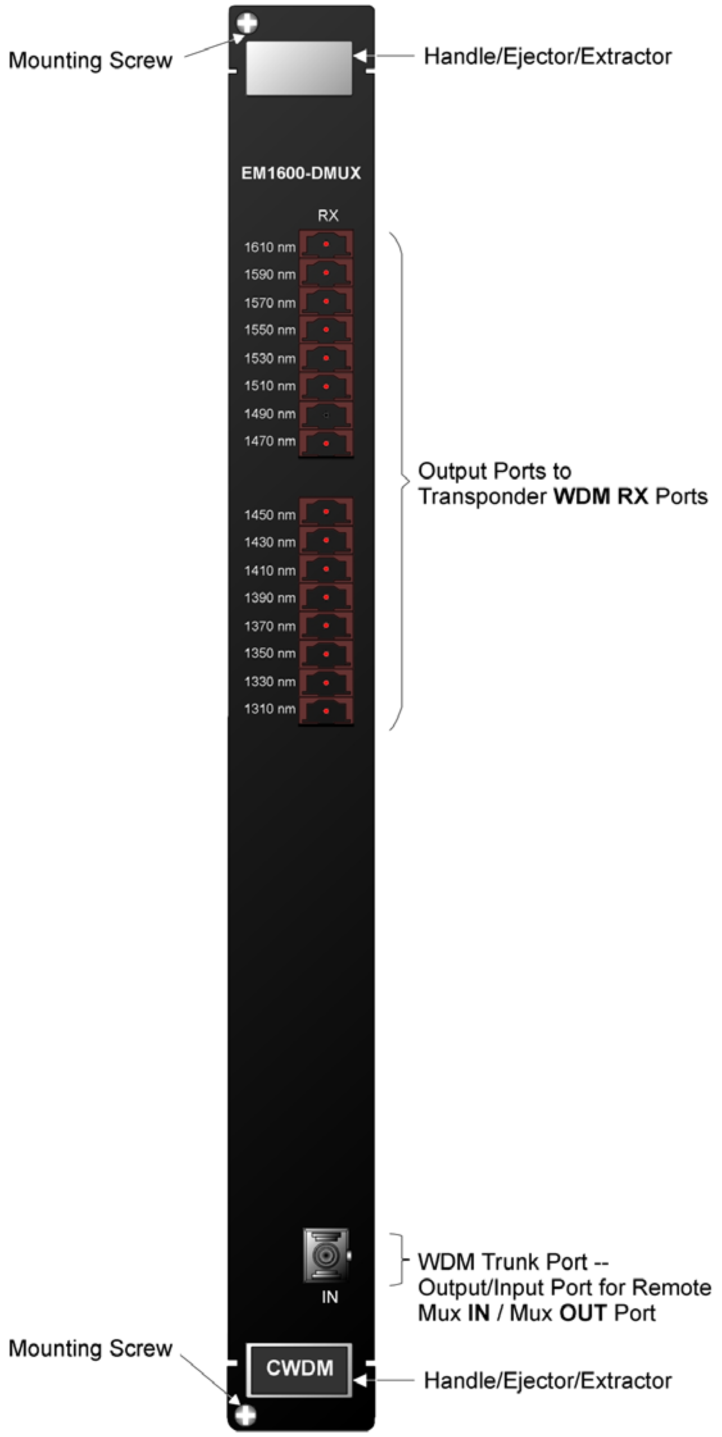


Figure 6: Demux Module Layout

Product Specification

<table>
<tr><th>Parameters</th><th>Values</th></tr>
<tr><td>IN Port (WDM Receive Port)</td><td></td></tr>
<tr><td>Purpose:</td><td>Connection to Mux OUT port, Demux IN port, OADM OUT port, Service DMUX port, or 1+1 DMUX port</td></tr>
<tr><td>Power Attenuation (CWDM or DWDM)</td><td><table><tr><th rowspan="2">Trunk Width</th><th colspan="2">Attenuation (dB)</th></tr><tr><th>Demux</th><th>Demux-Mux Pair</th></tr><tr><td>4-Channel</td><td>1.8</td><td>3.4</td></tr><tr><td>8-Channel</td><td>3</td><td>4.5</td></tr><tr><td>16-Channel</td><td>5.4</td><td>6.5</td></tr></table></td></tr>
<tr><td>Cable Length (max):</td><td>Per the lowest power output of all the modules in the LD1600. If a Transponder is connected to a Demux, the cable length depends on whether the technology is CWDM or DWDM and on channel bandwidth (Data Rate Range) – see Transponder . If an ESCON or GM2[8] is connected to a Demux, refer to ESCON Product Specification or GM2 Product Specification.</td></tr>
<tr><td>Cable Type:</td><td>Singlemode 9/125 µm</td></tr>
<tr><td>Cable Connector:</td><td>SC</td></tr>
<tr><td>RX Ports (Access Transmit Ports)</td><td></td></tr>
<tr><td>Purpose:</td><td>Connection to Transponder WDM RX ports, ESCON SFP RX ports, or GM2 TRUNK RX ports</td></tr>
<tr><td>Power Attenuation (CWDM or DWDM)</td><td></td></tr>
<tr><td>4-Channel</td><td>2.1 dB</td></tr>
<tr><td>8-Channel</td><td>3.3 dB</td></tr>
<tr><td>16-Channel</td><td>5.7 dB</td></tr>
<tr><td>Cable Length (max):</td><td>1 m (~ 3 ft)</td></tr>
<tr><td>Cable Type</td><td>Singlemode 9/125 µm</td></tr>
<tr><td>Cable Connectors</td><td>MiniSC (MU)</td></tr>
<tr><td>Mounting</td><td>Handle/ejector/extractor
Posidrive screws (two)</td></tr>
</table>

[8] GM2 is 2-Gigabit-Ethernet Multiplexer module

Physical Dimensions (W x H x D)	26.93 mm (1.06 in) x 263.4 mm (10.37 in) x 227.5 mm (8.956 in)
Weight (max)	1.2 kg (2.65 lb)

Management Module

Overview

The Management module enables management with an SNMP manager, TELNET station, and craft terminal (e.g., VT100 terminal or emulator).

A craft terminal can be connected to the serial/RS-232 port. An SNMP Manager or TELNET station can be connected to the Ethernet 10/100Base-TX or 100Base-FX port. A 100Base-FX port can be connected to a Service (or 1+1 Redundancy) module.

Figure 21 to *Figure 28* show how Management modules can be applied.

Features

- One 10/100Base-TX port for inband connection to NMS.
- Two 100Base-FX singlemode 1310 nm ports for remote LD1600 management by connection to a Service (or 1+1 Redundancy) module.
- One Serial/RS-232 port for local management.
- Power, SNMP data flow, Optical Service Channel (OSC), and Data Activity indicators
- Hot-swappable
- 1-slot size
- Pluggable

Layout

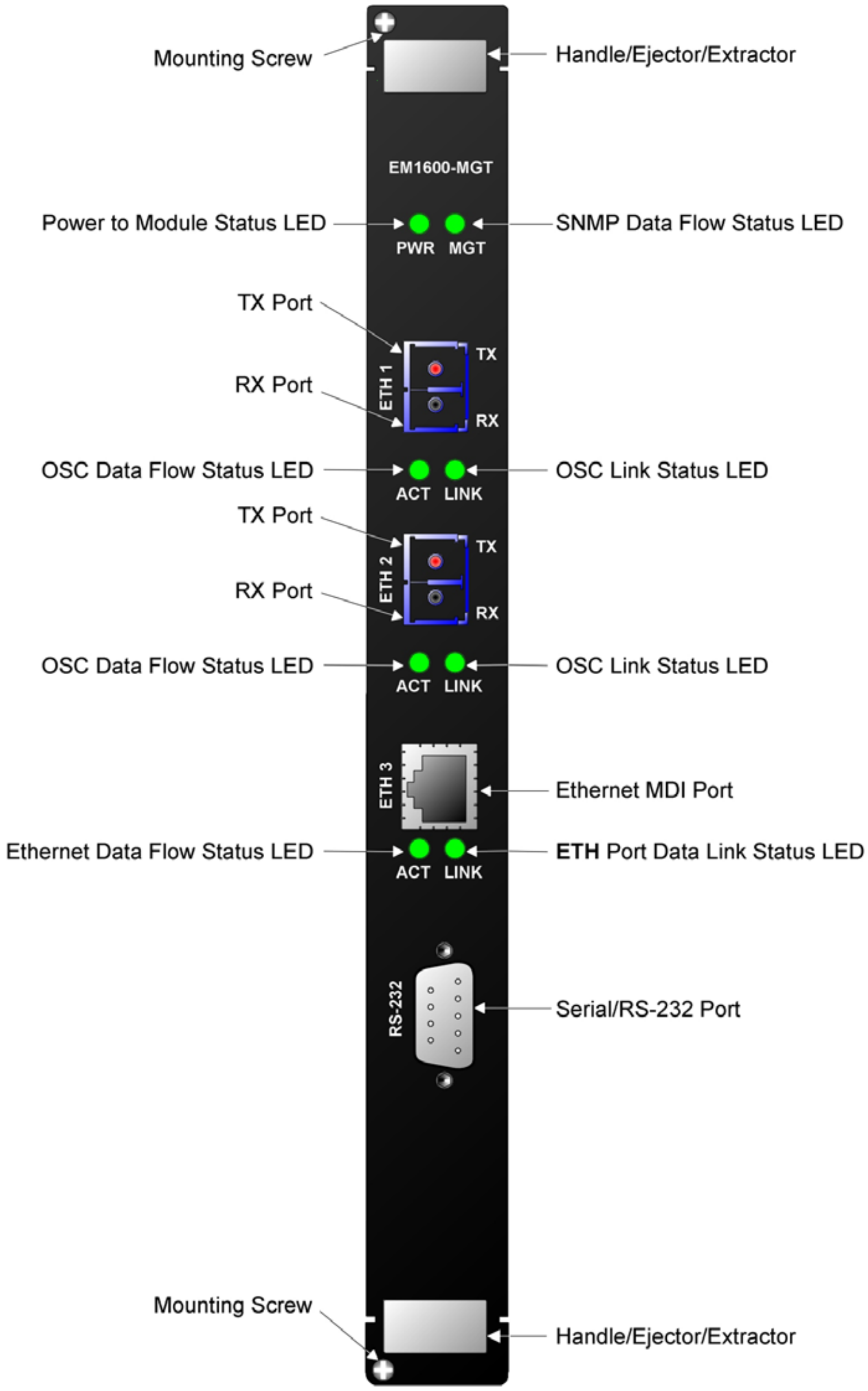


Figure 7: Management Module Layout

Product Specification

Parameters	Values
ETH 1 TX, **ETH 2 TX Ports** (Ethernet OSC Transmit Ports)	
Purpose (optional):	Connection to Service **MGT RX** port or 1+1 **MGT RX** port
Output Power:	+2 to –1 dBm
Operating Wavelength:	1310 nm
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 µm
Cable Connector	SC
ETH 1 RX, **ETH 2 RX Ports** (Ethernet OSC Receive Ports)	
Purpose (optional):	Connection to Service **MGT TX** port or 1+1 **MGT TX** port
Receiver Sensitivity:	-37 to –40 dBm
Operating Wavelength:	1310 nm
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 µm
Cable Connector	SC
ETH 3 (Ethernet Port)	
Purpose:	Connection to Ethernet hosting an NMS
Cable Length (max):	100 m (~ 330 ft)
Cable Type:	Category 5
Cable Connector:	RJ45 male 8-pin shielded
Pinout:	MDI: 1 → Rx+ 2 → Rx- 3 → Tx+ 6 → Tx-
Serial/RS-232 Management Port (**RS-232**)	
Purpose:	Connection to craft terminal/emulator
Cable Type:	RS-232
Cable Length (max):	15 m (~ 50 ft)
Cable Connector:	DB-9 female 9-pin shielded

Pinout:	2 → Rx 3 → Tx 5 → Gnd
LEDs PWR MGT: ETH 1 ACT: ETH 1 LINK: ETH 2 ACT: ETH 2 LINK: ETH 3 ACT: ETH 3 LINK:	 Power status SNMP data flow status OSC data flow status OSC link status OSC data flow status OSC link status Ethernet data flow status Ethernet link status
Mounting	Handle/ejector/extractor Posidrive screws (two)
Physical Dimensions (W x H x D)	26.93 mm (1.06 in) x 263.4 mm (10.37 in) x 227.5 mm (8.956 in)
Weight (max)	1.2 kg (2.65 lb)

Service Module

Overview

The Service (or supervisory) module provides a separate 1310 nm channel on the WDM trunk. It is needed only when it is required to manage one or two remote LD1600s which have no local connection to a Fast Ethernet network.

Figure 21 shows how Service modules can be applied.

Features

- Operating wavelength 1310 nm
- Singlemode optical fiber connectivity
- No electric power grounding or protection needed
- No opto-electric transducers used
- No EMI/RFI either to or from the Service Module
- Hot-swappable
- 1-slot size
- Pluggable

Layout

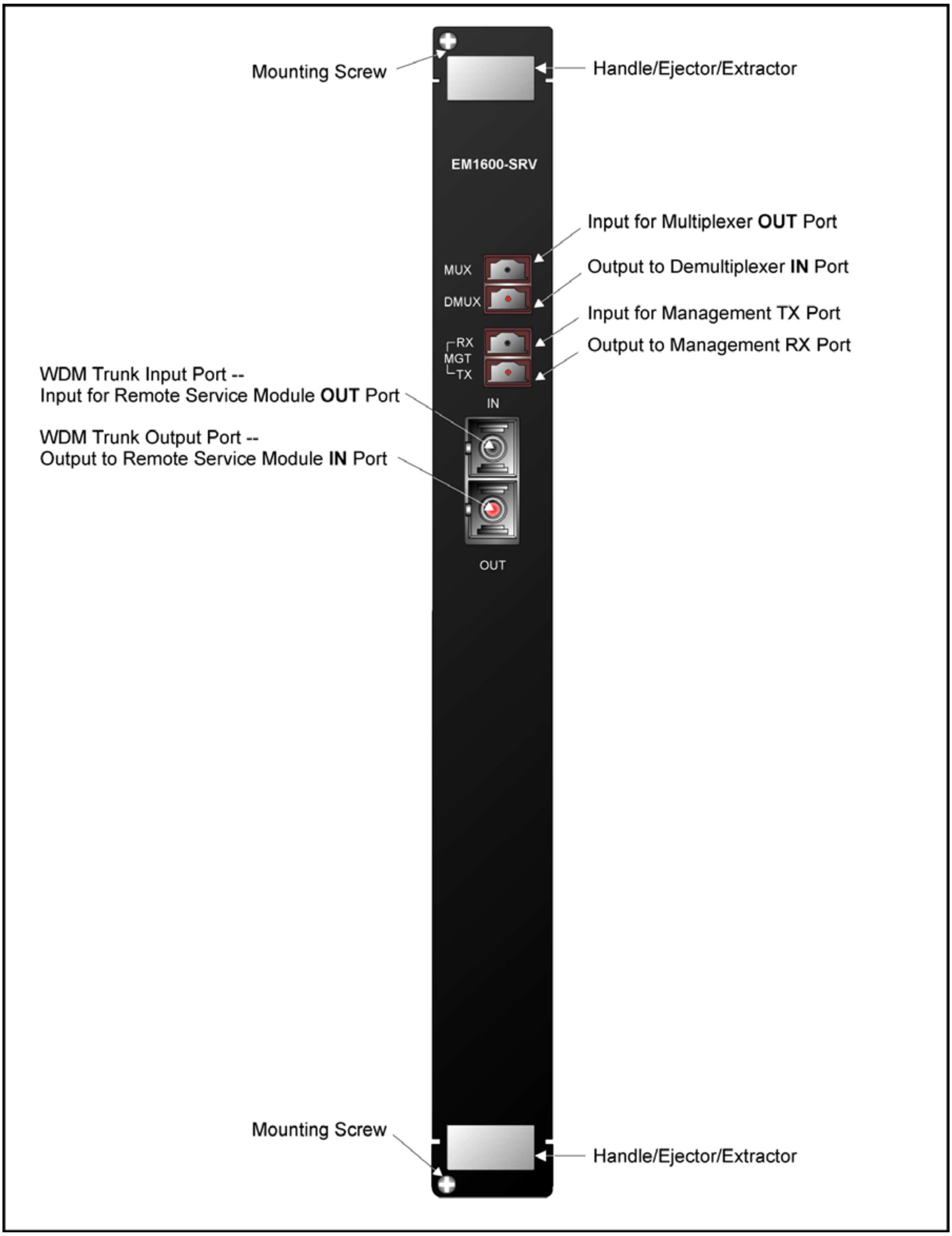


Figure 8: Service Module Layout

Product Specification

Parameters	Values
MUX Port (Multiplexer Port)	
Purpose:	Connection to Multiplexer **OUT** port
Power Attenuation:	0.8 to 1 dB
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	MiniSC (MU)
DMUX Port (Demultiplexer Port)	
Purpose:	Connection to Demultiplexer **IN** port
Power Attenuation:	0.8 to 1 dB
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	MiniSC (MU)
MGT TX Port (Management Transmit Port)	
Purpose:	Connection to Management **ETH 1 RX** or **ETH 2 RX** port
Power Attenuation:	0.8 to 1 dB
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	MiniSC (MU)
MGT RX Port (Management Receive Port)	
Purpose:	Connection to Management **ETH 1 TX** or **ETH 2 TX** port
Power Attenuation:	0.8 to 1 dB
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	MiniSC (MU)
IN Port (WDM OSC Receive Port)	
Purpose:	Connection to Service **OUT** port
Power Attenuation:	0.8 to 1 dB
Cable *Fiber* Length (max):	Per the *remote* Transponder power budget, which depends on whether the

	technology is CWDM or DWDM and on channel bandwidth (Data Rate Range)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	SC
OUT Port (WDM OSC Transmit Port)	
Purpose (optional):	Connection to Service **IN** port
Power Attenuation:	0.8 to 1 dB
Cable *Fiber* Length (max):	Per the *local* Transponder power budget, which depends on whether the technology is CWDM or DWDM and on channel bandwidth (Data Rate Range). (The *cable* length is the smaller of the fiber lengths for the **IN** Port and **OUT** Port.)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	SC
Mounting	Handle/ejector/extractor Posidrive screws (two)
Physical Dimensions (W x H x D)	26.93 mm (1.06 in) x 263.4 mm (10.37 in) x 227.5 mm (8.956 in)
Weight (max)	1.2 kg (2.65 lb)

1+1 Redundancy Module

Overview

The 1+1 Redundancy module is an interface for two fiberoptic cables for carrying identical data. The cables backup each other. The same information is transmitted on both fibers. Normally, the data on the primary link (cable connected to the Primary ports) is received by the nodes. When the primary link fails, i.e., no reception is detected, the secondary link becomes the active link. Two models are available:

1) *EM1600-RED*: 1+1 Redundancy module *with* full Service module functionality.
2) *EM1600-RED/NS*: 1+1 Redundancy module *without* Service module functionality.

Figure 22 shows how 1+1 Redundancy modules can be applied.

Features

- Operating wavelength 1310 nm
- Singlemode optical fiber connectivity
- No electric power grounding or protection needed
- No EMI/RFI either to or from the 1+1 Redundancy Module
- Hot-swappable
- 1-slot size
- Pluggable

Layout

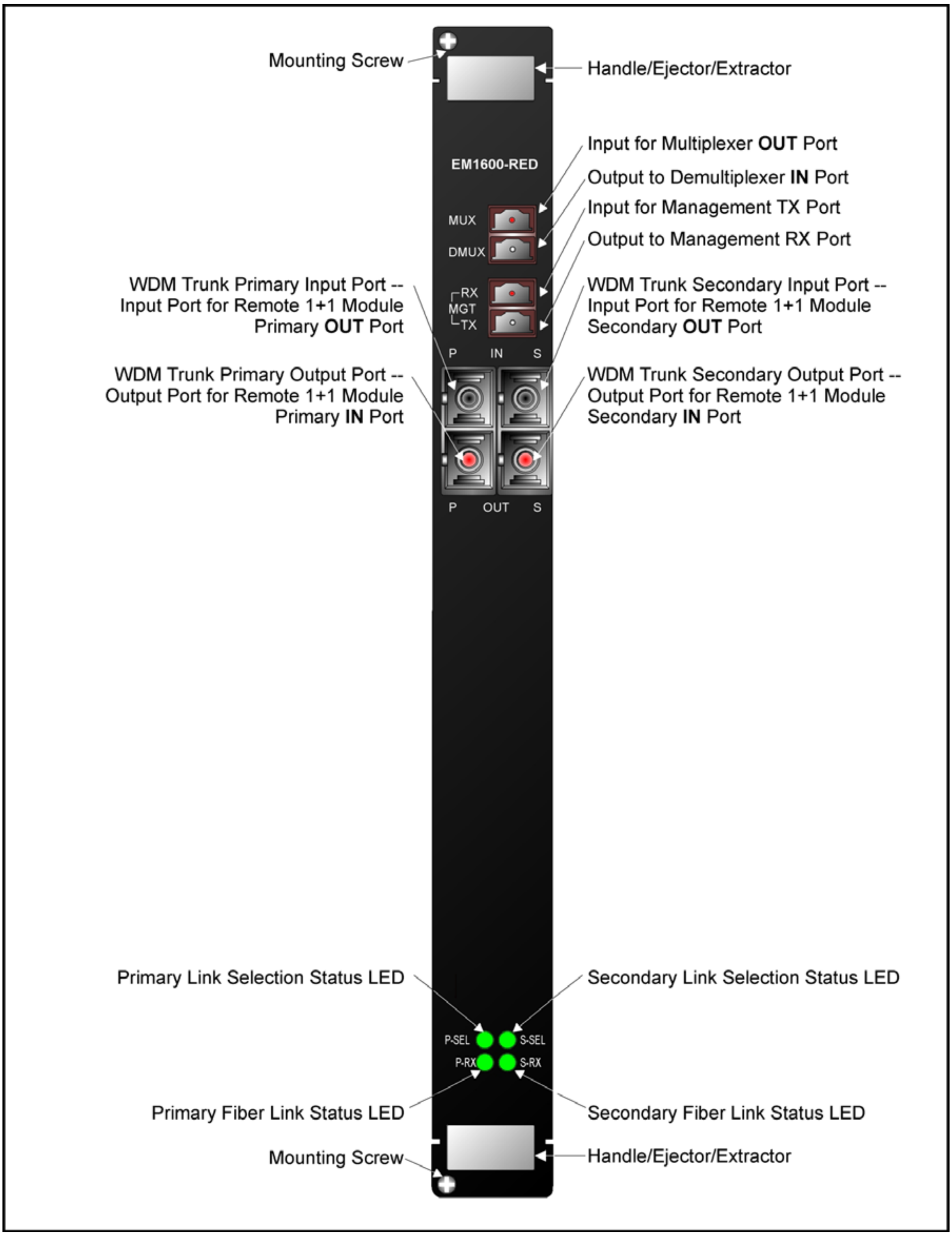


Figure 9: 1+1 Redundancy Module *with* Service Functionality Layout

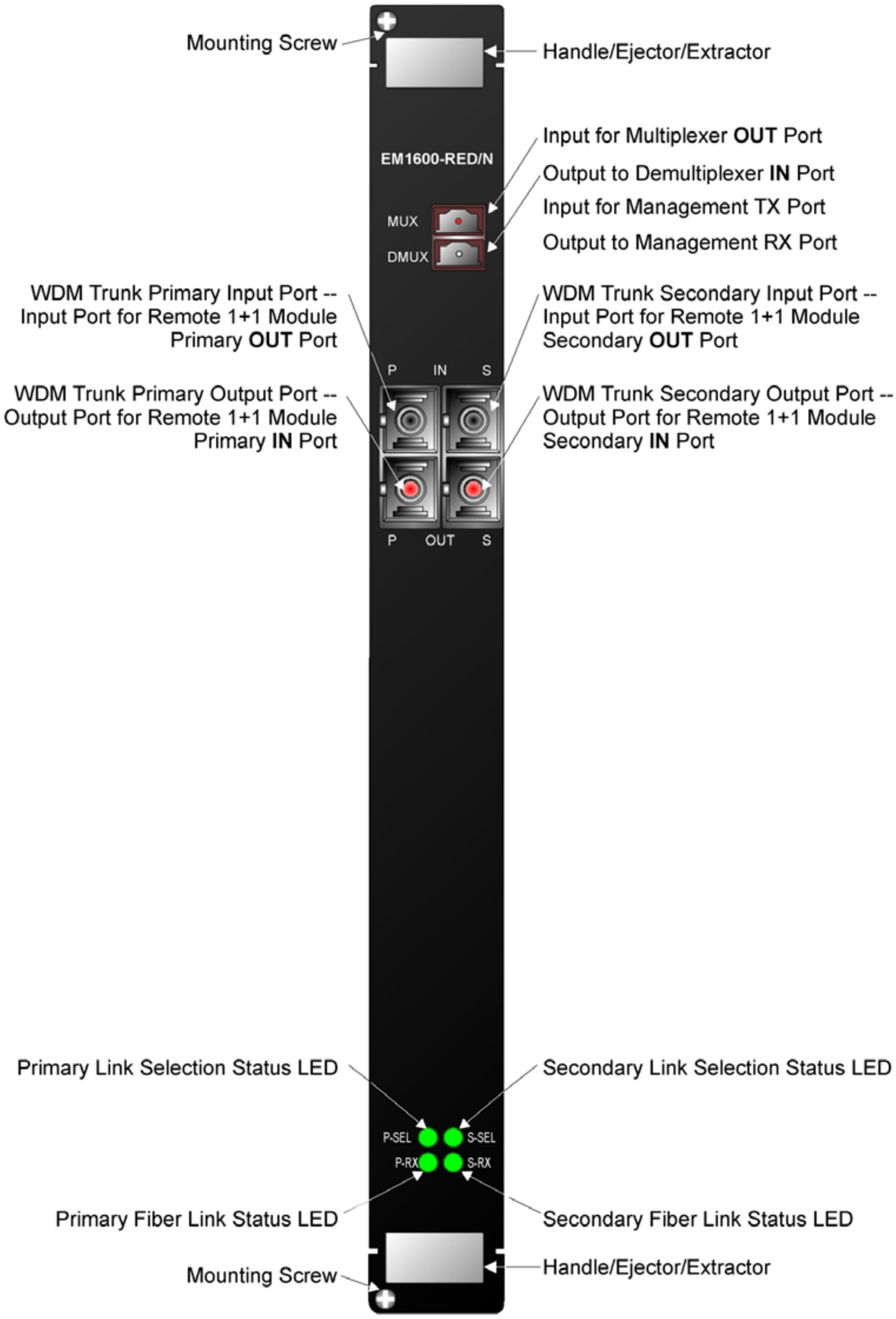


Figure 10: 1+1 Redundancy Module *without* Service Functionality Layout

Product Specification

Parameters	Values
MUX Port (Multiplexer Port)	
Purpose:	Connection to Multiplexer **OUT** port
Power Attenuation:	3.3 dB
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 μm
Cable Connector:	MiniSC (MU)
DMUX Port (Demultiplexer Port)	
Purpose:	Connection to Demultiplexer **IN** (**P** or **S**) port
Power Attenuation:	2 dB
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 μm
Cable Connector:	MiniSC (MU)
MGT TX Port (Management Transmit Port)	
Purpose:	Connection to Management **ETH 1 RX** or **ETH 2 RX** port
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 μm
Cable Connector:	MiniSC (MU)
MGT RX Port (Management Receive Port)	
Purpose:	Connection to Management **ETH 1 TX** or **ETH 2 TX** port
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 μm
Cable Connector:	MiniSC (MU)
IN P Port (WDM Primary Redundancy/OSC Receive Port)	
Purpose:	Connection to 1+1 **OUT P** port
Cable Length (max):	Per the *remote* Transponder power budget, which depends on whether the technology is CWDM or DWDM and on channel bandwidth (Data Rate Range)
Cable Type:	Singlemode 9/125 μm

Cable Connector:	SC
OUT P (WDM Primary Redundancy/OSC Transmit Port)	
Purpose (optional):	Connection to 1+1 **IN P** port
Cable Length (max):	Per the *local* Transponder power budget, which depends on whether the technology is CWDM or DWDM and on channel bandwidth (Data Rate Range)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	SC
IN S Port (WDM Secondary Redundancy/OSC Receive Port)	
Purpose:	Connection to 1+1 **OUT S** port
Cable Length (max):	Per the *remote* Transponder power budget, which depends on whether the technology is CWDM or DWDM and on channel bandwidth (Data Rate Range)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	SC
OUT S Port (WDM Secondary Redundancy/OSC Transmit Port)	
Purpose (optional):	Connection to 1+1 **IN S** port
Cable Length (max):	Per the *local* Transponder power budget, which depends on whether the technology is CWDM or DWDM and on channel bandwidth (Data Rate Range)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	SC
LEDs	
P-SEL:	Primary link selection status
S-SEL:	Secondary link selection status
P-RX:	Primary link receive port status
S-RX:	Secondary link receive port status
Mounting	Handle/ejector/extractor Posidrive screws (two)
Physical Dimensions (W x H x D)	26.93 mm (1.06 in) x 263.4 mm (10.37 in) x 227.5 mm (8.956 in)
Weight (max)	1.2 kg (2.65 lb)

OADM Module

Overview

The OADM module is a scalable, passive optical “add” and “drop” multiplexer/demultiplexer that can add and/or drop a specific channel (wavelength) to/from an optical WDM signal, while all other channels are routed from the input to the output with minimal attenuation. OADMs are required in ring and multipoint network topologies.

OADMs can be used to create a network topology in which a single wavelength can be added or dropped on demand, allowing an Optical Service Channel (OSC) to be provided at any point along a trunk. The technology enables flexible and intelligent planning and provisioning of optical services while at the same time simplifying deployment and maintenance of optical networks.

In the dual fiber OADM module, the **COM** port carries channels (wavelengths) to be dropped at the LD1600 as well as channels to be continued to the next LD1600. The **EXP** port carries only channels to be continued to the next LD1600.

Figure 24, Figure 25, Figure 27, and *Figure 28* show how the *Single-Interface* OADM module can be applied.

Figure 90 to *Figure 95* show how the *Dual-Interface* OADM module can be applied.

Features

- No electric power grounding or protection needed
- No opto-electric transducers used
- No EMI/RFI either to or from the OADM
- Scalable in increments of 1 port
- Can function in mutual redundancy mode
- Hot-swappable
- 1-slot size
- Pluggable

Layout

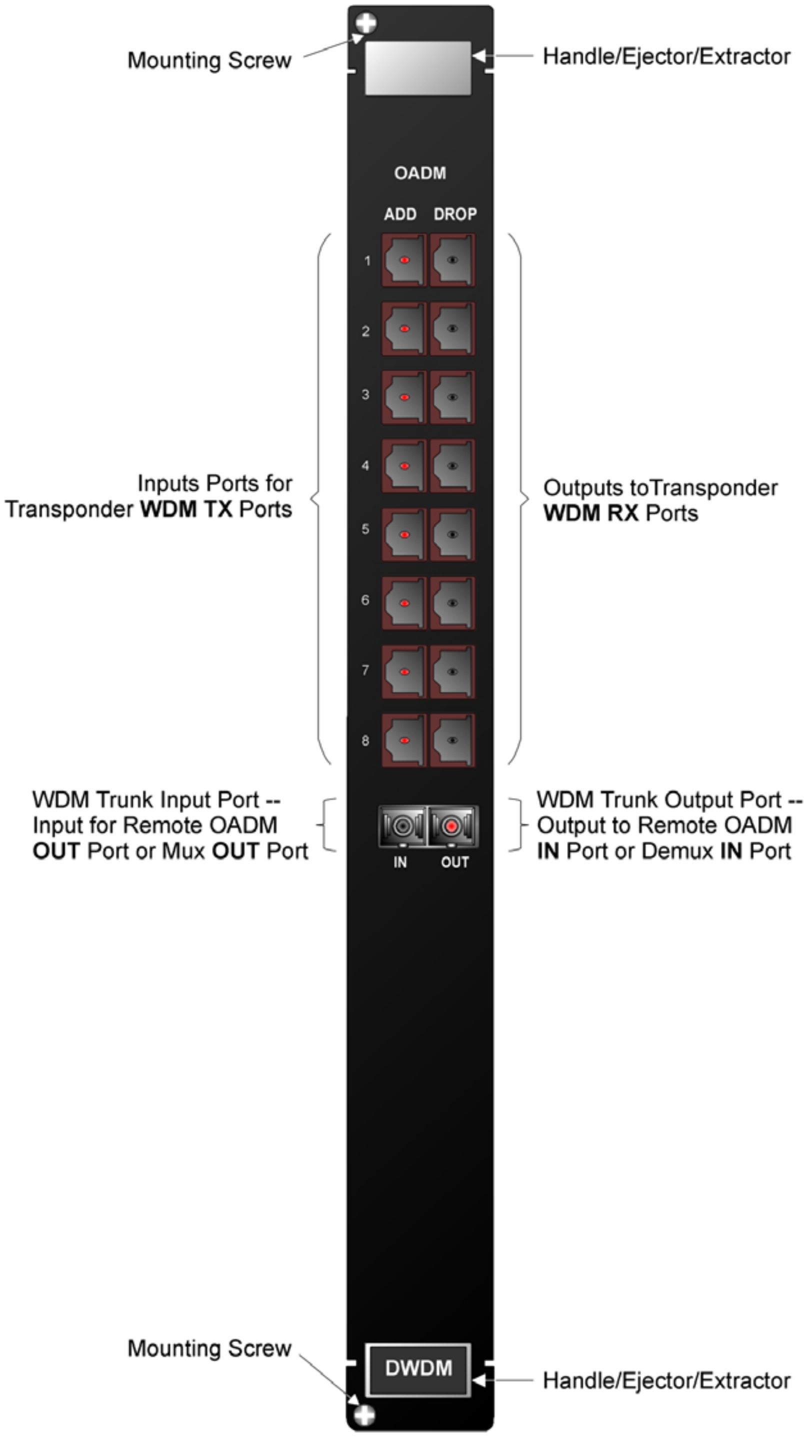


Figure 11: Single-Interface OADM Module Layout

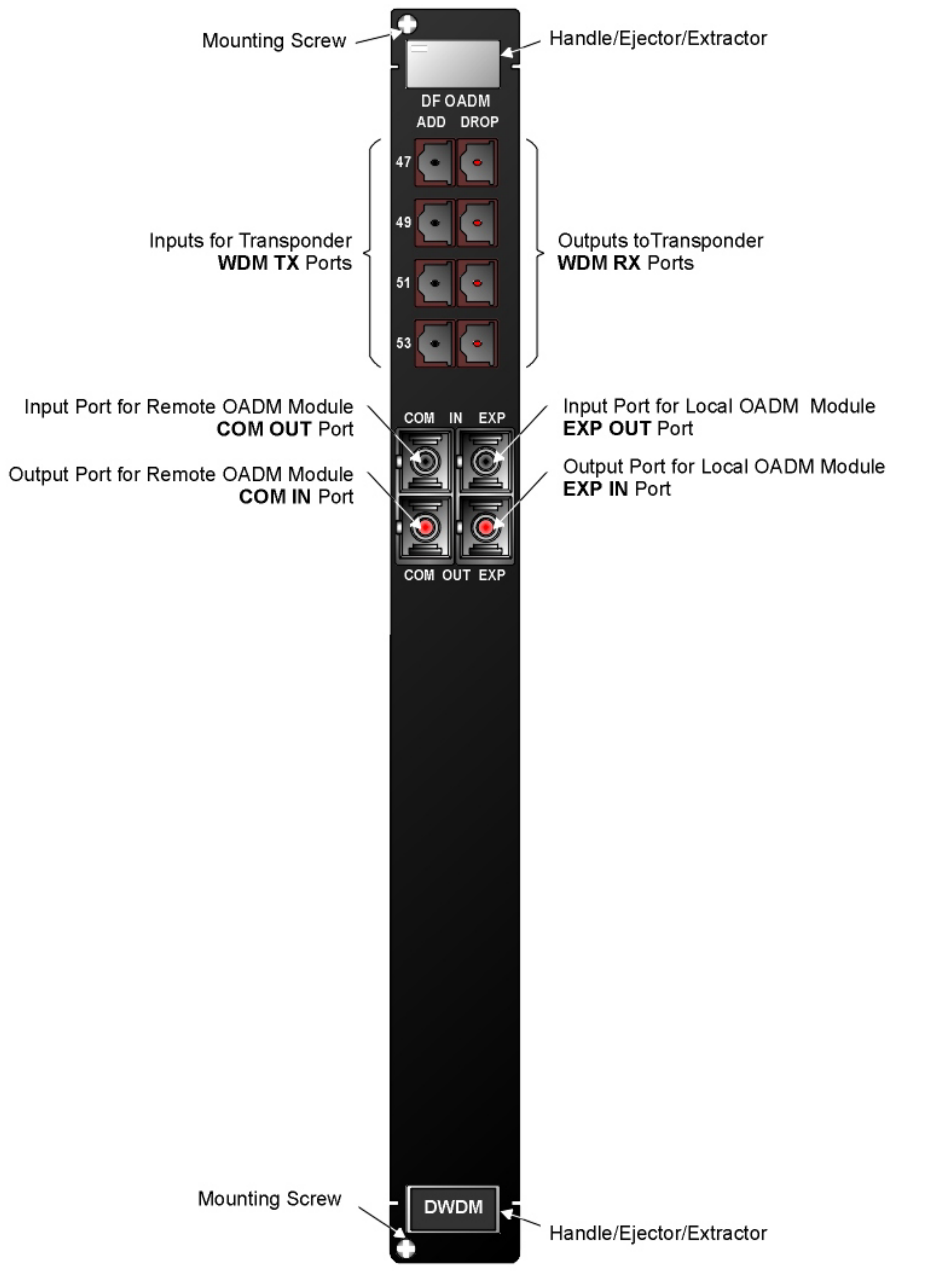


Figure 12: Dual-Interface OADM Module Layout

Product Specification

Parameters	Values
ADD Port (Multiplexer Port)	
Purpose:	Connection to Transponder **WDM TX** port
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	MiniSC (MU)
DROP Port (Demultiplexer Port)	
Purpose:	Connection to Transponder **WDM RX** port
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	MiniSC (MU)
IN Port (WDM Receive Port)	
Purpose:	Connection to *local* Service **MUX** port, *local* 1+1 **MUX** port, *remote* Multiplexer **OUT** port, or *remote* OADM **OUT** port
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	SC
IN COM Port (Dual-Interface OADM WDM Receive Port)	
Purpose:	Connection to *remote* OADM **OUT COM** port
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	SC
OUT Port (WDM Receive Port)	
Purpose:	Connection to *local* Service **DMUX** port, *local* 1+1 **DMUX** port, *remote* Multiplexer **IN** port, or *remote* OADM **IN** port
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	SC

OUT COM Port (Dual-Interface OADM WDM Transmit Port)	
Purpose:	Connection to *remote* OADM **IN COM** port
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 μm
Cable Connector:	SC
IN EXP Port (Dual-Interface OADM WDM Receive Port)	
Purpose:	Connection to *local* OADM **OUT EXP** port
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 μm
Cable Connector:	SC
OUT EXP Port (Dual-Interface OADM WDM Transmit Port)	
Purpose:	Connection to *local* OADM **IN EXP** port
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 μm
Cable Connector:	SC

Power Attenuation

OADM Type	**WDM Port Attenuation (dB)**		**Access Port Attenuation (dB)**			
	Single Interface	**Dual Interface**	**C1**	**C2**	**C3**	**C4**
1-Channel	1.3	0.9	1.3			
2-Channel	2.1	1.3	1.3	1.7		
3-Channel	2.9	1.7	1.3	1.8	2.1	
4-Channel	3.7	2.1	1.3	1.7	2.1	2.5

C1, C2, C3, and C4 are channels 1, 2, 3, and 4.

Mounting	Handle/ejector/extractor Posidrive screws (two)
Physical Dimensions (W x H x D)	26.93 mm (1.06 in) x 263.4 mm (10.37 in) x 227.5 mm (8.956 in)
Weight (max)	1.2 kg (2.65 lb)

OA Module

Overview

The OA module is an active 2-port DWDM optical signal amplifier. It is used in DWDM networks only and can amplify signals in the wavelength range 1528 to 1562 nm. The OA is usually applied when the distance between two LD1600s (or between an LD1600 and an LDx00[9]) exceeds 60-90 km, the exact distance depending on the quality of the fiberoptic cabling.

There are three types OAs:

Booster (Inserted at the beginning of the line)
In-Line (Inserted in the middle of the line)
Pre-amplifier (Inserted at the end of the line).

Figure 64 to *Figure 71* show how OA modules can be applied.

Features

- One input port, one output port
- Hot-swappable
- No signal processing
- 1-slot size
- LED indicators
- Pluggable

[9] LDx00 is LD400 or LD800.

Layout

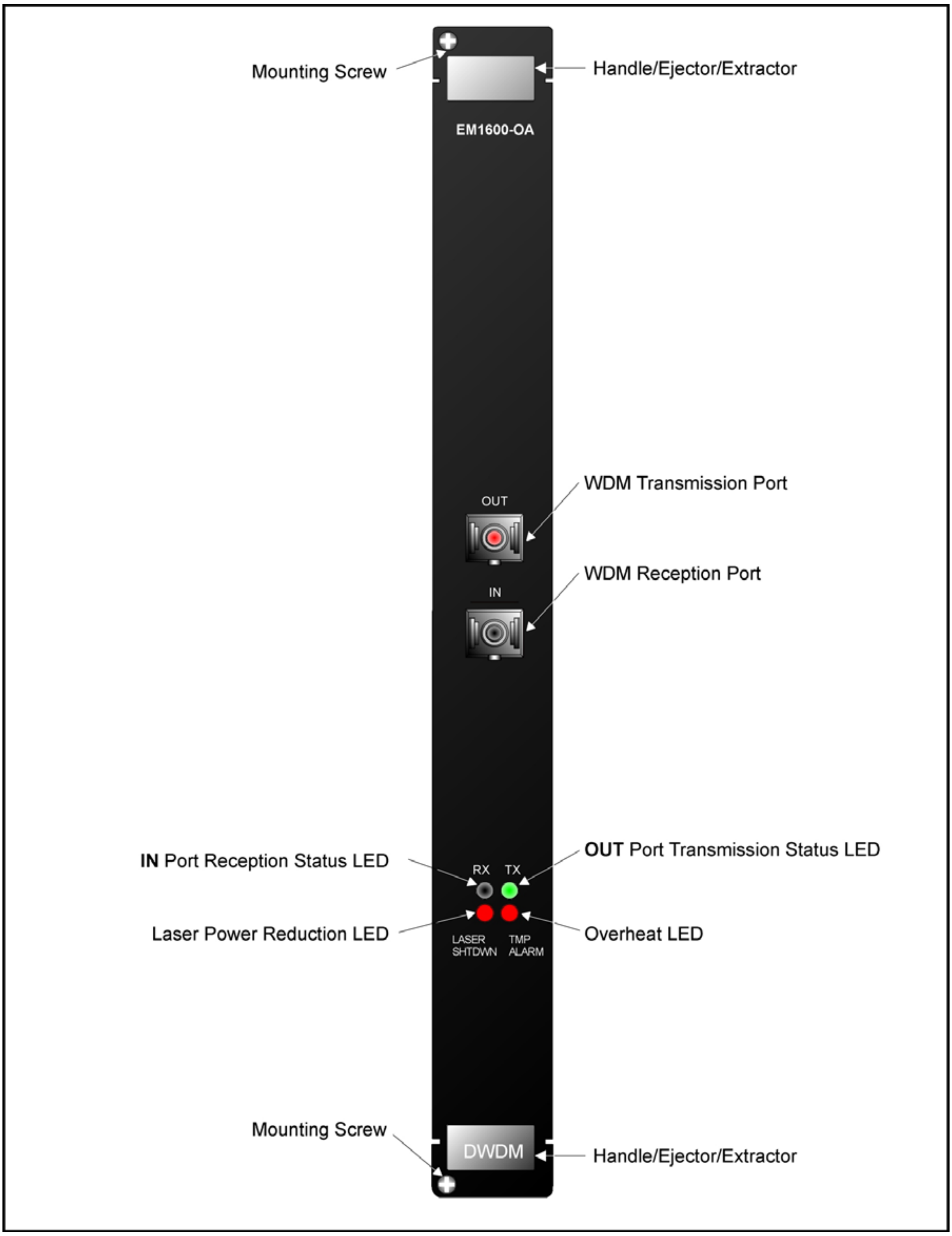


Figure 13: OA Module Layout

Product Specification

Parameters	Values
OUT Port (Multiplexer Port)	
Purpose:	Connection to Demultiplexer IN port or OADM IN port
Cable Length (max):	
Pre-amplifier:	1 m (~ 3 ft)
In-Line:	1 m (~ 3 ft)
Booster:	Per the formula[10] in the footnote
Cable Type:	Singlemode 9/125 µm
Cable Connector:	SC
IN Port (Multiplexer Port)	
Purpose:	Connection to Multiplexer OUT port or OADM OUT port
Cable Length (max):	
Pre-amplifier:	Per the formula in the footnote
In-Line:	1 m (~ 3 ft)
Booster:	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	SC
Output Power (Max)	+18 dBm
Power Consumption	
Single pump:	1 W
Dual pump:	2 W
Signal Gain	see table below
Gain Flatness at specified gain with GFF	
Min:	0 dB

Signal Gain:

	Pre-Amp	In-Line	Booster
Min	10 dB	20 dB	9 dB
Typ		25 dB	15 dB
Max			

[10] Cable length = $\frac{\text{[Output power of OA} - \text{Sensitivity of receiving port]} - \text{Path losses (in dB)}}{\text{Cable Attenuation (in dB/km)}}$

Typ: Max:	± 0.5 dB ± 1.0 dB
Polarization Mode Dispersion Typ: Max:	 0.3 picosec 0.5 picosec
Polarization Dependent Gain	
Typ:	± 0.2 dB
Max	± 0.5 dB
Transient Overshoot for 10 dB drop Typ: Max:	 0.5 dB 1.0 dB
Transient Suppression Time for 10 dB drop	Less than 32 μs
Input Power (Min) Pre-amplifier: In-line: Booster:	 -5 to -25 dBm -5 to -20 dBm +12 to -5 dBm
Noise Figure for Gain > 20 dB Typ: Max:	 5.0 dB 5.5 dB
Operating Wavelength:	1528 to 1563 nm (C-band)
Input/Output Isolation:	30 dB (min)
Input/Output Signal Return Loss:	25 dB
Monitoring:	Input power, Output power
Alarm:	Input power, Output power
LEDs LASER SHTDWN (ALS/APR): TMP ALARM: RX: TX:	 WDM transmission laser status Temperature status Port reception status Port transmission status
Operating Temperature Min: Max:	 0 °C (+ 32 °F) 45 °C (+ 113 °F)

Storage Temperature Min: Max:	 -10 °C (+ 14 °F) 70 °C (+ 158 °F)
Humidity (Relative, non-condensing, max)	85 %
Mounting	Handle/ejector/extractor Posidrive screws (two)
Physical Dimensions (W x H x D)	26.93 mm (1.06 in) x 263.4 mm (10.37 in) x 227.5 mm (8.956 in)
Weight (max)	1.2 kg (2.65 lb)

ESCON Multiplexer Module

Overview

The ESCON multiplexer module is a TDM that performs the following two primary functions:

1. Multiplexing data on *up to* four ESCON channels into one data stream to flow in one direction.
2. Demultiplexing a multiplexed data stream coming in the opposite direction into the four ESCON channels.

This function enables a pair of ESCON modules to carry up to four ESCON channels over a fiberoptic cable. ESCON channels can be carried inband[11] or outband[12].

ESCON modules can be installed in the LD1600 in slots 1 to 16.

Using just two LD1600s, sixteen pairs of ESCON modules can carry 64 ESCON channels *inband* (using CWDM or DWDM) over *a* ***single*** physical fiberoptic cable.

Major benefits in the use of ESCON modules include:

- Extended operating range
- Allows data of other protocols to be carried at the same *time*.
- Immediate, easy, and quick deployment
- Cabling bulk reduction by a factor of as much as 64
- Lower cost
- Advantages afforded by fiberoptic cabling, such as greater reliability, increased security, and added safety
- Enables pluggable add-on scalability and growth

The ESCON WDM interface can be fitted with any vendor SFP. This endows the ESCON module with flexible connectivity to terminal equipment and minimizes cost of investment on upgrades and deviations since to change any one or more of the interface properties, only the SFP, and not the whole ESCON module, needs to be replaced.

Figure 29 to *Figure 32* show how ESCON multiplexer modules can be applied.

Features

- Active 3R functionality
- Transmission and reception indicators
- Hot-swappable
- Access interface (receptacle) can host any vendor SFP meeting the MSA SFF-8074i standard for flexible connectivity to terminal equipment.
- SFF-8472 digital diagnostics support for SFP
- Installable in all LambdaDriver chassis
- 1-slot size
- Pluggable

[11] Inband means via WDM trunk

[12] Outband means without WDM trunk

Layout

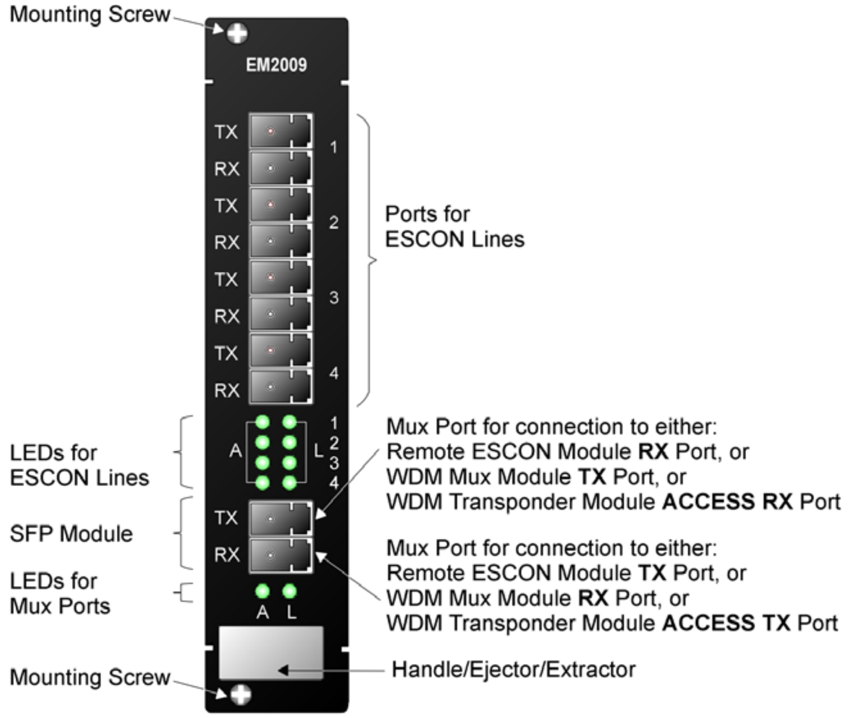


Figure 14: ESCON Module Layout

Product Specification

Parameters	**Values**
Data Rate Range	184 to 209 Mbps
WDM Grid CWDM (by interfacing with Transponder): DWDM:	 ITU-T G.694.2 ITU-T G.694.1
TX Port (Access Port) Purpose: Cable *Fiber* Length (max) Cable Type: Cable Connector:	 Connection to ESCON equipment input (RX) 2 km (6561 ft) Singlemode 9/125 µm LC
RX Port (Access Port) Purpose: Cable *Fiber* Length (max): Cable Type: Cable Connector:	 Connection to ESCON equipment output (TX) 2 km (6561 ft) Singlemode 9/125 µm LC
SFP **TX** Port (WDM Port) Purpose: Transmitter Output Power Cable Length (max): Outband (ESCON to ESCON) CWDM (1470 to 1610 nm) CWDM (1470 to 1610 nm) Inband (ESCON to Mux, OADM, or Transponder) Cable Type: Cable Connector:	 Connection to Multiplexer **TX** port, OADM **ADD** port, or Transponder **ACCESS RX** Per the SFP 60 km (196848 ft) 80 km (262464 ft) 1 m (~ 3 ft) Singlemode 9/125 µm Per the SFP (usually LC)
SFP **RX** Port (WDM Port) Purpose:	 Connection to Demultiplexer **RX** port, OADM **DROP** port, or Transponder **ACCESS TX**

Receiver Sensitivity	Per the SFP
APD Overload for ESCON-to-Mux/Demux module connection (Max)	-3 dBm
Cable Length (max):	1 m (~ 3 ft)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	Per the SFP (usually LC)
LEDs	
A1 to A4:	Per-port Access data reception synchronization status
L1 to L4:	Per-port Access link status
A:	WDM data reception synchronization status
L:	WDM link status
Mounting	Handle/ejector/extractor Posidrive screws (two)
Physical Dimensions (W x H x D)	26.93 mm (1.06 in) x 130.7 mm (5.145 in) x 227.5 mm (8.956 in)
Weight (max)	0.7 kg (1.5 lb)

Appendix K lists some of the available SFPs.

GM2 Gigagbit Ethernet Multiplexer Module

Overview

The GM2 multiplexer module is a TDM that performs the following two primary functions:

1. Multiplexing data on *two* Gigabit Ethernet channels into one 2.5 Gbps data stream to flow in one direction.
2. Demultiplexing a multiplexed 2.5 Gbps data stream coming in the opposite direction into *the* two Gigabit Ethernet channels.

This function enables a pair of GM2 modules to carry up to two Gigabit Ethernet channels over a fiberoptic cable. Gigabit Ethernet channels can be carried inband[13] or outband[14]. GM2 modules can be installed in the LD1600 in slots 1 to 16.

Using just two LD1600s, sixteen pairs of GM2 modules can carry 32 Gigabit Ethernet channels *inband* (using CWDM or DWDM) over *a* ***single*** physical fiberoptic cable.

Major benefits in the use of GM2 modules include:

– Extended operating range
– Concurrent carriage of data of other protocols.
– Immediate, easy, and quick deployment
– Cabling bulk reduction by a factor of as much as 32
– Lower cost
– Advantages afforded by fiberoptic cabling, such as greater reliability, increased security, and added safety
– Pluggable add-on scalability and growth

The GM2 WDM and ACCESS interfaces can be fitted with any vendor SFP. This endows the GM2 module with flexible connectivity to terminal equipment and minimizes cost of investment on upgrades and deviations since to change any one or more of the interface properties, only the SFP, and not the whole GM2 module, needs to be replaced.

Figure 33 to *Figure 35* show how GM2 multiplexer modules can be applied.

Features

- Active 3R functionality
- Transmission and reception indicators
- Access interface (receptacle) can host any vendor SFP meeting the MSA SFF-8074i standard for flexible connectivity to terminal equipment.
- SFF-8472 digital diagnostics support for SFP
- Hot-swappable
- Installable in all LambdaDriver chassis
- 1-slot size
- Pluggable

Models

No.	Model	Description
1	EM2009-GM2	CWDM or DWDM technology. Data Rate of channel in the range 1 to 2.5 Gbps. Operating distance up to 100 km without regeneration. Wavelength on access side 1310 μm. Wavelength on trunk side 850, 1310, or 1550 μm. SFP Access and Trunk ports.
2	TM-GM2	Same as EM2009-GM2, except that the Trunk ports are fitted with fixed MiniSC (Mu) connectors.

[13] Inband means via WDM trunk

[14] Outband means without WDM trunk

Layout

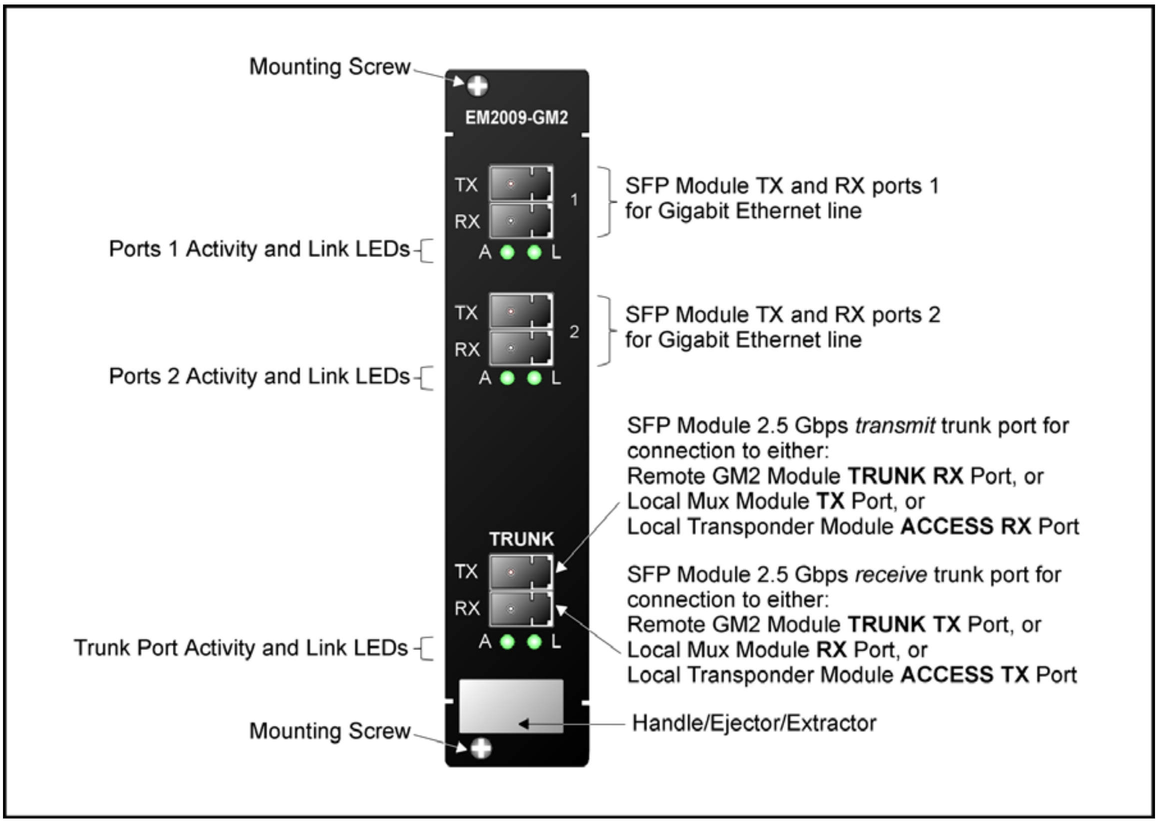


Figure 15: EM2009-GM2 Module Layout

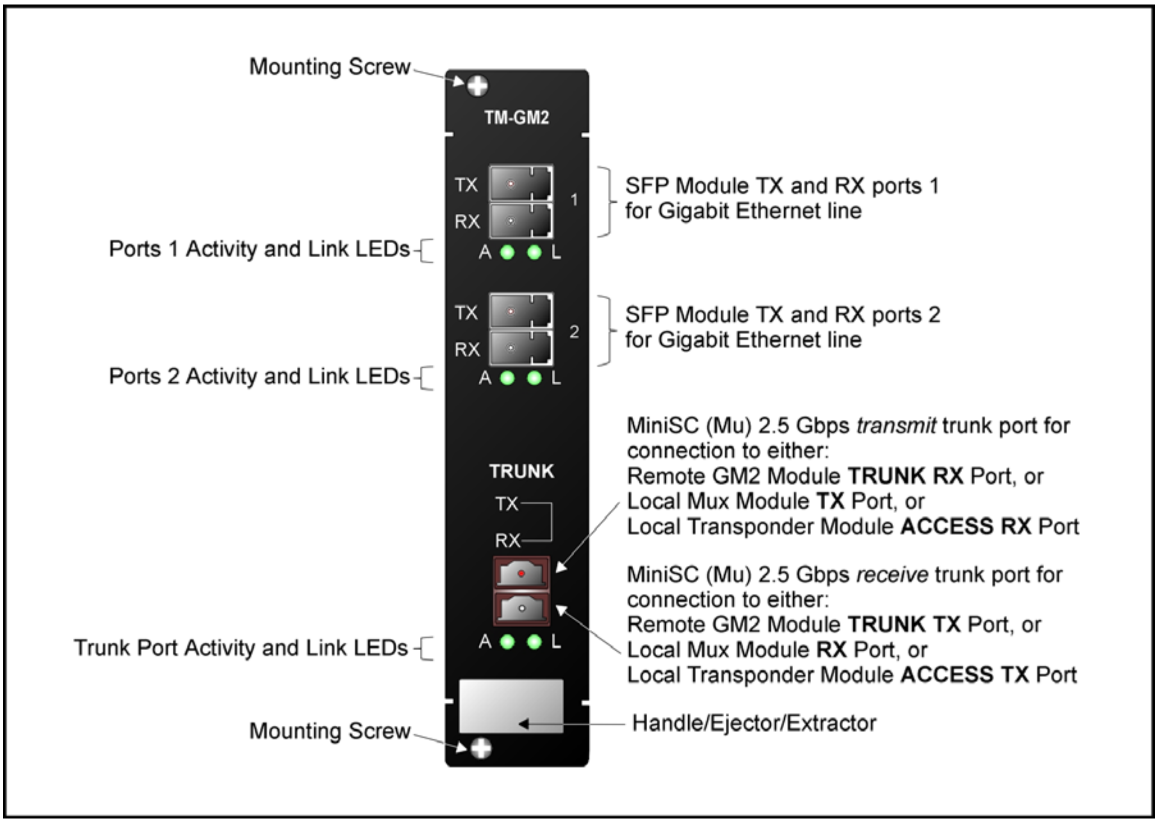


Figure 16: TM-GM2 Module Layout

Product Specification

Parameters	**Values**
Data Rate Range	1 to 2.5 Gbps
TX Port (Access Transmit Port)	
Purpose:	Connection to access unit receive port (RX)
Cable *Fiber* Length (max):	Per the GM2 access SFP output power and access unit receiver sensitivity – see Rule *17*, page *107*.
Cable Type:	Per the SFP (fiberoptic or copper)
Cable Connector:	Per the SFP
RX Port (Access Receive Port)	
Purpose:	Connection to access unit transmit port (TX)
Cable *Fiber* Length (max):	Per the access unit output power and GM2 access SFP receiver sensitivity – see Rule *17*, page *107*.
Cable Type:	Per the SFP (fiberoptic or copper)
Cable Connector:	Per the SFP
TRUNK TX Port (WDM Transmit Port)	
Purpose:	Connection to Multiplexer **TX** port or OADM **ADD** port
Grid	
CWDM:	ITU-T G.694.2
DWDM:	ITU-T G.694.1
Transmitter Output Power	
EM2009-GM2	Per the SFP (usually +2 to -4 dBm)
TM-GM2	
Transmission Dispersion Penalty for GM2-to-Mux/Demux module connection (Max)	Per the SFP
Cable Fiber Length (max):	
Outband	
EM2009-GM2 to EM2009-GM2	Per the *local* GM2 TRUNK SFP transmitter output power, *remote* GM2 TRUNK SFP receiver sensitivity, and power loss due to other elements in the signal path – see Rule *18*, page *108.*
TM-GM2 to TM-GM2	100 km (62.1 mi)

Inband	
GM2 to Mux or OADM (in same LD1600)	1 m (~ 3 ft)
Local Mux or OADM to *Remote* Mux or OADM (between two LD1600s)	
EM2009-GM2 to EM2009-GM2	Per the *local* GM2 TRUNK SFP transmitter output power, *remote* GM2 TRUNK SFP receiver sensitivity, and power loss due to other elements in the signal path – see Rule *18*, page *108.*
TM-GM2 to TM-GM2	100 km (62.1 mi)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	Per the SFP
TRUNK RX Port (WDM Receive Port)	
Purpose:	Connection to Demultiplexer **RX** port or OADM **DROP** port
Grid	
CWDM:	ITU-T G.694.2
DWDM:	ITU-T G.694.1
Receiver Sensitivity at **TRUNK RX** port	
EM2009-GM2	Per the SFP
TM-GM2	-20 to -26 dBm
APD Overload for GM2-to-Mux/Demux module connection (Max)	-4 dBm
Cable Fiber Length (max):	
Outband	
EM2009-GM2 to EM2009-GM2	Per the *remote* GM2 TRUNK SFP transmitter output power, *local* GM2 TRUNK SFP receiver sensitivity, and power loss due to other elements in the signal path – see Rule *18*, page *108.* (The *cable* length is the smaller of the fiber lengths for the **TRUNK TX** Port and **TRUNK RX** Port.)
TM-GM2 to TM-GM2	100 km (62.1 mi)
Inband	
GM2 to Mux or OADM (in same LD1600)	1 m (~ 3 ft)
Remote Mux or OADM to *Local* Mux or	

OADM (between two LD1600s)	
EM2009-GM2 to EM2009-GM2	Per the *remote* GM2 TRUNK SFP transmitter output power, *local* GM2 TRUNK SFP receiver sensitivity, and power loss due to other elements in the signal path – see Rule *18*, page *108.* (The *cable* length is the smaller of the fiber lengths for the **TRUNK TX** Port and **TRUNK RX** Port.)
TM-GM2 to TM-GM2	100 km (62.1 mi)
Cable Type:	Singlemode 9/125 µm
Cable Connector:	Per the SFP
LEDs	
A1, A2:	Per-port access data reception status
L1, L2:	Per-port access link status
A:	Trunk (WDM) data reception synchronization status
L:	Trunk (WDM) link status
Mounting	Handle/ejector/extractor Posidrive screws (two)
Physical Dimensions (W x H x D)	26.93 mm (1.06 in) x 130.7 mm (5.145 in) x 227.5 mm (8.956 in)
Weight (max)	0.7 kg (1.5 lb)

Appendix K lists some of the available SFPs.

AC Primary Power Supply Module

Overview

Power Supply module powers the LD1600. It is auto-adaptive in the range 100 to 240 Vac and can be backed up by a second power supply in the same LD1600 while equally sharing the output power load.

Features

- Hot-swappable
- Equal load-sharing
- Pluggable

Layout

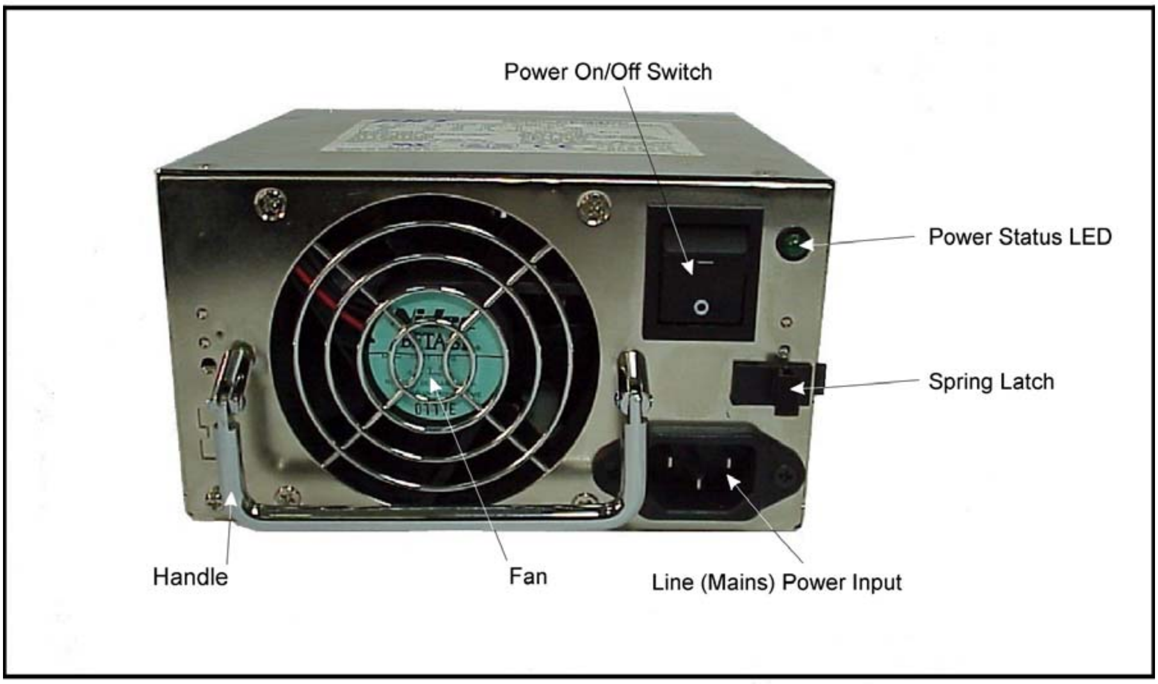


Figure 17: *AC* Power Supply Module Layout

DC Primary Power Supply Module (Optional)

Overview

Power Supply Module powers the LD1600. It is auto-adaptive in the range -48 to -60 Vdc and can be backed up by a second power supply in the same LD1600 while equally sharing the output power load.

Features

- Hot-swappable
- Equal load-sharing
- Pluggable

Layout

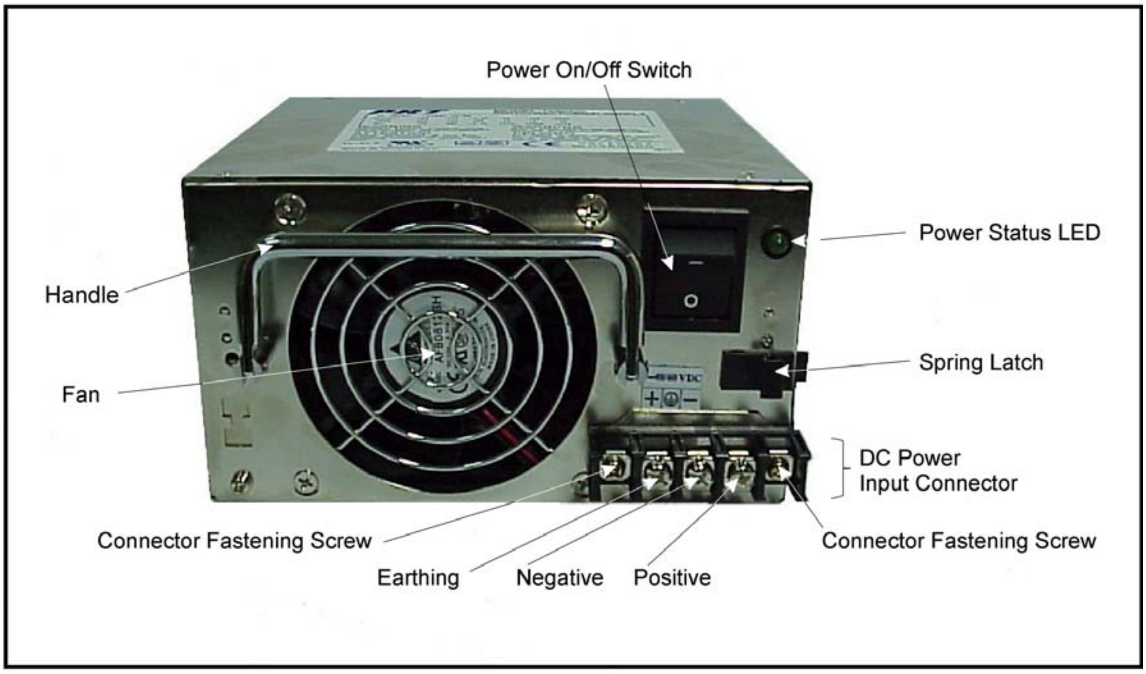


Figure 18: *DC* Power Supply Module Layout

AC Redundant Power Supply Module (Optional)

Overview

The AC redundant Power Supply Module is identical to the primary AC Power Supply Module. It serves two purposes:

– Backs up and is backed up by the primary AC Power Supply Module.

– Operates with the primary AC Power Supply Module in equal-load-sharing mode. This mode prolongs their service life.

Features

- Hot-swappable
- Equal load-sharing
- Pluggable

DC Redundant Power Supply Module (Optional)

Overview

The DC redundant Power Supply Module is identical to the primary DC Power Supply Module. It serves two purposes:

– Backs up and is backed up by the primary DC Power Supply Module.

– Operates with the primary DC Power Supply Module in equal-load-sharing mode. This mode prolongs their service life.

Features

- Hot-swappable
- Equal load-sharing
- Pluggable

Fan Module

Replaceable 3-fan plug-in unit.

Blank Panel Module

Overview

The Blank Panel module covers a vacant slot in the LD1600.

It protects the user against electrical shock and the LD1600 against harmful physical intrusion as well as overheating by assuring circulation of sufficient cooling air throughout the LD1600.

Two types of Blank Panel modules are available:

– Small Blank Panel module: Used to cover any one of Slots 1 to 16 when vacant.

– Big Blank Panel module: Used to cover any one of Slots 17 to 24 when vacant.

Layout

Figure 19: Small Blank Panel Module Layout

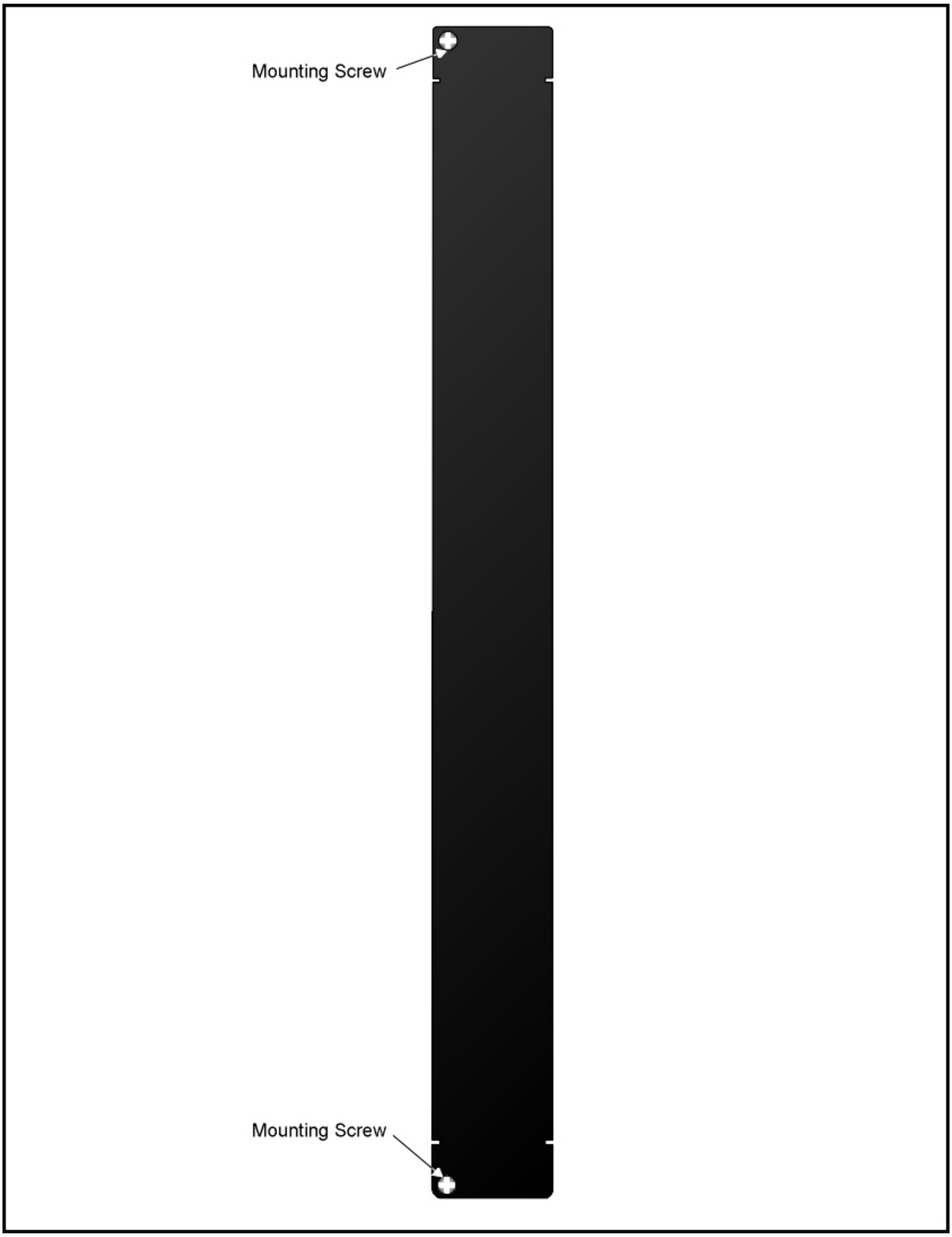


Figure 20: Big Blank Panel Module Layout

Channels

CWDM

The LD1600 can be configured to support up to 16 ITU-T G.694.2 standard CWDM channels. Each channel can carry data at any rate in the range 8 Mbps to 2.7 Gbps. The 16 channels span the wavelength range 1310 to 1610 nm with 20 nm spacing between the wavelengths.

Table 1 shows ITU-T G.694.2 standard CWDM channels (wavelengths).

Table 1: CWDM Channels – Nominal Central Wavelengths

Chan.	Wavelength (nm)
1	1270
2	1290
3	1310
4	1330
5	1350
6	1370
7	1390
8	1410
9	1430

Chan.	Wavelength (nm)
10	1450
11	1470
12	1490
13	1510
14	1530
15	1550
16	1570
17	1590
18	1610

DWDM

The LD1600 can be configured to support up to any of 16 ITU-T G.694.1 standard DWDM channels from among over 40. Each channel can carry data at any rate in the range 8 Mbps to 2.7 Gbps. The channel wavelengths have at least 0.8 nm spacing between them.

Table 2 shows ITU-T G.694.1 standard DWDM channels (frequencies and wavelengths).

Table 2: DWDM Channels – Numbers, Frequencies, and Wavelengths

Chan.	Freq. (GHz)	Wavelength (nm)
⇣	⇣	⇣
21	192100	1560.61
22	192200	1559.79
23	192300	1558.98
24	192400	1558.17
25	192500	1557.36
26	192600	1556.55
27	192700	1555.75
28	192800	1554.94
29	192900	1554.13
30	193000	1553.33
31	193100	1552.52
32	193200	1551.72
33	193300	1550.92
34	193400	1550.12
35	193500	1549.32
36	193600	1548.51
37	193700	1547.72
38	193800	1546.92
39	193900	1546.12
40	194000	1545.32

Chan.	Freq. (GHz)	Wavelength (nm)
41	194100	1544.53
42	194200	1543.73
43	194300	1542.94
44	194400	1542.14
45	194500	1541.35
46	194600	1540.56
47	194700	1539.77
48	194800	1538.98
49	194900	1538.19
50	195000	1537.40
51	195100	1536.61
52	195200	1535.82
53	195300	1535.04
54	195400	1534.25
55	195500	1533.47
56	195600	1532.68
57	195700	1531.90
58	195800	1531.12
59	195900	1530.33
60	196000	1529.55
⇣	⇣	⇣

Chapter 2
Applications

General

This chapter presents typical networking applications with the LD1600. These applications serve to show the scope of the application of the LD1600. The network in an example can be adopted as is or can be modified to meet a specific set of requirements. The examples together with the rules given on Page *107* serve to modify a network or build a new one. Each LD1600 can be managed locally or remotely using management stations described in the section *Management* on Page *21*.

Point-to-Point Network Topologies

Regular Point-to-Point

Scope

In the Regular Point-to-Point topology (example shown in *Figure 21*), up to 16 full-duplex channels can be created across the network. This means that up to 32 access-equipment units (e.g., LANs, PCs, etc.) can be interconnected with this network topology – two per channel.

Hardware

<u>Left LD1600</u>

Basic Contents: 1 Mux Module, 1 Demux Module, up to 16 Transponder Modules.

Options: 1 Management Module, 1 Service Module, 1 or 2 OA Modules.

<u>Right LD1600</u>

Same as for left LD1600.

Cabling

<u>Inter-LD1600 Cabling</u>

With Service Modules: As in *Figure 51*.

Without Service Modules: As in *Figure 41*.

<u>Intra-LD1600 Cabling</u>

Left LD1600

With Service and Management Modules:

Transponder-to-Mux: As in *Figure 53*.

Demux-to-Transponder: As in *Figure 54*.

Mux-to-Service: As in *Figure 56*.

Service-to-Demux: As in *Figure 56*.

Management-to-Service: As in *Figure 58*.

Without Service Module:

Simply skip connections for the Service module described just above. This means that the **OUT** ports of the Muxes are directly connected to the **IN** ports of the Demuxes, as shown in *Figure 41*.

Without Management Module:

Simply skip connections for the Management Module.

Right LD1600

Same as for left LD1600.

<u>LD1600 to RS-232/Ethernet Cabling</u>

LD1600-to-RS-232: As shown in *Figure 76*.

LD1600-to-Ethernet: As shown in *Figure 77*.

Data Flow

Left LD1600

Transponders 1 to 16 *transmit* on channels 1 to 16 on one fiber and *receive* on channels 1 to 16 on the other fiber.

Right LD1600

Same as for left LD1600.

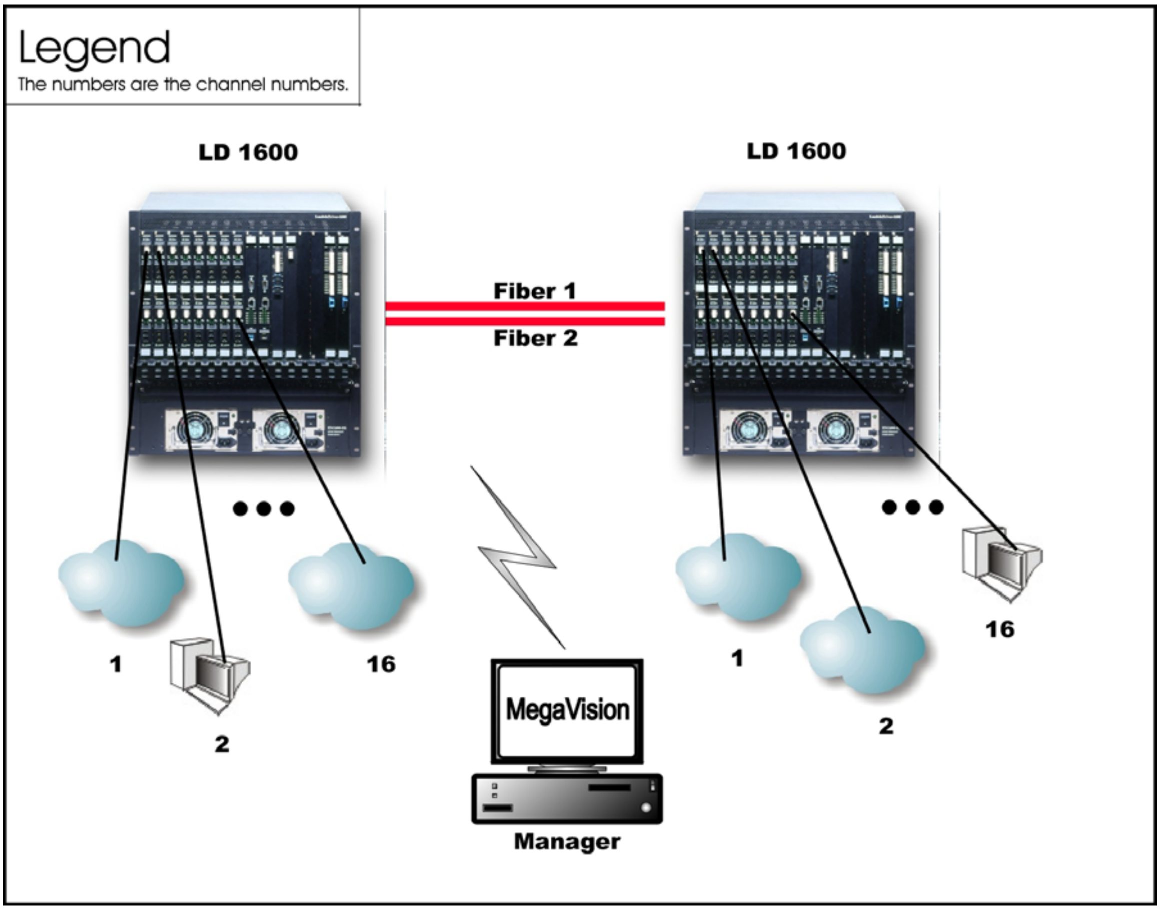


Figure 21: Regular Point-to-Point with up to 16 Full-Duplex Channels

Link-Protected Point-to-Point

Scope

In the Link-Protected Point-to-Point topology (example shown in *Figure 22*), up to 16 full-duplex channels can be created across the network. This means that up to 32 access-equipment units (e.g., LANs, PCs, etc.) can be interconnected with this network topology – two per channel. The Secondary and Primary fiber pairs back up each other.

The example shown in *Figure 22* uses 1+1 modules to implement redundancy. Appendix I shows examples (of ring topologies as well as point-to-point topologies) using OADM modules to implement redundancy.

Hardware

Left LD1600

Basic Contents: 1 Mux Module, 1 Demux Module, 1 1+1 Module, up to 16 Transponder Modules.

Options: 1 Management Module, 1 or 2 OA Modules.

Right LD1600

Same as for left LD1600.

Cabling

Inter-LD1600 Cabling
As in *Figure 52*.

Intra-LD1600 Cabling
Left LD1600
With Management Module:
Transponder-to-Mux: As in *Figure 53*
Demux-to-Transponder: As in *Figure 54*
Mux-to-1+1: As in *Figure 57*
1+1-to-Demux: As in *Figure 57*
Management-to-1+1: As in *Figure 59*
Without Management Module:
Simply skip connections for the Management Module.
Right LD1600
Same as for left LD1600.

LD1600 to RS-232/Ethernet Cabling
LD1600-to-RS-232: As shown in *Figure 76*.
LD1600-to-Ethernet: As shown in *Figure 77*.

Data Flow

Left LD1600
Normally, transmission and reception is on the Primary Link fiber pair (shown in *Figure 22*). Transponders 1 to 16 *transmit* on channels 1 to 16 on one fiber and *receive* on channels 1 to 16 on the other fiber.

Right LD1600
Same as for left LD1600.

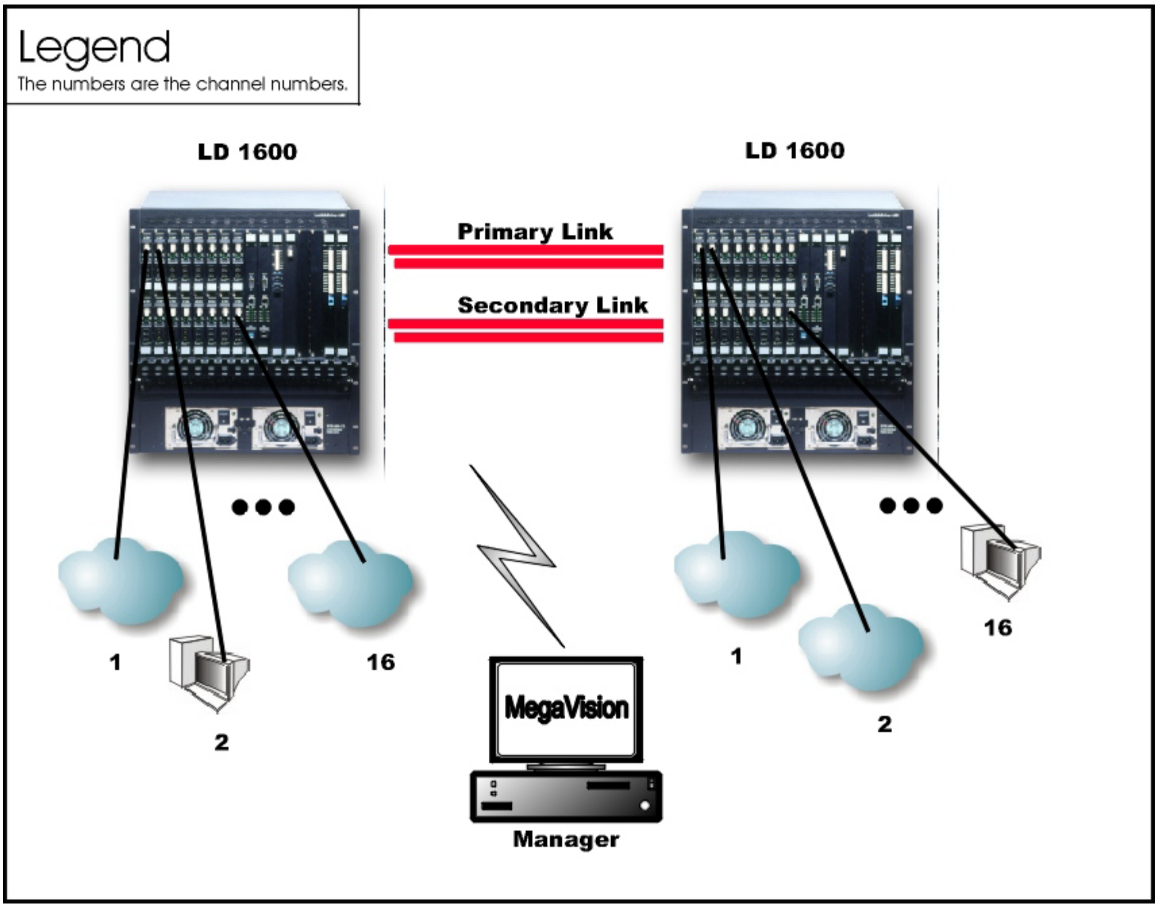


Figure 22: Link Protected Point-to-Point with up to 16 Full-Duplex Channels

Single-Fiber Point-to-Point

Scope

In the Single-Fiber Point-to-Point topology (example shown in *Figure 23*), although up to 16 channels can be created across the network with a single fiber, a channel can be used to either transmit or receive; not both. This means that two channels are required for transmission and reception between two access-equipment units (e.g., LANs, PCs, etc.). Accordingly, up to 16 access-equipment units can be interconnected with this network topology – two per channel *pair*.

Hardware

Left LD1600

Basic Contents: 1 Demux[15] Module, up to 16 Transponder Modules.

Options: 1 Management Module, 1 or 2 OA Modules.

Right LD1600

Same as for left LD1600.

Cabling

Inter-LD1600 Cabling

As in *Figure 42*.

Intra-LD1600 Cabling

Left LD1600

[15] Although a Mux Module could be used instead of a Demux Module, the Demux Module is preferable because it provides better channel separation.

Transponder-to-Demux: As in *Figure 53*. The transponders are channel **1**, **3**, **5**, **7**, **9**, **11**, **13**, and **15**. Accordingly, the transponder **WDM TX** ports connect to the Demux ports **1**, **3**, **5**, **7**, **9**, **11**, **13**, and **15** since a Demux port can receive/transmit only on a specific channel – Rule *16*. The transponder **WDM RX** ports connect to the Demux ports **2**, **4**, **6**, **8**, **10**, **12**, **14**, and **16** since a transponder can receive on any channel – Rule *5*. The **OUT** port of one Demux is directly connected to the **OUT** port of the second Demux, as shown in *Figure 42*.

Right LD1600

Transponder-to-Demux: As in *Figure 53*. The transponders are channel **2**, **4**, **6**, **8**, **10**, **12**, **14**, and **16**. Accordingly, the transponder **WDM TX** ports connect to the Demux ports **2**, **4**, **6**, **8**, **10**, **12**, **14**, and **16** since a Demux port can receive/transmit only on a specific channel – Rule *16*. The transponder **WDM RX** ports connect to the Demux ports **1**, **3**, **5**, **7**, **9**, **11**, **13**, and **15** since a transponder can receive any channel – Rule *5*.

Data Flow

Left LD1600

Transponders 1, 3, 5, 7, 9, 11, 13, and 15 *transmit* to the transponders 2, 4, 6, 8, 10, 12, 14, and 16 on channels 1, 3, 5, 7, 9, 11, 13, and 15. Transponders 2, 4, 6, 8, 10, 12, 14, and 16 receive these channels (i.e., channels 1, 3, 5, 7, 9, 11, 13, and 15). Transponders 1, 3, 5, 7, 9, 11, 13, and 15 *receive* from the transponders 2, 4, 6, 8, 10, 12, 14, and 16 on channels 2, 4, 6, 8, 10, 12, 14, and 16.

Right LD1600

Transponders 2, 4, 6, 8, 10, 12, 14, and 16 *transmit* to the transponders 1, 3, 5, 7, 9, 11, 13, and 15 on channels 2, 4, 6, 8, 10, 12, 14, and 16. Transponders 1, 3, 5, 7, 9, 11, 13, and 15 receive these channels (i.e., channels 2, 4, 6, 8, 10, 12, 14, and 16). Transponders 2, 4, 6, 8, 10, 12, 14, and 16 *receive* from the transponders 1, 3, 5, 7, 9, 11, 13, and 15 on channels 1, 3, 5, 7, 9, 11, 13, and 15.

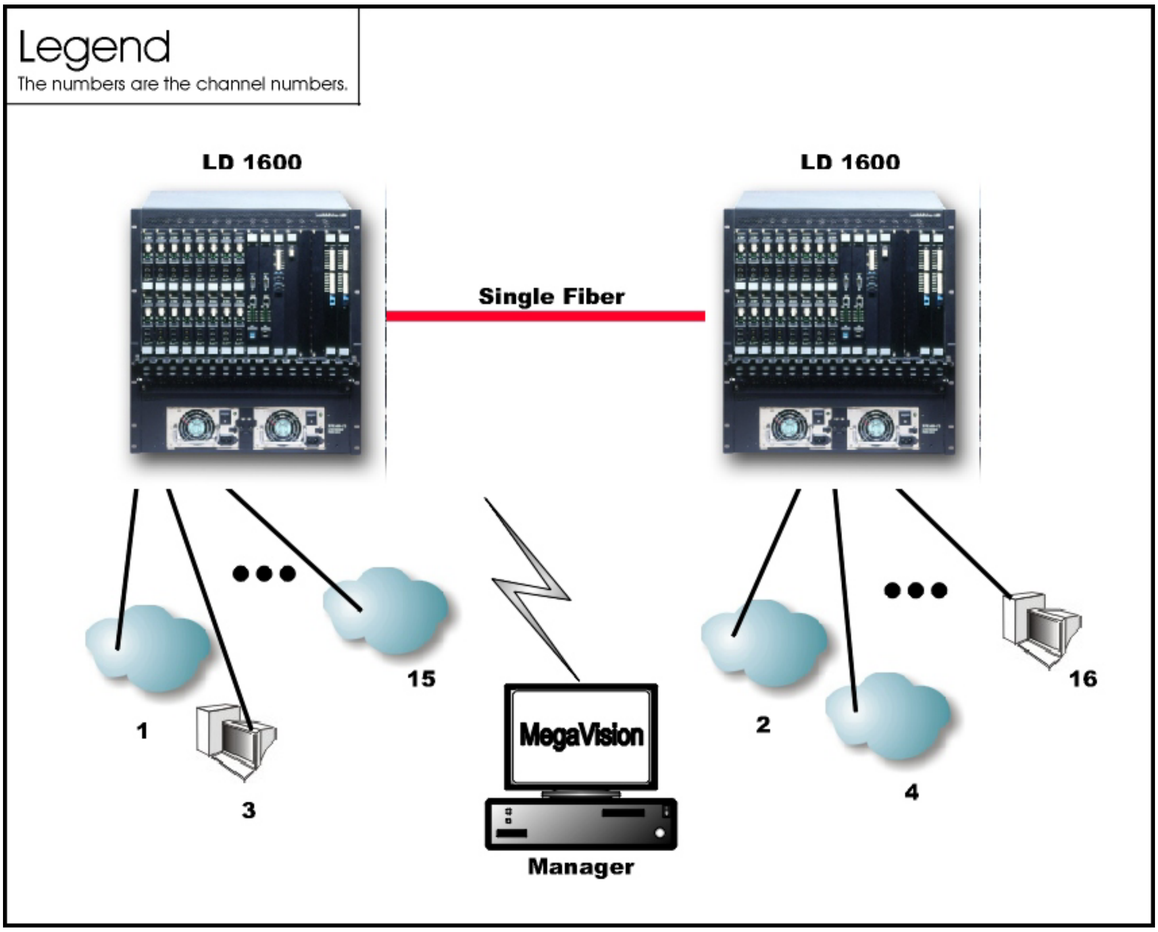


Figure 23: Single-Fiber Point-to-Point with up to 8 Full-Duplex Channels

Ring Network Topologies

Single-Fiber Ring

Scope

In the Single-Fiber Ring topology (example shown in *Figure 24*), up to 16 full-duplex channels can be created across the network. This means that up to 32 access-equipment units (e.g., LANs, PCs, etc.) can be interconnected with this network topology – two per channel. Note that a channel can be created between any two LD1600s.

Hardware

The hardware per LD1600 is as follows:

Basic Contents: 1 OADM Module and up to 8 Transponder Modules.

Options: 1 Management Module, 1 or 2 OA Modules.

Cabling

Inter-LD1600 Cabling

As in *Figure 45*.

Intra-LD1600 Cabling

Transponder-to-OADM: As in *Figure 55*. ***WDM TX*** ports of Transponders 1, 3, 5, 7, 9, 11, 13, and 15 (or 2, 4, 6, 8, 10, 12, 14, and 16) are connected to ***Add*** ports 1, 3, 5, 7, 9, 11, 13, and 15 (or 2, 4, 6, 8, 10, 12, 14, and 16) of the OADM. ***WDM RX*** ports of Transponders 1, 3, 5, 7, 9, 11, 13, and 15 (or 2, 4, 6, 8, 10, 12, 14, and 16) are connected to ***Drop*** ports 1, 3, 5, 7, 9, 11, 13, and 15 (or 2, 4, 6, 8, 10, 12, 14, and 16) of the OADM.

LD1600 to RS-232/Ethernet Cabling

LD1600-to-RS-232: As shown in *Figure 76*.

LD1600-to-Ethernet: As shown in *Figure 77*.

Data Flow

Top LD1600

Data from the access equipment units enter the **ACCESS RX** ports of Transponders 1, 3, 5, 7, 9, 11, 13, and 15. The data pass from the transponders **WDM TX** ports into the **Add** ports of the OADM. From the **OUT** port of the OADM, it passes onto the fiber connecting the *Right* LD1600.

Right LD1600

Data coming from the *Top* LD1600 enters the OADM **IN** port. The data on channels 1, 3, 5, 7, 9, 11, 13, and 15 is not required at this LD1600. Accordingly, it leaves the OADM on the **OUT** port and enters the fiber connecting the *Bottom* LD1600. The data on channels 2, 4, 6, 8, 10, 12, 14, and 16 pass to the OADM **IN** port. The data is then demultiplexed at the OADM **Drop** ports 2, 4, 6, 8, 10, 12, 14, and 16 and sent to the **WDM RX** port of the Transponders and emerge at the Transponder **ACCESS TX** port to enter the access equipment units.

Data flow from the access equipment units at this LD1600 is similar to that described for the *Top* LD1600, except that it is on channels 2, 4, 6, 8, 10, 12, 14, and 16.

Bottom LD1600

Data coming from the *Right* LD1600 enters the OADM Module **IN** port. The data on channels 2, 4, 6, 8, 10, 12, 14, and 16, is not required at this LD1600. Accordingly, it leaves the LD1600 at the OADM **OUT** port and enters the fiber connecting the *Left* LD1600. The data on channels 1, 3, 5, 7, 9, 11, 13, and 15 pass to the OADM **IN** port. The data is then demultiplexed at the OADM **Drop** ports 1, 3, 5, 7, 9, 11, 13, and 15 and sent to the **WDM RX** port of the Transponders and emerge at the Transponder **ACCESS TX** port to enter the access equipment units.

Data flow from the access equipment units at this LD1600 is similar to that described for the *Top* LD1600.

Left LD1600

Data coming from the *Bottom* LD1600 enters the OADM **IN** port. The data on channels 1, 3, 5, 7, 9, 11, 13, and 15 is not required at this LD1600. Accordingly, it leaves the LD1600 at the OADM

OUT port and enters the fiber connecting the *Top* LD1600. The data on channels 2, 4, 6, 8, 10, 12, 14, and 16 pass to the OADM **IN** port. The data is then demultiplexed at the OADM **Drop** ports 2, 4, 6, 8, 10, 12, 14, and 16 and sent to the **WDM RX** port of the Transponders and emerge at the Transponder **ACCESS TX** port to enter the access equipment units.

Data flow from the access equipment units at this LD1600 is similar to that described for the *Top* LD1600, except that it is on channels 2, 4, 6, 8, 10, 12, 14, and 16.

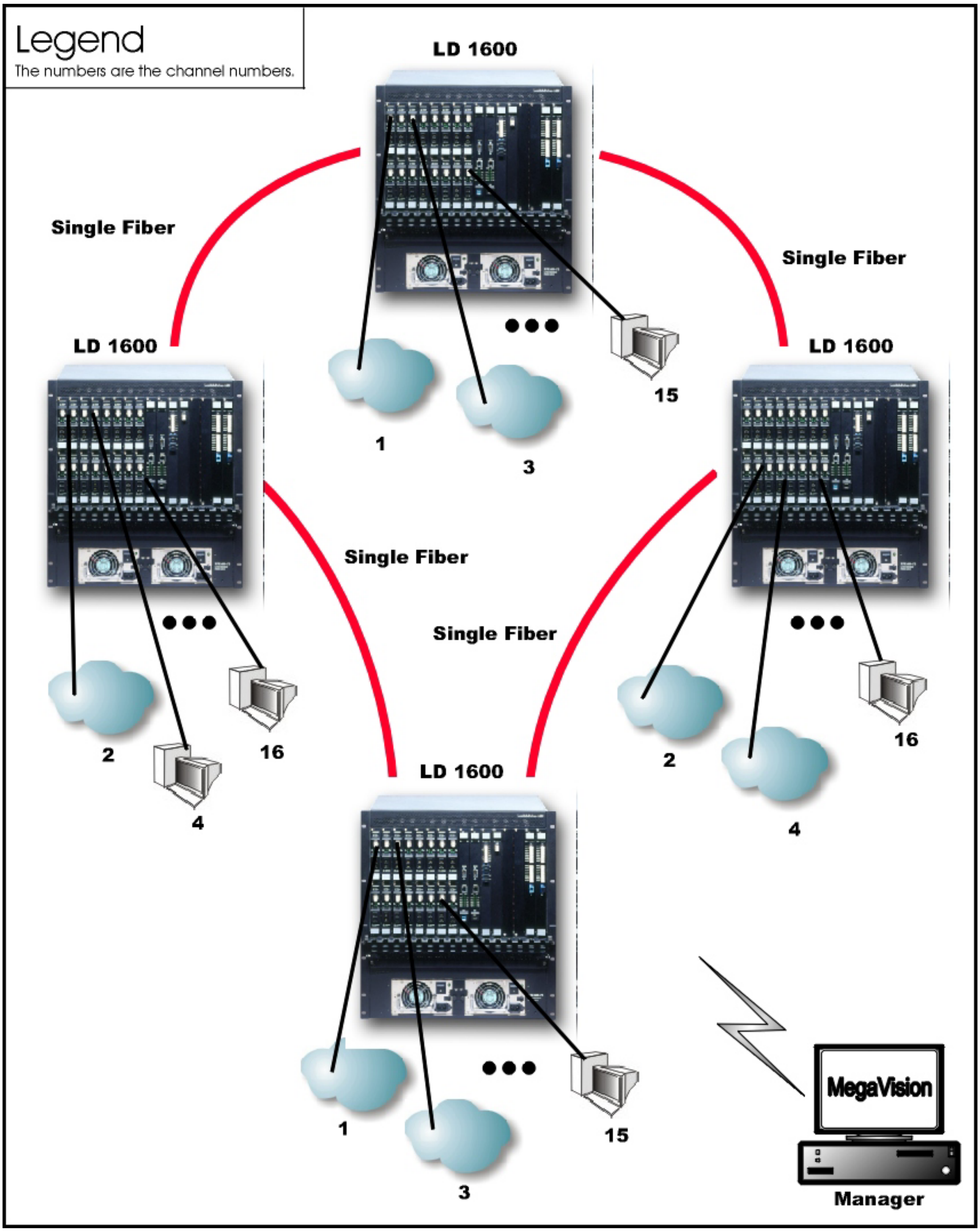


Figure 24: Single-Fiber Ring with up to 16 Full-Duplex Channels

Central Office Ring

Scope

In Central Office Ring topology (example shown in *Figure 25*), up to 16 full-duplex channels can be created across the network. This means that up to 32 access-equipment units (e.g., LANs, PCs, etc.) can be interconnected with this network topology – two per channel. Note that all channels run from the Branch Office (BO) LD1600s to the Central Office (CO) LD1600, i.e., no channels exist between the BOs.

Optimally, a Mux and a Demux module are installed at the CO while OADMs are installed at the BO LD1600s.

Hardware

CO LD1600

Basic Contents: 1 Mux Module, 1 Demux Module, and up to 16 Transponder Modules.

Options: 1 Management Module, 1 or 2 OA Modules.

BO LD1600

Basic Contents: 1 OADM Module and up to 8 Transponder Modules[16].

Options: 1 Management Module, 1 or 2 OA Modules.

Cabling

Inter-LD1600 Cabling

CO to BO: The **OUT** port of the Mux is connected to the **IN** port of the downstream OADM (as shown in *Figure 49*), and the **IN** port of the Demux is connected directly to the **OUT** port of the upstream OADM (as shown in *Figure* 50).

BO to BO: The **OUT** ports of the OADMs are connected to the **IN** ports of the OADMs, as shown in *Figure 45*.

Intra-LD1600 Cabling

At CO:

Transponder-to-Mux: As in *Figure 53*.

Transponder-to-Demux: As in *Figure 54*.

Mux-to-OADM: As in *Figure 49*.

Demux-to-OADM: As in *Figure 50*.

At BO:

Transponder-to-OADM: As in *Figure 55*. ***WDM TX*** ports of Transponders are connected to ***Add*** ports of the OADM. ***WDM RX*** ports of Transponders are connected to ***Drop*** ports of the OADM.

LD1600 to RS-232/Ethernet Cabling

LD1600-to-RS-232: As shown in *Figure 76*.

LD1600-to-Ethernet: As shown in *Figure 77*.

Data Flow

CO to BO

Data from the access equipment units enter the **ACCESS RX** ports of Transponders 1 to 16. The data pass from the transponders **WDM TX** ports into the Mux **TX** ports. From the Mux **OUT** port, the data pass onto the fiber connecting the downstream *BO* LD1600 (top).

This data enters the downstream *BO* LD1600 at the OADM **IN** port. Data on channels 9 to 16 are not required here. Accordingly, the data is passed directly to the OADM **OUT** port. Data on channels 1 to 8 enter the OADM **Drop** ports 1 to 8, go to the Transponder's **WDM RX** port and then **ACCESS TX** port to enter the access equipment unit.

Data on channels 1 to 16 coming from the upstream *BO* LD1600 (bottom) enter the *CO* at the Demux **IN** port. The channels are demultiplexed and the data on each channel emerges at the Demux **RX** ports. This data enters the Transponder **WDM RX** ports and emerges at the **ACCESS TX** port to enter the access equipment unit.

---

[16] The total number of transponder modules in all the BO LD1600s is at most 8.

BO to BO

Data coming from a *BO* LD1600 enters the OADM **IN** port. Data on channels not required at this LD1600 leaves the LD1600 at the OADM **OUT** port and enters the fiber connecting the downstream *BO* LD1600 (right). Data on channels required to be dropped enters the OADM Module **IN** port. The channels are demultiplexed and the data on these channels appear on the OADM **Drop** ports. From here they pass into the **WDM RX** port of the Transponders and emerge at the Transponder **ACCESS TX** port to enter the access equipment units.

Data coming from an access equipment unit enters the Transponder **ACCESS RX** port, emerges at the **WDM TX** port to enter the OADM **Add** port. From here, the data along with those from other channels (transponders) are multiplexed on the OADM **OUT** port, and placed on the fiber connecting the downstream LD1600.

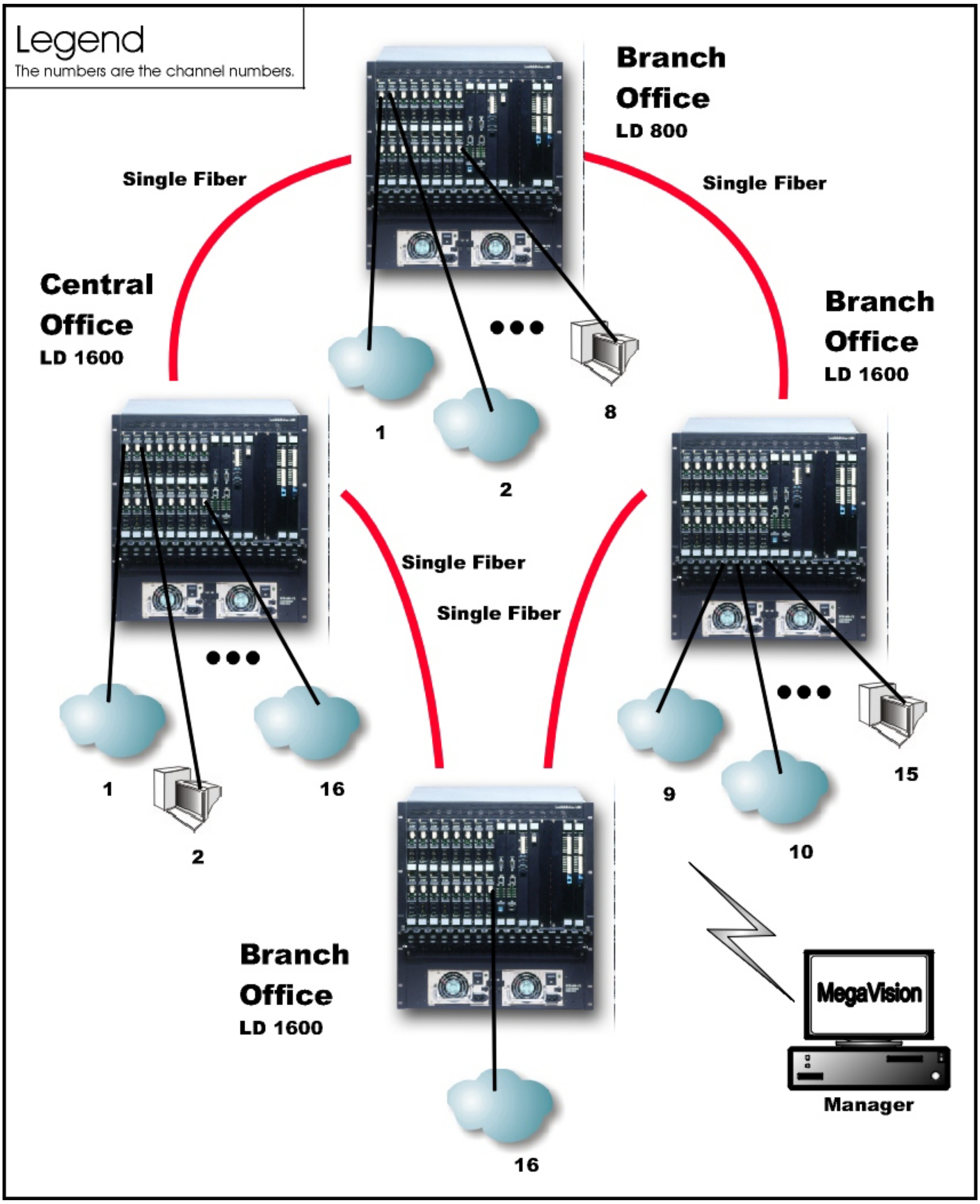


Figure 25: Central Office Ring with up to 16 Full-Duplex Channels

Star Network Topology

Scope

In the Star Network topology (example shown in *Figure 26*), although up to 16 channels can be created across the network using two single-fiber cables, a channel on one fiber can be used to either transmit or receive; not both. This means that two channels are required for transmission and reception between two access-equipment units (e.g., LANs, PCs, etc.). Accordingly, up to 32 access-equipment units can be interconnected with this network topology – two per channel. All channels run from the Branch Office (BO) LD1600s to the Central Office (CO) LD1600, i.e., no channels exist between the BOs.

Hardware

CO LD1600
Basic Contents: 2 Demux[17] Modules and up to 16 Transponder Modules1 to 8[18].
Options: 1 Management Module, 1 or 2 OA Modules.

Left BO LD1600
Basic Contents: 1 Demux Module and up to 8 Transponders 1 to 8.
Options: 1 Management Module, 1 or 2 OA Modules.
Right BO LD1600
Basic Contents: 1 Demux Module and up to 8 Transponders 9 to 16.
Options: 1 Management Module, 1 or 2 OA Modules.

Cabling

Inter-LD1600 Cabling

CO LD1600 to *Left* BO LD1600
As in *Figure 42*.

CO LD1600 to *Right* BO LD1600
As in *Figure 42*.

Intra-LD1600 Cabling

CO LD1600
Transponders **1** to **8** **WDM** ***TX*** ports to *Left* Demux ports **1** to **4**: As in *Figure 53*.
Transponders **1** to **8** **WDM** ***RX*** ports to *Left* Demux ports **9** to **16**[19]: As in *Figure 54*.
Transponders **9** to **16** **WDM** ***TX*** ports to *Right* Demux ports **9** to **16**: As in *Figure 53*.
Transponders **9** to **16** **WDM** ***RX*** ports to *Right* Demux ports **1** to **8**: As in *Figure 54*.

Left BO LD1600
Transponders **9** to **16** **WDM** ***TX*** ports to Demux ports **9** to **16**: As in *Figure 53*.
Transponders **9** to **16** **WDM** ***RX*** ports Demux ports **1** to **8**: As in *Figure 54*.
Right BO LD1600
Transponders **1** to **8** **WDM** ***TX*** ports to Demux ports **1** to **8**: As in *Figure 53*.
Transponders **1** to **8** **WDM** ***RX*** ports Demux ports **9** to **16**: As in *Figure 54*.

[17] Although a Mux Module could be used instead of a Demux Module, the Demux Module is preferable because it provides better channel separation.

[18] “Transponder Module 1” is used to denote a transponder that can transmit on channel 1.

[19] For Transponders **1** to **8**, mux ports 9 to 16 serve as demux ports 1 to 8 – see Rule 11.

Data Flow

CO LD1600

Transponders 1 to 8 *transmit*, on channels 1 to 8, receive data from the access equipment numbered 1 to 8 attached to the CO LD1600. These Transponders *receive*, on channels 9 to 16, data from the access equipment numbered 9 to 16 attached to the *left* BO LD1600.

Transponders 9 to 16 *transmit*, on channels 9 to 16, receive data from the access equipment numbered 9 to 16 attached to the CO LD1600. These Transponders *receive*, on channels 1 to 8, data from the access equipment numbered 1 to 8 attached to the *right* BO LD1600.

Left BO LD1600

Transponders 9 to 16 *transmit*, on channels 9 to 16, receive data from the access equipment numbered 9 to 16 attached to the *left* BO LD1600. These Transponders *receive*, on channels 1 to 8, data from the access equipment numbered 1 to 8 attached to the CO LD1600.

Right BO LD1600

Transponders 1 to 8 *transmit*, on channels 1 to 8, receive data from the access equipment numbered 1 to 8 attached to the *right* BO LD1600. These Transponders *receive*, on channels 9 to 16, data from the access equipment numbered 9 to 16 attached to the CO LD1600.

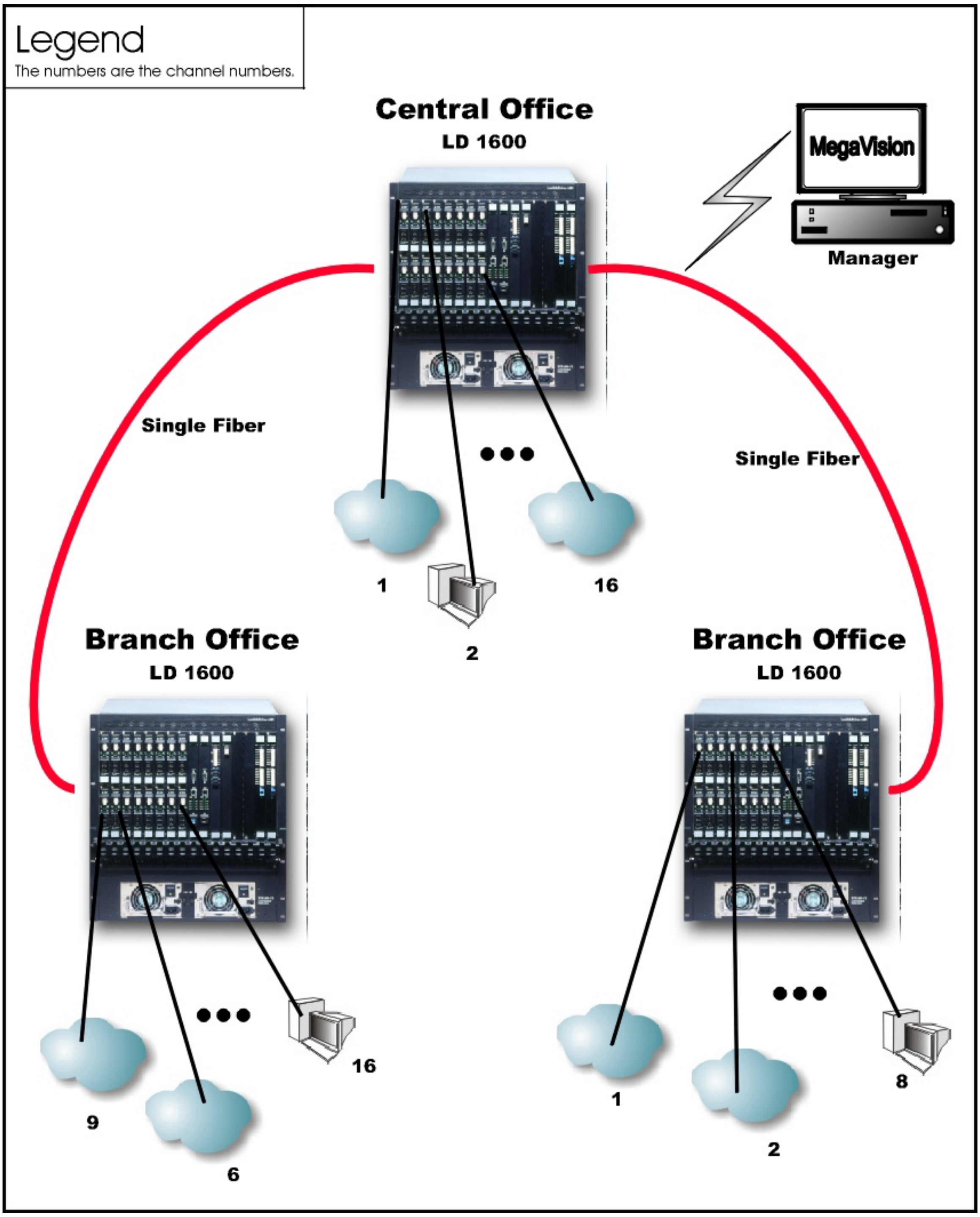


Figure 26: Star with up to 8 Full-Duplex Channels

Multipoint Network Topologies

Regular Multipoint

Scope

In Regular Multipoint topology (example shown in *Figure 27*), up to 16 full-duplex channels can be created across the network. This means that up to 32 access-equipment units (e.g., LANs, PCs, etc.) can be interconnected with this network topology – two per channel. Note that all channels run from the Branch Office (BO) LD1600s to the Central Office (CO) LD1600, i.e., no channels exist between the BOs.

Optimally, a Mux and a Demux module are installed at the CO while OADMs are installed at the BO LD1600s.

Hardware

Similar to Central Office Ring (Page *85*).

Cabling

Similar to Central Office Ring.

Data Flow

Similar to Central Office Ring.

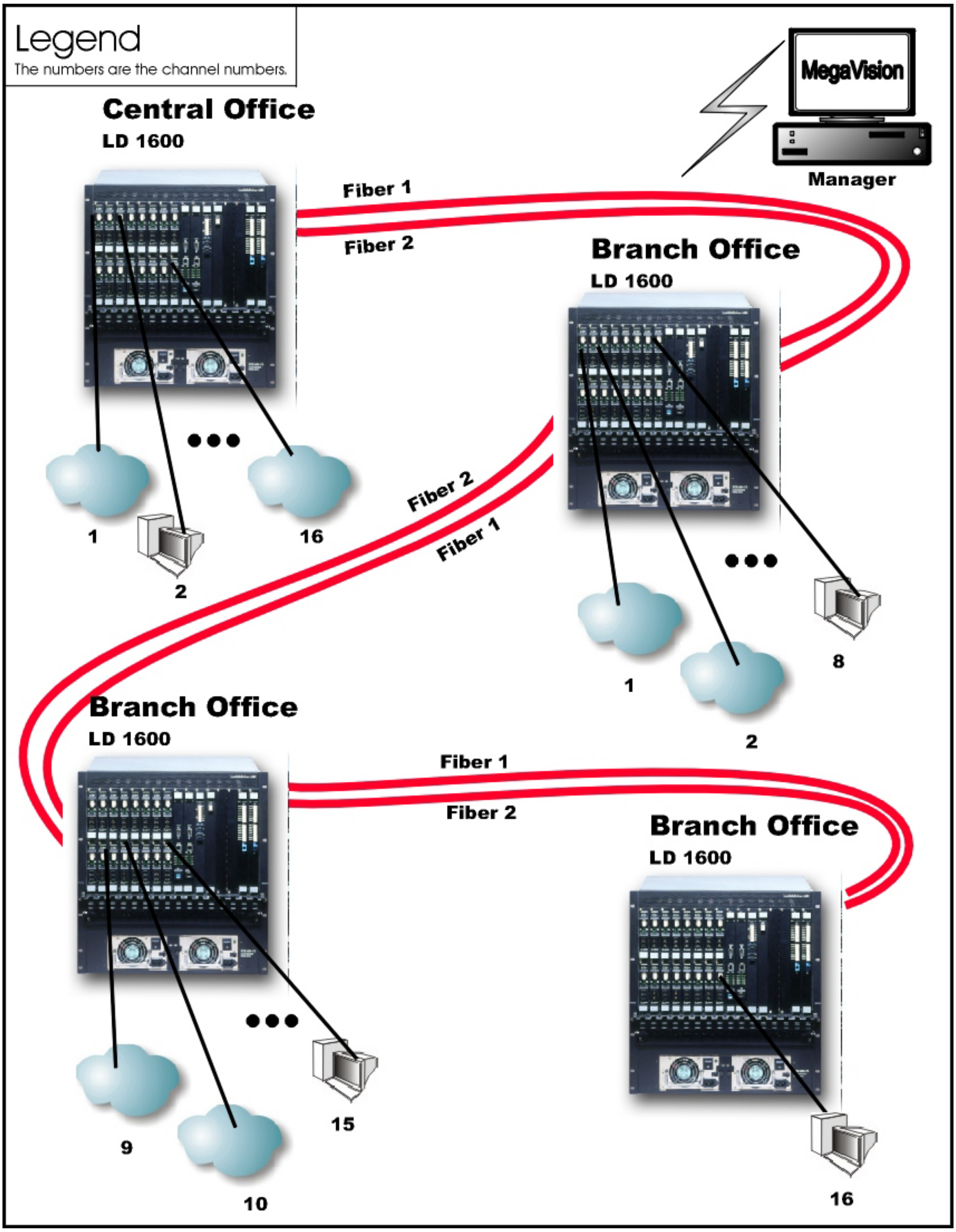


Figure 27: Multipoint with up to 16 Full-Duplex Channels

Repeated-Channel-Use Multipoint

In Repeated-Channel-Use Multipoint topology (example shown in *Figure 28*), 16 full-duplex channels can be created *per LD1600* by repeated use of one or more channels on differing fibers. This means that a virtually unlimited number of access-equipment units (e.g., LANs, PCs, etc.) can be interconnected with this network topology – two per channel. Note that channels 1 to 8 are used to interconnect 8 access-equipment units on the first LD1600 and 8 access-equipment units on the second LD1600. Channels 1 to 8 are again used to interconnect 8 access-equipment units on the second LD1600 and 8 access-equipment units on the third LD1600. Channels 1 to 8 are used yet again to interconnect 8 access-equipment units on the third LD1600 and 8 access-equipment units on the fourth LD1600. Channels 1 to 8 on one pair of fibers between two LD1600s are independent of channels 1 to 8 on another pair of fibers. Thus, for e.g., the two access-equipment units interconnected by Channel 1 between the first and second LD1600 are not connected to the two access-equipment units interconnected by Channel 1 between the second and third LD1600.

Note that in the second (right top) LD1600, the transponders in slots 1-8 are the same as the transponders in slots 9-16.

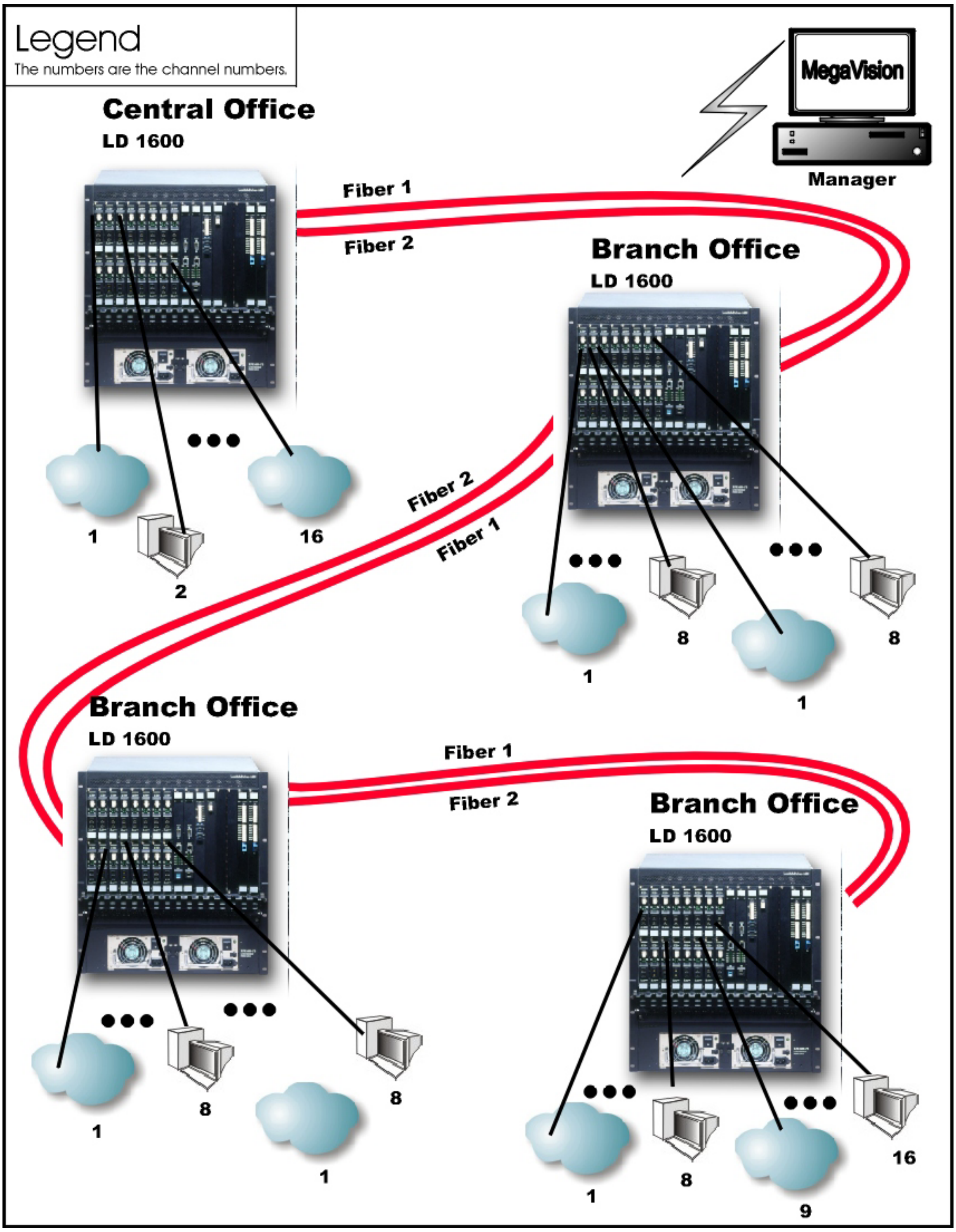


Figure 28: Repeated Channel Use Multipoint with up to 16 Full-Duplex Channels

ESCON

Outband Topologies

Point-to-Point

Scope

In the Outband Point-to-Point topology, up to 16 links, i.e., 64 ESCON channels can be supported by the topology. A link consists of a fiberoptic cable terminated by two ESCON Multiplexer modules, one at each end, and can carry up to four ESCON channels. The maximum operating ranges are shown in *Table 3*.

Table 3: *Outband* Operating Ranges for ESCON Multiplexer

Link	Range (Max)	Cable Type	Wavelength
ESCON Equipment to ESCON Multiplexer	2 km (1.24 mi)	Multimode	1310 nm
ESCON Multiplexer to ESCON Multiplexer (LD1600 to LD1600)	60 km (37.3 mi)	Singlemode	1470 to 1610 nm
	80 km (49.7 mi)	Singlemode	1470 to 1610 nm

Hardware

Left LD1600

Basic Contents: Up to 16 ESCON Multiplexer modules.

Options: 1 Management Module, 1 or 2 OA Modules.

Right LD1600

Basic Contents: Same as for left LD1600.

Options: Same as for left LD1600.

Cabling

Inter-LD1600 Cabling

For each pair of ESCON Multiplexer modules, one in the left LD1600 and the other in the right LD1600, occupying slots of the same number, interconnect the mux/demux ports (**TX** and **RX**, unnumbered) of one module to the mux/demux ports of the other module with a fiberoptic cable.

Intra-LD1600 Cabling

None.

LD1600 to RS-232/Ethernet Cabling

LD1600-to-RS-232: As shown in *Figure 76*.

LD1600-to-Ethernet: As shown in *Figure 77*.

Data Flow

Left LD1600

Data on ESCON channels to each ESCON Multiplexer module are multiplexed and sent to the right LD1600 where they are demultiplexed to continue on their respective channels.

Right LD1600

Same as for left LD1600.

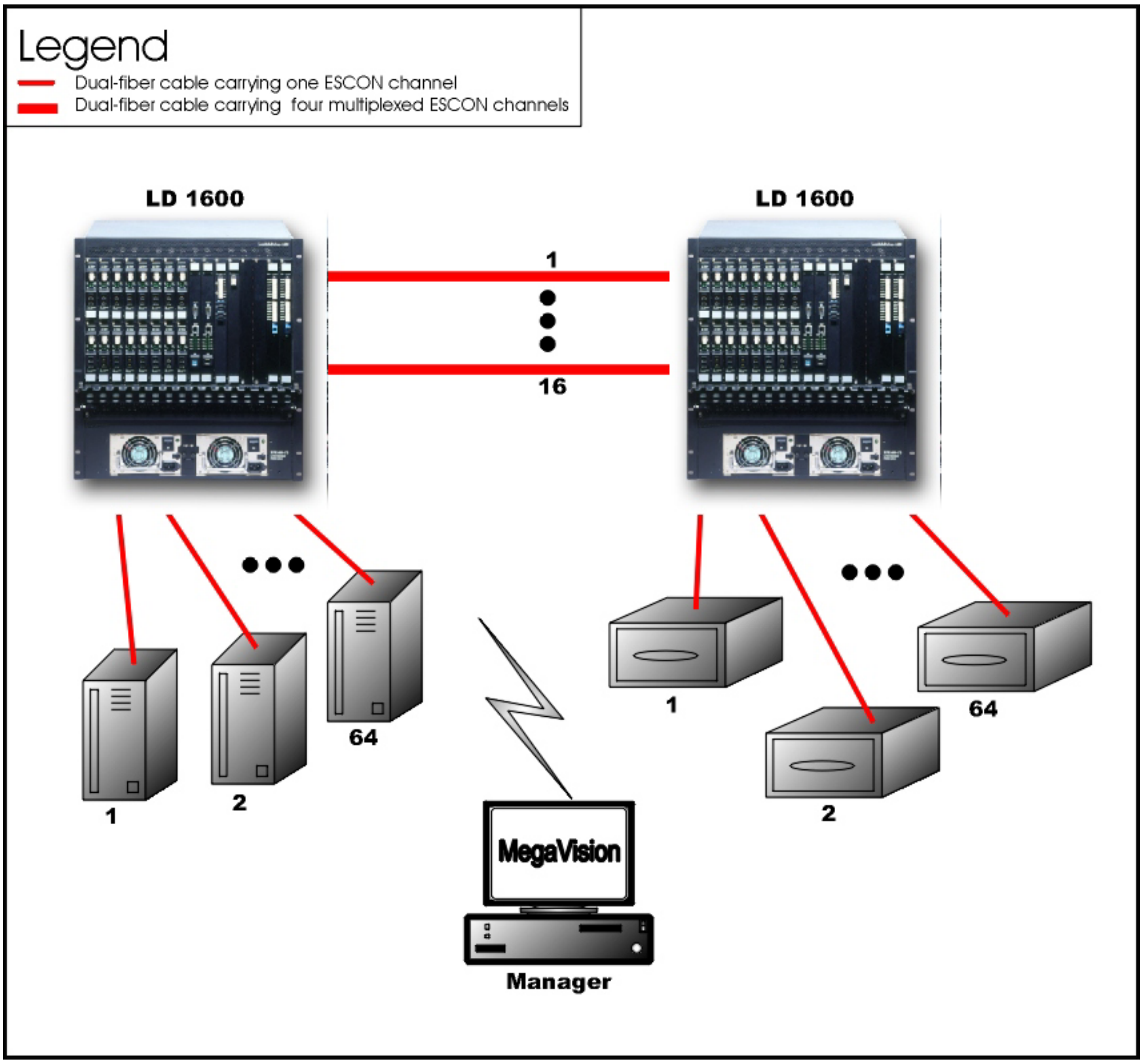


Figure 29: ESCON Outband Point-to-Point Topology

Star

Scope

In the Outband Star topology, up to 16 links, i.e., 64 ESCON channels can be supported by the topology. A link consists of a fiberoptic cable terminated by two ESCON Multiplexer modules, one at each end, and can carry up to four ESCON channels. All channels run from the Branch Office (BO) LD1600s to the Central Office (CO) LD1600s, i.e., no channels exist between the BOs. The maximum operating range between two LD1600s is the same as for the Point-to-Point configuration – see *Table 3*.

Hardware

CO LD1600

Basic Contents: Up to 16 ESCON Multiplexer modules.

Options: 1 Management Module, 1 or 2 OA Modules.

Left BO LD1600

Basic Contents: Up to 16 ESCON Multiplexer modules.

Options: Same as for CO LD1600.

Right BO LD1600

Basic Contents: Up to the difference between the number of ESCON Multiplexer modules in the CO LD1600 and the Left BO LD1600.

Options: Same as for CO LD1600.

Cabling

Inter-LD1600 Cabling

For each pair of ESCON Multiplexer modules, one in the CO LD1600 and the other in *a* BO LD1600, occupying slots of the same number, interconnect the mux/demux ports (**TX** and **RX**, unnumbered) of one module to the mux/demux ports of the other module with a fiberoptic cable.

Intra-LD1600 Cabling

None.

LD1600 to RS-232/Ethernet Cabling

LD1600-to-RS-232: As shown in *Figure 76*.

LD1600-to-Ethernet: As shown in *Figure 77*.

Data Flow

CO LD1600

Data on ESCON channels to each ESCON Multiplexer module are multiplexed and sent to the BO LD1600s where they are demultiplexed to continue on their respective channels.

Left BO LD1600

Data on ESCON channels to each ESCON Multiplexer module are multiplexed and sent to the CO LD1600 where they are demultiplexed to continue on their respective channels.

Right BO LD1600

Same as for the Left BO LD1600.

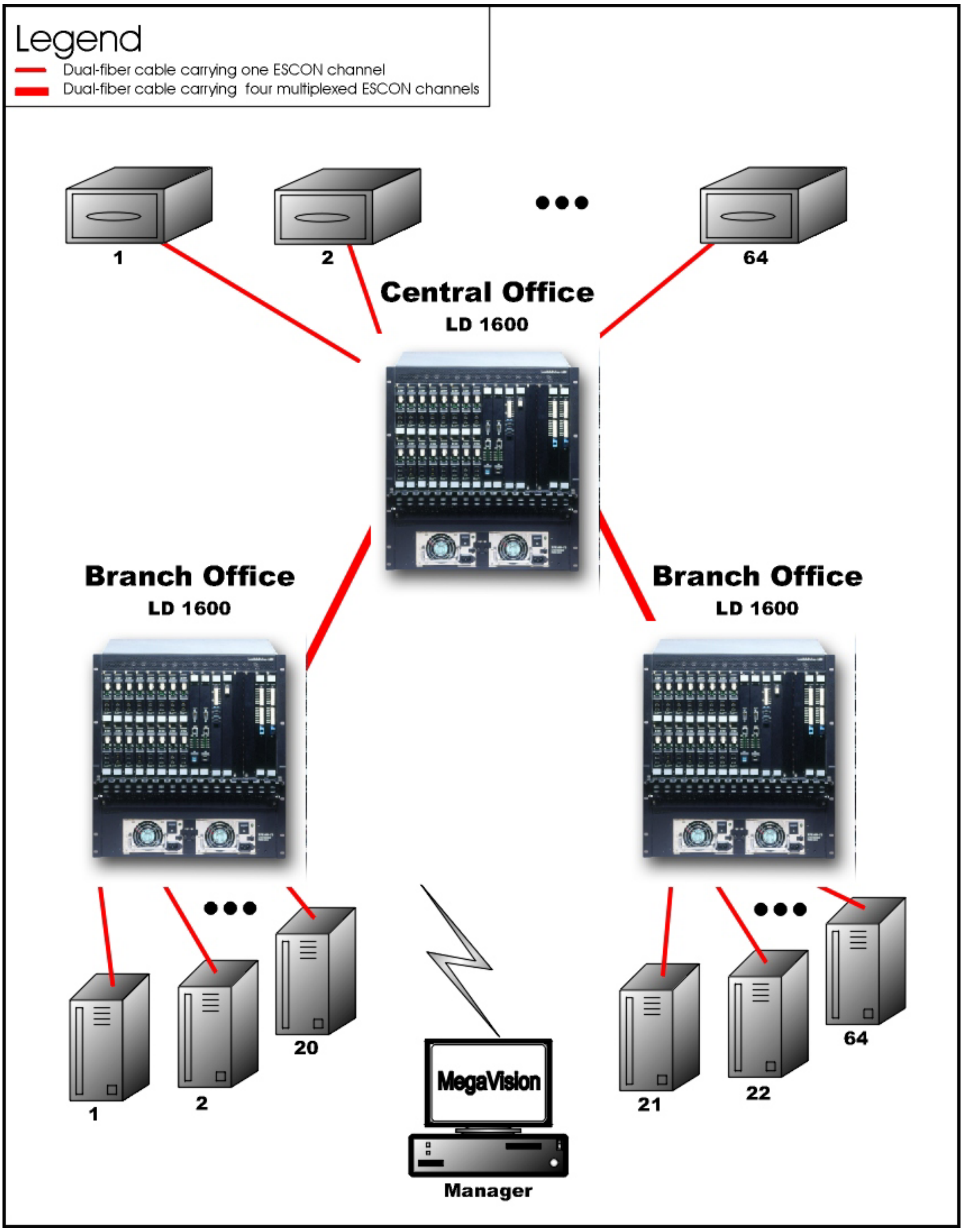


Figure 30: ESCON Outband Star Topology

Inband Topologies

<u>Medium Range Point-to-Point</u>

Scope

In the Inband Medium Range Point-to-Point Topology, which uses CWDM, (example shown in *Figure* 31), up to 16[20] channels can be created across the network. This means that up to 64

[20] Using fiberoptic cables which have no "water peak," up to 16 channels are possible even with CWDM.

ESCON lines can be interconnected with this network topology – four per channel. The maximum operating ranges are shown in *Table 4*.

Table 4: Inband *Medium* Operating Ranges for ESCON Multiplexer

Link	Range (Max)	Cable Type	Wavelength
ESCON Equipment to ESCON Multiplexer	2 km (6500 ft)	Multimode	1310 nm
LD1600 to LD1600	65 km (40.4 mi)	Singlemode	1550 nm

Hardware

Left LD1600

Basic Contents: 1 Mux Module, 1 Demux Module, up to 16 ESCON Multiplexer Modules.

Options: 1 Management Module, 1 Service Module, 1 or 2 OA Modules.

Right LD1600

Same as for left LD1600.

Cabling

Inter-LD1600 Cabling

With Service Modules: As in *Figure 51*.

Without Service Modules: As in *Figure 41*.

Intra-LD1600 Cabling

Left LD1600

With Service and Management Modules:

ESCON-to-Mux: As in *Figure 61*.

Demux-to-ESCON: As in *Figure 62*.

Mux-to-Service: As in *Figure 56*.

Service-to-Demux: As in *Figure 56*.

Management-to-Service: As in *Figure 58*.

Without Service Module:

Simply skip connections for the Service module described just above. This means that the **OUT** ports of the Muxes are directly connected to the **IN** ports of the Demuxes, as shown in *Figure 41*.

Without Management Module:

Simply skip connections for the Management Module.

Right LD1600

Same as for left LD1600.

LD1600 to RS-232/Ethernet Cabling

LD1600-to-RS-232: As shown in *Figure 76*.

LD1600-to-Ethernet: As shown in *Figure 77*.

Data Flow

Left LD1600

ESCON Multiplexer modules 1 to 16 *transmit* on channels 1 to 16 on one fiber and *receive* on channels 1 to 16 on the other fiber.

Right LD1600

Same as for left LD1600.

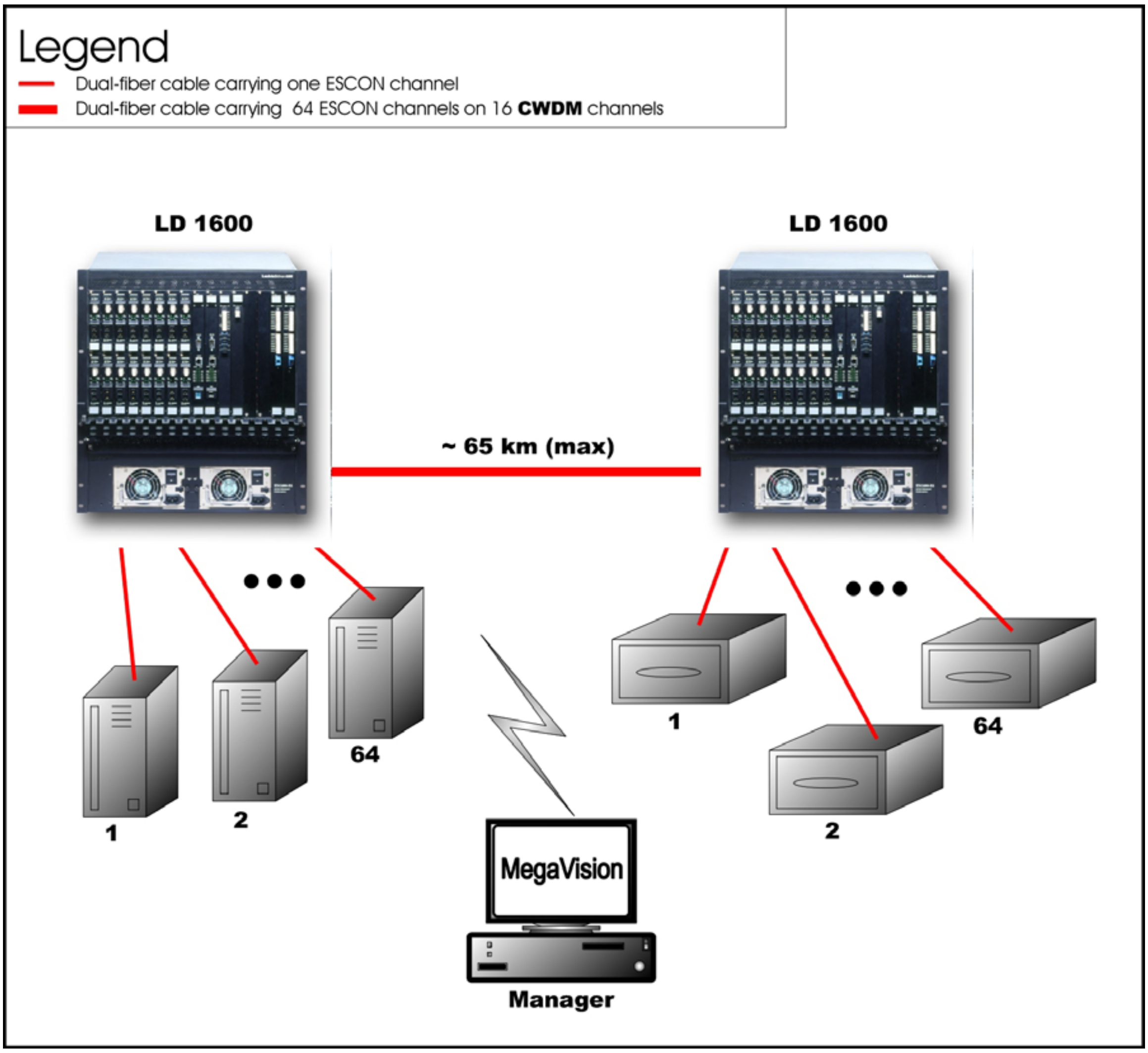


Figure 31: ESCON Inband Medium Range Point-to-Point Topology

<u>Long Range Point-to-Point</u>

Scope

In the Inband Long Range Point-to-Point Topology, which uses DWDM, (example shown in *Figure* 32), up to 16[21] channels can be created across the network. This means that up to 64 ESCON lines can be interconnected with this network topology – four per channel. The maximum operating range is up to 100 km or 62.1 mi.

Four LD1600s in point-to-point topology may be used instead of two as shown in *Figure* 32. In such a case, up to 32 ESCON lines can be interconnected. In *each* LD1600, a Transponder module is required for each ESCON Multiplexer Module, and one Mux and one Demux module.

Table 5: Inband *Long* Operating Ranges for ESCON Multiplexer

Link	Range (Max)	Cable Type	Wavelength
ESCON Equipment to ESCON Multiplexer	2 km (6500 ft)	Multimode	1310 nm
LD1600 to LD1600	100 km (62.1 mi)	Singlemode	1550 nm

[21] Using fiberoptic cables which have no “water peak,” up to 16 channels are possible even with CWDM.

Hardware

Left LD1600s

Basic Contents of LD1600 **A**: Up to 16 ESCON Multiplexer Modules.

Basic Contents of LD1600 **B**: 1 Mux Module, 1 Demux Module, 1 Transponder Module per ESCON Multiplexer Module.

Options for LD1600 **B**: 1 Management Module, 1 Service Module, 1 or 2 OA Modules.

Right LD1600s

Same as for left LD1600s.

Cabling

LD1600 (B) to LD1600 (B) Cabling

With Service Modules: As in *Figure 51*.

Without Service Modules: As in *Figure 41*.

LD1600 (A) to LD1600 (B) Cabling

ESCON-to-Transponder: With the aid of *Figure* 60*, i*nterconnect the ESCON Multiplexer modules in LD1600 (**A**) and the Transponder modules in LD1600 (**B**), making sure that modules in slots of the same number are interconnected.

Intra-LD1600 Cabling

LD1600 (A): None.

LD1600 (B):

With Service and Management Modules:

Transponder-to-Mux: As in *Figure 53*.

Demux-to-Transponder: As in *Figure 54.*

Mux-to-Service: As in *Figure 56*.

Service-to-Demux: As in *Figure 56*.

Management-to-Service: As in *Figure 58*.

Without Service Module:

Simply skip connections for the Service module described just above. This means that the **OUT** ports of the Muxes are directly connected to the **IN** ports of the Demuxes, as shown in *Figure 41*.

Without Management Module:

Simply skip connections for the Management Module.

LD1600 to RS-232/Ethernet Cabling

LD1600-to-RS-232: As shown in *Figure 76*.

LD1600-to-Ethernet: As shown in *Figure 77*.

Data Flow

Left LD1600s

ESCON Multiplexer modules 1 to 16 transmit to Transponder modules 1 to 16. The Transponder modules send the data to the Mux Module which multiplexes the data and drives it on the fiber connected to its OUT port towards the remote LD1600 (B).

The data received at the remote LD1600 (B) enters the IN port of the Demux Module which demultiplexes the data to the transponder modules. The transponder modules drive the data to the ESCON Multiplexer modules, which send the data to the ESCON lines.

Right LD1600s

Same as for left LD1600s.

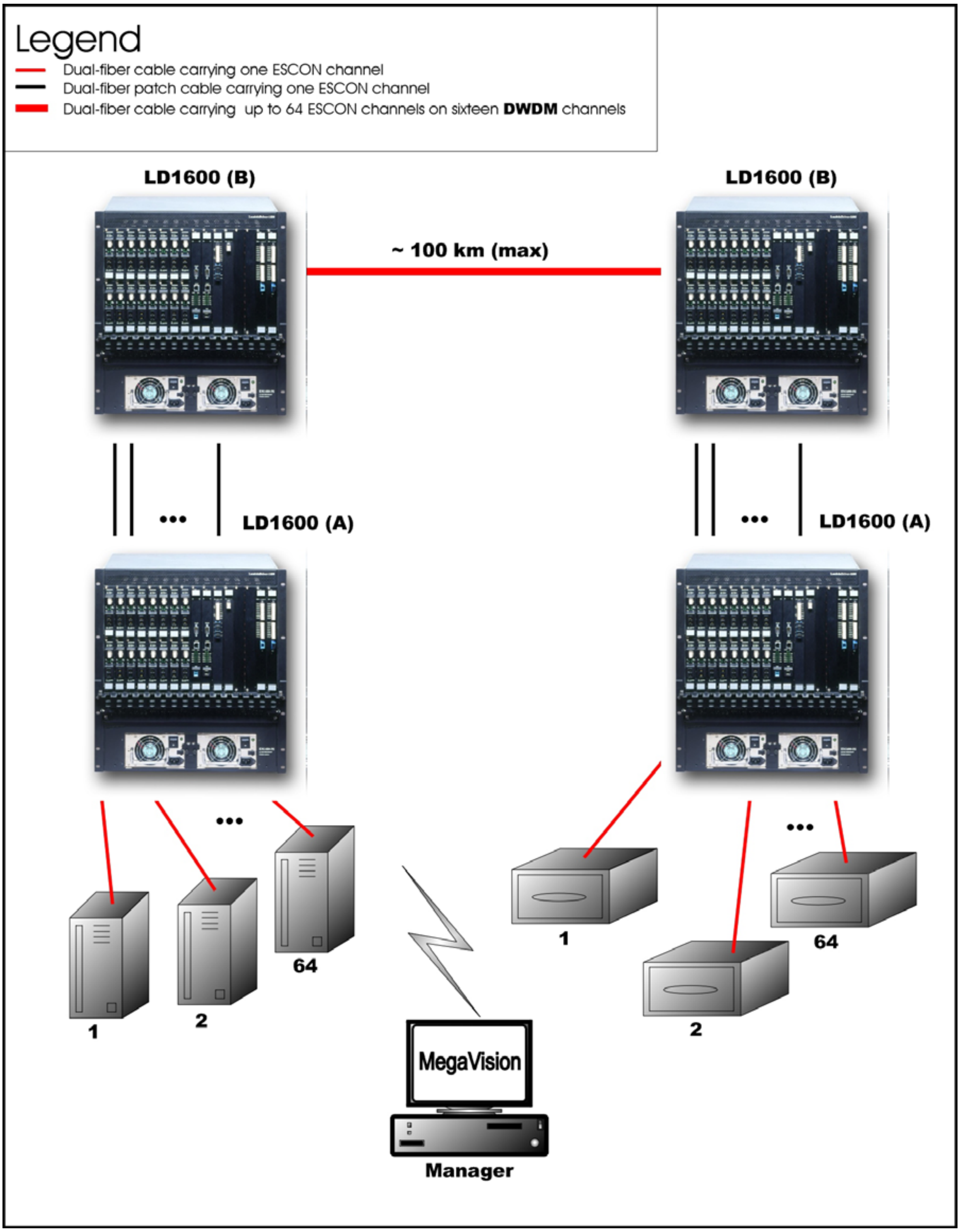


Figure 32: ESCON Inband Long-Range Point-to-Point Topology

GM2

Outband Topologies

Point-to-Point

Scope

In the Outband Point-to-Point topology, up to 16 links, i.e., 32 Gigabit Ethernet lines, can be carried by the topology. A link consists of a fiberoptic cable terminated by two GM2 modules, one at each end, and can carry up to two Gigabit Ethernet lines. The maximum operating range depends on the access side transceiver (SFP) and trunk side transceiver (SFP or fixed). For the fixed transceiver (DWDM), the operating range is 100 km (62.1 mi).

Hardware

Left LD1600

Basic Contents: Up to 16 GM2 modules.

Options: 1 Management Module, 1 or 2 OA Modules.

Right LD1600

Basic Contents: Same as for left LD1600.

Options: Same as for left LD1600.

Cabling

Inter-LD1600 Cabling

For each pair of GM2s, one in the left LD1600 and the other in the right LD1600, occupying slots of the same number, interconnect the trunk ports (**TRUNK TX** and **TRUNK RX**) of one GM2 to the trunk ports (**TRUNK RX** and **TRUNK TX**) of the other GM2 with a fiberoptic cable.

Intra-LD1600 Cabling

None.

LD1600 to RS-232/Ethernet Cabling

LD1600-to-RS-232: As shown in Figure 76.

LD1600-to-Ethernet: As shown in Figure 77.

Data Flow

Left LD1600

Data on Gigabit Ethernet channels to a GM2 in the left LD1600 are multiplexed and sent to the GM2 at the other end of the link in the right LD1600 where they are demultiplexed to continue on their respective channels.

Right LD1600

Same as for left LD1600 but in the opposite direction.

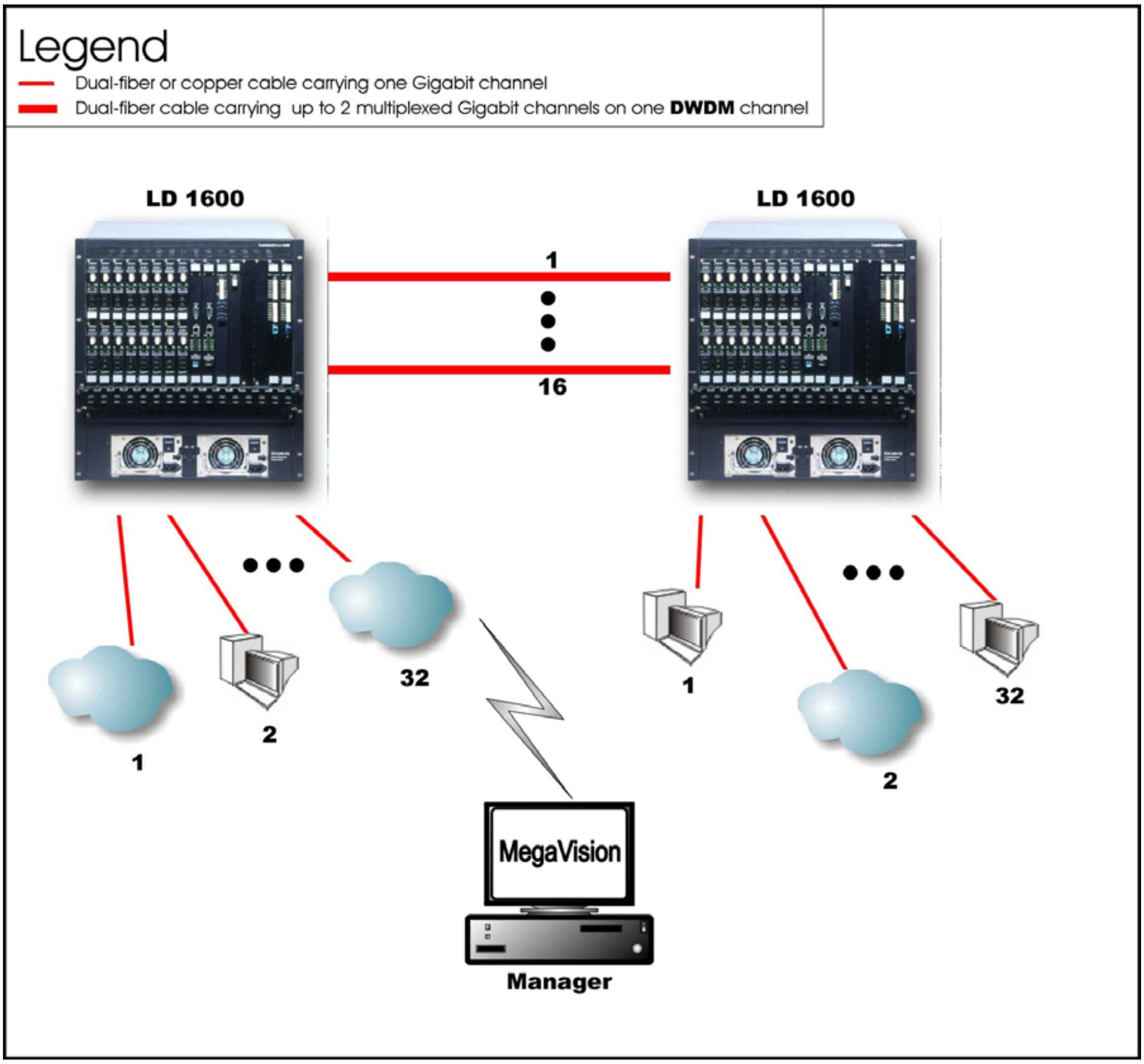


Figure 33: GM2 Outband Point-to-Point Topology

<u>Star</u>

Scope

In the Outband Star topology, up to 16 links, i.e., 32 Gigabit Ethernet lines can be carried by the topology. A link consists of a fiberoptic cable terminated by two GM2s, one at each end, and can carry up to two Gigabit Ethernet lines. All channels run from the Branch Office (BO) LD1600s to the Central Office (CO) LD1600s, i.e., no channels exist between the BOs. The maximum operating range depends on the access side transceiver (SFP) and trunk side transceiver (SFP or fixed). For the fixed transceiver (DWDM), the operating range is 100 km (62.1 mi).

Hardware

CO LD1600

Basic Contents: Up to 16 GM2 modules.

Options: 1 Management Module, 1 or 2 OA Modules.

Left BO LD1600

Basic Contents: Up to 16 GM2 modules.

Options: Same as for CO LD1600.

Right BO LD1600

Basic Contents: Up to the difference between the number of GM2 modules in the CO LD1600 and the Left BO LD1600.

Options: Same as for CO LD1600.

Cabling

Inter-LD1600 Cabling

For each pair of GM2 modules, one in the CO LD1600 and the other in *a* BO LD1600, occupying slots of the same number, interconnect the trunk ports (**TRUNK TX** and **TRUNK RX**) of one GM2 module to the trunk ports (**TRUNK RX** and **TRUNK TX**) of the other module with a fiberoptic cable.

Intra-LD1600 Cabling

None.

LD1600 to RS-232/Ethernet Cabling

LD1600-to-RS-232: As shown in Figure 76.

LD1600-to-Ethernet: As shown in Figure 77.

Data Flow

CO LD1600

Data on Gigabit Ethernet channels to a GM2 module are multiplexed and sent to the GM2 at the other end of the link in a BO LD1600 where they are demultiplexed to continue on their respective channels.

Left BO LD1600

Data on Gigabit Ethernet channels to a GM2 module are multiplexed and sent to the GM2 at the other end of the link in the CO LD1600 where they are demultiplexed to continue on their respective channels.

Right BO LD1600

Same as for the Left BO LD1600.

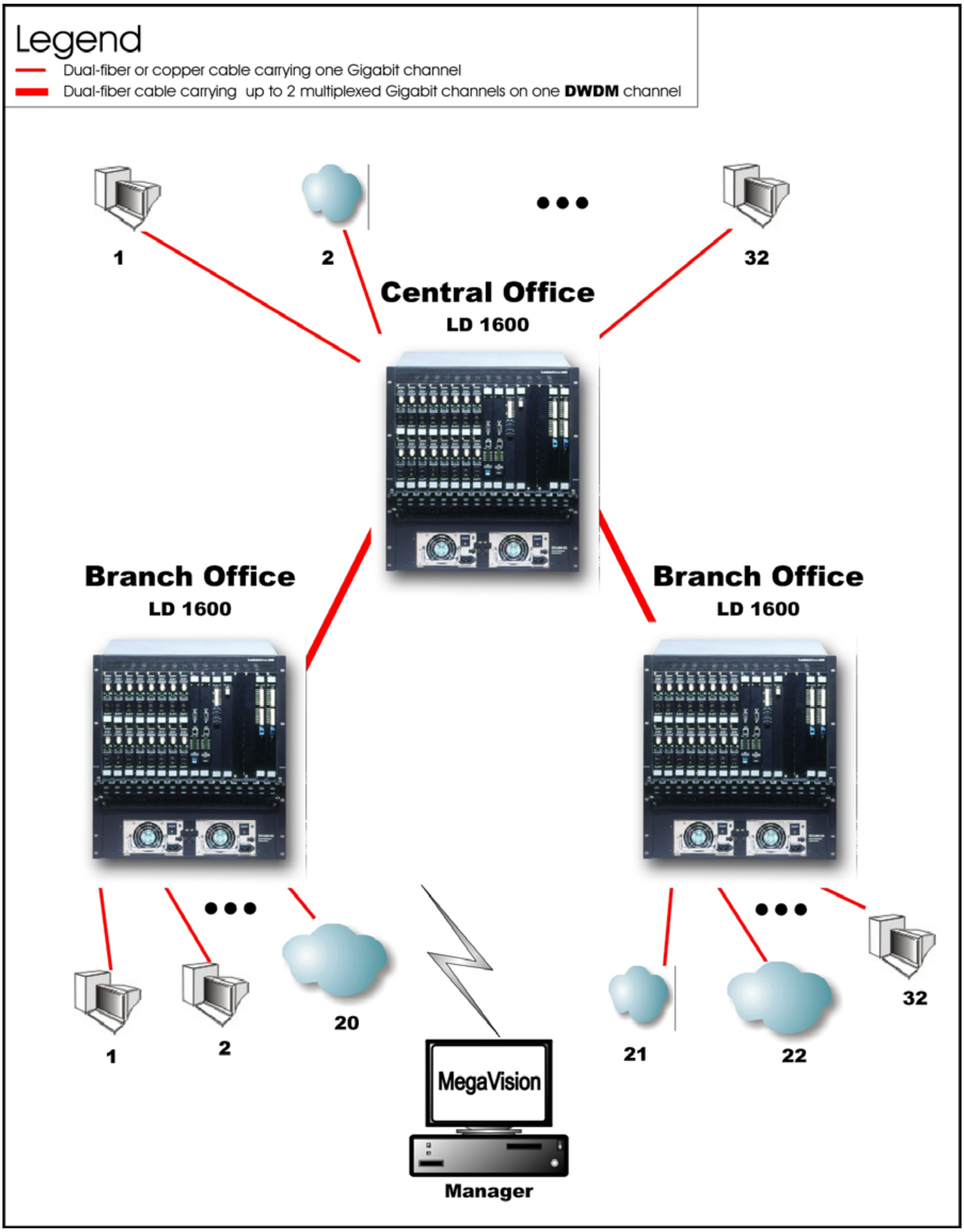


Figure 34: GM2 Outband Star Topology

Inband Topology

Scope

In the Inband Medium Range Point-to-Point Topology, which uses CWDM or DWDM technology, (example shown in *Figure 35*), up to 16[22] WDM channels can be created, each carrying two Gigabit Ethernet lines. This means that up to 32 Gigabit Ethernet lines can be carried across this network topology. The maximum operating range depends on the access side transceiver (SFP)

[22] Using fiberoptic cables which have no "water peak," up to 16 channels are possible even with CWDM.

and trunk side transceiver (SFP or fixed). For the fixed transceiver (DWDM), the operating range is 100 km (62.1 mi).

Hardware

Left LD1600

Basic Contents: 1 Mux Module, 1 Demux Module, up to 16 GM2 Multiplexer Modules.

Options: 1 Management Module, 1 Service Module, 1 or 2 OA Modules.

Right LD1600

Same as for left LD1600.

Cabling

Inter-LD1600 Cabling

With Service Modules: As in *Figure 51*.

Without Service Modules: As in *Figure 41*.

Intra-LD1600 Cabling

Left LD1600

With Service and Management Modules:

GM2-to-Mux: As in *Figure 73*.

Demux-to-GM2: As in *Figure 74*.

Mux-to-Service: As in *Figure 56*.

Service-to-Demux: As in *Figure 56*.

Management-to-Service: As in *Figure 58*.

Without Service Module:

Simply skip connections for the Service module described just above. This means that the **OUT** ports of the Muxes are directly connected to the **IN** ports of the Demuxes, as shown in *Figure 41*.

Without Management Module:

Simply skip connections for the Management Module.

Right LD1600

Same as for left LD1600.

LD1600 to RS-232/Ethernet Cabling

LD1600-to-RS-232: As shown in *Figure 76*.

LD1600-to-Ethernet: As shown in *Figure 77*.

Data Flow

Left LD1600

GM2 Multiplexer modules 1 to 16 *transmit* on channels 1 to 16 on one fiber and *receive* on channels 1 to 16 on the other fiber.

Right LD1600

Same as for left LD1600.

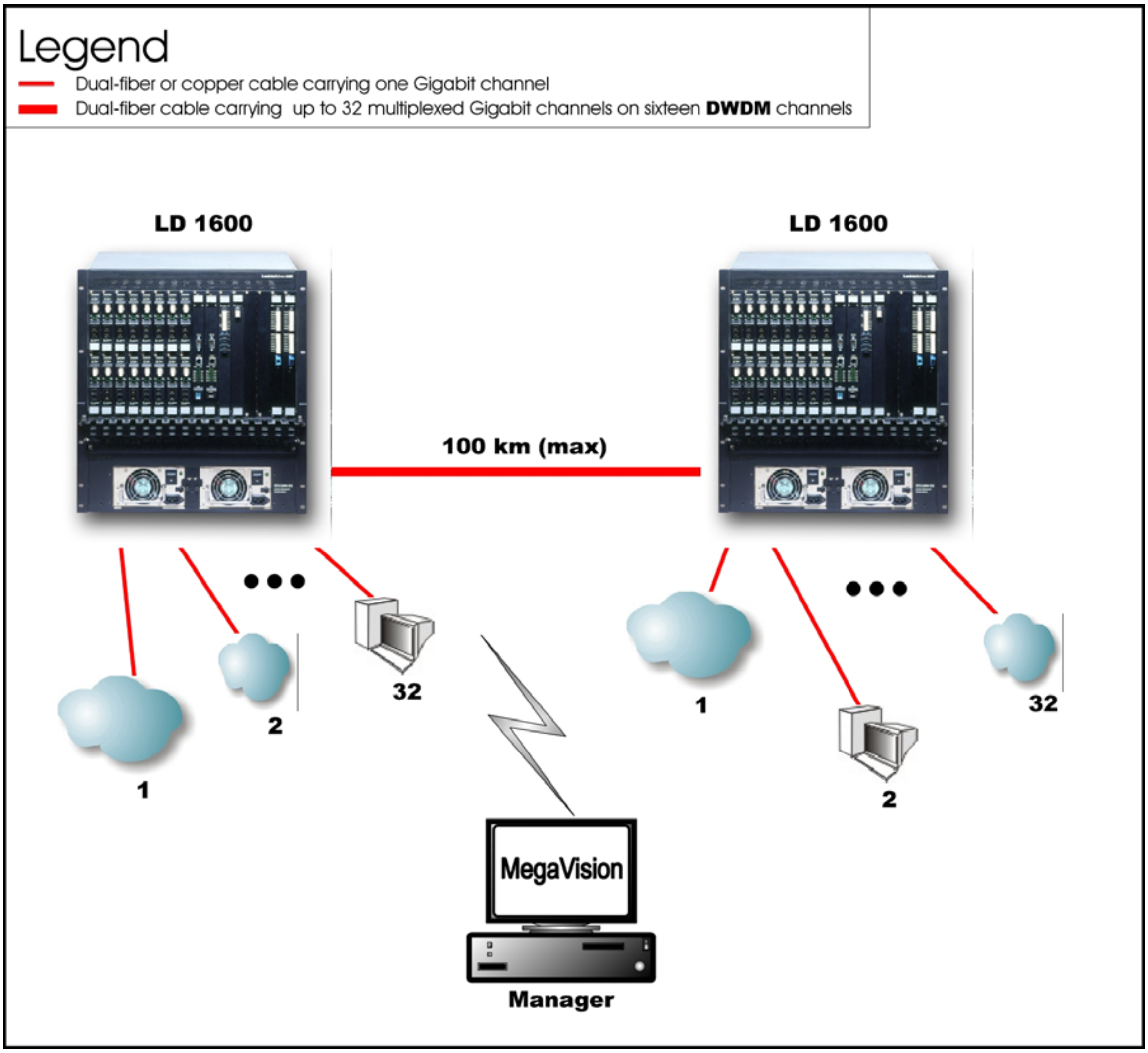


Figure 35: GM2 Inband Point-to-Point Topology

Rules for Network Topologies

Following is a set of rules to be applied when planning a network topology:

1. At least two LD1600s are required to create1 to 16 channels.
2. In a network topology, only two access-equipment units (e.g., LANs, PCs) can be interconnected per channel. Two access-equipment units on the same channel can communicate between each other only – they are isolated from the other access-equipment units.
3. To create a channel two transponders (or GM2 modules or ESCON modules) are required, one per LD1600.
4. Only one transponder (or GM2 module or ESCON module) is required to connect one access-equipment unit.
5. Transponder RX ports can receive on *any* channel.
6. Transponder TX ports can transmit only on a *specific* channel.
7. Muxes and Demuxes can be used in all network topologies *except* in *ring* network topologies. OADMs can be used in all network topologies. OADMs must be used instead of Muxes and Demuxes in ring network topologies.
8. Transponder, GM2, and ESCON modules can be plugged in Slots 1 to 16 in any order. However, for convenience, it is advisable to allocate the slots in some fixed order, for e.g., in the following left-to-right order: Transponders; GM2s; ESCONs (in ascending order of channel number/wavelength).
9. The two transponders of a TM2-SFP (dual transponder module) can be set to operate independently of each other or in mutual redundancy mode.
10. A DWDM transponder can be interfaced with a CWDM or DWDM multiplexer, demultiplexer, or OADM.

⚠	**Caution!** 11. The overload on the receiver of any transponder must NOT exceed -2 dBm otherwise the receiver will burn out!

12. To manage the LD1600, an Mgt (management) module must be installed in Slot 17.
13. Mux, Demux, OADM, 1+1, Service, and OA Modules must be plugged only in slots 19 to 24. For convenience, it is advisable to arrange them in some fixed order, for e.g., in the following left-to-right order: Mux; Demux; OADM; 1+1, Service, OA.
14. A transmitter port (TX/OUT) must be connected to a receiver port (RX/IN) and vice versa. In the single-fiber point-to-point topology (*Figure 23*) and star topology (*Figure 26*), this rule applies only to data flowing from a data source/terminal until it reaches the Demux's **OUT** port.
15. A mux/demux *trunk* port (OUT/IN) can receive and transmit on *any* channel.
16. A mux/demux *channel* port (TX/RX) can receive and transmit only on a *specific* channel.
17. <u>Access Cable Fiber Length</u>
    The maximum allowed length of fiber interconnecting an LD1600 and an access unit is calculated as follows:

    S = P / A

    where,

    S = Maximum allowed length

    P = [***Transmitter Power – Receiver Sensitivity***] dB. It is the power budget available between the LD1600 module and access unit.

    For the fiber connecting the Access TX port of the *local* module to the RX port of the *local* access unit:

    Transmitter Power is the output power of the Access TX port of the *local* module.

Receiver Sensitivity is that of the RX port of the *local* access unit.

For the fiber connecting the Access RX port of the *local* module to the TX port of the *local* access unit:

Transmitter Power is the output power of the TX port of the *local* access unit.

Receiver Sensitivity is that of the Access RX port of the *local* module.

The *cable* length is the smaller of the fiber lengths for the Access TX Port and Access RX Port.

A is the fiber attenuation/length (usually 0.25dB/km).

18. WDM Cable Fiber Length

The maximum allowed length of fiber[23] interconnecting two LD1600s is calculated as follows:

M = (P - L) / A

where,

M is the maximum allowed length

P is the LD1600 power budget = [***Transmitter Power – Receiver Sensitivity***] dB.

Transmitter Power and Receiver Sensitivity apply to Transponders, ESCONs, GM2s, and OAs. They are specified in Chapter 1 Overview, in the respective product specification section for each module.

For the fiber connecting the WDM TX port of the *local* module to the WDM RX port of the *remote* module:

Transmitter Power is the output power of the WDM TX port of the *local* module to which the access equipment is connected.

Receiver Sensitivity is that of the WDM RX port of the *remote* module to which the access equipment is connected.

For the fiber connecting the WDM TX port of the *remote* module to the WDM RX port of the *local* module:

Transmitter Power is the output power of the WDM TX port of the *remote* module to which the access equipment is connected.

Receiver Sensitivity is that of the WDM RX port of the *local* module to which the access equipment is connected.

The *cable* length is the smaller of the fiber lengths for the WDM TX Port and WDM RX Port.

L is the total power loss. This includes losses due to interposing modules, splices, etc., 2 dB transmission dispersion penalty for transponder-to-Mux/Demux module connection, plus a safety margin of 3 dB. The loss for each module is given in the product specification for the module. If a module has no loss, the loss is not specified.

Power loss applies to the modules Mux, Demux, OADM, Mgt, 1+1, and Service. It is specified in Chapter 1 Overview, in the respective product specification section for each module.

A is the fiber attenuation/length (usually 0.25dB/km).

For greater cabling lengths, an OA module (described in *OA Module*) has to be inserted:

– in the LD1600 to serve as a booster or pre-amplifier, or

– into the fiberoptic cabling interconnecting two LD1600s to serve as an in-line amplifier.

[23] There *are* fibers for interconnecting two LD1600s which may have lengths of as much as 90 km (56 mi) before it becomes necessary to insert an OA.

(A second OA module *increases* the operating distance by twice as much.)

19. OA modules operate in DWDM mode only.
20. For interconnecting modules *within* an LD1600 as well as *between* LD1600s, use only singlemode 9/125 μm fiberoptic cabling.
21. If two OADMs are present in an LD1600 for multiple channel Adds/Drops, the **OUT** port of either OADM must be connected to the **IN** port of the other OADM. (The remaining **IN** port is connected to the next upstream LD1600 and the remaining **OUT** port is connected to the next downstream LD1600.)
22. LD1600 In dual-fiber applications, to allow four transponders to be installed in an LD1600 an OADM must be used instead of 1 Mux and 1 Demux module. In single-fiber applications, a Demux module can be used instead.
23. If Y-cables[24] are used: For each pair of mutually redundant transponders, allocate a pair of adjacent slots, so that the odd-number slot has the smaller number.
    Valid slot pairs are: 1,2 and 3,4 and 5,6 and 7,8 and 9,10 because in each case the odd number is smaller.
    Invalid slot pairs are: 2,3 and 4,5 and 6,7 and 8,9 and 10,11 because in each case the odd number is larger.
24. A transponder configured to operate in redundancy mode and installed in an *odd*-number slot will be set by the LD1600 as the *Primary* transponder of the pair. A transponder configured to operate in redundancy mode and installed in an *even*-number slot will be set by the LD1600 as the *Secondary* transponder of the pair.

[24] Examples of network topologies using the Y-cable are shown in Appendix I.

Chapter 3
Installation

General

This chapter describes the requirements and detailed step-by-step procedure for installing the LD1600 and its components (modules and chassis).

Safety

Before installing the LD1600, ensure that the safety requirements noted in the chapter Safety Requirements are met.

Package Contents

Essentials

1. Chassis (as many as ordered by the customer)
2. Mux[25] module (1 per chassis) and Demux Module[26] (1 per chassis)
   or
   OADM modules (up to two per chassis – as many as ordered by the customer)
3. Transponder modules (1 to 16 per chassis – as many as ordered by the customer)
   (A transponder module is essential in all cases except if only ESCON and GM2 modules are to be used to operate in outband mode or medium-range inband mode. Details are given in the section *ESCON* on page *93* and the section *GM2* on page *101*.)
4. Power Supply module (1 or 2 per chassis)
5. Power Cord (1 per power supply)
6. Jumper Fiberoptic Cables kit
7. User Manual on CD (1)
8. Release Notes (1) – if provided

Options

1. Management module (1 or 2 per chassis)
2. 1+1 Protection module (1 per chassis)
3. Service module (1 per chassis)
4. ESCON Multiplexer module (as many as ordered by the customer)
5. GM2 Gigabit Ethernet Multiplexer module (as many as ordered by the customer)
6. OA module (as many as ordered by the customer)
7. Redundant Power Supply module (1 per chassis)
8. Power cord for backup power supply (1 per power supply)
9. Y-cables for exclusive end-to-end redundancy topologies (one per transponder)
   (Details are given in *Appendix I: Redundancy Protection Networks.*)

Requirements

[25] Muxes are not required for ring network configurations.

[26] Demuxes are not required for ring and single-fiber point-to-point network configurations.

Tools

- 6-inch Posidrive screwdriver (for the module screws)
- 6-inch flat-tip screwdriver

Mounting

Chassis

- Desktop (flat, stable, non-conductive static-free surface), or
- Rack space (19-inch x 11.5 U x 12 in ***or*** 483 mm x 512 mm x 305 mm).
  LD1600s installed in a closed or multi-unit rack assembly may require further evaluation by Certification Agencies. The following factors must be taken into consideration:
  1. The ambient temperature within the rack may be greater than the ambient temperature of the room. Installation should be such that the amount of air flow required for safe operation is not compromised. The maximum temperature for the equipment in this environment is 45 °C (113 °F). Ensure that this maximum temperature is not exceeded.
  2. Installation should be such that a hazardous instability condition does not result due to uneven loading

Transponders

If Y-cables[27] are used: For each pair of mutually redundant transponders, allocate a pair of adjacent slots, so that the odd-number slot has the smaller number.

Valid slot pairs are: 1,2 and 3,4 and 5,6 and 7,8 and 9,10.

Invalid slot pairs are: 2,3 and 3,4 and 4,5 and 6,7 and 8,9 and 10,11 because in each case the odd number is higher.

Important! The overload on the receiver of any transponder must NOT exceed –2 dBm otherwise the receiver will burn out.

Environmental

Temperature:	0 to 45 °C (32 to 113 °F).
Humidity:	Non-condensing, less than 85%.
Dust:	Less than 10^6 particles/m^3 (or 30,000 particles/ft^3).
Cooling air:	Must be allowed to flow around the LD1600 and through the air vents unobstructed. In addition, ensure that there is a clearance of at least 25 mm (1 inch) between the air vents and nearby objects.

Power

Check nameplate ratings to assure there is no overloading of supply circuits that could have an effect on overcurrent protection and supply wiring.

The line (mains) should be able to supply power[28] to the LD1600 according to the following specification:

AC:

– 100 to 120 Vac, 8 A, 60 Hz – for U.S.A, Canada, and Japan

or

– 200 to 240 Vac, 3 A, 50 Hz – for other countries

DC: -48 to -60 Vdc

DC rated equipment must be installed under the following conditions:

---

[27] Examples of network topologies using the Y-cable are shown in Appendix I.

[28] The required line (mains) power is specified on the front of each power supply and also in Appendix J.

1. The DC supply source to which the LD1600 is to be connected must be isolated from the alternating current source and reliably connected to earth or to a DC (SELV) source.
2. The LD1600 must be installed only in restricted access areas (Dedicated Equipment Rooms, Equipment Closets, or the like) in accordance with Articles 110-16, 110-17, and 110-18 of the National Electrical Code, ANSI/NFPA 70.
3. Input wiring to a terminal block must be routed and secured in such a manner that it is protected from damage and stress. Do not route wiring past sharp edges or moving parts.
4. A readily accessible disconnect device, with a 3 mm minimum contact gap shall be incorporated in the fixed wiring.
5. A listed circuit breaker suitable for protection of the branch circuit wiring and rated 48 Vdc minimum must be provided.

Note

It is recommended to connect the LD1600 through a UPS to ensure continued operation even when the line (mains) power gets cut off.

Grounding

Reliable earthing of the LD1600 must be maintained. Particular attention should be paid to supply connections when connecting to power strips, rather than to direct connections to the branch circuit.

Networking

Multiplexing

Singlemode 9/125 µm fiberoptic cables for interconnecting the LD1600s. The length of cabling supported depends on the power budget and power losses (e.g., cable attenuation, splices, etc.) and is calculated as described in Rule *17.* The required type of cable connector depends on the connector of the module to which the cable is to be connected. The module connectors are specified in Appendix J.

Management

*Out*band Management using Serial/RS-232 Connection

- Craft terminal (asynchronous ASCII terminal, e.g., *VT100* terminal),
  or
  Craft terminal emulator (e.g., PC with asynchronous ASCII terminal emulation software application such as *Microsoft Windows' HyperTerminal*).
- OS (e.g., *Microsoft Windows 95/98/2000/NT/XP*).
- Null-modem (straight, uncrossed) serial RS-232 cable with DB-9 9-pin *female* connector ***not*** longer than 15 m (50 ft).

*In*band Management using TELNET or SNMP Connection

- TELNET station (e.g., PC with TELNET application)
  or
  SNMP NMS
- OS (e.g., *Microsoft Windows 95/98/2000/NT/XP*)
- Category 5 cable with RJ45 8-pin *male* connector (or multimode 62.5/125 µm or singlemode 9/125 µm fiberoptic cable for a 1000Base-FX Gigabit Ethernet module) if the TELNET station or SNMP NMS is to be connected directly to the LD1600.
- IP Address for the LD1600. (An IP address should be assigned to the LD1600, initially using the interconnection shown in *Figure 76*.)

Web-based Management

- PC with OS such as *Microsoft Windows 95/98/2000/NT/XP*
  or
  SNMP NMS
- MRV's *MegaVision®* Web-based network management application, refer to the *MegaVision User Manual*.
- Interface on the Web.

Procedure

Note

This procedure must be performed for all LD1600s.

Configuration

The TM-SFP Transponder, TM2-SFP Transponder, TM-DXFP Transponder, and ESCON modules are the only components of the LD1600 that can be configured.

TM-SFP Single Transponder Module

Configure each TM-SFP Transponder module as follows:

1. With the aid of *Figure 36*, locate Jumper **JP6** on the TM-SFP Transponder module and position it using *Table 6*.

Table 6: JP6 Jumper Positioning

Mode	Jumper Position
LASER SD: Standard-compliant Protective Automatic Laser Shutdown (ALS/APR) mode. In this mode, the TM-SFP Transponder transmits in the access direction at a rate that is eye safe *so long as* it does not receive from the access direction, and transmits in the WDM direction at a rate that is eye safe *so long as* it does not receive from the WDM direction.	JP6 
LASER EN: Normal operation mode of TM-SFP Transponder. In this mode, the Transponder transmits in the access and WDM directions irrespective of whether it receives.	JP6 

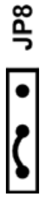
2. With the aid of *Figure 36*, locate Jumper **JP7** and position it using *Table 7*.

Table 7: JP7 Jumper Positioning

Mode	Jumper Position
NOR: TM-SFP Transponder to operate independently, i.e., in non-redundancy mode.	JP7 
RED: TM-SFP Transponder to operate in mutual redundancy mode with its companion transponder model in the *same* LD1600 and having the same operating wavelength. (This jumper setting is sufficient for redundancy mode operation; there is no need for further configuration, e.g., software using CLI commands, etc.)	JP7 

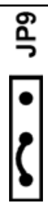
3. With the aid of *Figure 36*, locate Jumper **JP8** and position it using *Table 8*.

Table 8: JP8 Jumper Positioning

Mode	Jumper Position
<u>NOR:</u> TM-SFP Transponder to operate in normal mode.	
<u>RLB:</u> TM-SFP Transponder to operate in RLB test mode, which is described in Appendix C.	

4. With the aid of *Figure 36*, locate Jumper **JP9** and position it using *Table 9*.

Table 9: JP9 Jumper Positioning

Mode	Jumper Position
<u>NOR:</u> TM-SFP Transponder to operate in normal mode.	
<u>LLB:</u> TM-SFP Transponder to operate in LLB test mode, which is described in Appendix C.	

5. With the aid of *Figure 36*, locate DIP switch **SW1** on the TM-SFP Transponder module. To enable configuration by *software*, set the DIP switch as shown in the *first* row of *Table 13*.
   To hardware configure the TM-SFP Transponder module, set the DIP switch according to the row of *Table 13* that matches the transponder type and required speed.
6. Perform Steps *1* to *5* for each and every TM-SFP Transponder module.

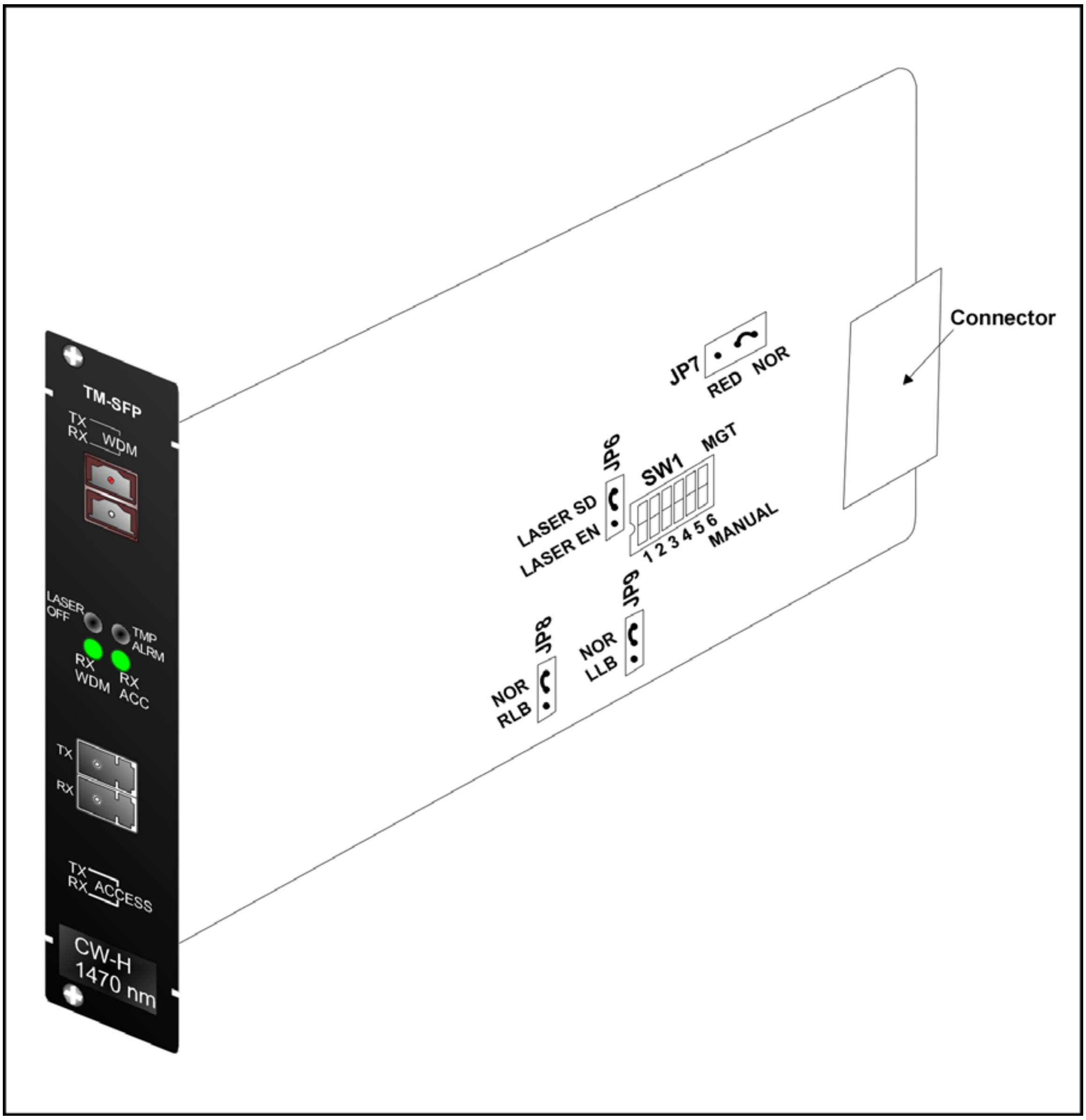


Figure 36: DIP Switch Location on TM-SFP Transponder Module

TM2-SFP Dual Transponder Module

Configure each TM2-SFP Transponder module as follows:

1. With the aid of *Figure 37*, locate Jumper **JP1** on the TM2-SFP Transponder module and position it using *Table 10*.

Table 10: JP1 Jumper Positioning

Mode	Jumper Position
EYE SAFE (LASER SD): Standard-compliant Protective Automatic Laser Shutdown (ALS/APR) mode. In this mode, the TM2-SFP Transponders **1** and **2** transmit in the access direction at a rate that is eye safe *so long as* both do not receive from the access direction, and transmit in the WDM direction at a rate that is eye safe *so long as* both do not receive from the WDM direction.	**JP1** [• ⌒•]
NORMAL (LASER EN): Normal operation mode of TM2-SFP Transponders **1** and **2**. In this mode, the	**JP1** [•⌒ •]

Transponders **1** and **2** transmit in the access and WDM directions irrespective of whether they receive.	

2. With the aid of *Figure 37*, locate Jumper **JP2** and position it using *Table 11*.

Table 11: JP2 Jumper Positioning

Mode	Jumper Position
<u>NORMAL:</u> TM2-SFP Transponders **1** and **2** to operate independently of each other, i.e., in non-redundancy mode.	JP2 
<u>TRANS-RED:</u> TM2-SFP Transponders **1** and **2** to operate in mutual redundancy mode with each other provided they have the same operating wavelength. (This jumper setting is sufficient for redundancy mode operation; there is no need for further configuration, e.g., software using CLI commands, etc.)	JP2 

3. With the aid of *Figure 37*, locate Jumpers **JP4** and **JP5** and position them using *Table 12*.

Table 12: JP4 and JP5 Jumpers Positioning

Mode	Transponder	Jumper Position
<u>NORMAL:</u> TM2-SFP Transponder (**1** or **2**) to operate in normal mode.	1	JP4  NORMAL LOOP
	2	JP5  NORMAL LOOP
<u>LOOP:</u> TM2-SFP Transponder (**1** or **2**) to operate in RLB test mode, which is described in Appendix C.	1	JP4  NORMAL LOOP
	2	JP5  NORMAL LOOP

4. With the aid of *Figure 37*, locate DIP switches **SW1** and **SW2** on the TM2-SFP Transponder module.
   To enable configuration by *software*, set the DIP switches as shown in the *first* row of *Table 13*.
   To hardware configure the TM2-SFP Transponder module, set the DIP switch according to the row of *Table 13* that matches the transponder type and required speed.
5. Perform Steps *1* to *4* for each and every Transponder module.

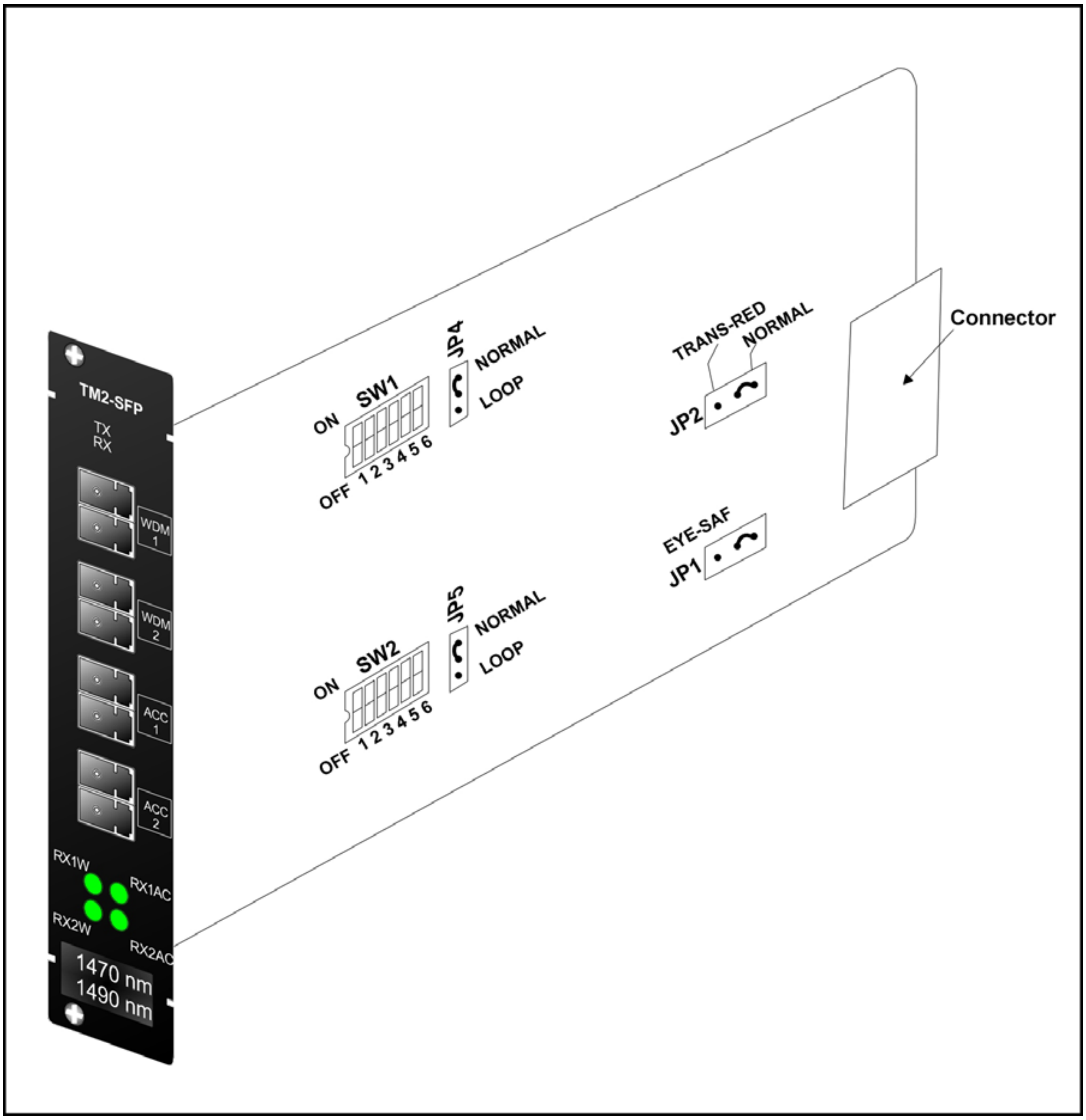


Figure 37: DIP Switch Location on TM2-SFP Transponder Module

Table 13: DIP Switch (SW1 or SW2) Setting of TM-SFP or TM-2SFP Transponder Module

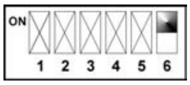
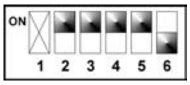
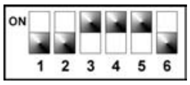
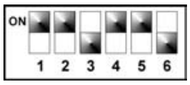
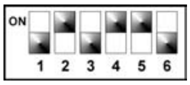
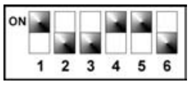
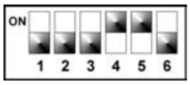
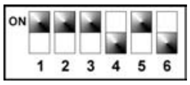
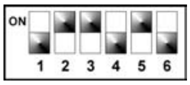
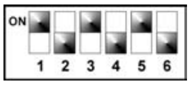
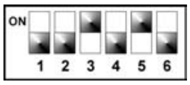
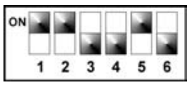
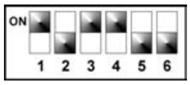
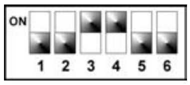
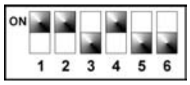
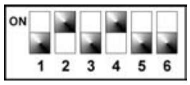
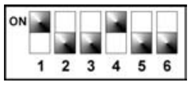
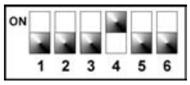
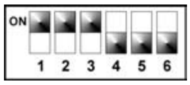
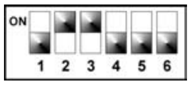
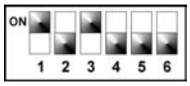
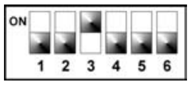
No.	Control	Transponder Type	Protocol	Data Rate (Mbps)	Setting
1	Software (Mgt)	Any	Any	10 to 2700	
2	Hardware (Manual)	Medium Speed	Having a data rate between 10 and 30 Mbps	10 to 30 (Bypass PLL)	
3			E3	31 to 45	
4			DS3	44 to 50	
5				46 to 52	
6			OC-1	50 to 66	
7				60 to 90	
8			DS3C	88 to 96	
9					
10			FDDI, FE	93to 133	
11			DS3X; E4; DTV; OC-3	121 to 179	
12				177 to 191	
13				175 to 201	
14			ESCON	186 to 260	
15			FC; DS4; CMI	241 to 359	
16			HDTV	354 to 382	
17				351 to 401	

Table 11: DIP Switch Setting of Transponder Module (Cont'd)

No.	Control	Transponder Type	Protocol	Data Rate (Mbps)	Setting
18			DTV	372 to 520	
19			FC; DS4C; OC-12	483 to 718	
20				707 to 765	
21				702 to 802	
22				744 to 1040	
23			FC; DS5; OC-24; GE; DS-5X	965 to 1435	
24		High Speed	HDTV	1419 to 1529	
25				1403 to 1604	
26				1488 to 2070	
27			OC-48; FC2.128G	1930 to 2700	

 Toggle in ON position.

 Toggle position immaterial.

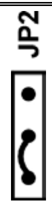
TM-DXFP 10 Gbps Transponder Module

Configure each TM-DXFP Transponder module as follows:

1. With the aid of *Figure 38*, locate Jumper **JP6** on the TM-DXFP Transponder module and position it using *Table 14*.

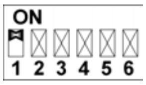
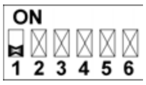
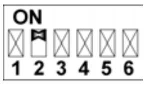
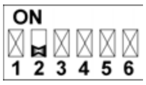
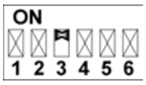
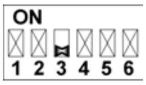
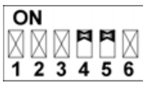
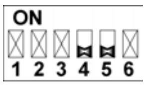
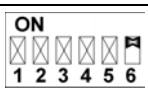
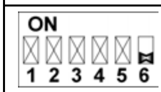
Table 14: JP2 Jumper Positioning

Mode	Jumper Position
<u>LASER SD:</u> Standard-compliant Protective Automatic Laser Shutdown (ALS/APR) mode. In this mode, the TM-DXFP Transponder transmits in the access direction at a rate that is eye safe *so long as* it does not receive from the access direction, and transmits in the WDM direction at a rate that is eye safe *so long as* it does not receive from the WDM direction.	

LASER EN: Normal operation mode of TM-DXFP Transponder. In this mode, the Transponder transmits in the access and WDM directions irrespective of whether it receives.	

2. With the aid of *Figure 38*, locate DIP switch **SW1** on the TM-DXFP Transponder module. and set it using *Table 15*.

Table 15: DIP Switch SW1 Setting of TM-DXFP Transponder Module

Toggle No.	Toggle Position	Function
1		RED: TM-DXFP Transponder to operate in mutual redundancy mode with its companion transponder model in the *same* LD1600 and having the same operating wavelength. (This jumper setting is sufficient for redundancy mode operation; there is no need for further configuration, e.g., software using CLI commands, etc.)
		NOR: TM-DXFP Transponder to operate independently, i.e., in non-redundancy mode.
2		RLB: TM-DXFP Transponder to operate in RLB test mode, which is described in Appendix C.
		NOR: TM-DXFP Transponder to operate in normal mode.
3		LLB: TM-DXFP Transponder to operate in LLB test mode, which is described in Appendix C.
		NOR: TM-DXFP Transponder to operate in normal mode.
4, 5		10.3 Gbps Ethernet
		9.95 Gbps OC-192/STM-64
6		Configuration control by software.
		Configuration control by hardware.

Toggle in ON position.

Toggle in OFF position.

Toggle position immaterial.

3. Perform Steps 1 to 2 for each and every TM-DXFP Transponder module.

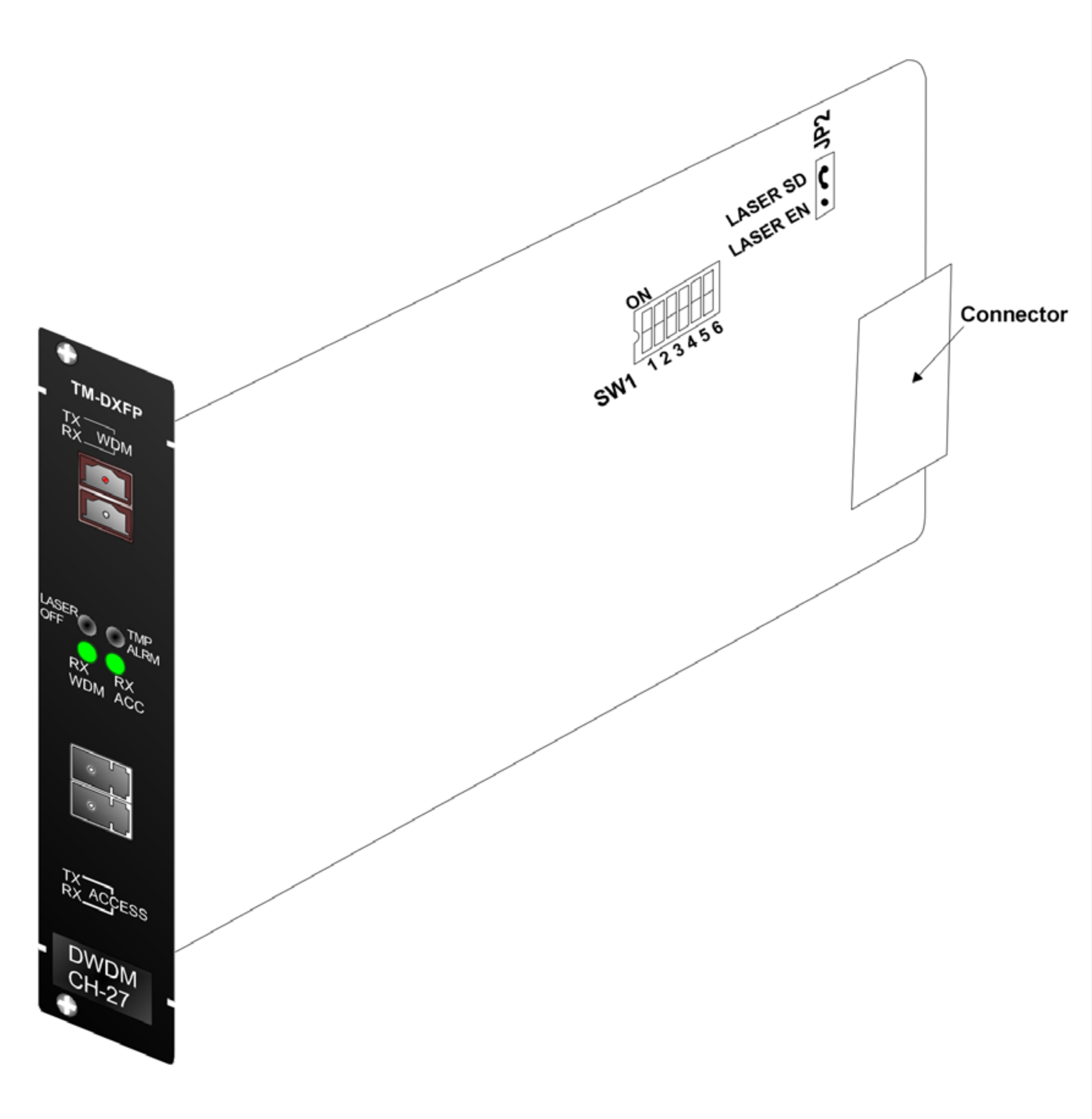


Figure 38: DIP Switch Location on TM-DXFP Transponder Module

ESCON Module

For *each pair* of ESCON modules to be linked to each other, do as follows:

For *one* ESCON module:
With the aid of *Figure 39,* locate the **MASTER** pins (**J2**) and make sure they are connected with a 2-pin jumper. (The **SLAVE** pins (**J3**) must be left unconnected.)
In *Table 16,* identify the DIP switch setting for which the operating wavelength is equal to that of the SFP. With the aid of *Figure 39,* locate the DIP switch, and set it accordingly.

For *the other* ESCON module:
With the aid of *Figure 39,* locate the **SLAVE** pins (**J3**) and make sure they are connected with a 2-pin jumper. (The **MASTER** pins (**J2**) must be left unconnected.)
In *Table 16,* identify the DIP switch setting for which the operating wavelength is equal to that of the SFP. With the aid of *Figure 39,* locate the DIP switch, and set it accordingly.

Note

Make sure the DIP switches have the same setting in both ESCON modules to be linked to each other.

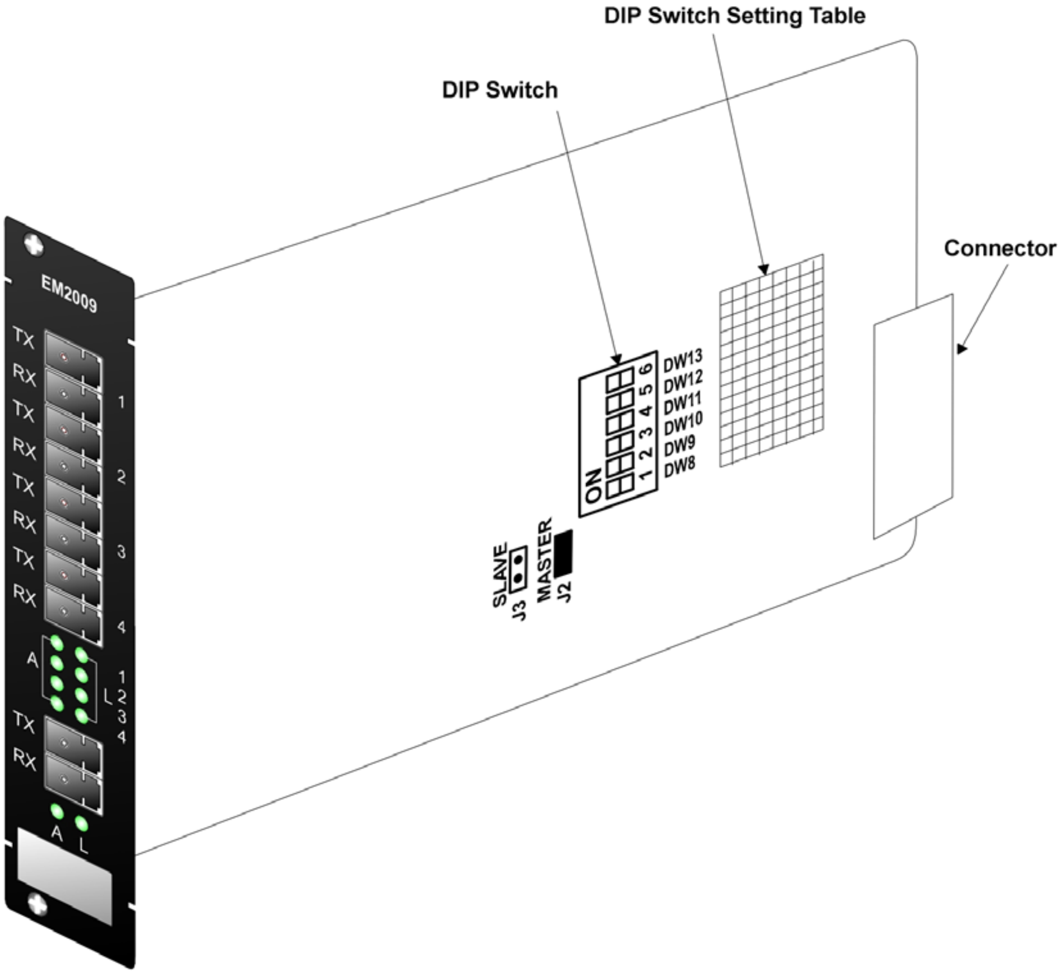
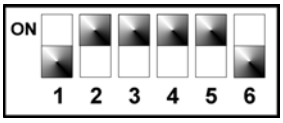
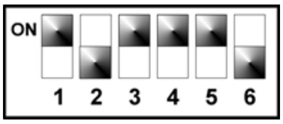
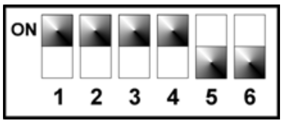
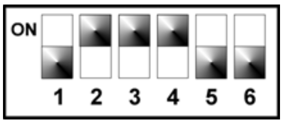
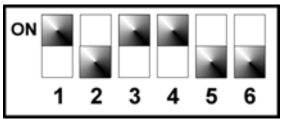
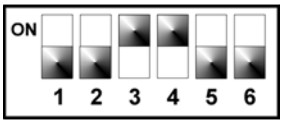
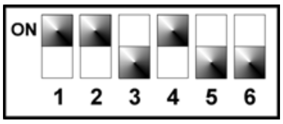
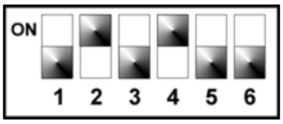
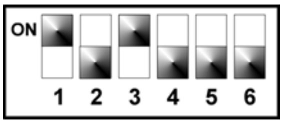
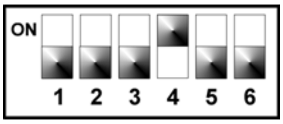


Figure 39: DIP Switch Location on ESCON Module

Table 16: DIP Switch Setting of ESCON Module

No.	**Operating Wavelength**	**Setting** (DW8 to DW13)
1	850 nm MultiMode	
2	1310 nm SingleMode	
3	1470 nm	

4	1490 nm	
5	1510 nm	
6	1530 nm	
7	1550 nm	
8	1570 nm	
9	1590 nm	
10	1610 nm	

Mounting

Chassis

Mount the LD1600 in a 19-inch rack or place it on a flat stable non-conductive static-free surface, such as a desktop.

Modules

<u>Transponder, ESCON, or GM2 Module</u>

1. If Y-cables are *not* used: Select any of Slots 1 to 16.
   If Y-cables are used: For each pair of mutually redundant transponders, select a pair of adjacent slots, so that the odd-number slot has the smaller number. Valid slot pairs are: 1,2 and 3,4 and 5,6 and 7,8 and 9,10.
2. If a Blank Panel is covering the slot, remove it by unfastening the two screws with a 6-inch posidrive screwdriver.
3. Holding the module by the panel, place it between the top and bottom rails in the slot. Then slide it until its panel is *almost* level with the front panel of the LD1600. (This assures that the module's connector is inserted into place.) Pull up the handle//ejector/extractor to lock the module in position.
4. Fasten the module with the two screws using a 6-inch posidrive screwdriver.
5. For the Transponder, ESCON, or GM2 module, insert the SFP transceiver/s (shown in *Figure 2, Figure 14,* and *Figure 15)* as described the section *SFP Module* on page *125*.

<u>Management Module</u>

1. Select Slot 17 or 18.
2. If a Blank Panel is covering the slot, remove it by loosening the two screws with a 6-inch posidrive screwdriver.

3. Holding the module by the panel, place it between the top and bottom rails in the slot. Then slide it until its panel is *almost* level with the front panel of the LD1600. (This assures that the module's connector is inserted into place.) Pull up the handle (ejector/extractor) to lock the module in position.
4. Fasten the module with the two screws using a 6-inch posidrive screwdriver.

<u>Mux, Demux, OADM, 1+1, Service, or OA</u>

1. Select any of Slots 19 to 24.
2. If a Blank Panel is covering the slot, remove it by loosening the two screws.
3. Holding the module by the panel, place it between the top and bottom rails in the slot. Then slide it until its panel is *almost* level with the front panel of the LD1600. (This assures that the module's connector is inserted into place.) Pull up the handle (ejector/extractor) to lock the module in position.
4. Fasten the module with the two screws.

<u>Power Supply Module</u>

1. Remove the Safety Plate (*Figure 40*) at the bottom of the LD1600 chassis (*Figure 1)* by undoing the two captive screws. (This step also releases the Blank Panel/s (if present) covering the Power Supply module slot/s.)
2. Remove the foam packing that may be present in the Power Supply module slot/s.
3. Holding the Power Supply module by its handle (*Figure 17* or *Figure 18*), slide it into the slot until the spring latch (*Figure 17* or *Figure 18)* locks into the chassis. (This assures that the module's connector is inserted into place.)
4. If only one Power Supply is inserted, cover the vacant slot with a blank panel.
5. Fasten the safety plate to the chassis with the two captive screws making sure that the screws are fully tightened.

Figure 40: Safety Plate

<u>Blank Panel Module</u>

1. Hold the Blank Panel module over a vacant slot.
2. Secure it in place with the screws.

⚠	**Caution!** Cover every vacant slot with a Blank Panel. (This protects the user against electrical shock and the LD1600 against harmful physical intrusion, and increases operation reliability by assuring circulation of sufficient cooling air throughout the LD1600.)

<u>SFP Module</u>

1. Holding the SFP module with the right side up, slide it about half-way into the SFP receptacle.
2. If the SFP module has a latching mechanism, while holding the SFP module with one hand gently release the latch with the other hand. Usually, the latch handle is a wire frame around the SFP module. To release the latch, swing down the wire frame.
3. With index finger and thumb pressed against the face edges of the SFP module, gently slide it as far into the SFP receptacle as possible. Holding the SFP module in this position, swing up the latch handle around the SFP module to latch it.

Cabling

Module to Module

<u>General</u>

This section shows how modules are to be cabled to each other.

Fiberoptic cables (jumpers) for module-to-module cabling within the same LD1600 are provided by *MRV*. The cables are labeled so that they can be connected to the right connectors.

> **Note**
>
> For convenience, connect the jumper fiberoptic cables via the LD1600 guide (shown in *Figure 1*).

Fiberoptic cables for LD1600 to LD1600 (or LD1600 to access equipment) must be supplied by the customer.

Mux to Demux External Cabling

Figure 41: Mux to Demux Cabling *between* LD1600s

Demux to Demux External Cabling for Single-Fiber Point-to-Point

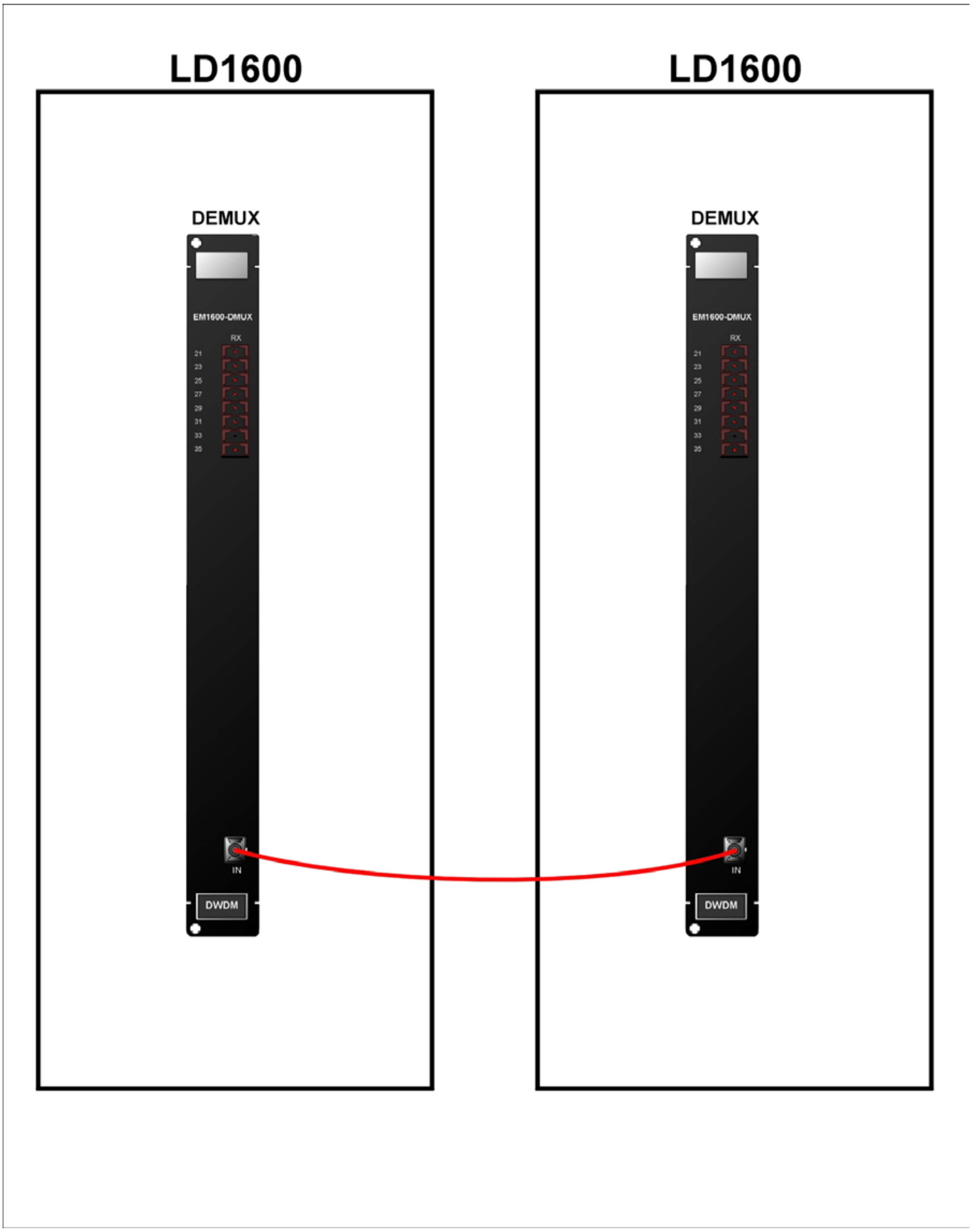


Figure 42: Demux to Demux Cabling *between* LD1600s

Single-Interface OADM to Single-Interface OADM Internal Cabling

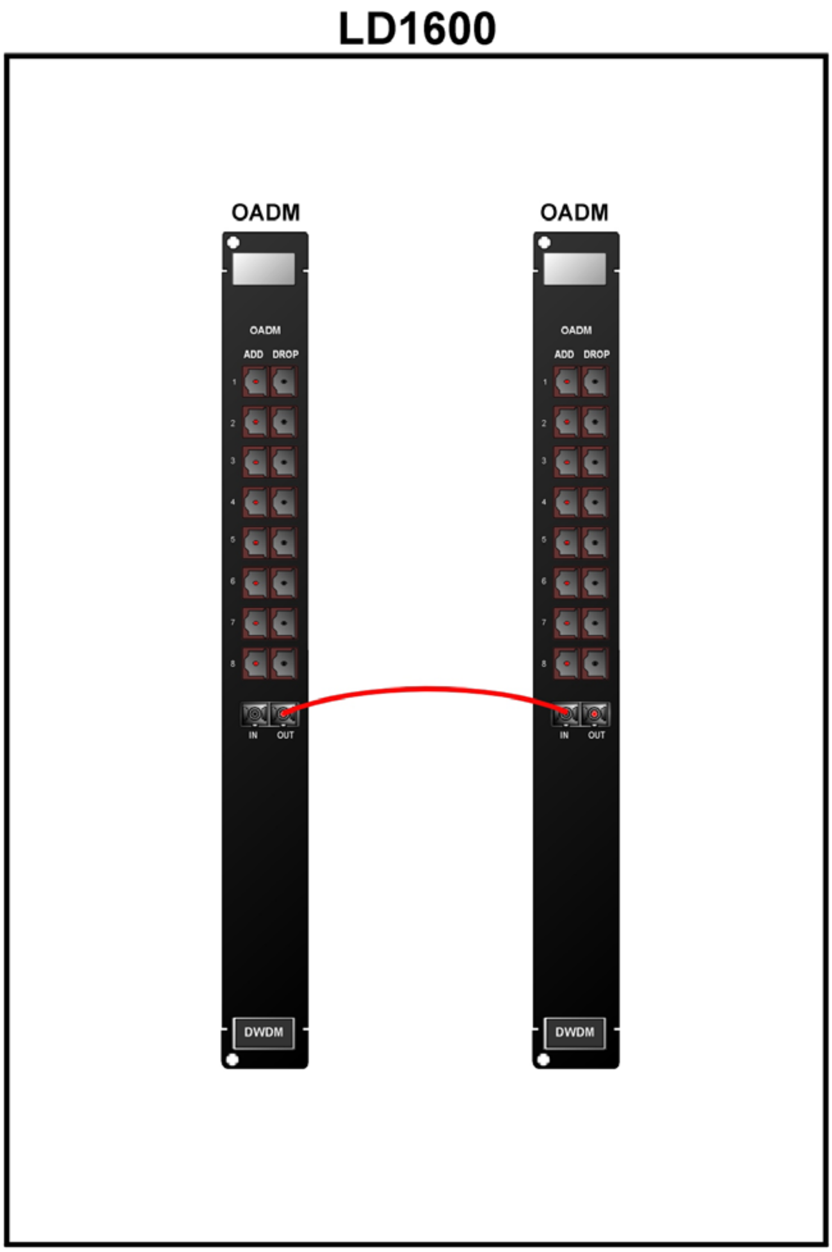


Figure 43: Single-Interface OADM to Single-Interface OADM Cabling *in* an LD1600

Dual-Interface OADM to Dual-Interface OADM-DF Internal Cabling

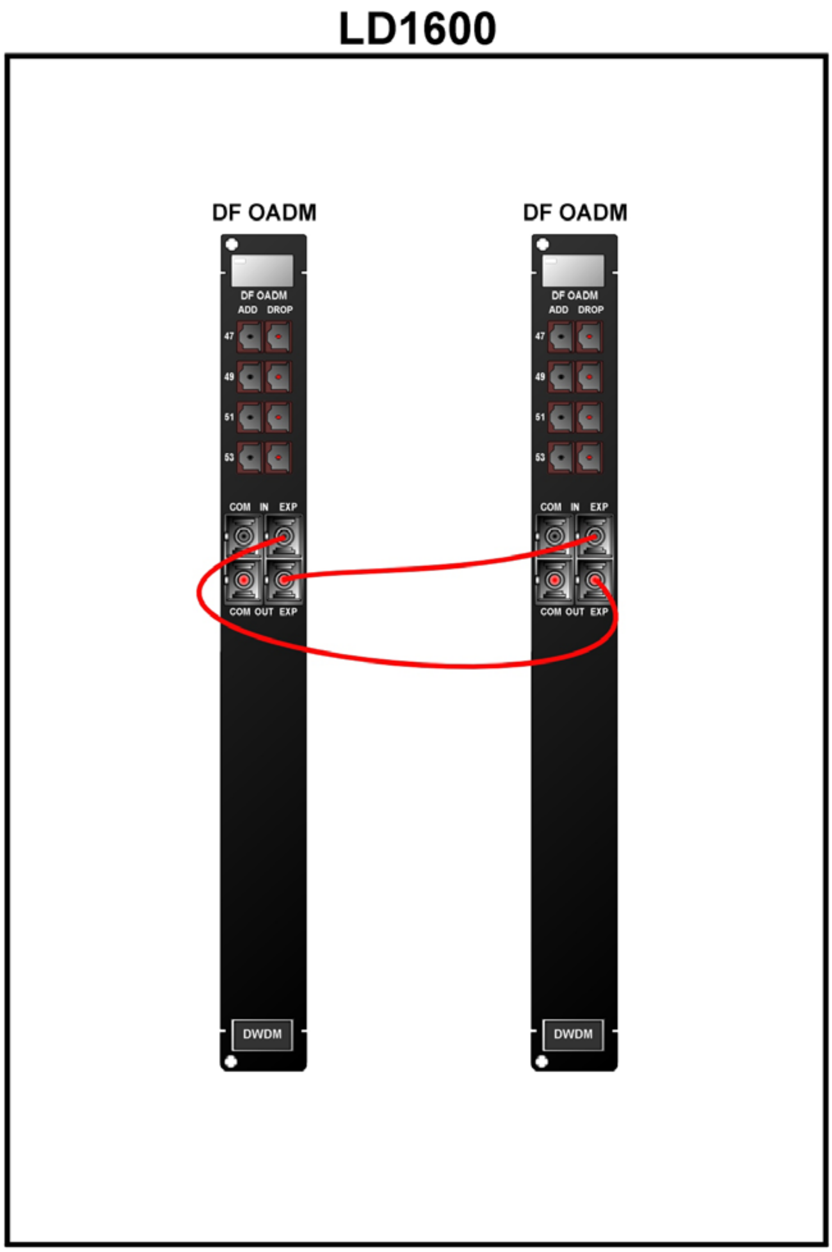


Figure 44: Dual-Interface OADM to Dual-Interface OADM Cabling *in* an LD1600

Single-Interface OADM to Single-Interface OADM External Cabling

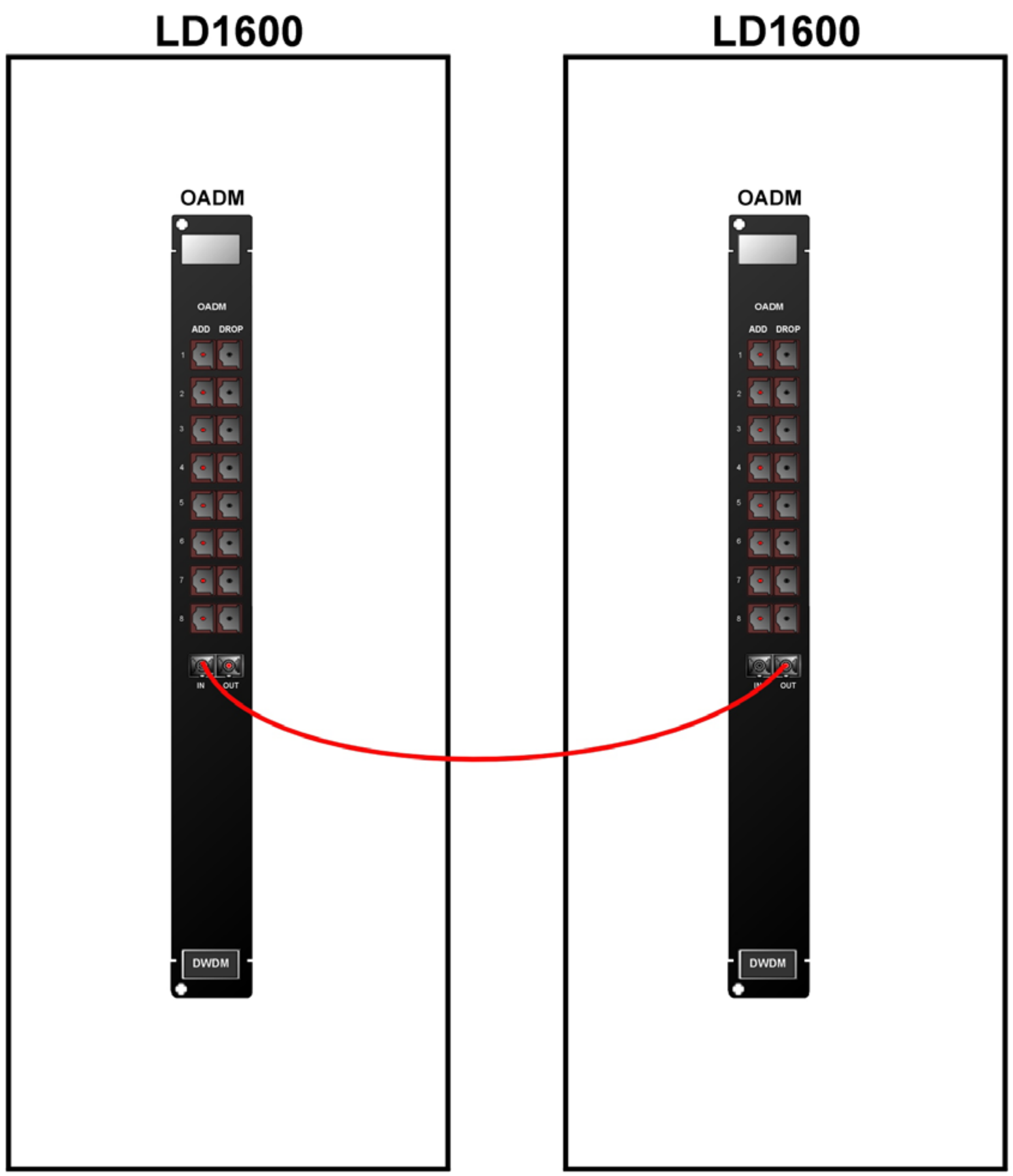


Figure 45: Single-Interface OADM to Single-Interface OADM Cabling *between* LD1600s

Dual-Interface OADM to Dual-Interface OADM External Cabling

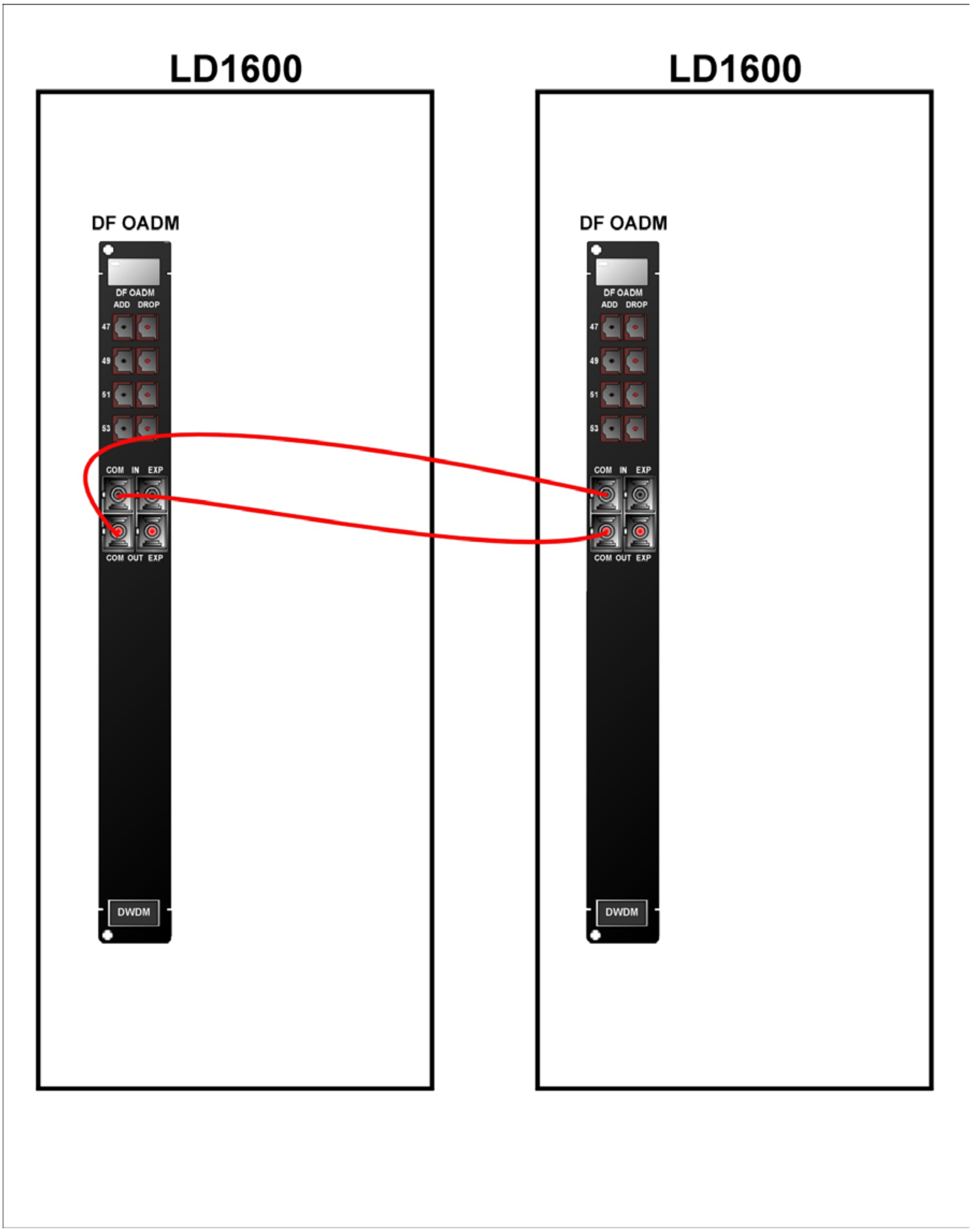


Figure 46: Dual-Interface OADM to Dual-Interface OADM Cabling *between* LD1600s

Single-Interface OADM to Service Internal Cabling

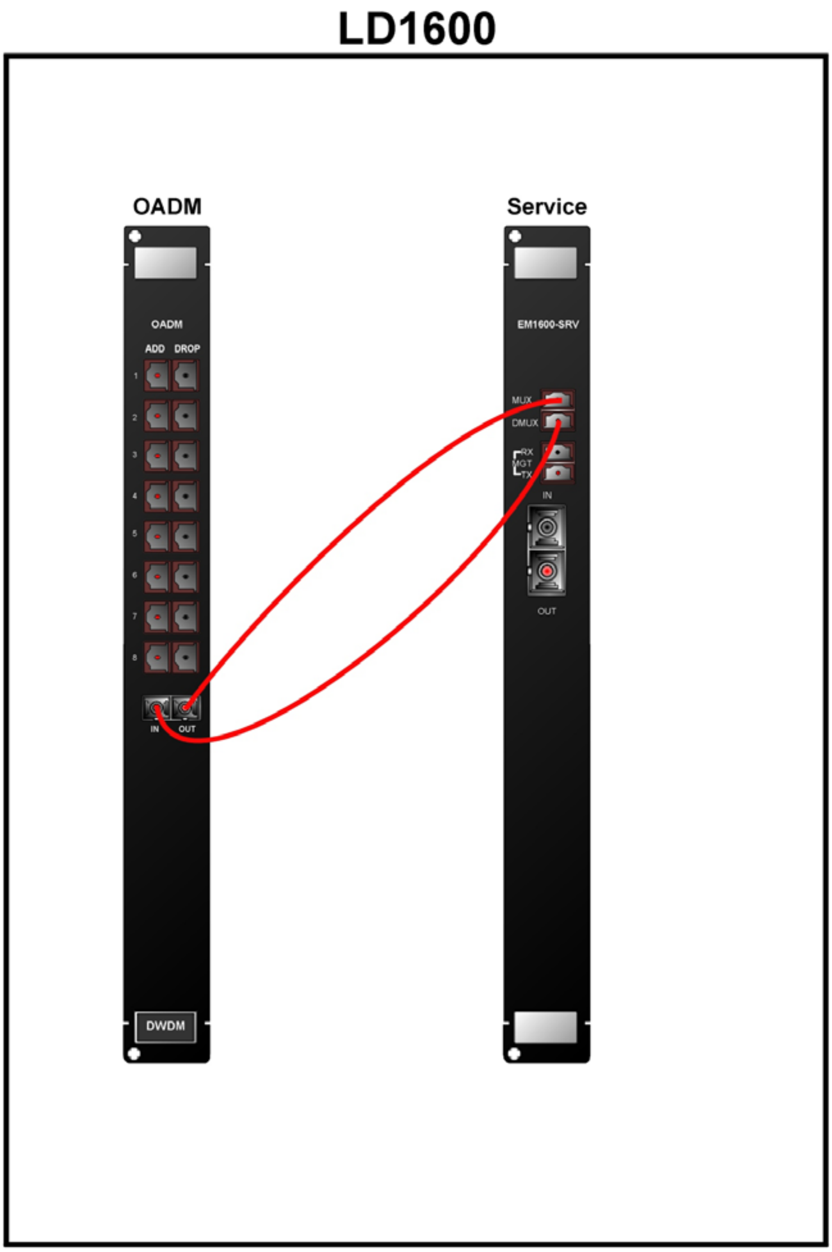


Figure 47: Single-Interface OADM to Service Cabling *in* an LD1600

Single-Interface OADM to 1+1 Internal Cabling

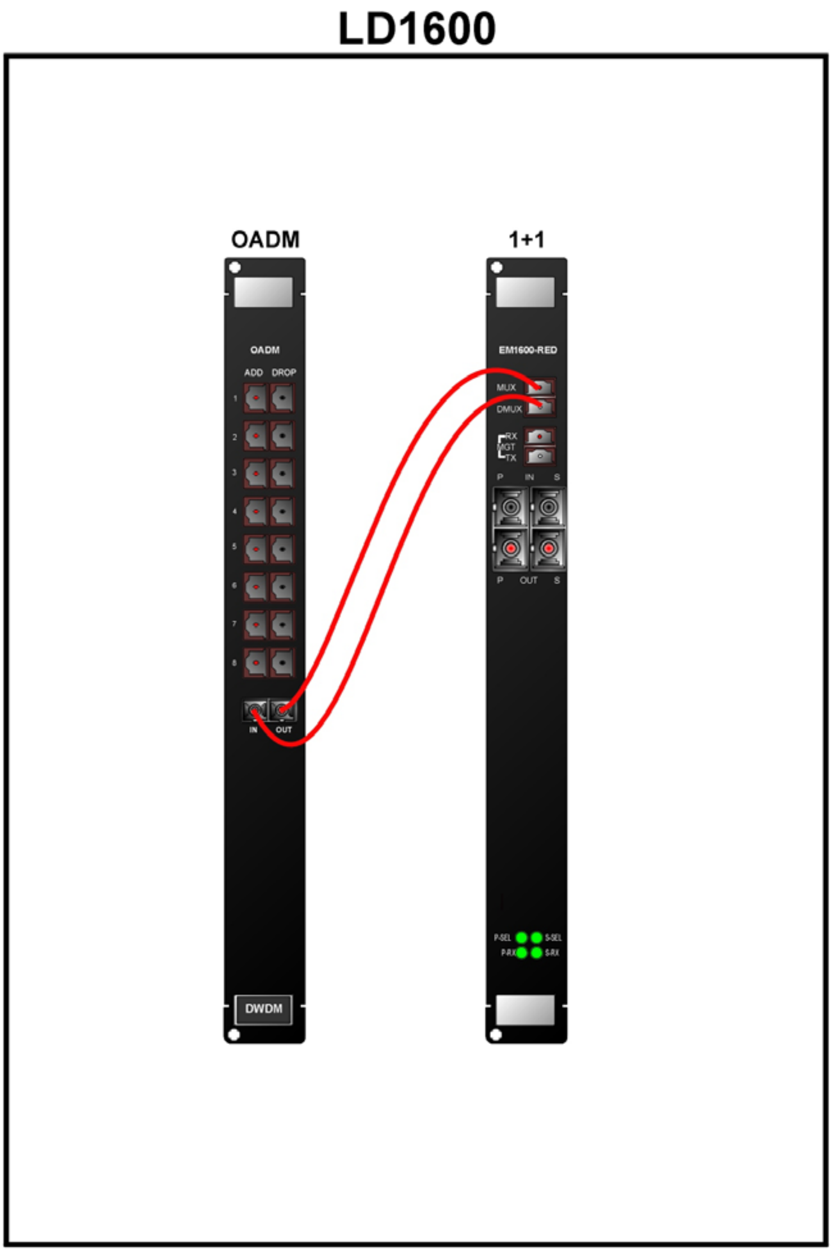


Figure 48: Single-Interface OADM to 1+1 Cabling *in* an LD1600

Single-Interface OADM to Mux External Cabling

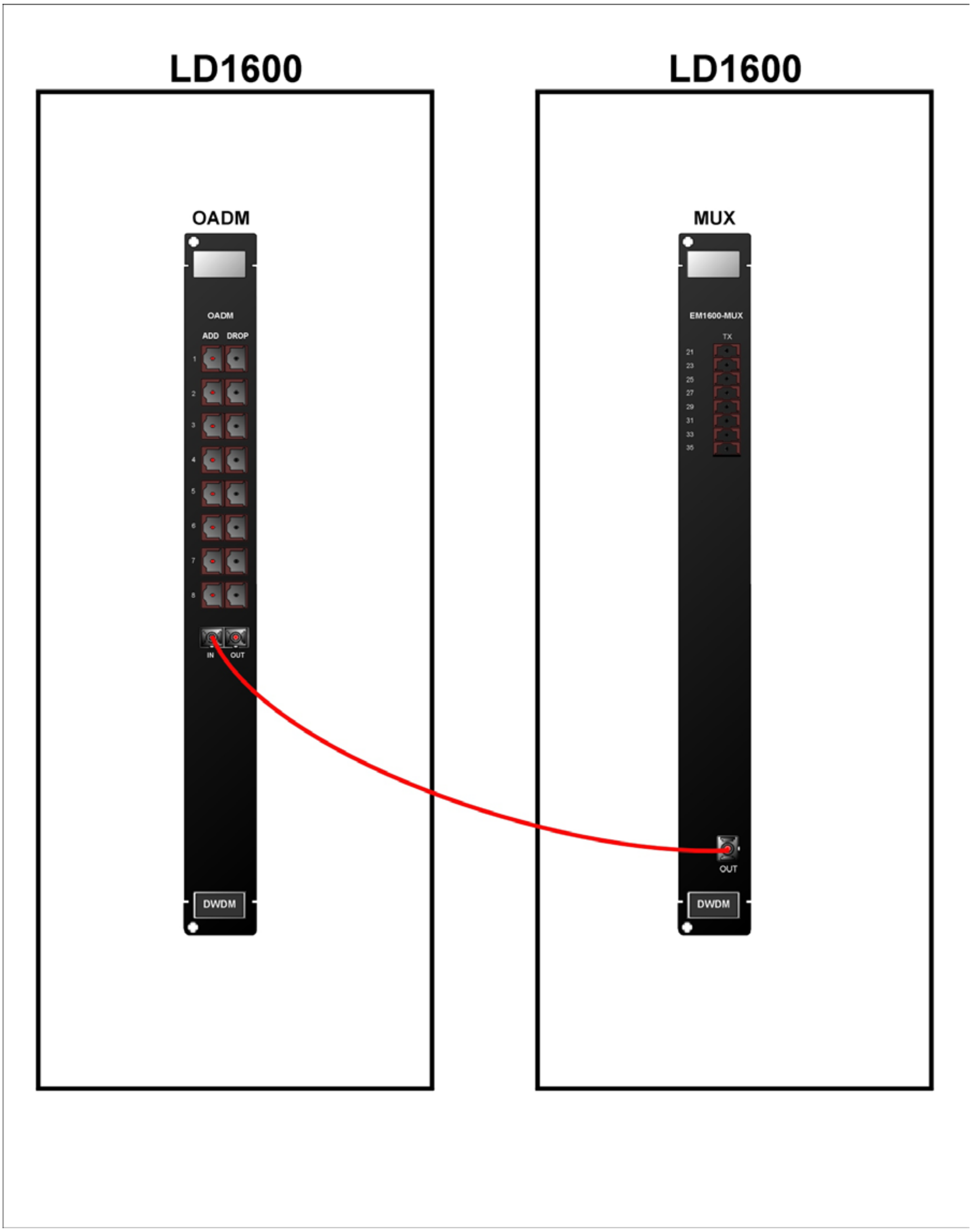


Figure 49: Single-Interface OADM to Mux Cabling *between* LD1600s

Single-Interface OADM to Demux External Cabling

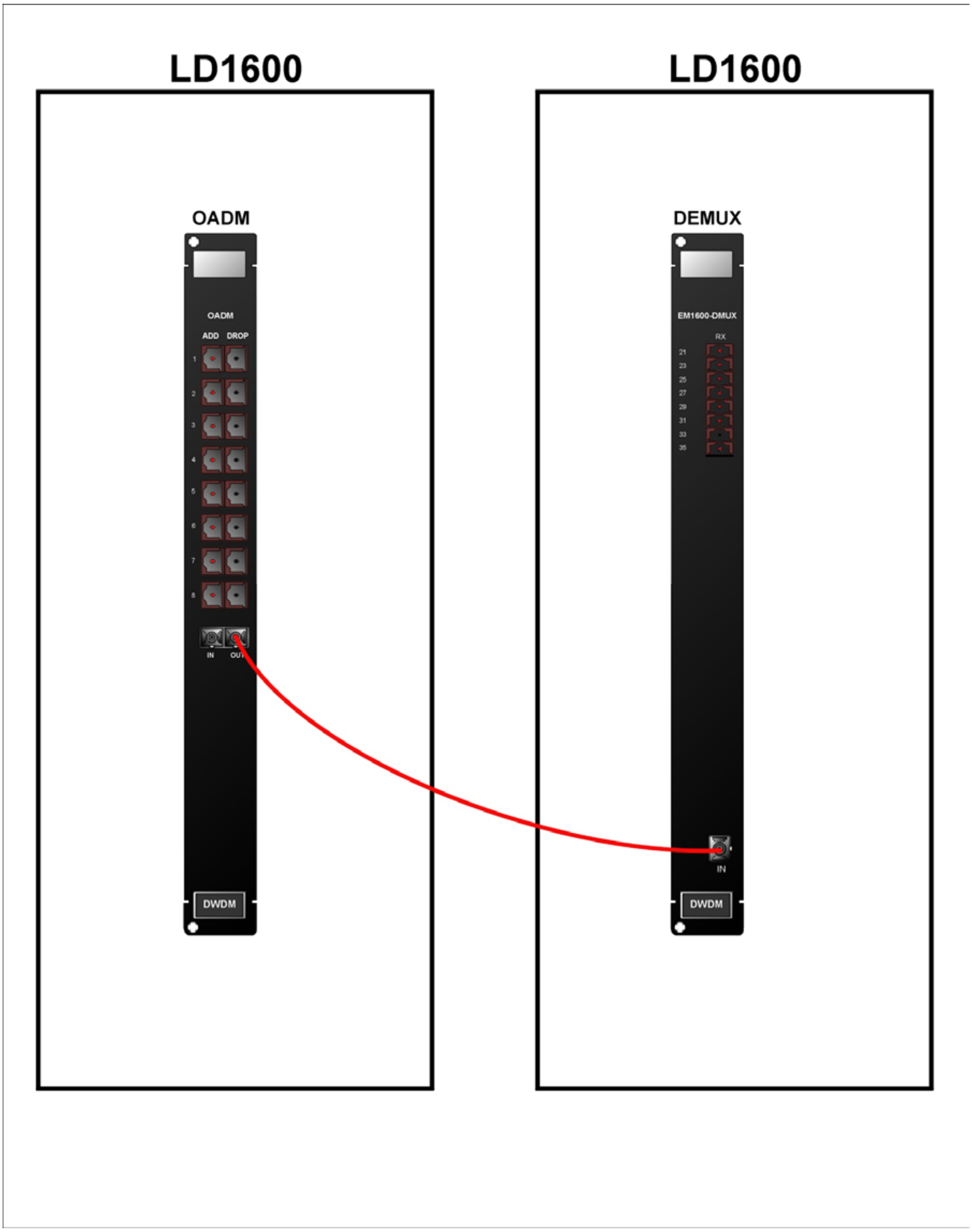


Figure 50: Single-Interface OADM to Demux Cabling *between* LD1600s

Service to Service External Cabling

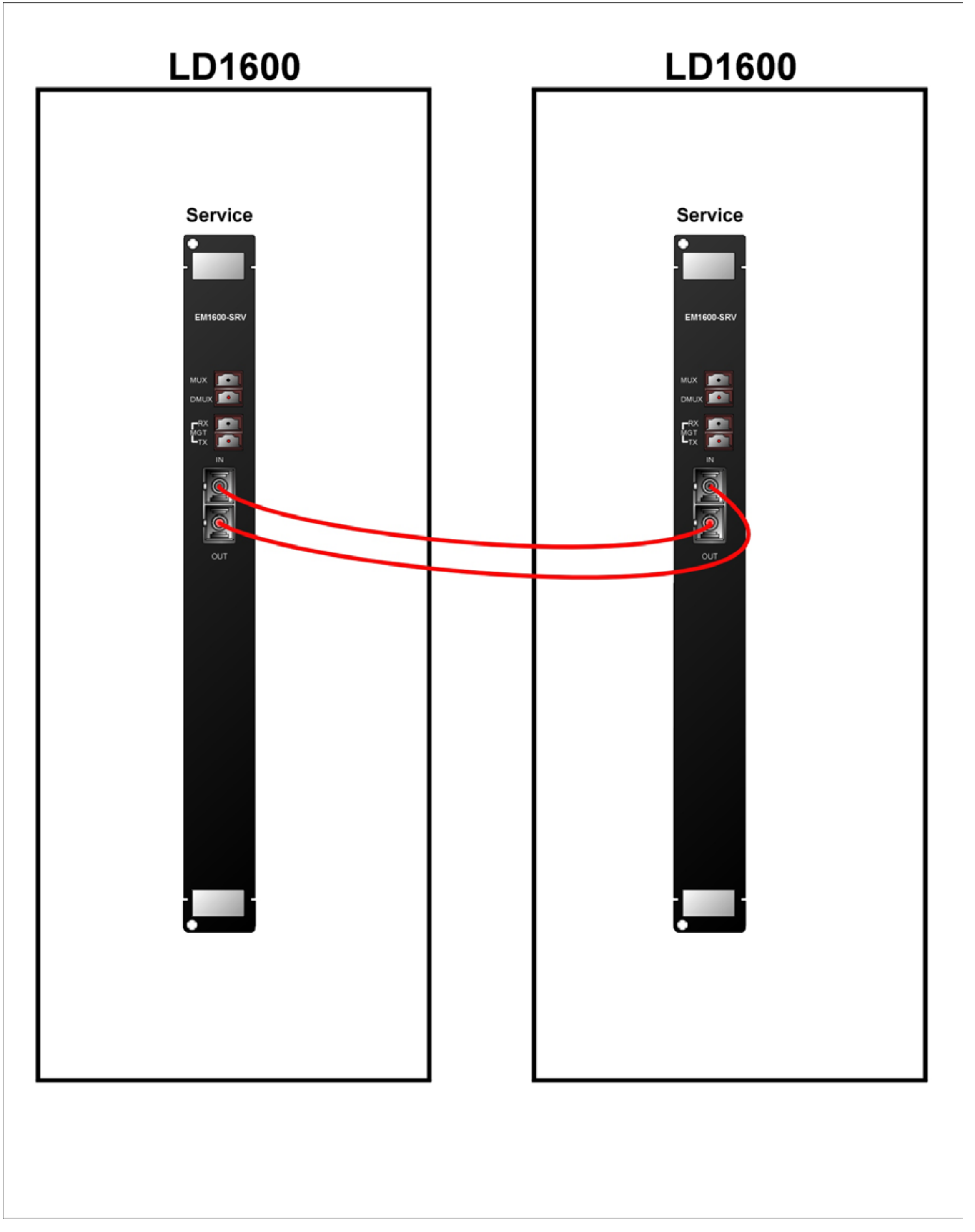


Figure 51: Service to Service Cabling *between* LD1600s

1+1 to 1+1 External Cabling

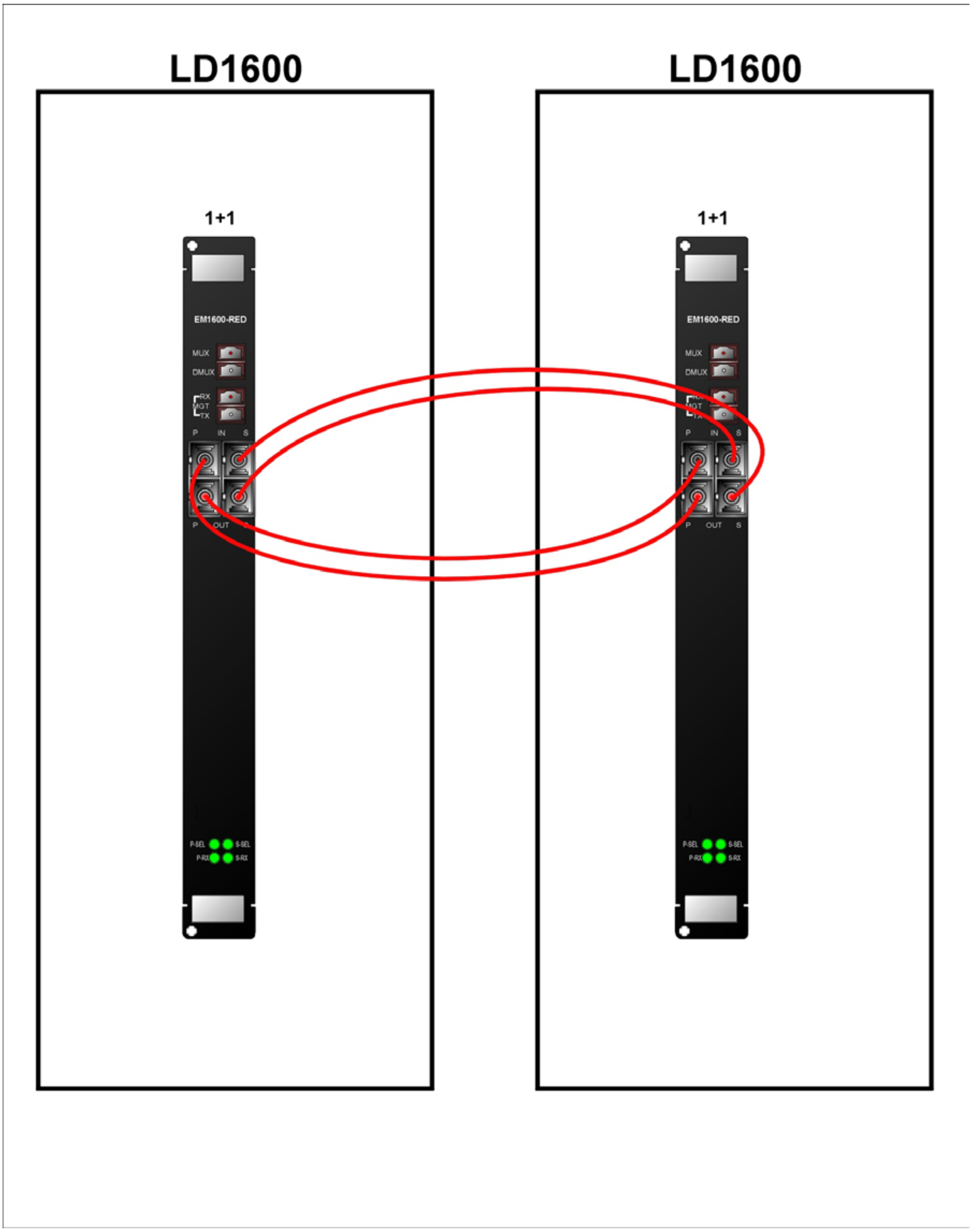


Figure 52: 1+1 to 1+1 Cabling *between* LD1600s

Transponder to Mux Internal Cabling

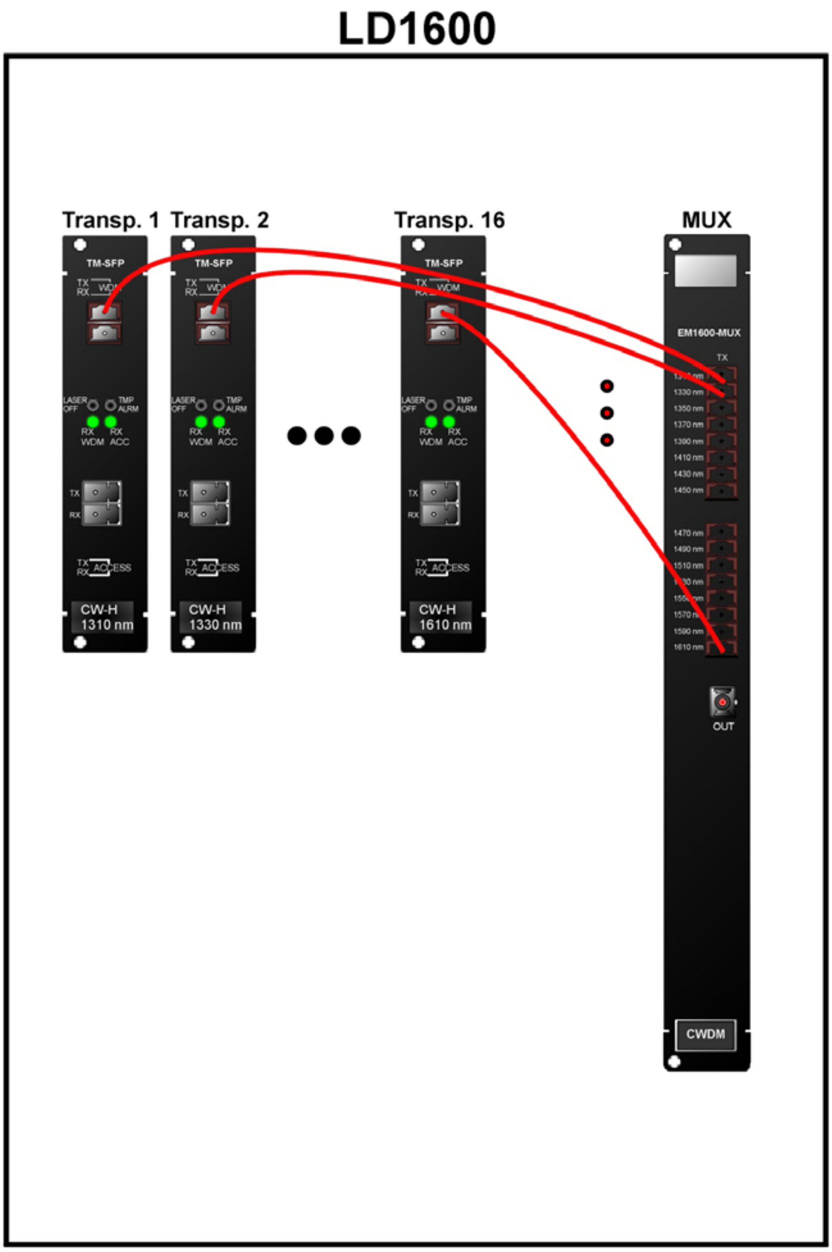


Figure 53: Transponder to Mux Cabling *in* an LD1600

Transponder to Demux Internal Cabling

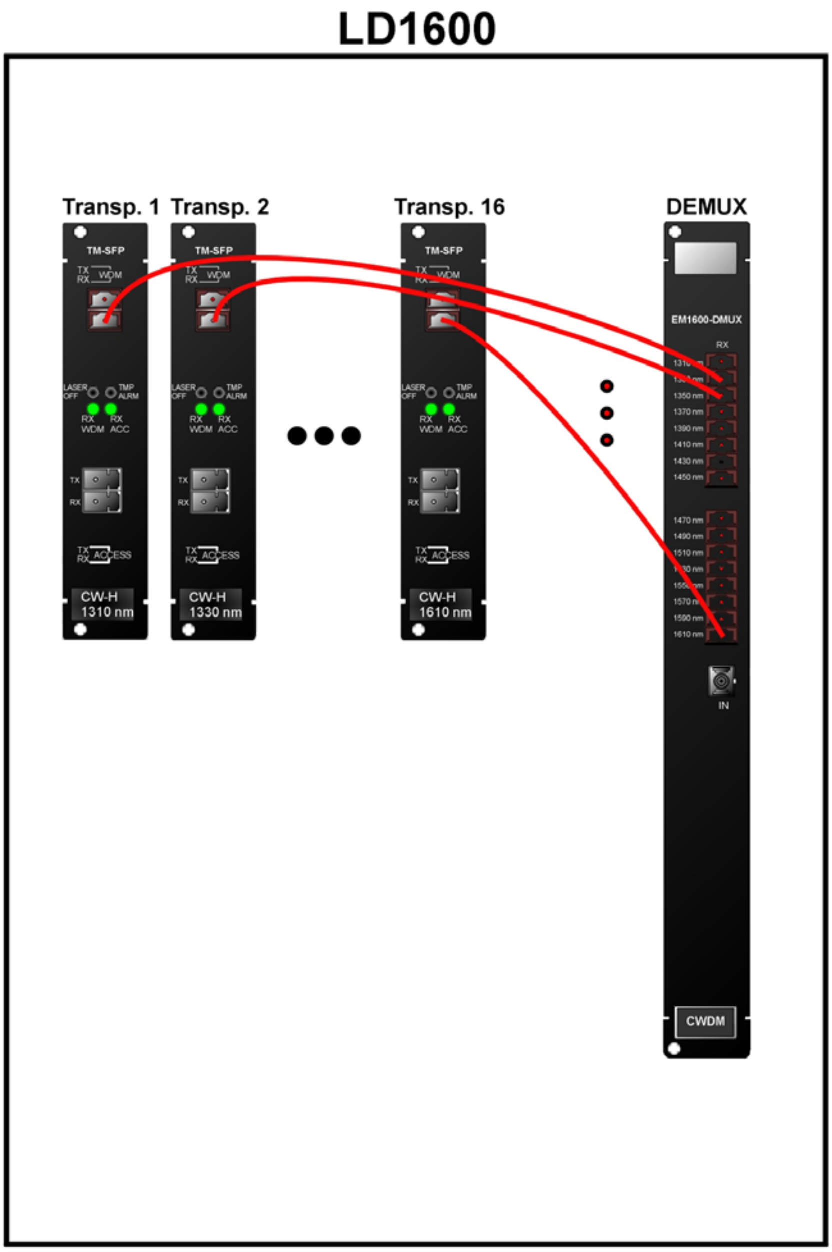


Figure 54: Transponder to Demux Cabling *in* an LD1600

Transponder to OADM Internal Cabling

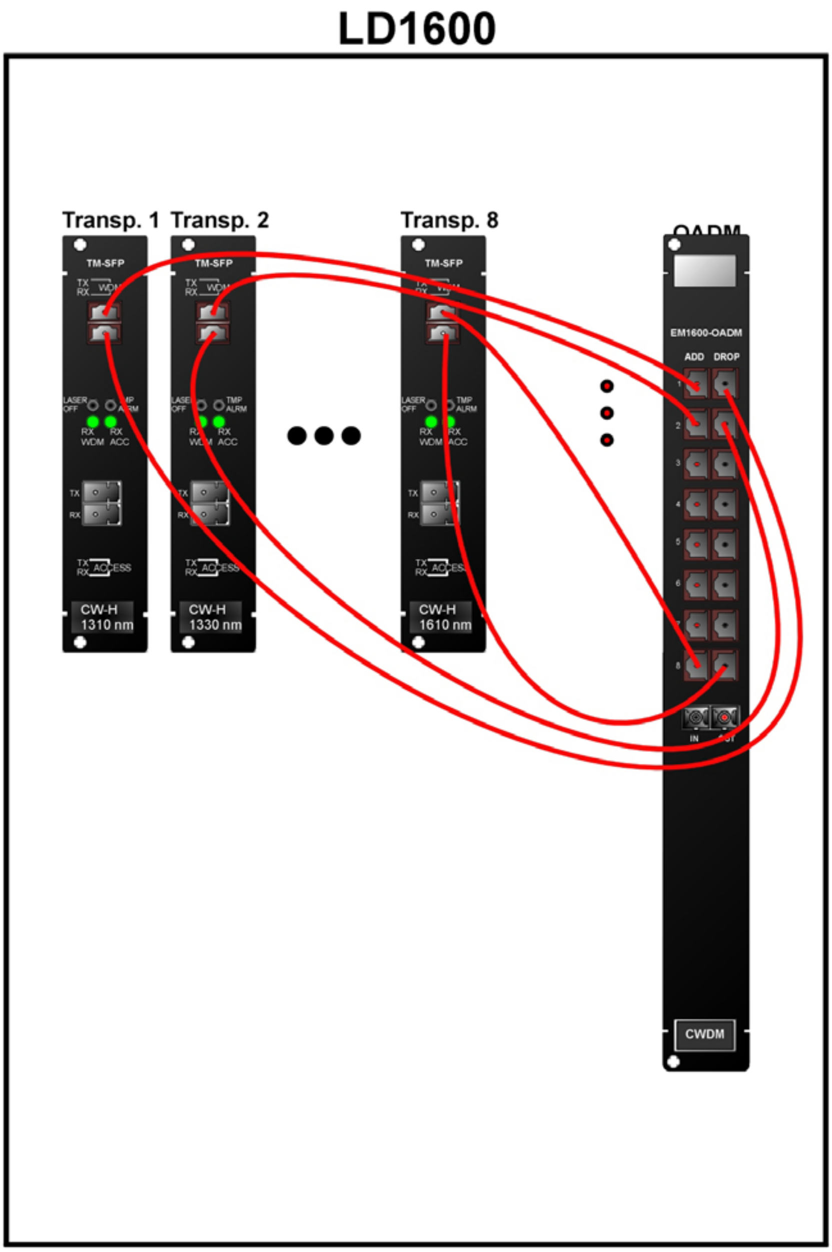


Figure 55: Transponder to OADM Cabling *in* an LD1600

Mux/Demux to Service Internal Cabling

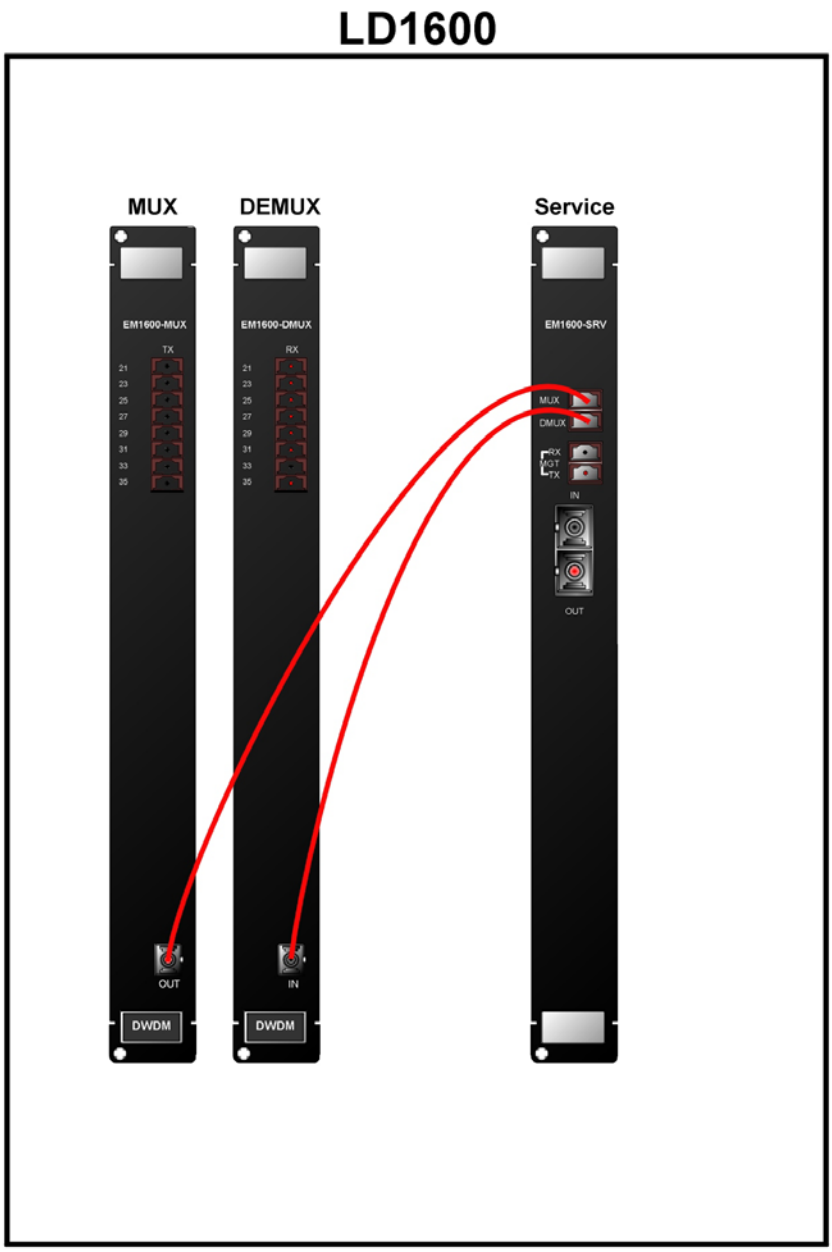


Figure 56: Mux/Demux to Service Cabling *in* an LD1600

Mux/Demux to 1+1 Internal Cabling

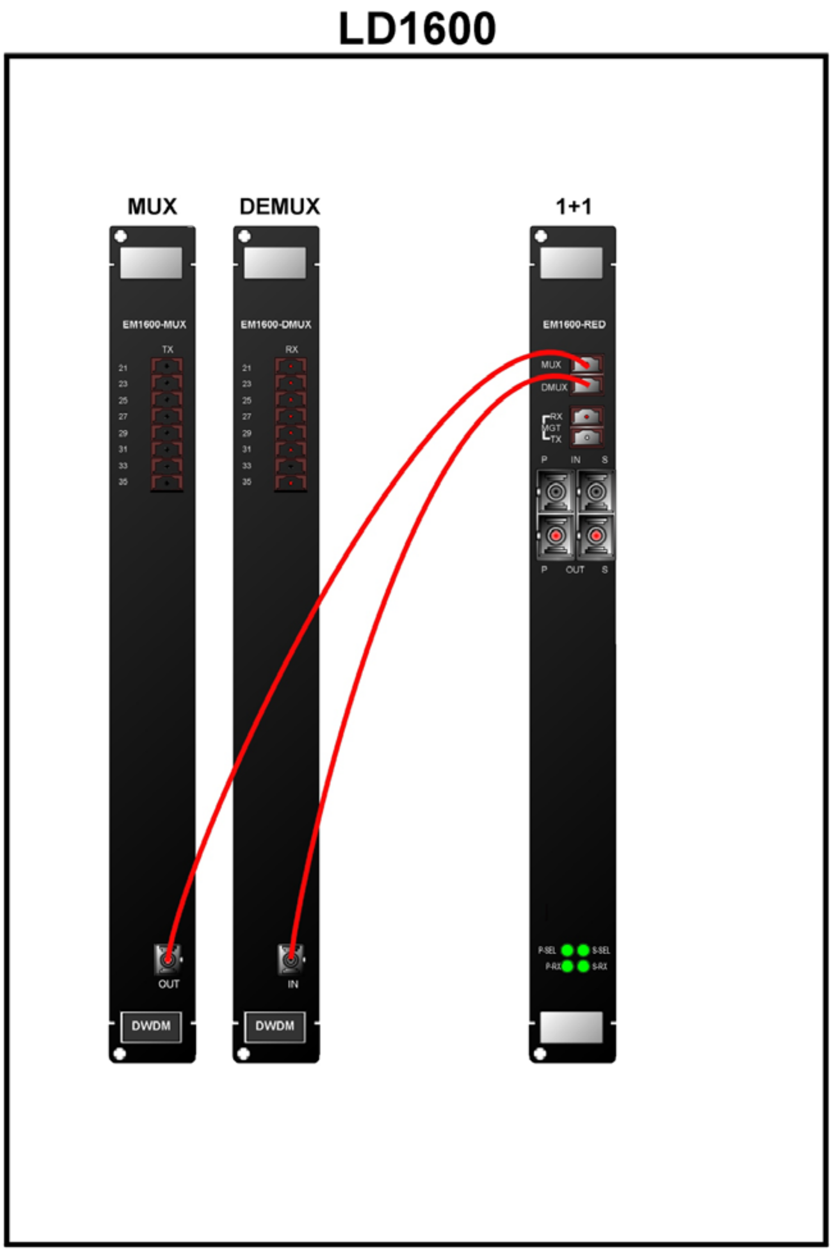


Figure 57: Mux/Demux to 1+1 Cabling *in* an LD1600

Service to Mgt Internal Cabling

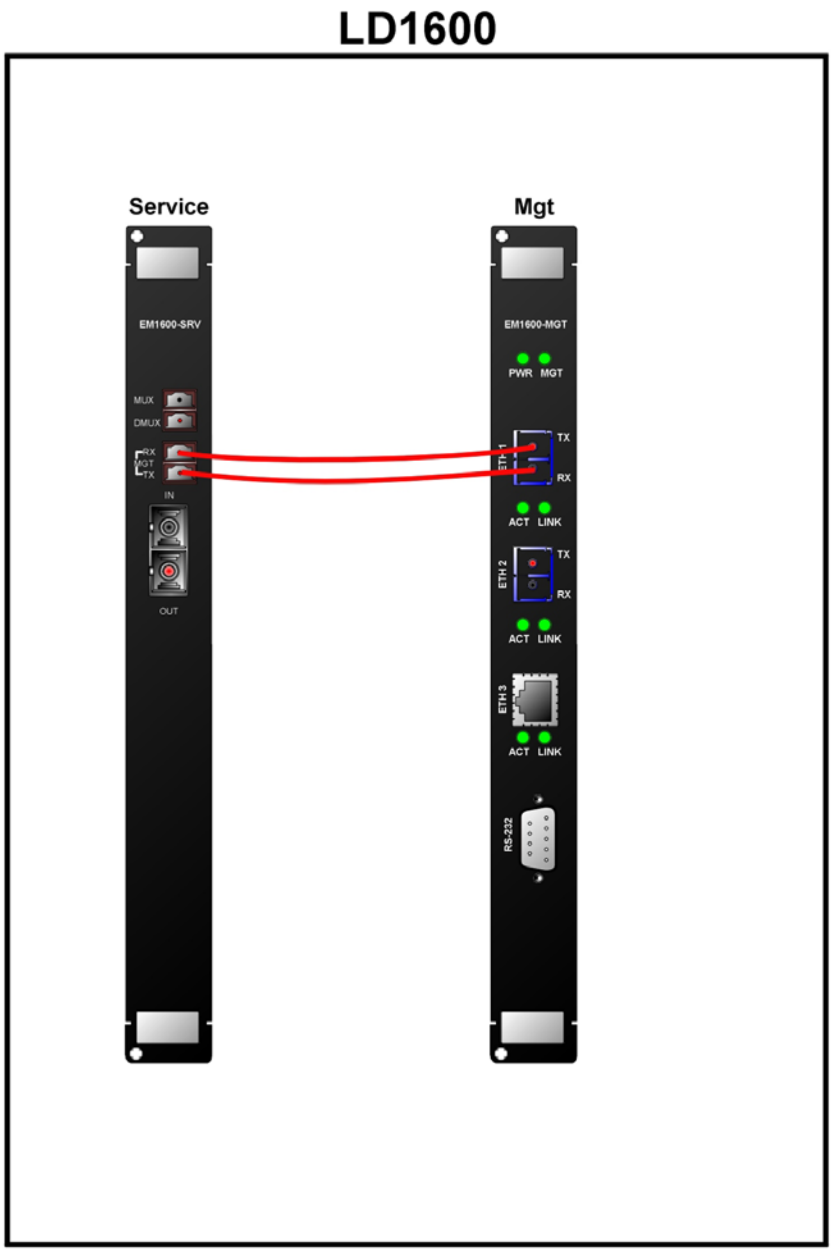


Figure 58: Service to Mgt Cabling *in* an LD1600

1+1 to Mgt Internal Cabling

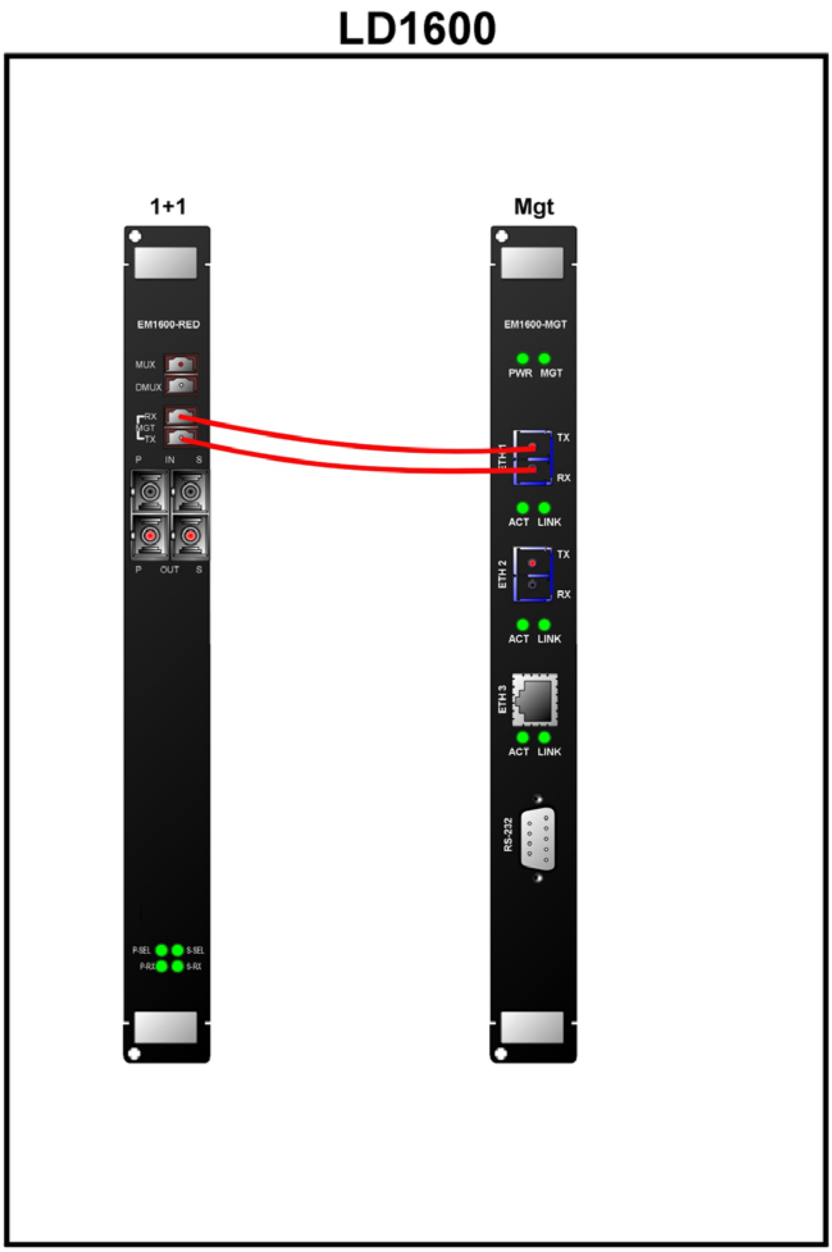


Figure 59: 1+1 to Mgt Cabling *in* an LD1600

ESCON to Transponder Internal Cabling

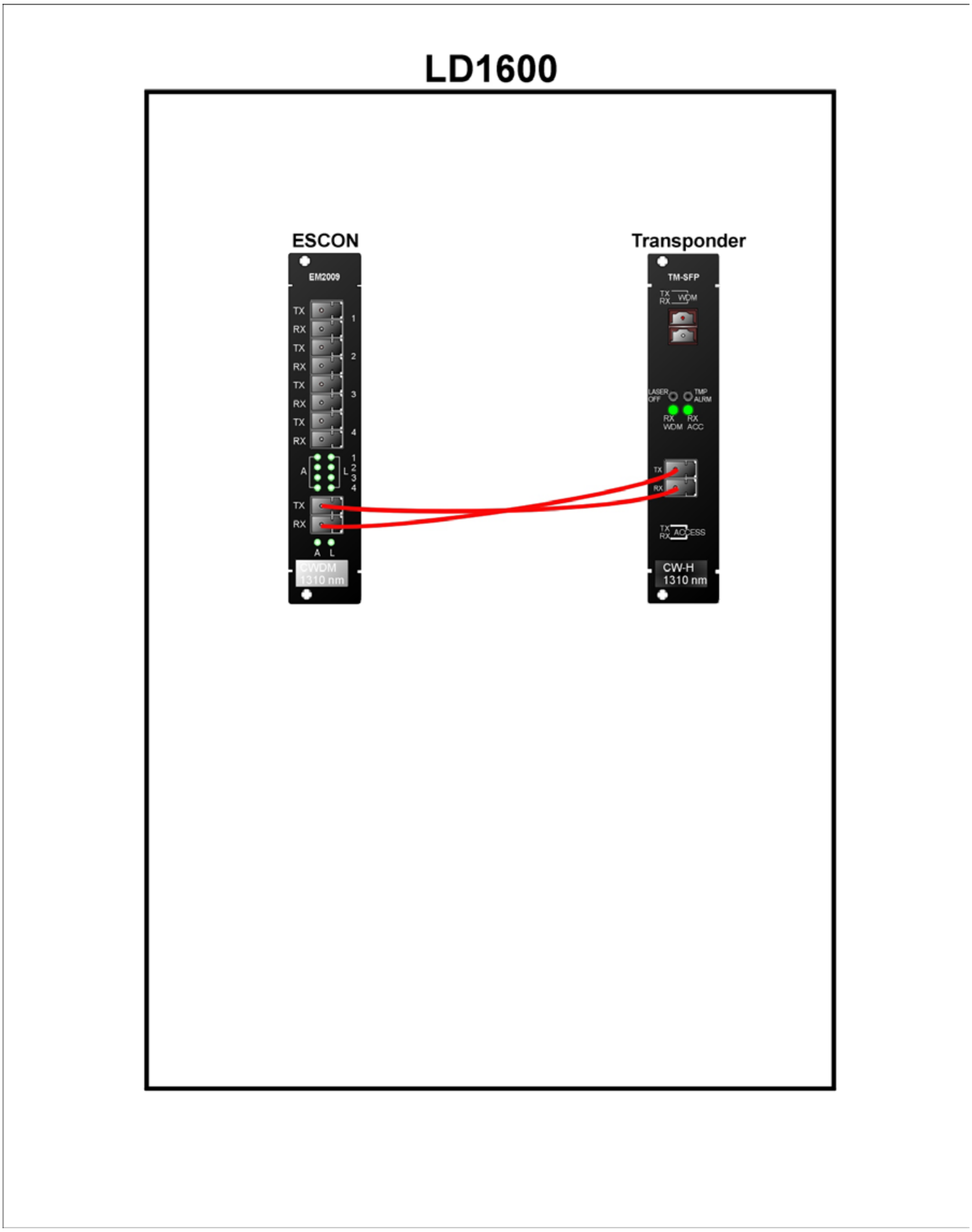


Figure 60: ESCON-to-Transponder Cabling *in* an LD1600

ESCON to Mux Internal Cabling

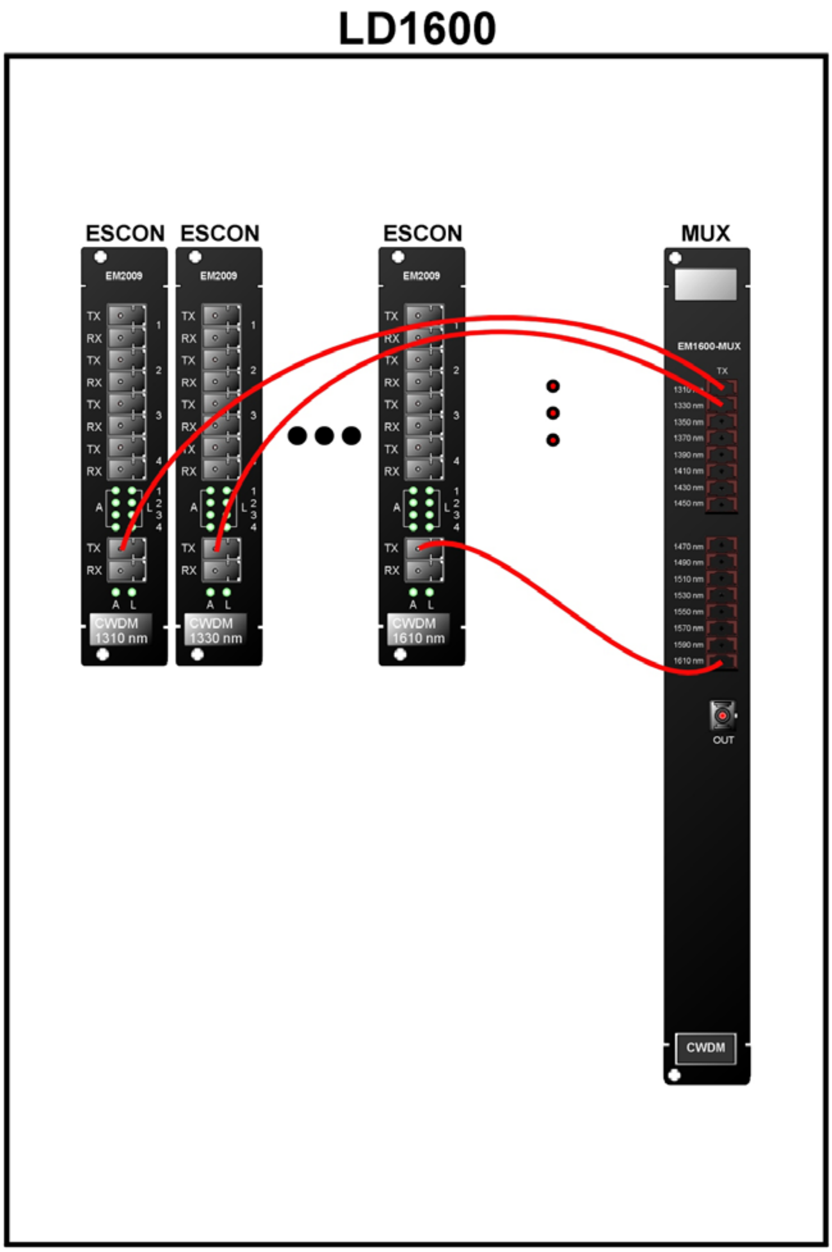


Figure 61: ESCON-to-Mux Cabling *in* an LD1600

ESCON to Demux Internal Cabling

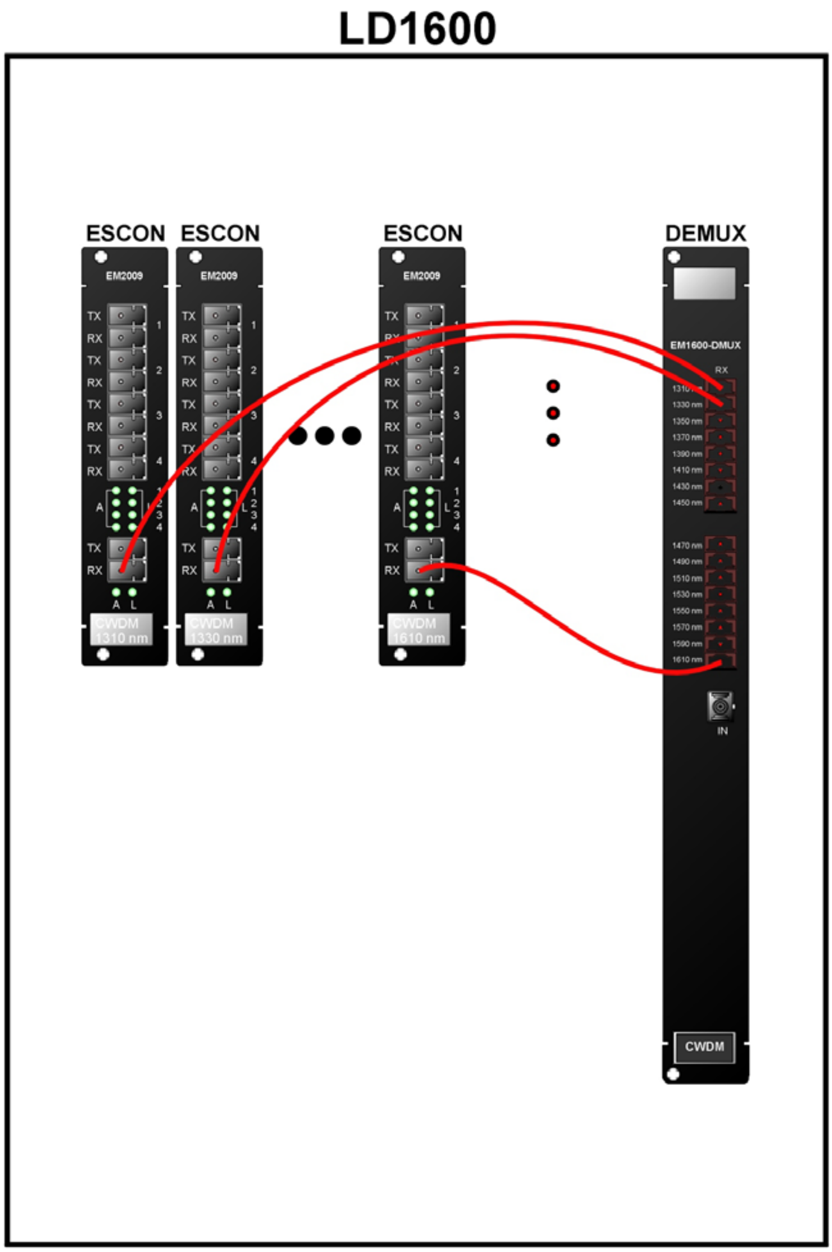


Figure 62: ESCON-to-Demux Cabling *in* an LD1600

ESCON to ESCON External Cabling

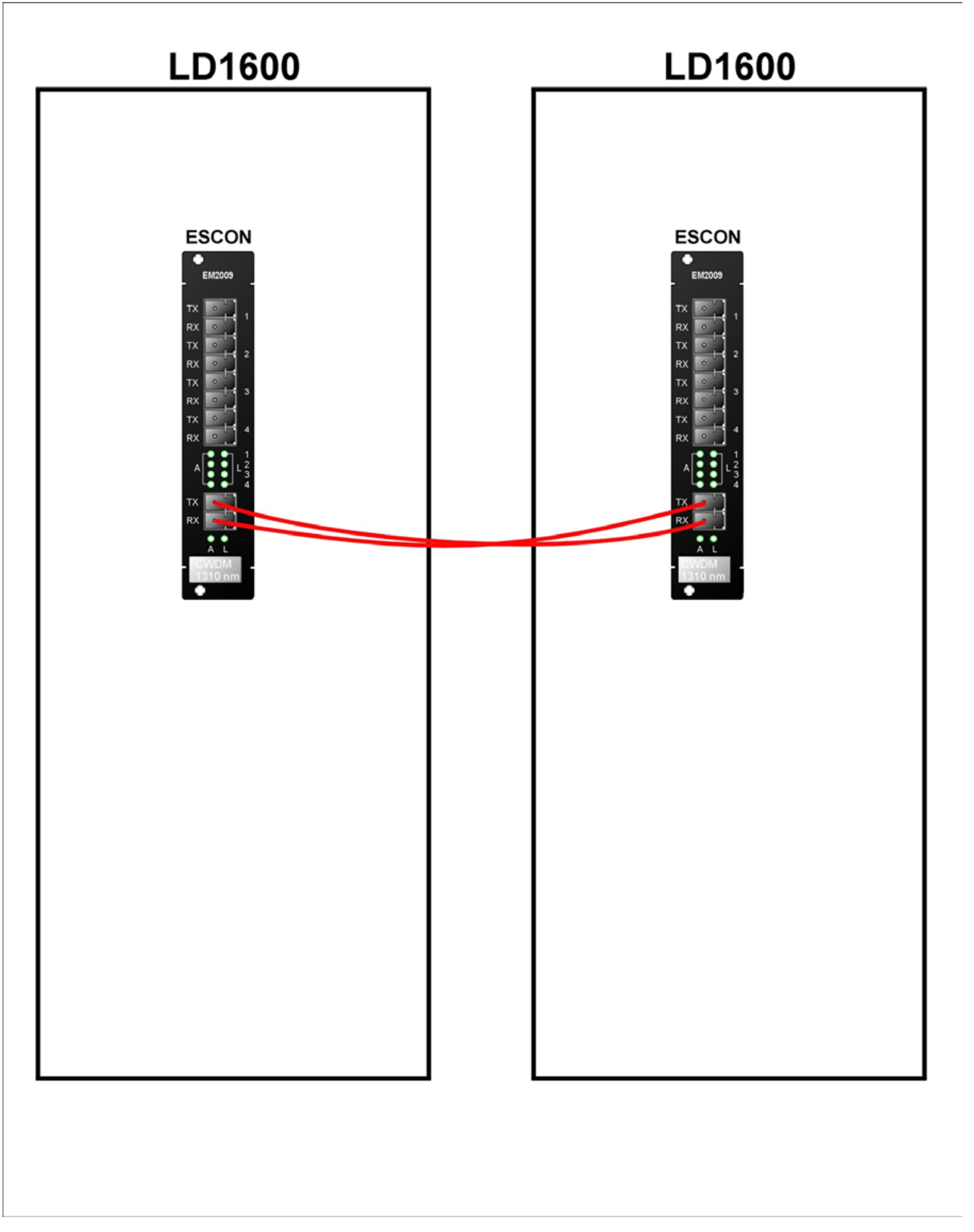


Figure 63: ESCON-to-ESCON Cabling *between* LD1600s

Pre-Amplifier OA to Demux Internal Cabling

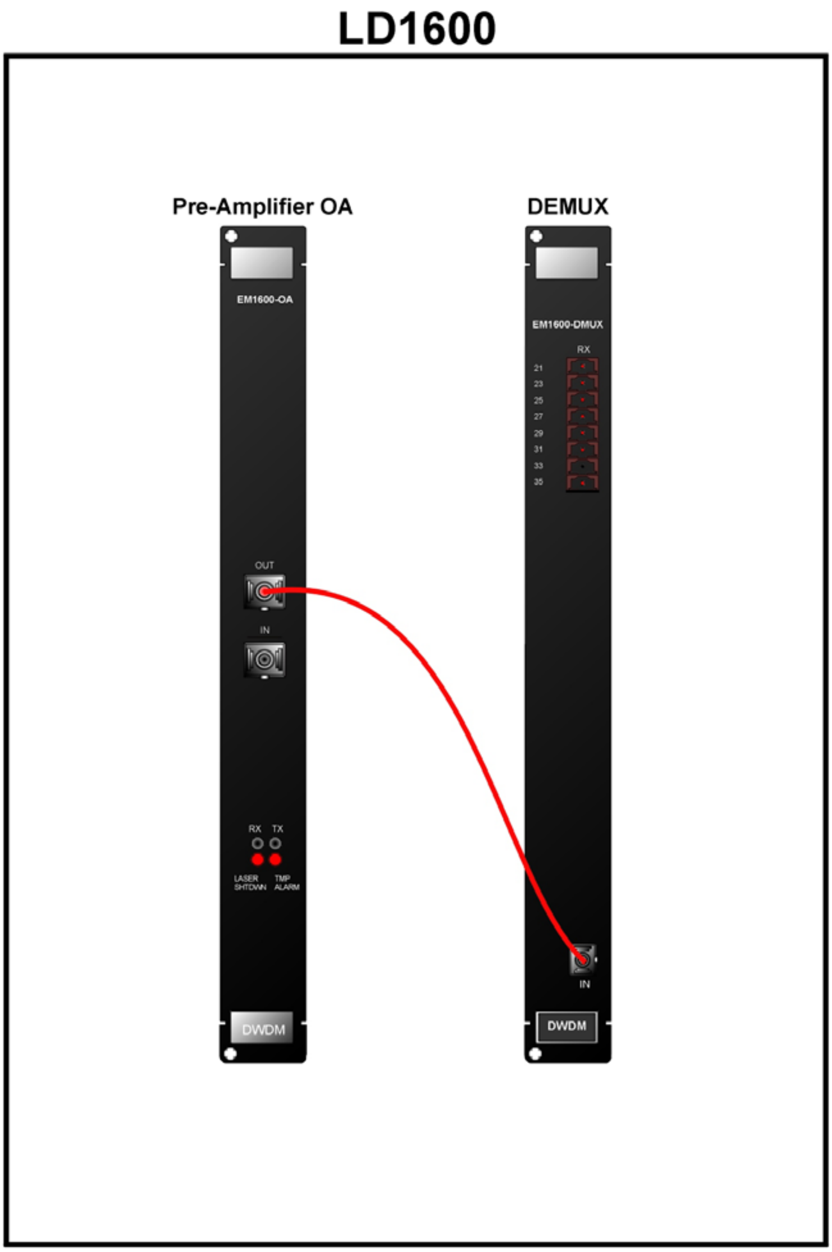


Figure 64: Pre-Amplifier OA to Demux Cabling *in* LD1600

Pre-Amplifier OA to Single-Interface OADM Internal Cabling

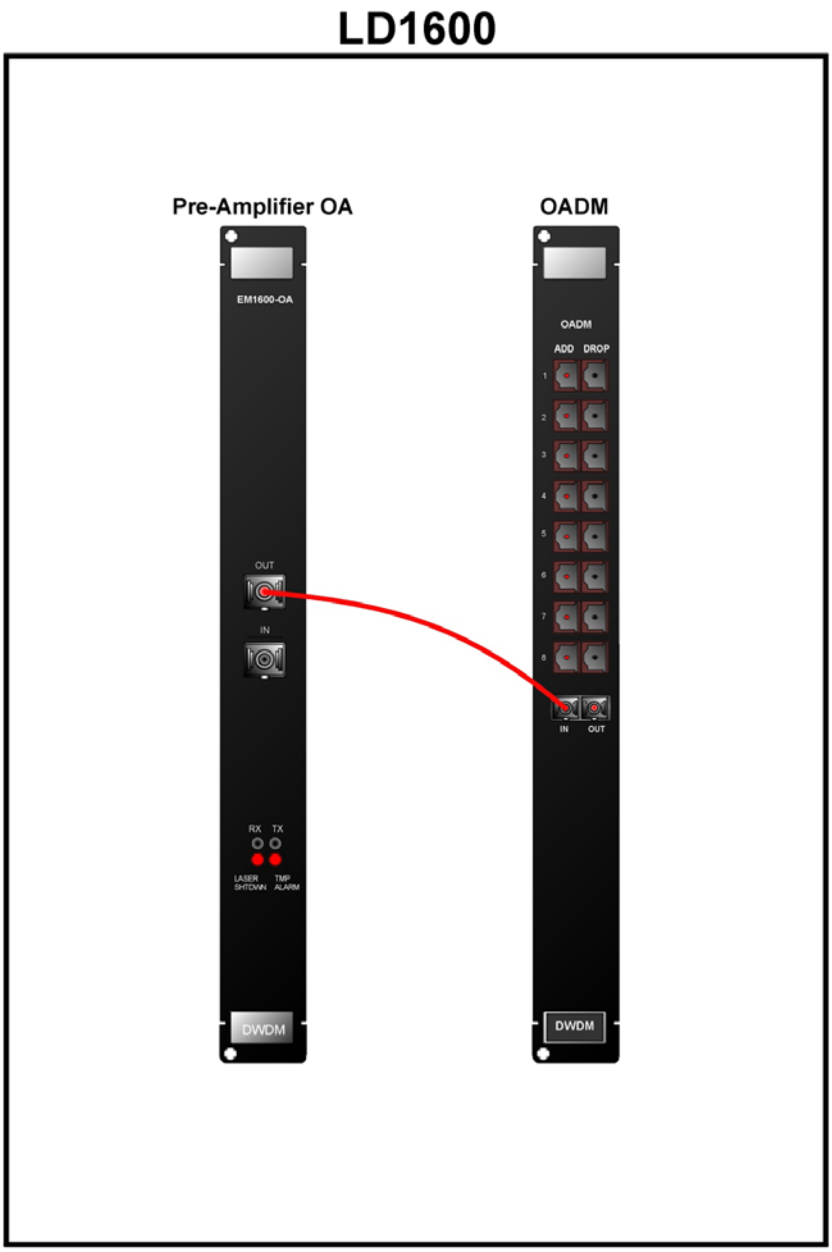


Figure 65: Pre-Amplifier OA to Single-Interface OADM Cabling *in* LD1600

Pre-Amplifier OA to Dual-Interface OADM Internal Cabling

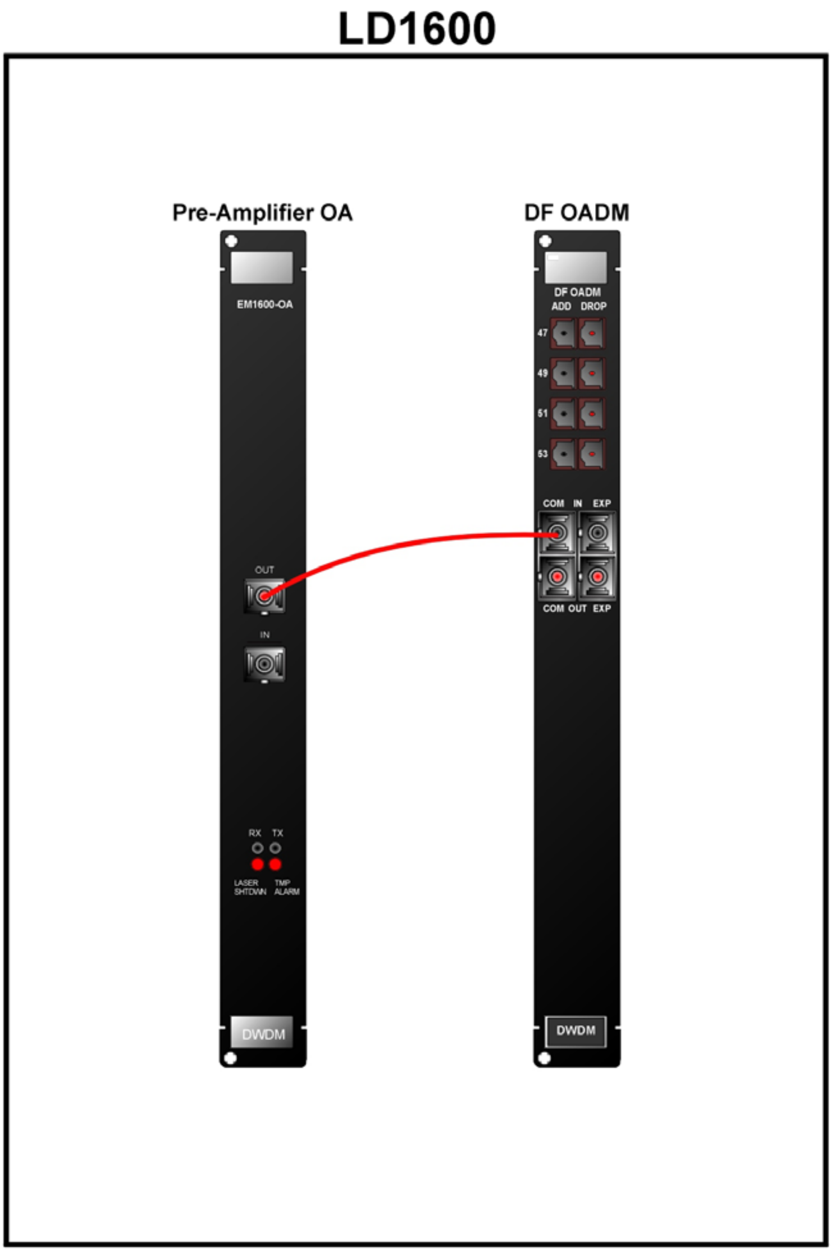


Figure 66: Pre-Amplifier OA to Dual-Interface OADM Cabling *in* LD1600

Mux to Booster OA Internal Cabling

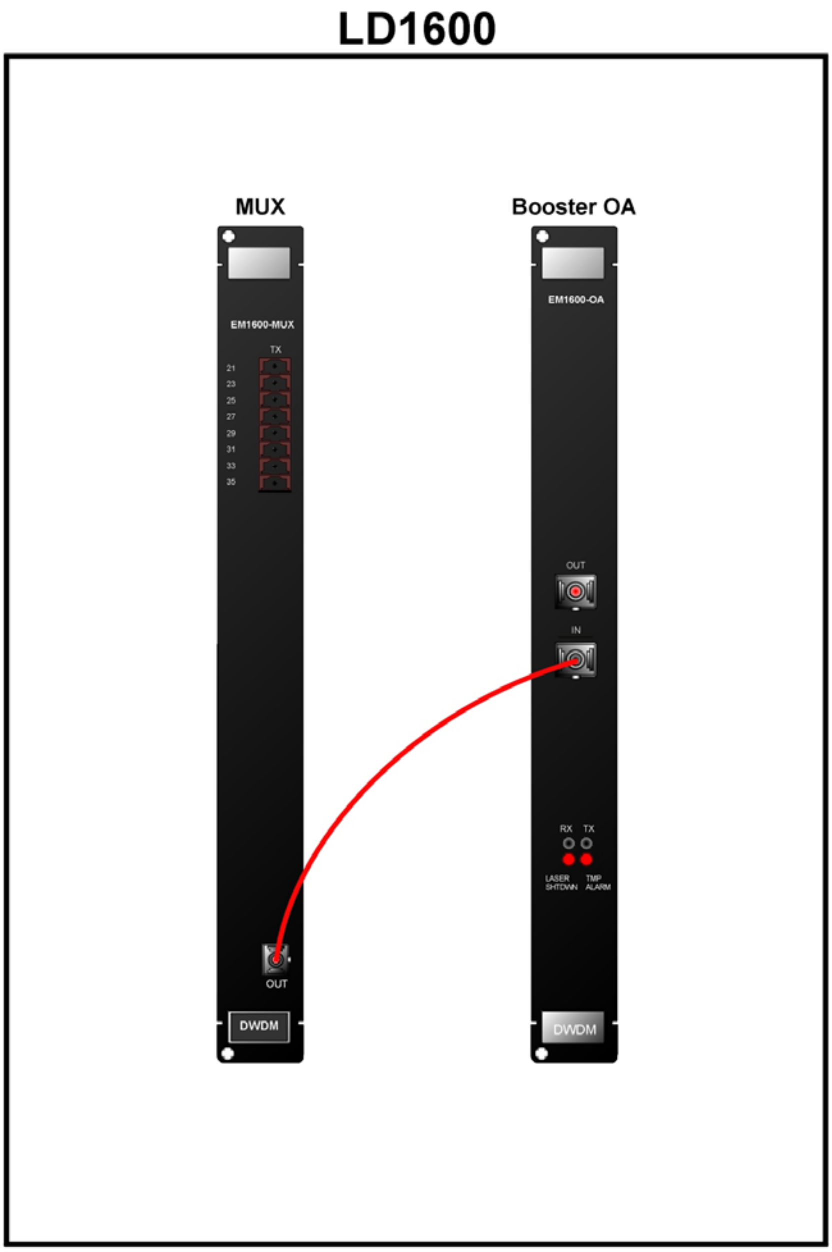


Figure 67: Mux to Booster OA Cabling *in* LD1600

Single-Interface OADM to Booster OA Internal Cabling

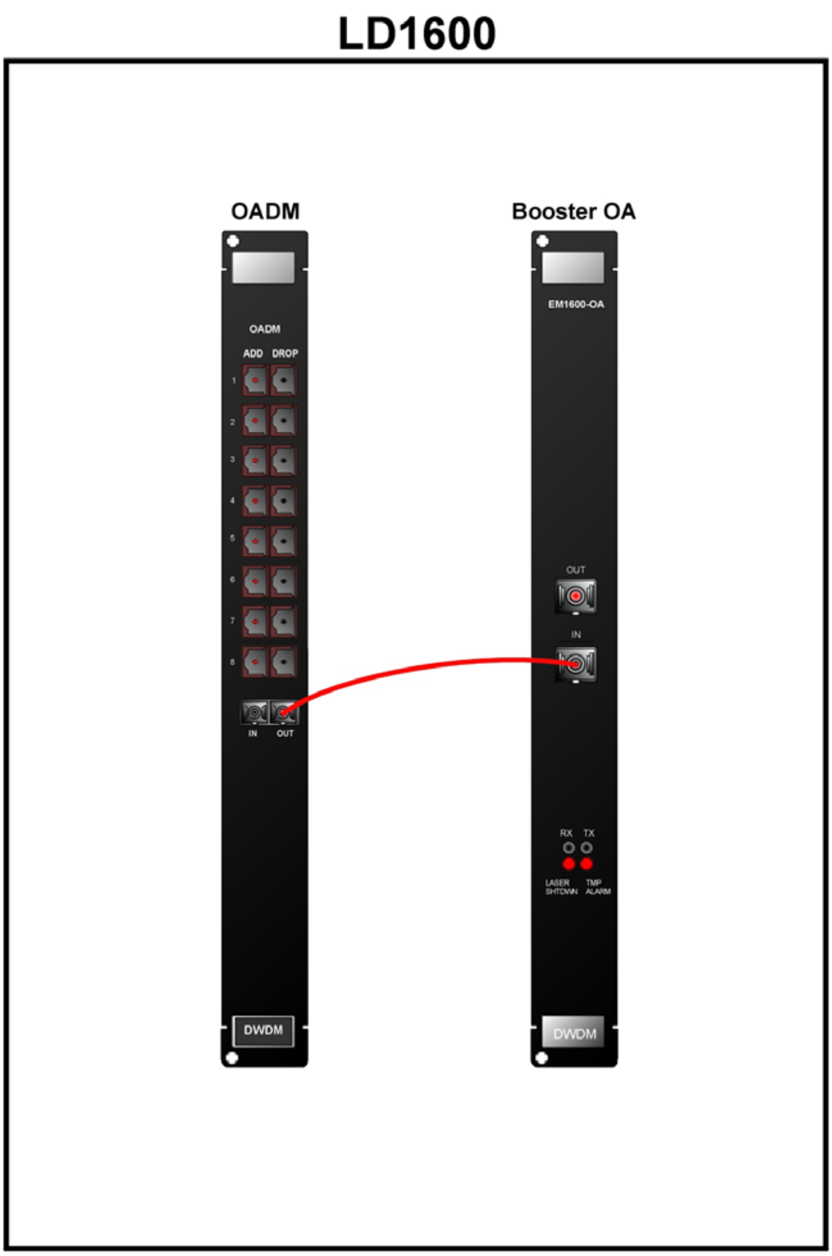


Figure 68: Single-Interface OADM to Booster OA Cabling *in* LD1600

Dual-Interface OADM to Booster OA Internal Cabling

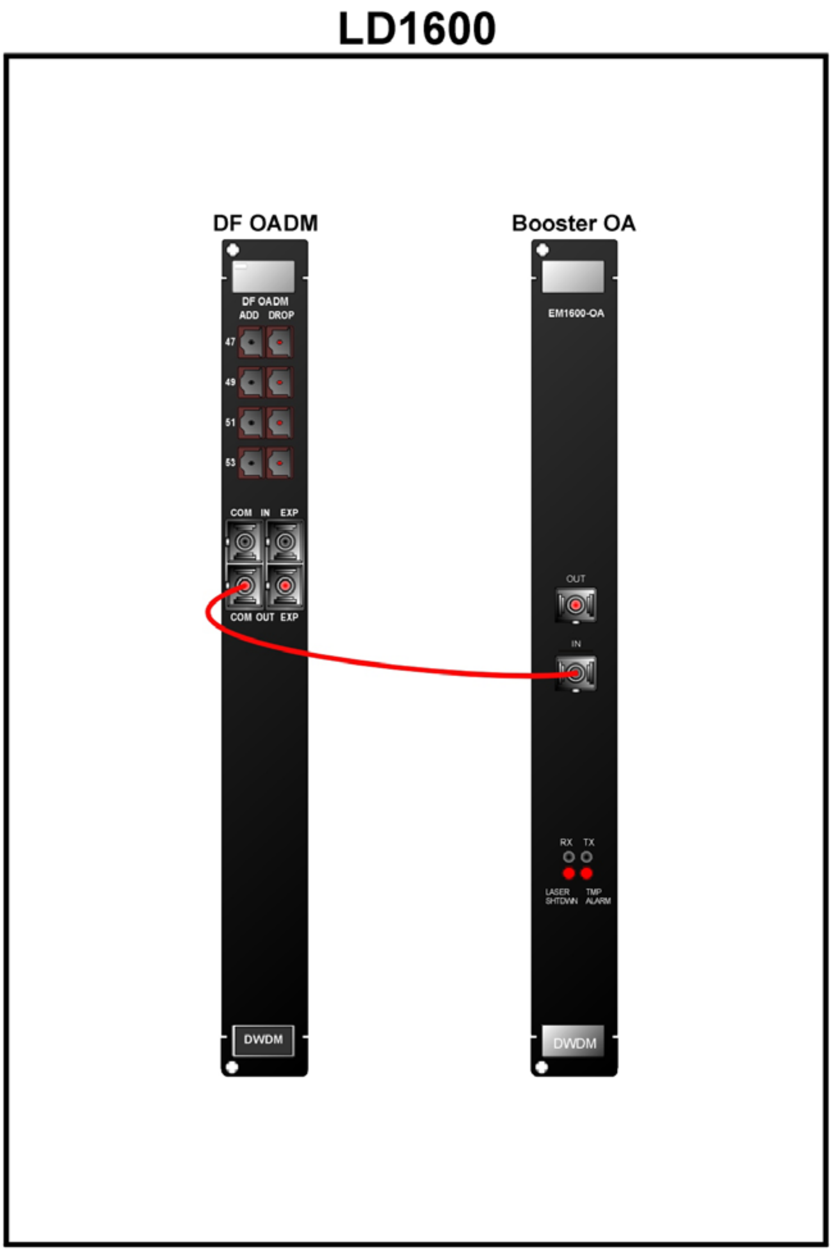


Figure 69: Dual-Interface OADM to Booster OA Cabling *in* LD1600

Single-Interface OADM to In-Line OA to Single-Interface OADM Internal Cabling

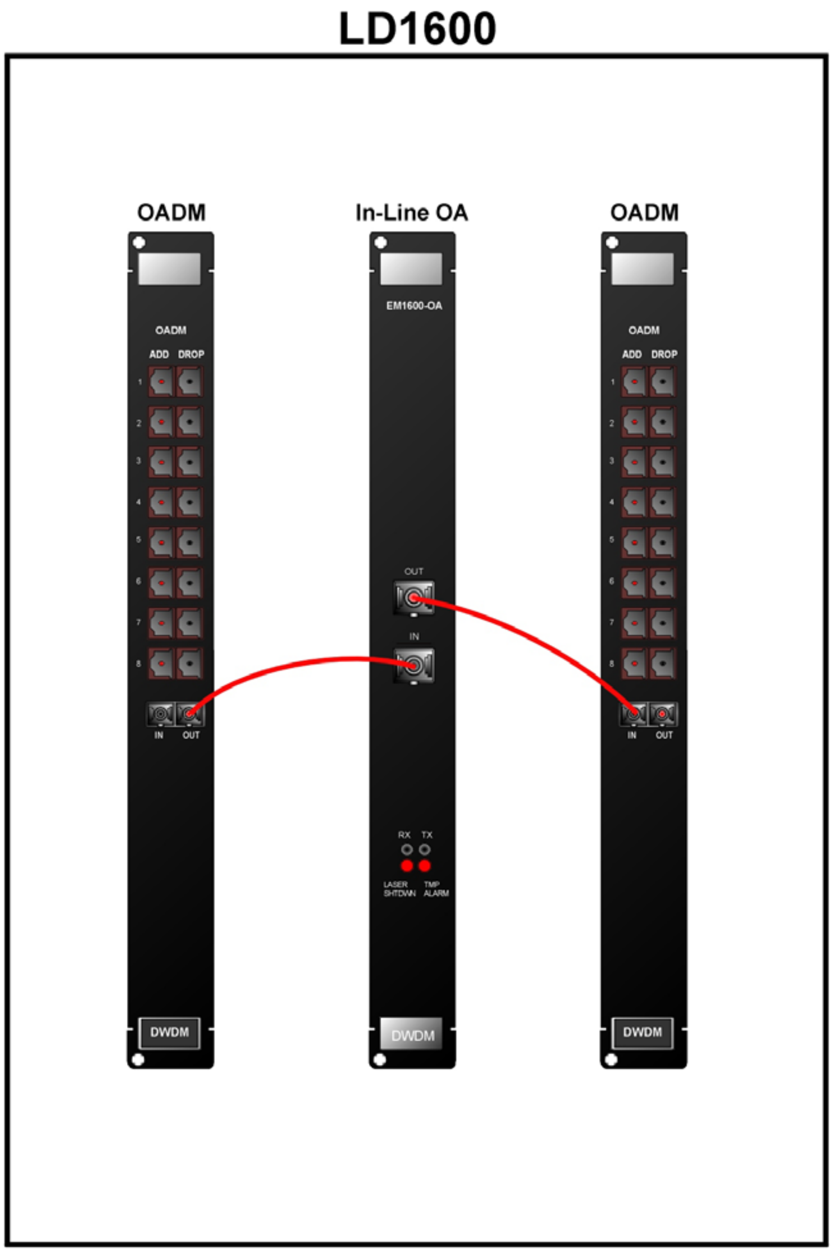


Figure 70: Single-Interface OADM to In-Line OA to Single-Interface OADM Cabling *in* LD1600

Dual-Interface OADM to In-Line OA to Dual-Interface OADM Internal Cabling

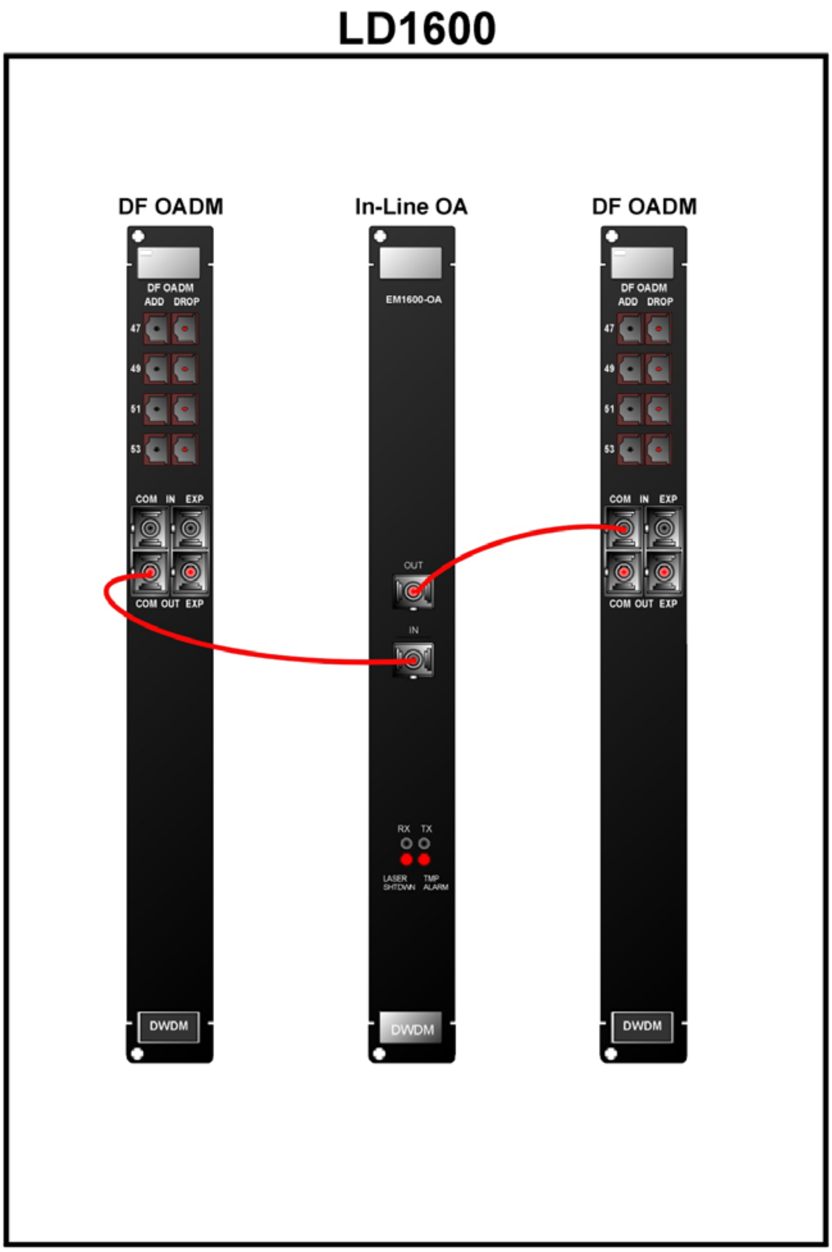


Figure 71: Dual-Interface OADM to In-Line OA to Dual-Interface OADM Cabling *in* LD1600

GM2 to Transponder Internal Cabling

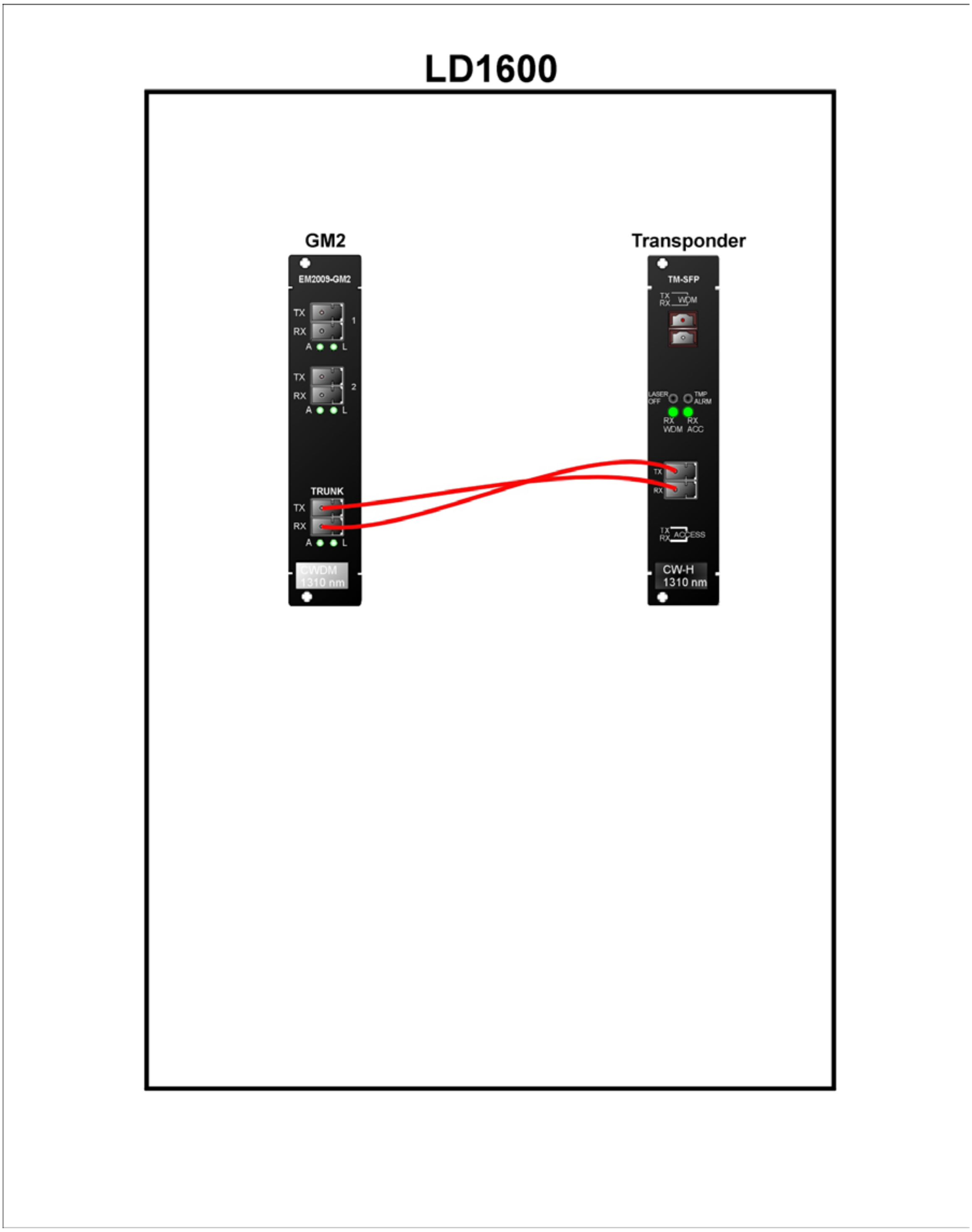


Figure 72: GM2-to-Transponder Cabling *in* an LD1600

GM2 to Mux Internal Cabling

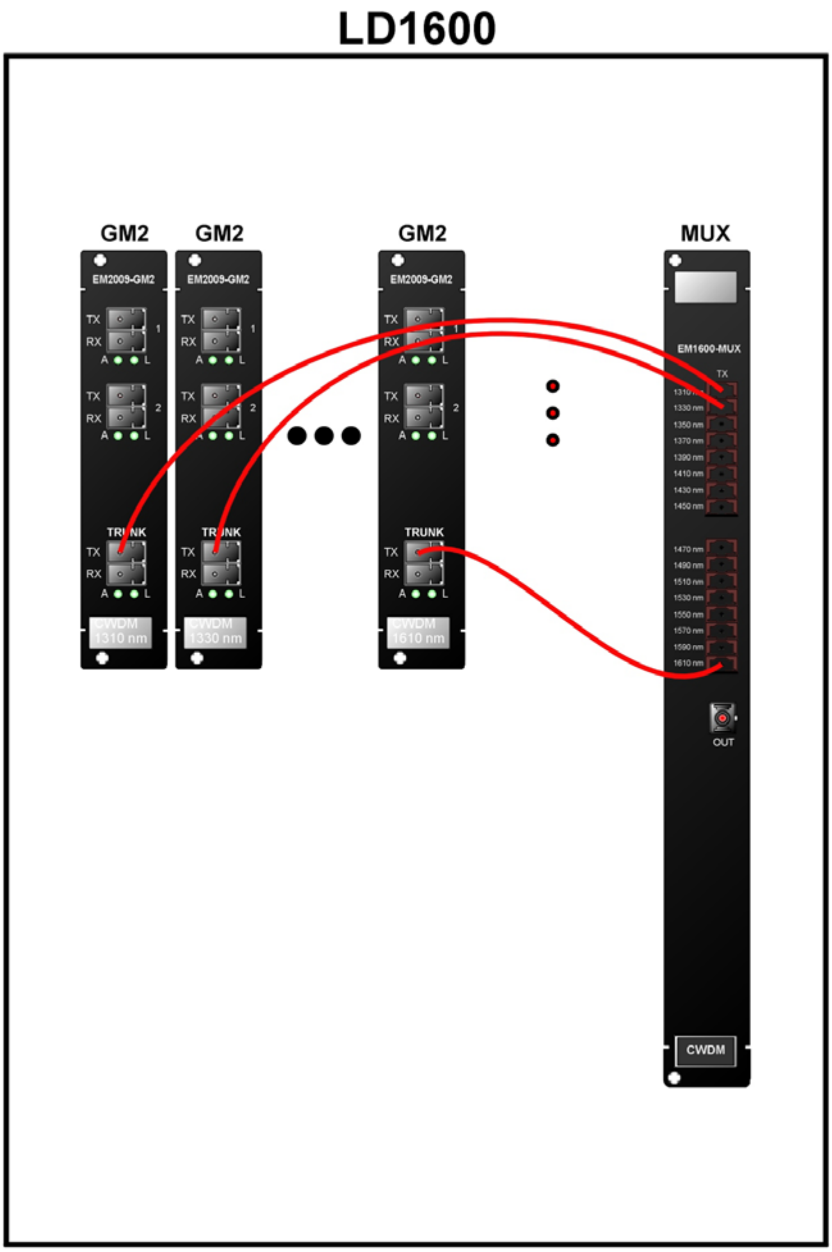


Figure 73: GM2-to-Mux Cabling *in* an LD1600

GM2 to Demux Internal Cabling

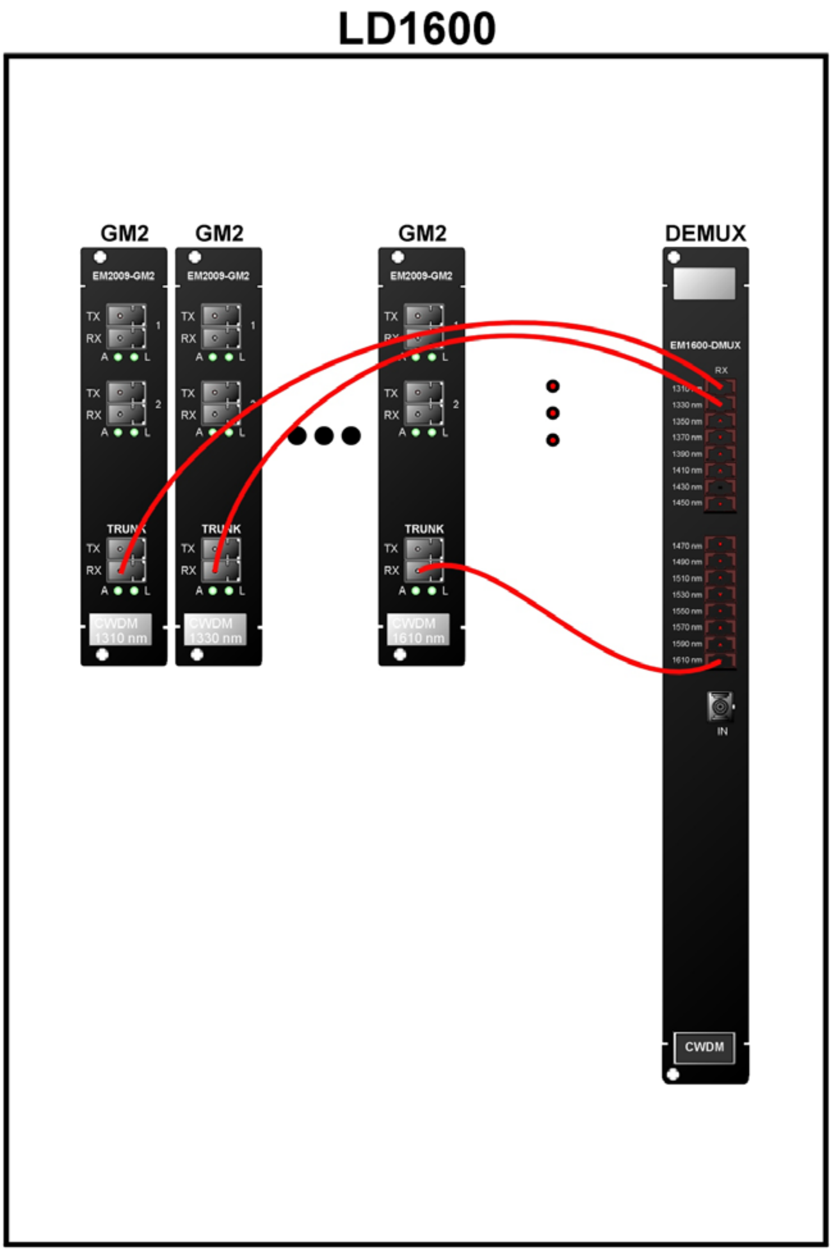


Figure 74: GM2-to-Demux Cabling *in* an LD1600

GM2 to GM2 External Cabling

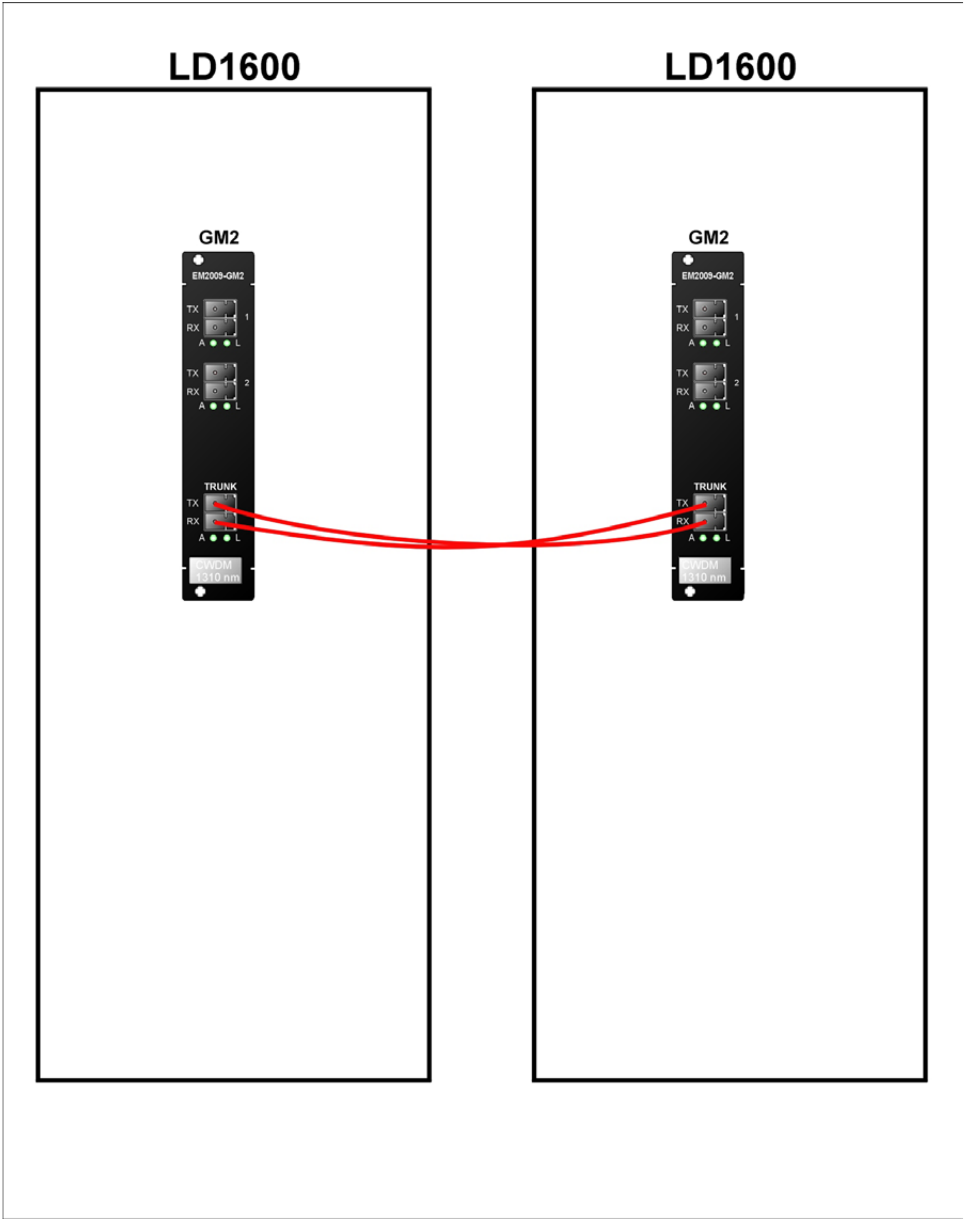


Figure 75: GM2-to-GM2 Cabling *between* LD1600s

Access Ports

Connect the access (data) ports of the Transponders to the access equipment with fiberoptic cabling.

Management Ports

To manage the LD1600, connect at least one of the following ports as described below.

Serial/RS-232 Port (For outband management)

With a null-modem (uncrossed) RS-232 cable having a female DB-9 connector, connect an ASCII terminal/emulator **serial port** to the Management Module's DB-9 male connector (marked **RS-232**, as shown in *Figure 7*) in one of the following ways:

- **Directly** – as shown in Figure 76.
- **Via Modem** – As described in Appendix F: Modem Setup and Installation.

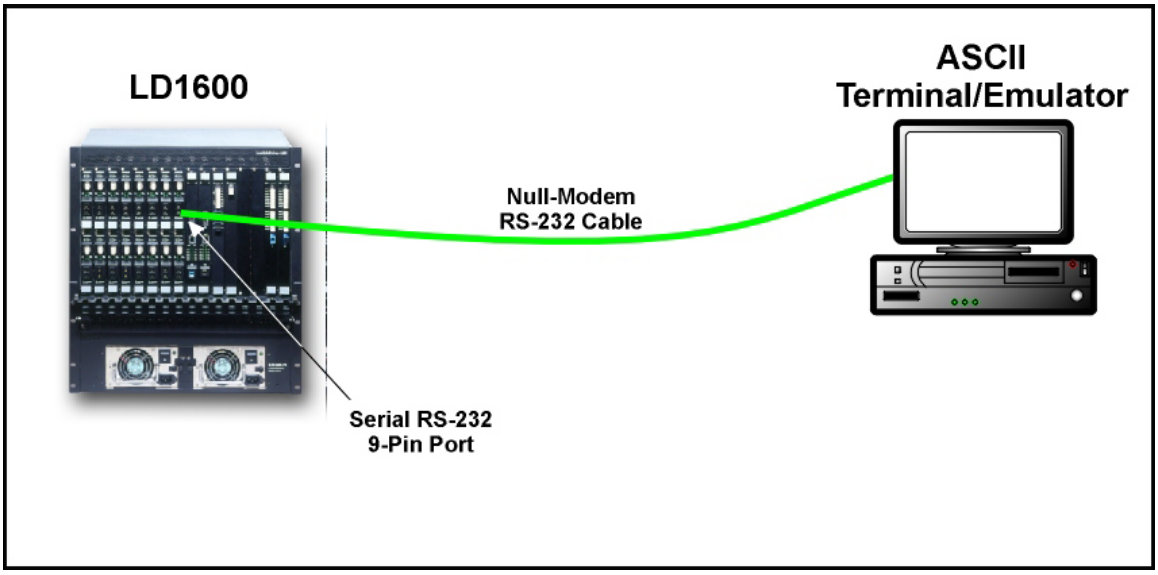


Figure 76: ASCII Terminal/Emulator Connection to LD1600 *Directly*

Ethernet Port (For inband management)

Connect the Management Module to an Ethernet LAN in the TELNET/SNMP/Web-based management station's broadcast domain – see *Figure 77* – in *either* of the following ways:

- With a fiberoptic cable having two male SC connectors, connect the Management Module's SC connectors (unmarked – see *Figure 7*) to the LAN.
- With a Category 5 shielded cable having an RJ45 male connector, connect the Management Module's RJ45 connector (marked **ETH** – see *Figure 7*) to the LAN.

Note

The Category 5 shielded cable must be straight-wired if it is to be connected to a DTE (e.g., PC) and cross-wired if it is to be connected to a DCE (e.g., hub). The wiring of a straight and cross cable are shown in *Figure 87* and *Figure 88*, respectively.

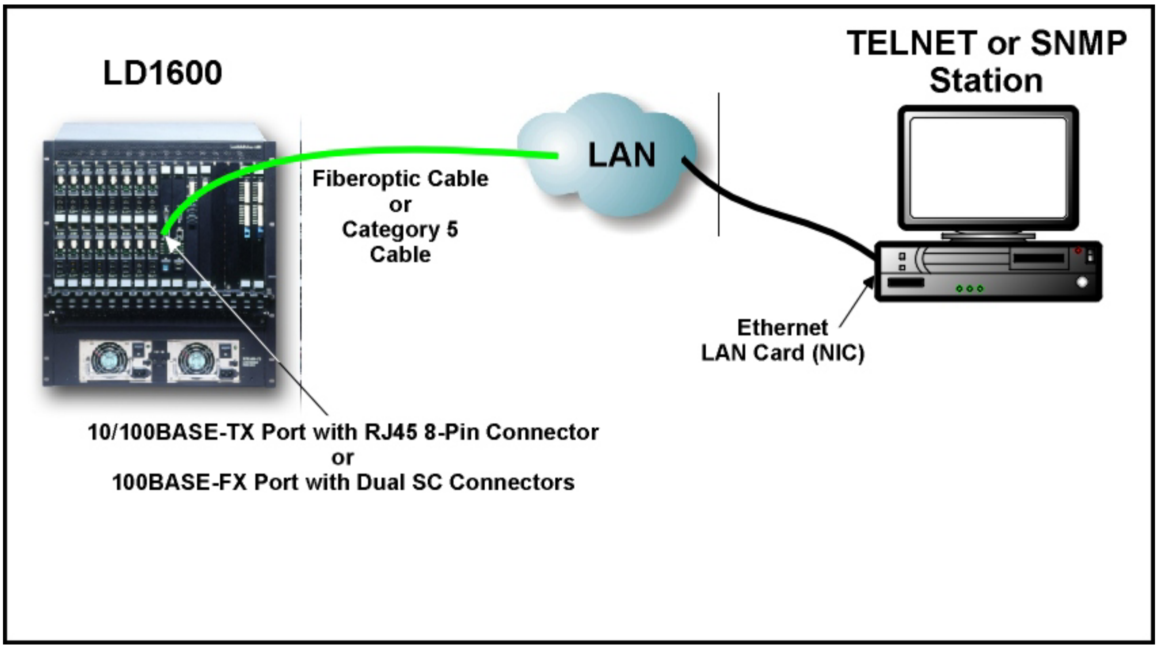


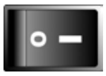
Figure 77: TELNET Station Connection to LD1600

Power Line Connection

1. Set the switch  of each Power Supply to the **0** (off) position.
2. Connect one (both) power cord(s) to the LD1600.
3. Connect the end(s) of the power cord(s) to the power line (mains).

Chapter 4
Startup, Setup, and Operation

Startup

To start up the LD1600, set the switch  of each Power Supply to the **I** (On) position. This causes the LD1600 to undergo initialization.

Setup

Default Settings

The LD1600 is set up at the factory before it is shipped out. This setup is referred to as the Default Setup. The default settings can be *changed* to suit the administrator as described in the section *Custom Settings*. The administrator can also restore all the default settings with the single CLI command **`init-nvram`**.

The Default Settings (and the CLI commands for changing them) are given in *Table 17*.

Table 17: Default Settings

Console

No.	Setting		CLI Command
	Description	Value	
1	**Page Size** – Number of lines per console page.	**22**	set-page
2	**Prompt** – Prompt given by console.	**SYS_console>**	set-prompt
3	**Password** – password required for accessing console.	**Enter**	set-password

System

No.	Setting		CLI Command
	Description	Value	
1	**Baud Rate** – Rate in baud at which the LD1600 can communicate on the serial channel via the RS-232 port.	**9600** (fixed)	(None)
2	**TFTP File Name** – Name of SNMP Agent software file to be downloaded.	**flash.hex**	set-sw-file
3	**TFTP Server IP Address** – IP address of TFTP server (relevant only if the TFTP Mode is *Client*).	**0.0.0.0**	set-tftp-srvr
4	**TFTP Mode** – Whether the LD1600 is a Client or Server for the SNMP Agent software file.	**client**	set-tftp-mode

IP

No.	Setting		CLI Command
	Description	Value	
1	**IP Address** – IP address of device agent.	**0.0.0.0**	set-ip
2	**Default Gateway** – IP address "default gateway" node where packets should be sent in the absence of other routing information.	**0.0.0.0**	set-gatew

SNMP

No.	Setting		CLI Command
	Description	Value	
1	**Read Community String** – Password for getting information on a specific SNMP setting of the LD1600.	**public**	set-comm
2	**Write Community String** – Password for changing a specific SNMP setting of the LD1600.	**private**	set-comm
3	**Traps Authentication** – Sending of traps regarding authenticity of access to LD1600.	**disable**	set-auth
4	**System Contact** – Contact information for the LD1600.	(None)	(None – the SNMP object for changing the value is **sysContact**.)
5	**System Name** – Mnemonic for easily identifying the LD1600.	(None)	(None – the SNMP object for changing the value is **sysName**.)
6	**System Location** – Location of the LD1600.	(None)	(None – the SNMP object for changing the value is **sysLocation**.)

Custom Settings

The administrator can *change* the settings of the default setup by CLI commands (described in the Chapter 5) or SNMP commands (described in *MegaVision LambdaDriver 1600 Management User Guide*).

Operation

LD1600 becomes fully operational within a few seconds after being powered on.

During operation, Automatic Laser Shutdown (ALS/APR) and Link Integrity Notification (LIN) functions are activated. For details on ALS/APR and LIN, refer to the section *Transponder Module* on page *23*.

Its operation can be monitored by:

- Interpreting the status of its LEDs with the aid of *Table 18*, below.
- TELNET station or ASCII terminal as described in the Chapter 5.
- SNMP NMS or MIB browser.
- MRV's Web-based SNMP management application *MegaVision*®

If there is a problem, use Appendix B to resolve it.

Table 18: Front Panel LEDs

Module	LED	Status	Significance
Power Supply	PWR	ON-Green	Power distribution OK.
		OFF	Power distribution faulty.
Transponder	ACC(ESS) RX	ON-Green	Reception at access port OK.
		OFF	Reception at access port faulty.
	WDM RX	ON-Green	Reception at WDM port OK.
		OFF	Reception at WDM port faulty.
	LASER OFF	ON-Red	WDM Transmission laser faulty.
		OFF	WDM Transmission laser OK.
	TMP ALRM	ON-Red	Module too hot.
		OFF	Module temperature OK.
Management	PWR	ON-Green	Power to module OK.
		OFF	Power to module faulty.
	MGT	ON-Green	SNMP data flowing.
		OFF	No SNMP data flowing.
	ETH 1 ACT	ON-Green	OSC data flowing.
		OFF	No OSC data flowing.
	ETH 1 LINK	ON-Green	OSC link OK.
		OFF	OSC link faulty.
	ETH 2 ACT	ON-Green	OSC data flowing.
		OFF	No OSC data flowing.
	ETH 2 LINK	ON-Green	OSC link OK.
		OFF	OSC link faulty.
	ETH 3 ACT	ON-Green	Ethernet data flowing.
		OFF	No Ethernet data flowing.
	ETH 3 LINK	ON-Green	Ethernet link OK.
		OFF	Ethernet link faulty.
1+1 Redundancy	P-SEL	ON-Green	Primary link selected.
		OFF	Primary link deselected.
	S-SEL[29]	ON-Green	Secondary link selected.
		OFF	Secondary link deselected.
	P-RX	ON-Green	Primary link receiveport OK.
		OFF	Primary link receiveport faulty.
	S-RX	ON-Green	Secondary link receiveport OK.
		OFF	Secondary link receiveport faulty.
ESCON Multiplexer	L1, L2, L3, or L4	ON-Green	Port (1, 2, 3, or 4) link to network *OK*.
		OFF	Port (1, 2, 3, or 4) link to network *faulty*.
	A1, A2, A3, or A4	ON-Green	Reception at port (1, 2, 3, or 4) synchronized.
		OFF	Reception at port (1, 2, 3, or 4) *not* synchronized.
	L	ON-Green	Multiplex port link to network *OK*.
		OFF	Multiplex port link to network *faulty*.

[29] When S-SEL LED is OFF, P-SEL LED should be ON, and vice versa.

	A	ON-Green	Multiplexed port receiving valid data.
		OFF	Multiplexed port *not* receiving valid data.
OA	LASER SHTDWN	ON-Red	WDM Transmission laser to IN port *off*.
		OFF	WDM Transmission laser to IN port *OK*.
	TMP ALARM	ON-Red	Module temperature *out of range*.
		OFF	Module temperature *OK*.
	RX	ON-Green	Input signal power at IN Port *out of range*.
		OFF	Input signal power at IN Port *OK.*
	TX	ON-Green	Output signal power at OUT Port *out of range*.
		OFF	Output signal power at OUT Port *OK.*
GM2	L1 or L2	ON-Green	Port 1 or 2 link to network *OK*.
		OFF	Port 1 or 2 link to network *faulty*.
	A1 or A2	ON-Green	Port 1 or 2 receiving data.
		OFF	Port 1 or 2 *not* receiving data.
	TRUNK L	ON-Green	Trunk (WDM) Port link to network *OK*.
		OFF	Trunk (WDM) Port link to network *faulty*.
	TRUNK A	ON-Green	Remote Port 1 and remote Port 2 transmitting.
		Slow BLINKS	Remote Port 1 transmitting, Remote Port 2 *not* transmitting.
		Fast BLINKS	Remote Port 1 *not* transmitting, Remote Port 2 transmitting.
		OFF	Remote Port 1 and remote Port 2 *not* transmitting.

Chapter 5
CLI Management

General

This chapter describes how to custom setup and manage the LD1600 through its CLI with either of the following management stations:

- ASCII terminal/emulator (e.g., VT100 terminal or emulator), or
- TELNET station

For Web-based management of the LD1600, refer to *MRV*'s MegaVision NMS User Manual.

Functions

The CLI provides the following functions:

- Setting of system parameter values, including the serial line and/or the console's parameters
- Setting of LD1600 SNMP Agent parameter values
- Setting of port parameter values
- Network performance monitoring
- Module status monitoring
- Statistical data recording
- Software upgrading/downloading

Management Station Connection

Refer to Section *Management Ports*, page *160*.

Management Station Setup

ASCII Terminal/Emulator Setup

If you are using a PC, run the emulation software application (e.g., Microsoft Window's HyperTerminal) from the windows OS.

Setup the ASCII terminal/emulator as follows:

Table 19: ASCII Terminal/Emulator Setup for CLI Management

Transmit/Receive Rate	Data Length	Parity	Stop Bit	Flow Control
9600	8 bits	None	1	None

TELNET Station Setup

Assign an IP address to the LD1600. This can be done using an ASCII terminal/emulator connected to the LD1600 **RS-232** port directly or via modem as shown in *Figure 76* or *Figure 89*.

Make sure that a TELNET connection exists between the TELNET station and the LD1600. This connection can be made using a Microsoft Windows operating system as follows:

1. Click **Start** and then **Run…**.
2. When the Run window opens, type **telnet** , a blank space, the IP address of the LD1600, and press **Enter**.

Password

Access to the CLI of the LD1600 is restricted by password. The existing password can be changed as follows:

1. Type **`set-password`**, press **Enter**.
2. Type the existing password, press **Enter**.
3. Type the new password, press **Enter**.
4. Retype the new password to confirm, press **Enter**.

CLI Types

Either of the following CLIs can be accessed to manage the LD1600:

- **Operational CLI** – Accessible *after* the LD1600 becomes operational. It can be accessed remotely from a TELNET station or locally with an ASCII terminal/emulator.
- **Boot CLI** – Accessible *before* the LD1600 becomes operational. It can be accessed only *locally* with an ASCII terminal/emulator connected to its RS-232 port; it cannot be accessed by TELNET. It has fewer commands. It is used only to perform downloading of new operative software when the LD1600 cannot become operational.

CLI Access

> **Note**
>
> LD1600 continues normal operation whether the Operational or Boot CLI is accessed or not!

To access the Operational or Boot CLI, perform the following steps:

1. For ASCII Terminal/Emulator
   Ensure that the ASCII terminal/emulator has been set up as described in *Table 19*.
   For TELNET station
   Ensure that an IP address has been assigned to the LD1600. (This can be done using the interconnection in *Figure 76* or *Figure 89*.)
2. Attempt to enter a management session with the ASCII terminal/emulator or TELNET station.
3. When the management session window opens, ensure that the LD1600 is powered on.
4. For Operational CLI
   Wait until the system prompt **`username`** appears.
   For Boot CLI
   When the message
   ```
   Initialization . . . from boot
   #
   1  2
   ```
   appears in the window and before the count of 5 is reached, strike any key.
5. Enter a user name or press **Esc** to skip it.
6. Wait until the system prompt **`password`** appears.
7. If the current password is the factory default password, either type a new password or press **Enter** to skip it.
   If the current password is *not* the factory default password, type the password to enter a CLI session.
8. Wait for the system prompt **`SYS_console>`** to appear. The prompt indicates that connection to the CLI is established and the LD1600 is ready to be managed.

CLI Commands

General

CLI commands can be invoked when the Operational or Boot CLI is accessed. (The section *CLI Access* gives the procedure for accessing these two CLIs.) This section presents these CLI commands, describes their functions, specifies their interdependence (if any), explains their syntax, and gives examples of usage for each in order to show how they may be used.

The set of CLI commands available depends on the type of CLI accessed, i.e., *Operational* CLI or *Boot* CLI. CLI commands available in one CLI type and not the other are identified as such in the section *Specification,*page *171*.

The CLI commands for configuring and managing the LD1600 are divided into several groups. They are: **console**; **system**; **ip**; **snmp** (in Operational CLI only); **slot-stat**; **statistics** (in Operational CLI only). Typing the name of the group lists the commands available in the group as well as the description of the commands.

On entry into a CLI session, any command can be directly executed or polled for information without having to first type the name of the group to which it belongs. Typing **?** and pressing **Enter** at the **SYS_Console** prompt displays the command menus. To poll any command for information on arguments (extensions) that have to be typed in order to execute the command, type the command followed by **?** and press **Enter**.

To type a command quickly, type the first letter(s) and press **Tab**.

Note
A blank space must be typed between a command and its argument(s) – if any – as well as between two consecutive arguments.

The system remembers the commands invoked in a CLI session. The remembered commands can be displayed by typing **#**. The display also shows the number code assigned by the LD1600 to each of these commands. To type a remembered command quickly, type **#** and the number code.

Table 20 describes the function of the symbols that appear in the CLI commands.

Table 20: Function of Symbols in CLI Commands

Symbol	Function
#	Represents the word number.
< >	Encloses a mandatory command argument (extension). Do not type this symbol with the command argument!
|	Separates choices in a command argument. Only one choice may be selected. Do not type this symbol with the command argument!
{ }	Encloses an optional command argument. To list items having number IDs: Type the individual numbers separated by hyphens and/or Type the lowest and highest number separated by two dots (**..**) to specify a range of consecutive numbers. Do not type this symbol with the command argument! Example: To list items 1, 3, 4 to 7, and 9, type **1-3-4..7-9**
( )	Encloses the description of the command.

The CLI commands can be divided into two groups:

– Global Commands

– Module-specific Commands

Global Commands

All CLI commands in the section *Specification,* on page *171*, other than those listed in *Table 21* are applicable to the LD1600 as a whole.

Module-specific Commands

All CLI commands under the group *console*, on page *171*, as well as those in the row "Any" of *Table 21* are applicable to all modules. Additional CLI commands that apply to specific modules are given in *Table 21*. Details on these (and other) commands are given in the section *Specification*.

Table 21: CLI Commands per Module

Module	CLI Commands	
	Syntax	**Description**
Any	`get-wdm-card-stat` `sys-stat`	Show status of cards in device. Show system status information.

Transponder	`set-transponder-rate`
	`set-laser-mode`
	`get-card-wdm-power`
	`get-transponder-lb`
	`set-transponder-lb`
	`get-trans-red-stat`
	`set-trans-primary-state`
	`get-sfp-spec-info`
	`get-sfp-diagnostics`
	`get-trans-counters`
	`clear-trans-counters`
		Set module rate.
		Set laser mode (enable or disable laser).
		Show WDM input and output optical power in dBm units.
		Show module mode (normal operation or LoopBack).
		Set module mode (normal operation or LoopBack).
		Show module redundancy status.
		Activate primary or secondary transponder.
		Show SFP vendor data.
		Show SFP diagnostic data.
		Show module counters.
		Clear module counters.

Management	`get-card-ports-stat`
	`clr-eth-mgt-cnt`
	`get-eth-mgt-cnt`
		Show status of module ports.
		Clear Ethernet counter readings of management port.
		Show Ethernet counter readings of management port.

1+1 Redundancy	`get-redun-card-stat` `set-opt-switch`	Show status of 1+1 redundancy modules. Activate primary (P) or secondary (S) link for 1+1 redundancy module.
OADM	`get-adc-lambda-info`	Show information (e.g., operating wavelength, etc.) on OADM modules (ADC = Single-interface, ADCD = Dual-interface)
ESCON	`get-card-ports-stat`	Show status of module ports.

GM2, FC2	`get-card-ports-stat`
	`get-transponder-lb`
	`set-transponder-lb`
	`get-sfp-spec-info`
		Show status of module ports.
		Show module mode (normal operation or LoopBack).
		Set module LoopBack/normal mode.
		Show module SFP vendor data.

	`get-sfp-diagnostics`
	`get-trans-counters`
	`clear-trans-counters`
		Show module SFP diagnostic data.
		Show module port counters.
		Clear module port counters.

OA	`get-oa-parameters`
	`get-oa-config`
	`set-oa-run-mode`
		Show optical amplifier parameters.
		Show optical amplifier configuration.
		Set optical amplifier operation mode.

The CLI commands are presented in detail below under their respective groups (**console**, **system**, **ip**, etc.).

Specification

This section describes each CLI command in detail. When invoking a command for a module port, the following

console

Command	help-kbd
Description	List console keys having CLI functionality.
Syntax	**`help-kbd`**
Default	–

Example	`SYS_console>help-kbd`
	`------------------------------------------------------------------------`
	`^U (or Esc) - Delete current line.`
	`^W          - Delete previous word.`
	`! or ^P     - Show previous command.`
	`Tab         - Complete a command if its first few letters are typed.`
	`Backspace   - Delete previous letter.`
	`?           - When typed after:`
	`System prompt  - show command menus.`
	`Within command - show all commands with same prefix.`
	`After command  - show all command parameters.`
	`#           - List past commands together with their number code.`
	`To type a command quickly, type # and the number code.`
	`------------------------------------------------------------------------`

Notes	The console keys are described in detail below.

Command	`^U`[30] (or `Esc`)
Description	Delete current line.
Syntax	**Ctrl** **u** (or **Esc**)
Default	–
Example	Suppose the current display is `SYS_console>ping 193.128.56.74 387106.` To delete all the text (`ping 193.128.56.74 387106`) after the system prompt `SYS_console>`, press **Ctrl** **u** (or **Esc**).
Notes	–

Command	^W
Description	Delete previous word.

[30] **^** = **`Ctrl`**

Syntax	Ctrl w
Default	–
Example	Suppose the current display is `SYS_console>ping 193.128.56.74 387106.` To delete all the rightmost word (`387106`), press Ctrl w.
Notes	–

Command	! (or ^P)
Description	Show previous command.
Syntax	! (or Ctrl p)
Default	–
Example	Suppose the previous command is `system` and the current command is `console` as indicated by the display `SYS_console>console` on the screen. On invoking the command ! (or Ctrl p) `SYS_console>system` will show.
Notes	–

Command	Tab
Description	Complete a command after its first few letters (that are unique to the command) are typed. Tab adds alphanumeric characters to a typed string ***if*** each added character is the only one that can be added to form a new string that is common to one or more commands. If the new string is common to two or more commands, one or more additional characters will have to be typed in order to complete the command with Tab.
Syntax	Tab
Default	–
Example	Suppose the current line on the screen is `SYS_console>se`. Pressing Tab will add the unique characters common to one or more commands to complement the display to `SYS_console>set-`. By typing `at` to give `SYS_console>set-at` and pressing Tab the display becomes `SYS_console>set-attr-`. At this point, to display the command: `set-attr-prompt` type `p`. `set-attr-msg` type `m`. `set-attr-text` type `t`. and press Tab
Notes	–

Command	Backspace
Description	Delete previous letter.
Syntax	Backspace
Default	–
Example	Suppose the current line on the screen is `SYS_console>set-`. On pressing Backspace, the display becomes `SYS_console>set`. On pressing Backspace, again, the display becomes `SYS_console>se`.

Notes	–

Command	?
Description	When typed: *Before a command (After the system prompt) –* Show command menus. *Within a command –* Show all commands with same prefix. *After a command –* Show all command parameters.
Syntax	?
Default	–

Example	1
	`SYS_console>?`
	
	`Commands groups are:`
	`-----------------------`
	`console        Show console menu.`
	`system         Show system menu.`
	`ip             Show IP menu.`
	`snmp           Show SNMP menu.`
	`slot           Show slot menu.`
	`statistics     Show statistics menu.`
	`--------------------------------------------------------------------------`
	`! show previous command, ^U delete current line, ^W delete previous word.`
	2
	`SYS_console>set-transponder-?`
	
	`command 'set-transponder-' not found`
	
	`Commands matching <set-transponder->`
	`---------------------------------------------------------------------`
	`set-transponder-rate Set transponder rate.`
	`set-transponder-lb Set transponder LoopBack state.`
	3
	`SYS_console>set-transponder-lb ?`
	
	`set-transponder-lb     Set transponder LoopBack state.`
	`[arg #0]  <slot number>.`
	`[arg #1]  Loopback state: n-normal | l-loopback, Default = normal`

Notes	–

Command	#
Description	List past commands together with their number code.
Syntax	#
Default	–

Example	`SYS_console>#`
	`1: console`
	`2: help-kbd`

	3: system 4: help-kbd 5: ip 6: ping 193.128.56.74 55 7: set-transponder-lb 5 n 8: set-page 22
Notes	To type a command quickly, type **#** and the number code.

Command	banner
Description	Show device banner.
Syntax	**banner**
Default	–
Example	SYS_console>banner ** * MRV Lambda Driver - 800 Version 1.1.0a * MRV System Console **
Notes	–

Command	clear
Description	Clear screen leaving only the system prompt.
Syntax	**clear**
Default	–
Example	SYS_console>clear
Notes	The system prompt remains on the screen after the clear command is invoked.

Command	login
Description	Re-enter CLI session.
Syntax	**login**
Default	–
Example	SYS_console>login Please Login username:admin password: ** * MRV Lambda Driver - 800 Version 1.1.0a * MRV System Console **
Notes	–

Command	logout
Description	Exit CLI and/or TELNET session.
Syntax	**logout**
Default	–
Example	SYS_console>logout The message "Connection to host lost" appears.

	`Press the button OK to exit.`
Notes	–

Command	set-page
Description	Set console page size.
Syntax	**`set-page opt.[arg #0]`** where, **`opt.[arg #0]`** = <**5..127|0**> **5..127** = Page size (number of lines of text displayable on the screen at a time) in the range 5..127 **0** = Last lines of commands.
Default	**`opt.[arg #0] = 22`** (lines per page)
Example	`SYS_console>set-page 22` `Page size was set to 22 (lines/page)`
Notes	The message "more…" appears whenever there are more lines in a list than the page size. In response, press **q** to abort display of additional lines or **Esc** to scroll to the end of the list.

Command	set-prompt
Description	Change console prompt.
Syntax	**`set-prompt opt.[arg #0]`** where, **`opt.[arg #0]`** = <**PROMPT**> **PROMPT** = New prompt (alphanumeric)
Default	**`opt.[arg #0] = SYS_console>`**
Example	`SYS_console>set-prompt LambdaDriver1600>>` `LambdaDriver1600>>`
Notes	–

Command	set-attr-prompt
Description	Set prompt attributes.
Syntax	**`set-attr-prompt [arg #0]`** where, **`[arg #0]`** = <**0|1|2|4|8**> **0** = normal; **1** = bold; **2** = underlined; **4** = blinking; **8** = reverse video
Default	–
Example	`SYS_console>set-attr-prompt 8` `SYS_console>`
Notes	Command available only in Operational CLI.

Command	set-attr-msg
Description	Set message attributes.
Syntax	**`set-attr-msg [arg #0]`** where,

	`[arg #0]` = `<0|1|2|4|8>` `0` = normal; `1` = bold; `2` = underlined; `4` = blinking; `8` = reverse video
Default	–
Example	`SYS_console>set-attr-msg 4`
Notes	Command available only in Operational CLI.

Command	set-attr-text
Description	Set text attributes.
Syntax	**`set-attr-text [arg #0]`** where, `[arg #0]` = `<0|1|2|4|8>` `0` = normal; `1` = bold; `2` = underlined; `4` = blinking; `8` = reverse video
Default	–
Example	`SYS_console>set-attr-text 2`
Notes	Command available only in Operational CLI.

Command	set-password
Description	Change console access password. (No argument is required with this command.)
Syntax	**`set-password`**
Default	No password; simply press **Enter** after entering the username.

Example	`SYS_console>set-password`
	`Enter old password:*******`
	`Enter new password:************`
	`Enter new password again:************`
	`CLI running changed password.`

Notes	The procedure for changing the console password is described in the section *Password* on page *168*. No argument for this command.

system

Command	sys-stat
Description	Show system status information.
Syntax	**`sys-stat [arg #0]`** where, `[arg #0]` = `<a|s>` `a` = general and ports info `s` = general info only
Default	–

Example	`SYS_console>sys-stat s`
	`Optical Access Lambda Driver - 800`
	`Date: Jul 17 2003 Time: 11:22:18`
	`Operative Software version : 1.1.0a`
	`Boot Software Version : 1.0.4`
	`CPU Card H/W Version : 1`
	`CPU Card FPGA Version : 3`

	`Power supply 1 is ........ : Not Working`
	`Power supply 2 is ........ : Working`
	`Fan 1 is ................. : OK`
	`Fan 2 is ................. : OK`
	`Fan 3 is ................. : OK`
	`SNMP Object ID is         : < 1.3.6.1.4.1.629.100.2.1>`
	`System MAC Address        : 00-20-1a-00-ce-03`
	`Total uptime(hundredths of seconds) :   612900`
	`Total uptime(days, hh:mm:ss format) : 0 days, 1:42:09.00`

Notes	–

Command	warm-reset
Description	Warm reset device.
Syntax	**`warm-reset`**
Default	–
Example	`SYS_console>warm-reset`
Notes	–

Command	cold-reset
Description	Cold reset device.
Syntax	**`cold-reset`**
Default	–
Example	`SYS_console>cold-reset`
Notes	–

Command	get-last-err
Description	Show information about last fatal error.
Syntax	**`get-last-err`**
Default	–

Example	`SYS_console>get-last-err`
	`System information since the last hardware reset`
	`------------------------------------------------`
	`Software resets number : 1`
	`Fatal error text       :`
	`Fatal error uptime     : 0 days, 1:44:14.00`

Notes	–

Command	init-nvram
Description	Change all device settings to factory default settings.
Syntax	**`init-nvram`**
Default	–

Example	`SYS_console>init-nvram`
	`NVRAM was initialized to default values`
	`Changes will be effective after boot`

Notes	This command will cause all the user-configured settings to be lost and replaced by the factory default settings, shown in *Table 17* on Page *163*). If you want to re-enter some or all the user settings, record them before executing the command

	init-nvram.

Command	get-sw-file
Description	Show name of SNMP Agent software file to be downloaded.
Syntax	**get-sw-file**
Default	–
Example	SYS_console>get-sw-file NVRAM based remote software file name is flash.hex
Notes	–

Command	set-sw-file
Description	Set name of SNMP Agent software file to be downloaded.
Syntax	**set-sw-file opt.[arg #0]** where, **opt.[arg #0]** = **<FILENAME>** **FILENAME** = SNMP Agent software filename
Default	**opt.[arg #0] = flash.hex**
Example	SYS_console>set-sw-file LambdaDriver_Version_4.1.0.3 remote software file name changed to <LambdaDriver_Version_4.1.0.3>
Notes	–

Command	get-tftp-srvr
Description	Show IP address of TFTP server.
Syntax	**get-tftp-srvr**
Default	–
Example	SYS_console>get-tftp-srvr The IP address of the remote TFTP server is: 000.000.000.000 This means that the TFTP server IP address has not been set!
Notes	–

Command	set-tftp-srvr
Description	Set IP address of TFTP server.
Syntax	**set-tftp-srvr opt.[arg #0]** where, **opt.[arg #0]** = <TFTP Server IP Address>.
Default	**opt.[arg #0] = 0.0.0.0**
Example	SYS_console>set-tftp-srvr 193.245.67.98 The IP address of the remote TFTP server is: 193.245.067.098
Notes	–

Command	set-tftp-mode
Description	Select TFTP download mode.
Syntax	**set-tftp-mode opt.[arg #0]** where, **opt.[arg #0] = <client|server>**

	client = LD1600 TFTP as client **server** = LD1600 as TFTP server
Default	**opt.[arg #0] = client**
Example	`SYS_console>set-tftp-mode client` `Switch Tftp client is enabled for next download`
Notes	–

Command	get-tftp-mode
Description	Show current TFTP download mode.
Syntax	**get-tftp-mode**
Default	–
Example	`SYS_console>get-tftp-mode` `Tftp client will be operate on next software download`
Notes	–

Command	sw-dnld
Description	Perform TFTP software download.
Syntax	**sw-dnld**
Default	–
Example	`SYS_console>sw-dnld`
Notes	For the detailed procedure on how to upgrade/download software to the LD1600, refer to Appendix A.

Command	cancel-sw-dnld
Description	Abort new software download and revert to the previous software.
Syntax	**cancel-sw-dnld**
Default	–
Example	`SYS_console>cancel-sw-dnld`
Notes	Command available only in Boot CLI.

ip

Command	get-ip
Description	Show current IP address.
Syntax	**get-ip**
Default	–

Example	`SYS_console>get-ip`
	`The device IP address is : 194.090.136.062`
	`The device IP address after boot will be undefined`

Notes	–

Command	set-ip
Description	Set IP address.
Syntax	**set-ip opt.[arg #0]** where, **opt.[arg #0] = <IP address>**

Default	**opt.[arg #0] = 0.0.0.0**

Example	`SYS_console>set-ip 197.66.236.78`
	` Device IP address is set for this session`
	` Device IP address changed in the NVRAM`

Notes	–

Command	get-ip-cfg
Description	Show current IP configuration.
Syntax	**get-ip-cfg**
Default	–

Example	`SYS_console>set-ip 191.222.38.57`
	` Device IP address remain unchanged for this session`
	` Device IP address changed in the NVRAM`

Notes	–

Command	set-ip-cfg
Description	Set IP address and netmask of agent.
Syntax	**set-ip-cfg [arg #0] [arg #1]** where, **[arg #0] = <IP address>** **[arg #1] = <Netmask>**
Default	–

Example	`SYS_console>set-ip-cfg 198.234.85.7 255.255.0.0`
	`Accepted ip=198.234.085.007 mask=255.255.000.000 broadcast=255.255.255.255`
	` Device IP configuration remain unchanged for this session`
	` Device IP configuration changed in the NVRAM`
	` After boot the IP configuration will be:`
	` Failed to set IP configuration`

Notes	–

	clear-ip-cfg
Description	Clear IP settings in NVRAM, i.e., set the IP address and netmask of the LD1600 to the default values (0.0.0.0 and 0.0.0.0).
Syntax	**clear-ip-cfg**
Default	–
Example	`SYS_console>clear-ip-cfg` ` Device IP Configuration cleaned`
Notes	⚠ **Caution!** Invoking the command **clear-ip-cfg** at a TELNET station will disrupt connection to the LD1600! To reestablish connection, an IP address will have to be reassigned to the LD1600 using the interconnection shown in *Figure 76*.

Command	get-gatew
Description	Show default gateway.
Syntax	**get-gatew**
Default	–

Example	`SYS_console>get-gatew` `The default gateway address is : 197.090.222.58`
Notes	–

	set-gatew
Description	Set/change default gateway.
Syntax	**`set-gatew opt.[arg #0]`** where, **`opt.[arg #0] = <IP address of default gateway>.`**
Default	**`opt.[arg #0] = 0.0.0.0`**
Example	`SYS_console>set-gatew 197.090.222.58`
Notes	**Caution!** Changing the default gateway using the command **`set-gatew`** at a TELNET station will disrupt connection to the LD1600! To reestablish connection, the appropriate Default Gateway address will have to be assigned to the LD1600 using, for e.g., the interconnection shown in *Figure 76*.

Command	get-arp-tbl
Description	Show ARP table entries together with their indexes (IDs).
Syntax	**`get-arp-tbl opt.[arg #0] opt.[arg #1]`** where, **`opt.[arg #0]`** = <Index of entry to be displayed first while excluding entries of lower index>. **`opt.[arg #1]`** = <Number of entries to be displayed>.
Default	**`opt.[arg #0]`** = First entry of ARP table. **`opt.[arg #1]`** = Till end of ARP table.

Example	`SYS_console>get-arp-tbl 0 2`
	`ARPTBL number of entries = 3`
	`#### If Ip MAC TTL`
	`==================================================`
	`0 01 194.090.136.254 00-00-b0-2f-04-00 1200`
	`1 01 194.090.136.244 00-01-03-8a-00-84 1200`

Notes	Command available only in Operational CLI.

Command	del-arp-entry
Description	Delete ARP table entries.
Syntax	**`del-arp-entry [arg #0]`** where, **`[arg #0] = <IP address in entry|*>`** **`(* = all entries)`**
Default	–
Example	`SYS_console>del-arp-entry 197.090.222.58`
Notes	Command available only in Operational CLI.

Command	add-arp-entry

Description	Add entry to ARP table.
Syntax	**add-arp-entry [arg #0] [arg #1] [arg #2]** where, **[arg #0] = <IP address>.** **[arg #1] = <MAC (physical) address>.** **[arg #2] = <Interface number>.**
Default	–
Example	`SYS_console>add-arp-entry 192.44.212.75 00-03-3e-7a-f8-94 100` `ARP Table Entry succesfully added`
Notes	Command available only in Operational CLI.

Command	ping
Description	Check whether device responds.
Syntax	**ping [arg #0] [arg #1]** where, **[arg #0] = <Destination IP address>.** **[arg #1] = <Number of packets to send or 0 for continual PING>.**
Default	–

Example	`SYS_console>ping 194.90.137.191 4`
	`Use CTRL-C or ping-stop to stop the ping process`
	`194.090.137.191 Alive. echo reply: id 26, seq 1, echo-data-len 0`
	`194.090.137.191 Alive. echo reply: id 26, seq 2, echo-data-len 0`
	`194.090.137.191 Alive. echo reply: id 26, seq 3, echo-data-len 0`
	`194.090.137.191 Alive. echo reply: id 26, seq 4, echo-data-len 0`
	`PING process stopped - statistics :`
	`ICMP echo requests 4`
	`ICMP echo responses 4`
	`PING process - press <CR> for prompt`

Notes	Ping cannot be activated from a TELNET session! To stop continual ping, invoke the command **ping-stop**. Command available only in Operational CLI.

Command	ping-stop
Description	Stop ping process.
Syntax	**ping-stop**
Default	–
Example	`SYS_console>ping-stop`
Notes	Command available only in Operational CLI.

snmp
(in Operational CLI only)

Command	get-comm
Description	Show current read and/or write community string.
Syntax	**get-comm [arg #0]** where, **[arg #0] = <read|write|*>.** **(* = read and write)**
Default	–
Example	`SYS_console>get-comm *`

	`Current read  community is: < public >` `Current write community is: < private >`
Notes	–

Command	set-comm
Description	Change read or write community string.
Syntax	**set-comm [arg #0] [arg #1]** **opt.[arg #0] = <read|write>** **[arg #1] = <New community string>**
Default	**read = public** **write = private**
Example	`SYS_console>set-comm write Zorro` `New write community is: < Zorro >`
Notes	–

Command	get-auth
Description	Show traps authentication mode.
Syntax	**get-auth**
Default	–
Example	`SYS_console>get-auth` `The authentication trap messages are enabled`
Notes	–

Command	set-auth
Description	Change traps authentication mode.
Syntax	**set-auth [arg #0]** where, **[arg #0] = <enable|disable>**
Default	–

Example	`SYS_console>set-auth disable`
	`The authentication trap message mode change OK`
	`The authentication trap messages are DISABLED`

Notes	–

Command	get-traps
Description	Show destination stations in trap list.
Syntax	**get-traps**
Default	–
Example	`SYS_console>get-traps` `Trap table is empty !!!`
Notes	–

Command	add-trap
Description	Add a destination station to the trap list.
Syntax	**add-trap [arg #0] [arg #1]**

	where, **[arg #0] = <IP address>.** **[arg #1] = <Community string>.**
Default	–

Example	`SYS_console>add-trap 198.33.45.222 Zorro`
	`Entry 198.33.45.222 - Zorro added`
	`SNMP TRAP TABLE`
	`===============`
	`IPADDR                         COMMUNITY`
	`---------------------------------------------------`
	`198.033.045.222   -----------     Zorro`
	`---------------------------------------------------`

Notes	–

Command	del-trap
Description	Delete a destination station from the trap list.
Syntax	**del-trap [arg #0]** where, **[arg #0] = <IP address>.**
Default	–
Example	`SYS_console>del-trap 198.33.45.222` `Entry 198.33.45.222 deleted`
Notes	–

slot

Command	get-wdm-card-stat
Description	Show status of cards in device.
Syntax	**get-wdm-card-stat opt.[arg #0]** where, **opt.[arg #0] = <slot>-<slot>-<slot>** and/or **<slot>..<slot>** i.e., individual slot numbers (separated by hyphens), or range of slots.
Default	**opt.[arg #0]** = all slots

Example	`SYS_console>get-wdm-card-stat 2-8`
	`SLT CARD_TYPE LAMBDA  RATE  ACC_OPT_RX WDM_OPT_RX WDM_LSR AMB_TMP`
	`==================================================================`
	`  2  TM-SFP-C  1530  GigaEth     OFF     OFF      Disable    Normal`
	`  8 EM2009-CH  1470  Bypass      OFF     OFF        OK       Normal`

Notes	–

Command	get-redun-card-stat
	Show status of 1+1 redundancy modules.
Syntax	**get-redun-card-stat opt.[arg #0]** where, **opt.[arg #0] = <slot>-<slot>-<slot>** and/or **<slot>..<slot>** i.e., individual slot numbers (separated by hyphens), or range of slots.
Default	**opt.[arg #0]** = all slots

<table>
<tr><td>Example</td><td><code>SYS_console>get-redun-card-stat</code>
<code>SLT CARD_TYPE SW_POSITION LAST_CMD PRIMARY_RX SECONDARY_RX</code>
<code>===</code>
<code>6 LD800-RED Primary Manual OFF OFF</code></td></tr>
<tr><td>Notes</td><td>–</td></tr>
</table>

<table>
<tr><td>Command</td><td>get-card-ports-stat</td></tr>
<tr><td>Description</td><td>Show status of module ports.</td></tr>
<tr><td>Syntax</td><td>get-card-ports-stat</td></tr>
<tr><td></td><td>–</td></tr>
<tr><td>Example</td><td><code>SYS_console>get-card-ports-stat</code>
<code>SLT CARD_TYPE LAMBDA MUX_LNK MUX_ACT LNK1 ACT1 LNK2 ACT2 LNK3 ACT3 LNK4 ACT4</code>
<code>==</code>
<code>17 LD1600_MNG 1310 N/A N/A OFF OFF OFF OFF ON OFF</code></td></tr>
<tr><td>Notes</td><td>For the GM2 module, <code>MUX</code> in the table displayed when the command <code>get-card-ports-stat</code> is invoked designates the trunk port.</td></tr>
</table>

<table>
<tr><td>Command</td><td>set-opt-switch</td></tr>
<tr><td>Description</td><td>Activate primary (P) or secondary (S) link for 1+1 redundancy card.</td></tr>
<tr><td>Syntax</td><td>set-opt-switch opt.[arg #0]
where,
opt.[arg #0] = <P|S>.
P = Primary link
S = Secondary link</td></tr>
<tr><td>Default</td><td>opt.[arg #0] = P</td></tr>
<tr><td>Example</td><td><code>SYS_console>set-opt-switch s</code>
<code>CLI_set_redundant_card_status:</code>
<code>No card type 'LD1600_RED' or 'LD800_RED' in chassis</code></td></tr>
<tr><td>Notes</td><td>–</td></tr>
</table>

<table>
<tr><td>Command</td><td>set-transponder-rate</td></tr>
<tr><td>Description</td><td>Set module rate.</td></tr>
<tr><td>Syntax</td><td>set-transponder-rate [arg #0] [arg #1]
where,
[arg #0] = <slot>-<slot>-<slot> and/or <slot>..<slot>
i.e., individual slot numbers separated by hyphens, or range of slot numbers.
[arg #1] = <1|2>
1 - TM-SFP or Transponder 1 of TM2-SFP
2 - Transponder 2 of TM2-SFP
[arg #2] = <1..27>
1 = BYPASS; 2 = E3; 3 = DS3; 4 = OC1; 5 = DS3C; 6 = FE; 7 = FDDI; 8 = E4; 9 = DTV; 10 = OC3; 11 = ESCON; 12 = FC256M; 13 = DS4; 14 = CMI; 15 = HDTV; 16 = HDTV2; 17 = DTV2; 18 = FC531M; 19 = OC12; 20 = FC1.062G; 21 = DS5; 22 = OC24; 23 = GE; 24 = DS5X; 25 = HDTV3; 26 = OC48; 27 = FC2.125G.</td></tr>
</table>

Default	–

Example	`SYS_console>set-transponder-rate 8 15`
	`CLI_set_transponder_rate:`
	` Transponder card in slot 8 is in rate  HDTV`

Notes	The value **`BYPASS`** must be selected for **`[arg #1]`** if the data rate of the terminal equipment is between 10 and 30 Mbps.

Command	set-laser-mode
Description	Set laser mode (enable or disable laser).
Syntax	**`set-laser-mode [arg #0] [arg #1]`** where, **`[arg #0] = <slot>-<slot>-<slot>`** and/or **`<slot>..<slot>`** i.e., individual slot numbers separated by hyphens, or range of slot numbers. **`[arg #1] = <1|2>`** **`1`** - TM-SFP or Transponder 1 of TM2-SFP **`2`** - Transponder 2 of TM2-SFP **`[arg #2] = <1|2>`** **`1 =`** Enable laser; **`2 =`** Disable laser
Default	–

Example	`SYS_console>set-laser-mode 2 1`
	`CLI_set_laser_mode:`
	`Transponder card in slot 2 laser mode is DISABLE.`

Notes	–

Command	get-card-wdm-power
Description	Show WDM input and output optical power in dBm units.
Syntax	**`get-card-wdm-power opt.[arg #0]`** where, **`opt.[arg #0] = <slot>-<slot>-<slot>`** and/or **`<slot>..<slot>`** i.e., individual slot numbers (separated by hyphens), or range of slots.
Default	**`opt.[arg #0] =`** all slots

	`SYS_console>get-card-wdm-power`
	` SLT CARD_TYPE   Rx-PM(dBm)  TX-PM(dBm)`
	` ====================================`
	`   1  TM-SFP-C      -31          +1.0`
	`   2  TM-SFP-C      -22          +0.5`

Notes	–

Command	get-transponder-lb
Description	Show module mode (normal operation or LoopBack).
Syntax	**`get-transponder-lb opt.[arg #0]`** where, **`opt.[arg #0] = <slot>-<slot>-<slot>`** and/or **`<slot>..<slot>`** i.e., individual slot numbers separated by hyphens, and/or range of slot numbers.
Default	**`opt.[arg #0] =`** all slots

Example	`SYS_console>get-transponder-lb`
	
	`SLT CARD_TYPE      RLB       LLB`
	`=================================`
	`  8 EM2009-2GE`
	`        Port T    Normal  LoopBack`
	`        Port 1    Normal   Normal`
	`        Port 2    Normal   Normal`

Notes	The letter **T** in the example above designates trunk.

Command	set-transponder-lb
Description	Set module mode (normal operation or LoopBack).
Syntax	**set-transponder-lb [arg #0] [arg #1] opt.[arg #2] opt.[arg #3]** where, **[arg #0] = <slot>-<slot>-<slot>** and/or **<slot>..<slot>** i.e., individual slot numbers separated by hyphens, or range of slot numbers. **[arg #1] = <port>-<port>-<port>** and/or **<port>..<port>** i.e., individual port numbers separated by hyphens, or range of port numbers. Enter **1** as this argument for TM-SFP or Transponder 1 of TM2-SFP. Enter **2** as this argument for Transponder 2 of TM2-SFP. **opt.[arg #2] = <rlb|llb>** **rlb** = Remote LoopBack mode **llb** = Local LoopBack mode **opt.[arg #3] = <n|l>** **n** = enable normal operation **l** = enable loopback mode
Default	**opt.[arg #2] = rlb** **opt.[arg #3] = normal**

Example	`SYS_console>set-transponder-lb 8 0 llb 1`
	`set-transponder-loop-back:`
	`Transponder card in slot 8, port T: local  LoopBack state is LoopBack.`

Notes	To specify the trunk port, for **[arg #1]** type **0**. The letter **T** in the example above designates trunk. Select **l** for **opt.[arg #3]** *only* if diagnostics tests are to be performed on the LD1600 because communication for the transponder in the slot will be disrupted.

Command	get-trans-red-stat
	Show module redundancy status.
Syntax	**get-trans-red-stat opt.[arg #0]** where, **opt.[arg #0] = <slot>-<slot>-<slot>** and/or **<slot>..<slot>** i.e., individual slot numbers separated by hyphens, or range of slot numbers.
Default	**opt.[arg #0]=** all slots
Example	`SYS_console>get-trans-red-stat`

	SLT CARD_TYPE Redundant Primary/Secondary == 1 TM-SFP-C Redundant Primary 2 TM-SFP-C Redundant Secondary --
Notes	–

Command	set-trans-primary-state
Description	Activate primary or secondary transponder. (The other transponder of the pair goes into standby.)
	set-trans-primary-state [arg #0] opt.[arg #1] where, **[arg #0] = <slot number>.** **[arg #1] = <1|2>** **1** - TM-SFP or Transponder 1 of TM2-SFP **2** - Transponder 2 of TM2-SFP **opt.[arg #2] = <p|s>** **p** = primary transponder **s** = secondary transponder
Default	**opt.[arg #1] = primary**
Example	SYS_console>set-trans-primary-state 2 p set-trans-primary-state: Transponder card in slot 2 primary/secondary state is Primary . SLT CARD_TYPE Redundant Primary/Secondary == 1 TM-SFP-C Redundant Secondary 2 TM-SFP-C Redundant Primary --
Notes	–

Command	get-adc-lambda-info
Description	Show information (e.g., operating wavelength, etc.) on OADM modules (ADC = Single-interface, ADCD = Dual-interface).
Syntax	**get-adc-lambda-info opt.[arg #0]** **opt.[arg #0] = <slot>-<slot>-<slot>** and/or **<slot>..<slot>** i.e., individual slot numbers separated by hyphens, or range of slot numbers.
Default	**opt.[arg #0]** = all slots
Example	SYS_console>get-adc-lambda-info SLT CARD_TYPE WDM #Ports #L1 #L2 #L3 #L4 #L5 #L6 #L7 #L8 == 2 ADCD CWDM 4 1470 1490 1510 1530 3 ADCD CWDM 4 1550 1570 1590 1610
Notes	–

Command	get-sfp-spec-info
Description	Show SFP vendor data.
Syntax	**get-sfp-spec-info [arg #0] [arg #1]** **[arg #0] = <slot>-<slot>-<slot>** and/or **<slot>..<slot>**

	i.e., individual slot numbers separated by hyphens, or range of slot numbers. **[arg #1]** = **<port>-<port>-<port>** and/or **<port>..<port>** i.e., individual port numbers separated by hyphens, or range of port numbers.
Default	–
Example	SYS_console>get-sfp-spec-info 8 0 Identifier : SFP Connector : LC Transceiver : 1000BASE-LX Vendor Name : FINISAR CORP. Vendor P/N : FTRJ1521P1BCL Vendor Rev. : A Wavelength : 1550nm
Notes	To specify the trunk port, for **[arg #1]** type **0**. For a GM2 module, the letter **T** appearing when the command **get-sfp-diagnostics** is invoked designates trunk.

Command	get-sfp-diagnostics
Description	Show SFP diagnostic data.
Syntax	**get-sfp-diagnostics [arg #0] [arg #1]** **[arg #0]** = **<slot>-<slot>-<slot>** and/or **<slot>..<slot>** i.e., individual slot numbers separated by hyphens, or range of slot numbers. **[arg #1]** = **<port>-<port>-<port>** and/or **<port>..<port>** i.e., individual port numbers separated by hyphens, or range of port numbers.
Default	–
Example	SYS_console>get-sfp-diagnostics 8 0 SFP Digital Diagnostics ************************ Description Real-Time Value -------------------- --------------- Temperature (C)/(F): 42/107 Voltage (V): 3.3814 TX Bias (mA): 0.192 TX Power (dBm)/(mW): -35.2/0.000 RX Power (dBm)/(mW): -30.2/0.001
Notes	To specify the trunk port, for **[arg #1]** type **0**. For a GM2 module, the letter **T** appearing when the command **get-sfp-diagnostics** is invoked designates trunk.

Command	get-trans-counters
Description	Show module counters.
	get-trans-counters
Default	–
Example	SYS_console>get-trans-counters

	`EM2009_2GE Port Counters`
	`====================================`
	`Slot #8`
	`Port #1:`
	`Counter #1 : 23810`
	`Counter #2 : 0`
	`Port #2:`
	`Counter #1 : 56070`
	`Counter #2 : 0`

Notes	Counter 1 shows the number of frames received from the remote port by the local port. Counter 2 shows the number of error bits in the frames received from the remote port by the local port.

Command	clear-trans-counters
Description	Clear module counters.
Syntax	**clear-trans-counters opt.[arg #0] opt.[arg #1]** **opt.[arg #0] = <slot>-<slot>-<slot>** and/or **<slot>..<slot>** i.e., individual slot numbers separated by hyphens, or range of slot numbers. **opt.[arg #1] = <port>-<port>-<port>** and/or **<port>..<port>** i.e., individual port numbers separated by hyphens, or range (**1..2**) of port numbers.
Default	**opt.[arg #0] = all** **opt.[arg #1] = all**
Example	`SYS_console>clear-trans-counters 8 1` `Clear Port 1 Counters at slot 8`
Notes	–

Command	get-oa-parameters
Description	Show optical amplifier parameters.
Syntax	**get-oa-parameters [arg #0]** **[arg #0] = <slot>-<slot>-<slot>** and/or **<slot>..<slot>** i.e., individual slot numbers separated by hyphens, or range of slot numbers.
Default	–

Example	`SYS_console>get-oa-parameters 5`
	
	`Optical Amplifier Parameters`
	`*****************************`
	`Module Configuration and Type          Module Version, S/N`
	`-----------------------------          -------------------`
	`Configuration : Dual Pump              Hardware Version : 2.0`
	`Module Type   : Amplet                 Software Version : 2.2`
	`                                       Serial Number    : 33 3`
	`Module Temperature`
	`------------------`
	`Temperature   :  30.7 (C)`
	
	`Pump Current and P/S Voltage           Optical Power`

	---------------------------- ------------- Pump-1 Drive Current : 1.5(mA) Input Power : -34.86(dBm) Pump-1 Max Drive Current : 236.0(mA) Output Power : -13.00(dBm) Pump-2 Drive Current : 0.0(mA) Module Gain : 21.86(dB) Pump-2 Max Drive Current : 266.0(mA) Pump-1 Power : 0.00(mW) Pump-2 Power : 0.00(mW) Power Supply Voltage : 3.44(V) Maximum Power : 18.00(dBm) Rated Gain : 15.00(dB) Alarm Information ----------------- Alarm Status : Optical Input Alarm Optical Output Alarm
Notes	–

Command	get-oa-config
Description	Show optical amplifier configuration.
Syntax	**get-oa-config [arg #0]** **[arg #0] = <slot>-<slot>-<slot>** and/or **<slot>..<slot>** i.e., individual slot numbers separated by hyphens and/or range of slot numbers.
Default	–
Example	SYS_console>get-oa-config 5 Optical Amplifier Configuration ******************************** Operation Mode Enable/Disable -------------- -------------- Operation Mode : Constant Output Power Auto Shutdown: ENABLE Module Threshold Set Points ---------------- ---------- Input Threshold : -20.00(dBm) Pump-1 Current Setting : 1.1(mA) Output Threshold : 0.00(dBm) Pump-2 Current Setting : 0.0(mA) Shutdown Threshold : -30.00(dBm) Output Power Setting : 18.00(dBm) Low T Threshold : 0.0(C) Gain Setting : 15.00(dB) High T Threshold : 70.0(C)
Notes	The letter `T` in the example above designates temperature.

Command	set-oa-run-mode
Description	Show optical amplifier configuration.
Syntax	**set-oa-run-mode [arg #0] [arg #1]** **[arg #0] = <slot>-<slot>-<slot>** and/or **<slot>..<slot>** i.e., individual slot numbers separated by hyphens and/or range of slot numbers. **[arg #1] = <0|1|2>** **0** - normal operation **1** - shutdown **2** - eye-safe mode.
Default	–

Example	`SYS_console>set-oa-run-mode 3 2` `Operation set to Eye-Safe.`
Notes	

statistics
(in Operational CLI only)

Command	clr-eth-mgt-cnt
Description	Clear Ethernet counter readings of management port.
Syntax	**`clr-eth-mgt-cnt`**
Default	–
Example	`SYS_console>clr-eth-mgm-cnt`
Notes	–

Command	get-eth-mgt-cnt
Description	Show Ethernet counter readings of management port.
Syntax	**`get-eth-mgt-cnt`**
Default	–
Example	(see below)
Notes	–

Example:

```
SYS_console>get-eth-mgm-cnt
            Management Port MIB II Interface Counters
====================================================================
 Received:
        Octets           (ifInOctets)        :   2197152
        Unicast Pkts     (ifInUcastPkts)     :      1970
        Non-Unicast Pkts (ifInNUcastPkts)    :     15834
        Discarded Pkts   (ifInDiscards)      :         0
        Errors           (ifInErrors)        :         1
        Unknown Protocol (ifInUnknownProtos) :         0
 Transmitted:
        Octets           (ifOutOctets)       :    165679
        Unicast Pkts     (ifOutUcastPkts)    :      2277
        Non-Unicast Pkts (ifOutNUcastPkts)   :         1
        Discarded Pkts   (ifOutDiscards)     :         0
        Errors           (ifOutErrors)       :         0
```

Appendix A:
Software Upgrading/Downloading

General

Software can be upgraded/downloaded into the LD1600 in either of the following modes:

- LD1600 as TFTP client
- LD1600 as TFTP server

Setup for upgrade/download can be done with either of the following:

- ASCII terminal or emulator, as described in this appendix.
- TELNET station, as described in this appendix.
- Web-based or SNMP manager, as described in *MegaVision NMS User Manual*

Note

Upgrading/downloading does not affect LD1600 operation or user-configured settings.

Requirements

Interconnection

<u>For ASCII Terminal/Emulator</u>: as shown in *Figure 76* or *Figure 89*.

<u>For TELNET Station</u>: Interconnection as shown in *Figure 77*.

Setup

<u>For ASCII Terminal/Emulator</u>: as described in the section *ASCII Terminal/Emulator Setup* on Page *167*.

- LD1600 IP Address[31]. (If the LD1600 was never assigned an IP address, one can be assigned using the interconnection shown in *Figure 76* or *Figure 89*.)
- TFTP Server having a TFTP program and the file containing the operative program to be downloaded to the LD1600.
- TFTP Server IP Address (if LD1600 is to be set as client)
- TFTP File Name, i.e., name of file containing the operative program to be downloaded to the LD1600

Procedure

1. Enter an Operational CLI session. (The procedure is described in the section *CLI Access* on Page *168*, Step *4*.)
2. If a TELNET station is being used, verify interconnectivity between the LD1600 and TFTP server with the command **`ping`**.
3. Set the LD1600 as a *client* or *server* with the command **`set-tftp-mode`**.
4. If the LD1600 has been configured as a client, enter the IP Address of the TFTP Server with the command **`set-tftp-server`**.
5. Enter the TFTP File Name with the command **`set-sw-file`**.

[31] Once an IP address is assigned to the LD1600, it can be changed at a TELNET station with the command **`set-ip`**.)

6. Start TFTP download with the command **`sw-dnld`**.

After upgrading/downloading is completed, the LD1600 automatically performs reset to run the new software. Reset retains the user-configured settings; it does *not* change them into the default settings.

Appendix B: Troubleshooting

The troubleshooting procedure is given in *Table 22*. Read the entries in the column **Problem** until you reach the problem that applies to the LD1600. Then perform the corrective action(s) appearing in the same row. If the problem persists, note the status of the LEDs and consult your *MRV* representative.

Table 22: Startup and Operation Troubleshooting

No.	Problem	Probable Cause	Corrective Actions
1	Power Supply LED **PWR** off.	No line (mains) power.	1. Verify that the LD1600 power switch is set to the **I** position. 2. Check power cord connection. 3. Check source of power. 4. Check power cord.
2	Transponder Module LED **RX ACC** off.	Cable, access equipment, or port malfunction.	1. Check connections, type, power loss, length, and integrity of cable interconnecting transponder port **ACC RX** and access equipment. 2. Insure TX to RX interconnection for each optical fiber. 3. Clean fiberoptic connectors as described in Appendix E. 4. Check the access equipment. 5. Temporarily connect the access equipment to another transponder port to determine if the port is faulty.
3	Transponder Module LED **RX WDM** off.	Cable or port malfunction.	1. Check connections and integrity of cable interconnecting transponder **WDM RX** port to the Mux, Demux, or OADM in the same LD1600. 2. Clean fiberoptic connectors as described in Appendix E. 3. Temporarily connect the Mux, Demux, or OADM to another transponder to determine if the transponder port is faulty.
4	Transponder Module LED **TMP ALRM** on-red.	Insufficient cooling of the Transponder.	1. Verify that no obstacles to cooling air flow are present around the LD1600. 2. Verify that the fans are running.

Table 18: Startup and Operation Troubleshooting (Cont'd)

No.	Problem	Probable Cause	Corrective Actions
5	Transponder Module LED **LASER OFF** on-red.	Cable or port malfunction.	1. Check connections and integrity of cable interconnecting transponder **WDM TX** port to the Mux, Demux, or OADM in the same LD1600. 2. Clean fiberoptic connectors as described in Appendix E. 3. Temporarily connect the Mux, Demux, or OADM to another transponder to determine if the transponder port is faulty.
6	Management Module LED **PWR** off.	Power cannot reach module.	1. Verify that the LD1600 is powered on, i.e., Power Supply LED **PWR** is on. 2. Verify that Management Module is properly seated in the LD1600 chassis.
7	Management Module LED **ACT** (for Mgt/SNMP) off.	No connection between the Management Module and host (management station).	1. Verify that connection to the Ethernet LAN to which the host is connected is OK. (The host can be connected to the local LD1600 or to a/the remote LD1600.) 2. Host is connected to the Ethernet LAN. 3. The host is correctly setup and operational.
8	Management Module LED **LINK** (for **ETH**) off.	No connection between the Management Module and Ethernet LAN.	1. Verify that connection to the Ethernet LAN is OK.
9	Management Module LED **ACT** (for **ETH**) off.	No connection between the Management Module and host (management station).	1. Verify that connection to the Ethernet LAN is OK. 2. Verify that the DTEs on the Ethernet LAN are connected.
10	Management Module LED **OSC LINK** off.	No connection between the Management Module and remote LD1600 Ethernet LAN.	1. Verify connection to remote LD1600, i.e., the fiberoptic cable interconnects both the local LD1600 and remote LD1600(s). 2. Verify that the DTEs on the remote LD1600 Ethernet LAN(s) are connected.
11	Management Module LED **OSC ACT** off.	No connection between the Management Module and host (management station).	1. Verify that connection to the 1+1 or Service Module is OK. 2. Verify that the host is connected to the remote LD1600 Ethernet LAN, is properly set up, and operational.

Table 18: Startup and Operation Troubleshooting (Cont'd)

No.	Problem	Probable Cause	Corrective Actions
12	1+1 Module **P-RX** LED off.	**IN P** port *not* receiving from **OUT P** port of remote LD1600.	1. Verify that the fiber connected to the local LD1600 **IN P** port (primary) is connected to the remote LD1600 **OUT P** port (primary).
13	1+1 Module **S-RX** LED off.	**IN S** port *not* receiving from **OUT S** port of remote LD1600.	1. Verify that the fiber connected to the local LD1600 **IN S** port (secondary) is connected to the remote LD1600 **OUT S** port (secondary).
14	1+1 Module **P-SEL** LED off.	Primary link faulty.	1. Verify that the fiber connected to the local LD1600 **OUT P** port (primary) is connected to the remote LD1600 **IN P** port (primary).
15	1+1 Module **P-SEL** and **S-SEL** LEDs off.	Both primary and secondary links faulty.	1. Perform the corrective action described in row 14, just above. 2. Verify that the fiber connected to the local LD1600 **OUT S** port (secondary) is connected to the remote LD1600 **IN S** port (secondary).
16	ESCON Module **L1**, **L2**, **L3**, or **L4** LED off	Input from local ESCON line not being received.	1. Check the connection of the local ESCON cable to the ESCON Module. 2. Check the integrity of the local ESCON cable to the ESCON Module. 3. Check power of signal from ESCON line.
17	ESCON Module **L** LED off.	No link to remote ESCON Multiplexer Module.	1. Check the connection of the cable that is between the two LD1600s at the *local* ESCON Module. 2. Check the connection of the cable that is between the two LD1600s at the *remote* ESCON Module. 3. Check the integrity of the cable between the two LD1600s.
18	ESCON Module **A1**, **A2**, **A3**, or **A4** LED permanently off	ESCON equipment not transmitting.	1. Check the *local* ESCON equipment.
19	ESCON Module **A** LED permanently off.	No valid data from remote ESCON Module.	1. Check the *remote* ESCON equipment.

Table 18: Startup and Operation Troubleshooting (Cont'd)

No.	Problem	Probable Cause	Corrective Actions
20	GM2 **L1** or **L2** LED off	No link between local Gigabit Ethernet device and local GM2 port 1 or 2.	1. Check the connection of the Category 5 cable to the GM2 Module port 1 or 2. 2. Check the integrity of the Category 5 cable to the GM2 Module. 3. Check power of the signal from Gigabit Ethernet device connected to GM2 Module port 1 or 2.
21	GM2 **A1** or **A2** LED off	Local Gigabit Ethernet Device connected to GM2 port 1 or 2 not transmitting	1. Check the local Gigabit Ethernet device.
22	GM2 **TRUNK L** LED off	No link between the local GM2 trunk port and one or both Gigabit Ethernet devices connected to the remote GM2 ports 1 and 2.	1. Check the connection of the cable interconnecting the local GM2 Module and remote GM2 Module. 2. Check the integrity of the cable interconnecting the local GM2 Module and remote GM2 Module. 3. Check the power of the signal from Gigabit Ethernet devices connected to the remote GM2 ports 1 and 2.
23	GM2 **TRUNK A** LED *off*	Gigabit Ethernet devices connected to the remote GM2 ports 1 and 2 not transmitting.	1. Check the remote Gigabit Ethernet devices.
24	GM2 **TRUNK A** LED blinking *rapidly* (4 blinks per second)	Gigabit Ethernet device connected to the remote GM2 Port 1 not transmitting.	1. Check the Gigabit Ethernet device connected to the remote GM2 Port 1.
25	GM2 **TRUNK A** LED blinking *slowly* (1 blink per second)	Gigabit Ethernet device connected to the remote GM2 Port 2 not transmitting.	1. Check the Gigabit Ethernet device connected to the remote GM2 Port 2.
26	OA **RX** LED OFF	Input signal power too weak.	1. Ensure that the cable connected to the OA module **IN** port is correctly and properly connected at both ends. 2. Check the transmission output power of the module connected to the **OUT** port of the OA. 3. Verify that the cable is undamaged.

No.	Problem	Probable Cause	Corrective Actions
27	No communication on a channel	WDM power signal too weak.	1. Check the link integrity by performing the RLB test as described in Appendix C. 2. Check cable connections. 3. Check device at other end of cable. 4. Check whether the cable is damaged. 5. If the cable is fiberoptic, clean its connectors as described in Appendix E. 6. Using the command **`get-card-wdm-power`**, determine the input and output power of the transponder. 7. If the *output* power is too low, replace the transponder. 8. If the *input* power is too low: a. Check the output power of the remote transponder. Replace the remote transponder if its power is too low. b. Check the cabling

Appendix C: LoopBack Tests

General

LoopBack tests (RLB, LLB, and TLB tests) are used to identify the faulty element of a network.

Transponders

This section describes the loopback tests for an LD1600 network using Transponders for connecting access units.

Hardware/Software Control

Table 23 shows, for each transponder model, whether RLB and LLB tests can be software or hardware controlled.

Table 23: Transponder RLB and LLB Control by Software and Hardware

Transponder Model	RLB		LLB	
	S/W	H/W	S/W	H/W
TM-SFP	✓	✓		✓
TM2-SFP	✓	✓		
TM-DXFP	✓	✓	✓	✓

RLB Test

Purpose

The RLB test is used to determine whether the local LD1600, WDM cabling connected to it, and remote LD1600's WDM interface are OK.

Data Path

The data path (roundtrip) in an RLB test is shown schematically in *Figure 78* below.

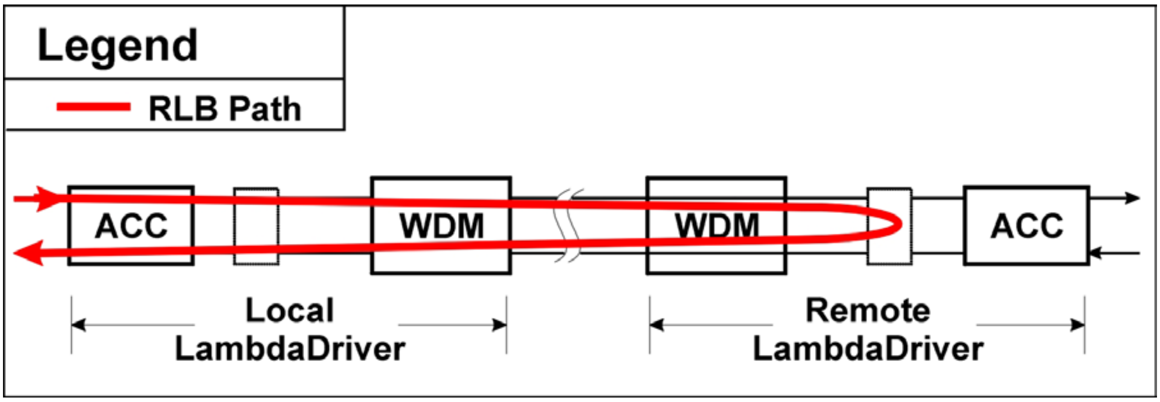


Figure 78: Data Path in RLB Test using a Transponder

The data path in detail with reference to *Figure 79* is as follows:

Local LD1600 (Transponder → Mgt → OA → OADM or Mux → 1+1 or Service) →
WDM Trunk Cabling →
Remote LD1600 (1+1 or Service → OADM or Demux → OA → Mgt → Transponder, excluding interface to Access Unit → Mgt → OA → OADM or Mux → 1+1 or Service) →

WDM Trunk Cabling →
Local LD1600 (1+1 or Service → OADM or Demux → OA → Mgt → Transponder).

Preparation

<u>TM-SFP</u>

Software Control

The procedure for configuring the TM-SFP transponders in the local and remote LD1600s so that they can be controlled by software is as follows:

Local

1. Place the Transponder to be installed in the local LD1600 on a flat clean static-free stable surface.
2. With the aid of *Figure 36* on page *115,* locate DIP switch **SW1** on the Transponder.
3. Set the DIP switch as shown in row 1 of *Table 13* on page *118*.
4. Insert the Transponder in the *local* LD1600.
5. At the management station, invoke the CLI command:

   `set-transponder-lb [arg #0] [arg #1] opt.[arg #2] opt.[arg #3]`

   where,

   `[arg #0]` = Slot number of the local transponder

   `[arg #1]` = **1** (number of the transponder in the slot)

   `opt.[arg #2]` = **`rlb`** (RLB mode)

   `opt.[arg #3]` = **`n`** (enable normal mode)

Remote

1. Place the Transponder to be installed in the remote LD1600 on a flat clean static-free stable surface.
2. With the aid of *Figure 36* on page *115,* locate DIP switch **SW1** on the Transponder.
3. Set the DIP switch as shown in row 1 of *Table 13* on page *118*.
4. Insert the Transponder in the *remote* LD1600
5. Ensure that the *remote* TM-SFP transponder is connected to the *local* TM-SFP transponder with intra- and inter-LD1600 cabling.
6. At the management station, invoke the CLI command:

   `set-transponder-lb [arg #0] [arg #1] opt.[arg #2] opt.[arg #3]`

   where,

   `[arg #0]` = Slot number of the local transponder

   `[arg #1]` = **1** (number of the transponder in the slot)

   `opt.[arg #2]` = **`rlb`** (RLB mode)

   `opt.[arg #3]` = **`l`** (enable loopback mode)

Hardware Control

The procedure for configuring the TM-SFP transponders in the local and remote LD1600s so that they can be controlled by hardware is as follows:

Local

1. Place the Transponder to be installed in the local LD1600 on a flat clean stable surface.
2. With the aid of *Figure 36* on page *115,* locate DIP switch **SW1** on the Transponder.
3. Set the DIP switch according to the appropriate row (number 2 onwards) of *Table 13* on page *118.*

4. With the aid of *Figure 36* on page *115*, locate Jumper **JP8** on the Transponder module and, using *Table 8* on page *114*, set it to the position **NOR** (factory default).
5. Insert the Transponder in the *local* LD1600.

Remote

1. Place the Transponder to be installed in the remote LD1600 on a flat clean stable surface.
2. With the aid of Figure 36 on page 115, locate DIP switch **SW1** on the Transponder.
3. Set the DIP switch according to the appropriate row (number 2 onwards) of *Table 13* on page *118.*
4. With the aid of *Figure 36* on page *115*, locate Jumper **JP8** on the Transponder module and, using *Table 8* on page *114*, set it to the position **RLB**.
5. Insert the Transponder in the *remote* LD1600.
6. Ensure that the *remote* TM-SFP transponder is connected to the *local* TM-SFP transponder with intra- and inter-LD1600 cabling.

<u>TM2-SFP</u>

Software Control

The procedure for configuring the TM2-SFP transponders in the local and remote LD1600s so that they can be controlled by software is as follows:

Local

1. Place the Transponder to be installed in the local LD1600 on a flat clean static-free stable surface.
2. Choose Transponder **1** or **2** as the local transponder to be used in the RLB test.
3. With the aid of *Figure 37* on page *117*, locate DIP switch **SW1** (if Transponder **1** was chosen) or DIP switch **SW2** (if Transponder **2** was chosen) on the Transponder module.
4. Set the DIP switch as shown in row 1 of *Table 13* on page *118*.
5. Insert the Transponder in the *local* LD1600.
6. At the management station, invoke the CLI command:

   `set-transponder-lb [arg #0] [arg #1] opt.[arg #2] opt.[arg #3]`

   where,

   `[arg #0]` = Slot number of the local transponder

   `[arg #1]` = **1** (for Transponder 1) or **2** (for Transponder 2)

   `opt.[arg #2]` = **`rlb`** (RLB mode)

   `opt.[arg #3]` = **`n`** (enable normal mode)

Remote

1. Place the Transponder to be installed in the remote LD1600 on a flat clean static-free stable surface.
2. Choose the remote transponder having the same number as the local transponder.
3. With the aid of *Figure 37* on page *117*, locate DIP switch **SW1** (if Transponder **1** was chosen) or DIP switch **SW2** (if Transponder **2** was chosen) on the Transponder module.
4. Set the DIP switch as shown in row 1 of *Table 13* on page *118*.
5. Insert the Transponder in the *remote* LD1600.
6. Ensure that the *remote* TM2-SFP transponder is connected to the *local* TM2-SFP transponder with intra- and inter-LD1600 cabling.
7. At the management station, invoke the CLI command:

   `set-transponder-lb [arg #0] [arg #1] opt.[arg #2] opt.[arg #3]`

   where,

[arg #0] = Slot number of the local transponder

[arg #1] = 1 (for Transponder 1) or **2** (for Transponder 2)

opt.[arg #2] = rlb (RLB mode)

opt.[arg #3] = l (enable loopback mode)

Hardware Control

The procedure for configuring the TM2-SFP transponders in the local and remote LD1600s so that they can be controlled by hardware is as follows:

Local

1. Place the Transponder to be installed in the local LD1600 on a flat clean stable surface.
2. Choose Transponder **1** or **2** as the local transponder to be used in the RLB test.
3. With the aid of *Figure 37* on page *117*, locate DIP switch **SW1** (if Transponder **1** was chosen) or DIP switch **SW2** (if Transponder **2** was chosen) on the Transponder module.
4. Set the DIP switch according to the appropriate row (number 2 onwards) of *Table 13* on page *118.*
5. With the aid of *Figure 37* on page *117*, locate Jumper **JP4** (if Transponder **1** was chosen) or Jumper **JP5** (if Transponder **2** was chosen) on the Transponder module and, using *Table 12* on page *116*, set it to the position **NORMAL** (factory default).
6. Insert the Transponder in the *local* LD1600.

Remote

1. Place the Transponder to be installed in the remote LD1600 on a flat clean stable surface.
2. Choose the remote transponder having the same number as the local transponder.
3. With the aid of *Figure 37* on page *117*, locate DIP switch **SW1** (if Transponder **1** was chosen) or DIP switch **SW2** (if Transponder **2** was chosen) on the Transponder module.
4. Set the DIP switch according to the appropriate row (number 2 onwards) of *Table 13* on page *118*.
5. With the aid of *Figure 37* on page *117*, locate Jumper **JP4** (if Transponder **1** was chosen) or Jumper **JP5** (if Transponder **2** was chosen) on the Transponder module and, using *Table 12* on page *116*, set it to the position **LOOP**.
6. Insert the Transponder in the *remote* LD1600.
7. Ensure that the *remote* TM2-SFP transponder is connected to the *local* TM2-SFP transponder with intra- and inter-LD1600 cabling.

<u>TM-DXFP</u>

Software Control

The procedure for configuring the TM-DXFP transponders in the local and remote LD1600s so that they can be controlled by software is as follows:

Local

1. Place the Transponder to be installed in the local LD1600 on a flat clean static-free stable surface.
2. With the aid of *Figure 38* on page *121,* locate DIP switch **SW1** on the Transponder.
3. Set the DIP switch toggle 6 to the **ON** position (for configuration control by software) as shown in row 6 of *Table 15* on page *120*.
4. Insert the Transponder in the *local* LD1600.
5. At the management station, invoke the CLI command:

   set-transponder-lb [arg #0] [arg #1] opt.[arg #2] opt.[arg #3]

   where,

   [arg #0] = Slot number of the local transponder

`[arg #1]` = 1 (number of the transponder in the slot)

`opt.[arg #2]` = `rlb` (RLB mode)

`opt.[arg #3]` = `n` (enable normal mode)

Remote

1. Place the Transponder to be installed in the remote LD1600 on a flat clean static-free stable surface.
2. With the aid of *Figure 38* on page *121,* locate DIP switch **SW1** on the Transponder.
3. Set the DIP switch toggle **6** to the **ON** position (for configuration control by software) as shown in row 6 of *Table 15* on page *120*.
4. Insert the Transponder in the *remote* LD1600
5. Ensure that the *remote* TM-DXFP transponder is connected to the *local* TM-DXFP transponder with intra- and inter-LD1600 cabling.
6. At the management station, invoke the CLI command:

   `set-transponder-lb [arg #0] [arg #1] opt.[arg #2] opt.[arg #3]`

   where,

   `[arg #0]` = Slot number of the local transponder

   `[arg #1]` = 1 (number of the transponder in the slot)

   `opt.[arg #2]` = `rlb` (RLB mode)

   `opt.[arg #3]` = `l` (enable loopback mode)

Hardware Control

The procedure for configuring the TM-DXFP transponders in the local and remote LD1600s so that they can be controlled by hardware is as follows:

Local

1. Place the Transponder to be installed in the local LD1600 on a flat clean stable surface.
2. With the aid of *Figure 38* on page *121,* locate DIP switch **SW1** on the Transponder.
3. Set the DIP switch with the aid of *Table 15* on page *120,* ensuring, in particular, that toggle **2** is set to the **ON** position (RLB mode), toggle **3** is set to the **OFF** position (Normal mode), and toggle **6** is set to the **OFF** position (for configuration control by hardware) as shown in row 6.
4. Insert the Transponder in the *local* LD1600.

Remote

1. Place the Transponder to be installed in the remote LD1600 on a flat clean stable surface.
2. With the aid of *Figure 38* on page *121,* locate DIP switch **SW1** on the Transponder.
3. Set the DIP switch with the aid of *Table 15* on page *120,* ensuring, in particular, that toggle **6** is set to the **OFF** position (for configuration control by hardware) as shown in row 6.
4. Insert the Transponder in the *remote* LD1600.
5. Ensure that the *remote* TM-DXFP transponder is connected to the *local* TM-DXFP transponder with intra- and inter-LD1600 cabling.

Interconnection

Interconnect the local and remote LD1600s, Tester (capable of generating frames), and Management station as shown in *Figure 79.*

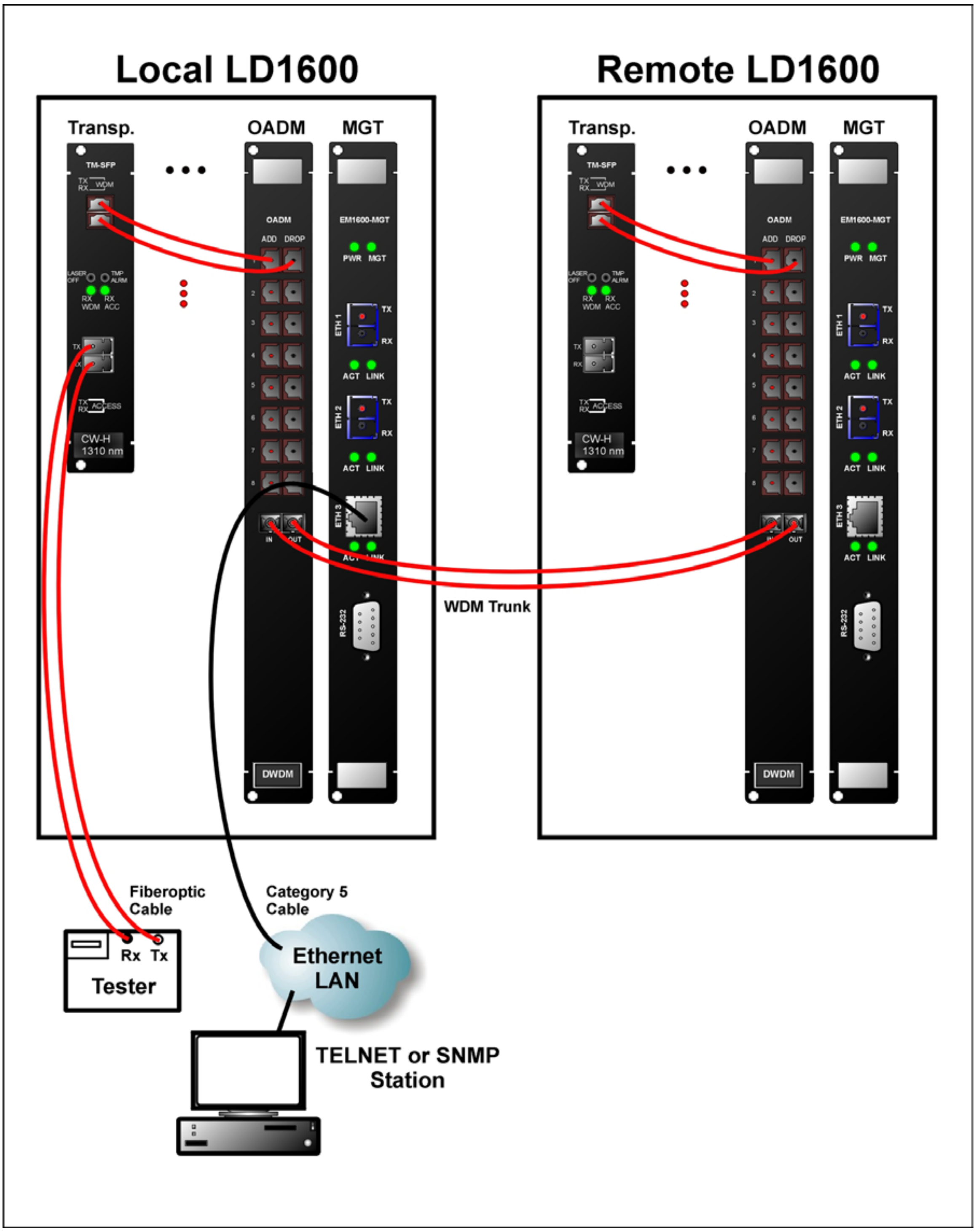


Figure 79: RLB/LLB Test Network Topology using Transponders

Procedure

Feed data signals from the tester and check them after they have made the roundtrip.

LLB Test

Purpose

The LLB test is used to determine whether the *local* Transponder's electro-optical circuitry is OK.

Data Path

The data path (round-trip) in an LLB test is shown schematically in *Figure 80* below. (The remote transponder is not used in the LLB test.)

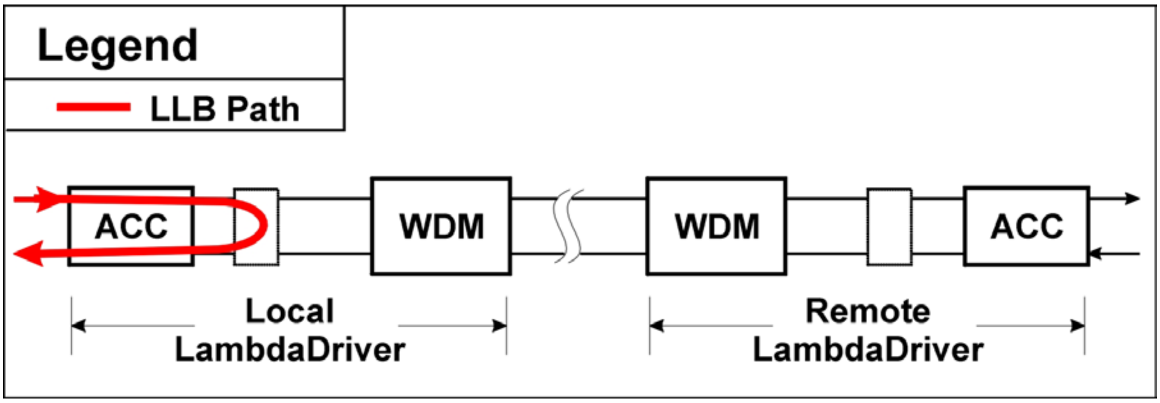


Figure 80: Data Path in LLB Test using a Transponder

Preparation

TM-SFP

Software Control

LLB test is not available by software control for the TM-SFP transponder.

Hardware Control

The procedure for configuring the TM-SFP transponders in the local LD1600s so that they can be controlled by hardware is as follows:

1. Place the Transponder to be installed in the local LD1600 on a flat clean stable surface.
2. With the aid of *Figure 36* on page *115,* locate DIP switch **SW1** on the Transponder.
3. Set the DIP switch according to the appropriate row (number 2 onwards) of *Table 13* on page *118.*
4. With the aid of *Figure 36* on page *115*, locate Jumper **JP9** on the Transponder module and, using *Table 9* on page *114*, set it to the position **LLB**.
5. Insert the Transponder in the *local* LD1600.

TM2-SFP

LLB test is not available for the TM2-SFP transponder.

TM-DXFP

Software Control

The procedure for configuring the TM-DXFP transponders in the local LD1600s so that they can be controlled by software is as follows:

1. Place the Transponder to be installed in the local LD1600 on a flat clean static-free stable surface.
2. With the aid of *Figure 38* on page *121,* locate DIP switch **SW1** on the Transponder.
3. Set the DIP switch toggle 6 to the **ON** position (for configuration control by software) as shown in row 6 of *Table 15* on page *120*.
4. Insert the Transponder in the *local* LD1600.
5. At the management station, invoke the CLI command:

set-transponder-lb [arg #0] [arg #1] opt.[arg #2] opt.[arg #3]

where,

[arg #0] = Slot number of the local transponder

[arg #1] = 1 (number of the transponder in the slot)

opt.[arg #2] = llb (LLB mode)

opt.[arg #3] = 1 (enable loopback mode)

Hardware Control

The procedure for configuring the TM-DXFP transponders in the local LD1600s so that they can be controlled by hardware is as follows:

1. Place the Transponder to be installed in the local LD1600 on a flat clean stable surface.
2. With the aid of *Figure 38* on page *121,* locate DIP switch **SW1** on the Transponder.
3. Set the DIP switch with the aid of *Table 15* on page *120,* ensuring, in particular, that toggle **2** is set to the **OFF** position (Normal mode), toggle **3** is set to the **ON** position (LLB mode), and toggle **6** is set to the **OFF** position (for configuration control by hardware).
4. Insert the Transponder in the *local* LD1600.

Interconnection

Interconnect the local and remote LD1600s, Tester (capable of generating frames), and Management station as shown *Figure 79* on page *205.*

Procedure

Send data from the tester and verify that the same data is received by it.

GM2s

This section describes the loopback tests for an LD1600 network using GM2s for connecting access units.

RLB Test

Purpose

The RLB test is used to determine whether the local LD1600, WDM cabling connected to it, and remote LD1600's[32] WDM interface and GM2 access interface are OK.

Data Path

The data path (roundtrip) in an RLB test is shown schematically in *Figure 81* below.

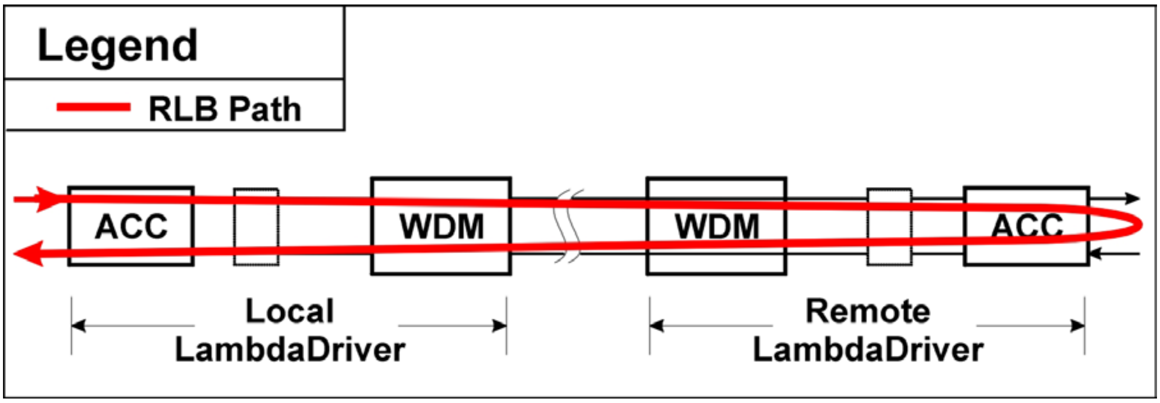


Figure 81: Data Path in RLB Test using a GM2

The data path in detail with reference to *Figure 82* is as follows:
Local LD1600 (GM2 → Mgt → OA → OADM or Mux → 1+1 or Service) →
WDM Trunk Cabling →
Remote LD1600 (1+1 or Service → OADM or Demux → OA → Mgt → GM2, including interface to Access Unit → Mgt → OA → OADM or Mux → 1+1 or Service) →
WDM Trunk Cabling →
Local LD1600 (1+1 or Service → OADM or Demux → OA → Mgt → GM2).

Preparation

Local LD1600

1. Insert the GM2 in the *local* LD1600.
2. At the management station, invoke the CLI command:

   `set-transponder-lb [arg #0] [arg #1] opt.[arg #2] opt.[arg #3]`

   where,

   `[arg #0]` = Slot number of the local GM2

   `[arg #1]` = **1** (for GM2 access port 1) or **2** (for GM2 access port 2)

   `opt.[arg #2]` = **`rlb`** (RLB mode)

   `opt.[arg #3]` = **`n`** (enable normal mode)

Remote LD1600

1. Insert the GM2 in the *remote* LD1600
2. Ensure that the *remote* GM2 is connected to the *local* GM2 with intra- and inter-LD1600 cabling.

---

[32] GM2 is model EM2009-GM2 or TM-GM2.

3. At the management station, invoke the CLI command:

   `set-transponder-lb [arg #0] [arg #1] opt.[arg #2] opt.[arg #3]`

   where,

   `[arg #0]` **=** Slot number of the local GM2

   `[arg #1] =` **1** (if access port 1 was selected for the local GM2 in step *2* of the section *Local LD1600*, just above) or **2** (if access port 2 was selected for the local GM2 in step *2* of the section *Local LD1600*, just above)

   `opt.[arg #2] = rlb` (RLB mode)

   `opt.[arg #3] = l` (enable loopback mode)

Interconnection

Interconnect the local and remote LD1600s, Tester (capable of generating frames), and Management station as shown in *Figure 82.*

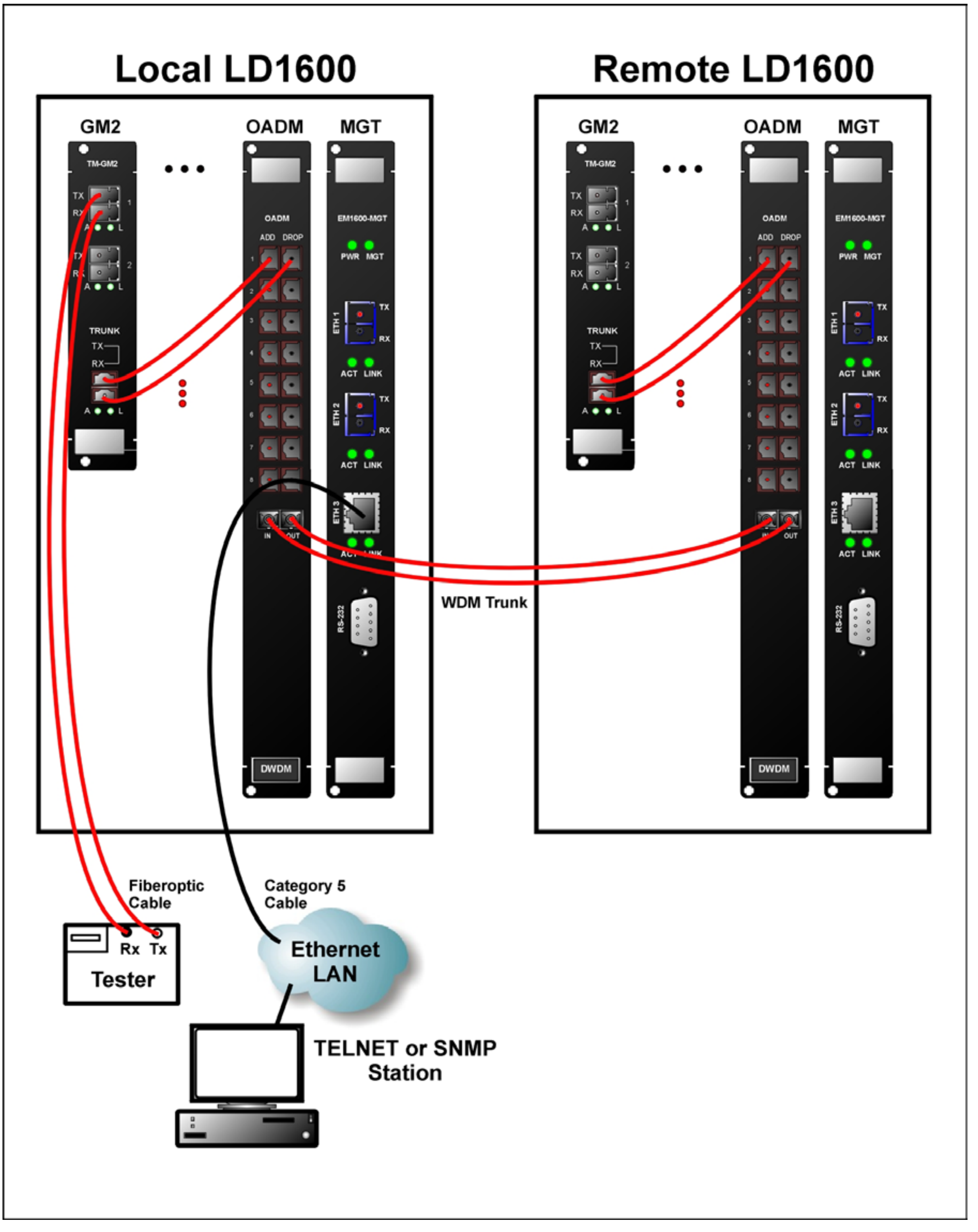


Figure 82: RLB/LLB/TLB Test Network Topology using GM2s

Procedure

Feed data signals from the tester and check them after they have made the roundtrip.

LLB Test

Purpose

The LLB test is used to determine whether the local GM2's electro-optical circuitry is OK.

Data Path

The data path (round-trip) in an LLB test is shown schematically in *Figure 83* below. (The remote GM2 is not used in the LLB test.)

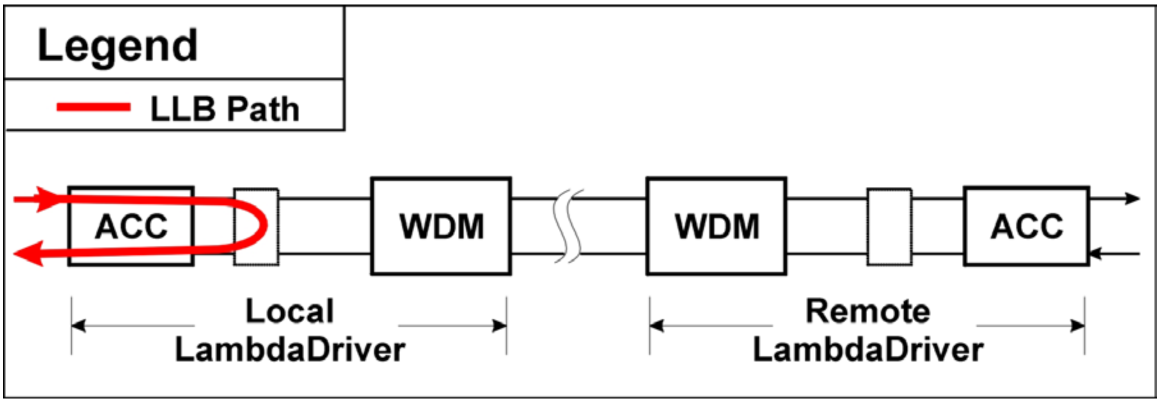


Figure 83: Data Path in LLB Test using a GM2

Preparation

1. Insert the GM2 in the *local* LD1600.
2. At the management station, invoke the CLI command:

   `set-transponder-lb [arg #0] [arg #1] opt.[arg #2] opt.[arg #3]`

   where,

   `[arg #0]` = Slot number of the local GM2

   `[arg #1]` = **1** (for GM2 access port 1) or **2** (for GM2 access port 2)

   `opt.[arg #2]` = `llb` (LLB mode)

   `opt.[arg #3]` = `1` (enable loopback mode)

Interconnection

Interconnect the local and remote LD1600s, Tester (capable of generating frames), and Management station as shown *Figure 82* on page *210.*

Procedure

Send data from the tester and verify that the same data is received by it.

TLB Test

Purpose

The TLB test is used to determine whether the *local* GM2's electro-optical circuitry and the *local* LD1600's WDM interface are OK.

Data Path

The data path (round-trip) in an TLB test is shown schematically in *Figure 84* below. (The remote GM2 is not used in the TLB test.)

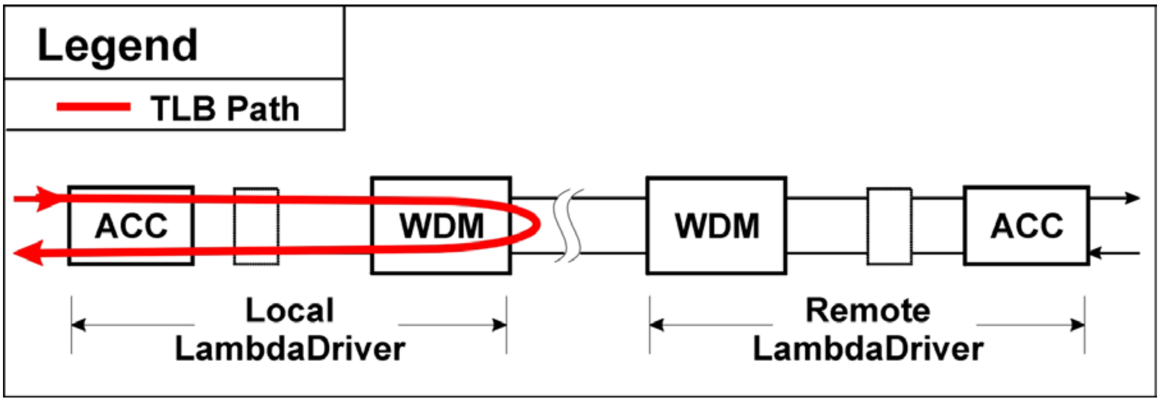


Figure 84: Data Path in TLB Test using a GM2

Preparation

1. Insert the GM2 in the *local* LD1600.
2. At the management station, invoke the CLI command:

   `set-transponder-lb [arg #0] [arg #1] opt.[arg #2] opt.[arg #3]`

   where,

   `[arg #0]` = Slot number of the local GM2

   `[arg #1]` = **0** (for GM2 trunk port)

   `opt.[arg #2]` = **`llb`** (TLB mode)

   `opt.[arg #3]` = **`1`** (enable loopback mode)

Interconnection

Interconnect the local and remote LD1600s, Tester (capable of generating frames), and Management station as shown *Figure 82* on page *210.*

Procedure

Send data from the tester and verify that the same data is received by it.

Appendix D: Cable Wiring

DB-9 Connector Signal	DB-9 Connector Pin	DB-25 Connector Pin	DB-25 Connector Signal
RxD	**2**	**3**	TxD
TxD	**3**	**2**	RxD
Gnd	**5**	**7**	Gnd

Figure 85: Null-Modem RS-232 Cable Wiring

DB-9 Connector Signal	DB-9 Connector Pin	DB-25 Connector Pin	DB-25 Connector Signal
DCD	**1**	**8**	DCD
RxD	**2**	**3**	RxD
TxD	**3**	**2**	TxD
DTR	**4**	**20**	DTR
Gnd	**5**	**7**	Gnd
DSR	**6**	**6**	DSR
RTS	**7**	**4**	RTS
CTS	**8**	**5**	CTS
RI	**9**	**22**	RI

Figure 86: Modem RS-232 Cable Wiring

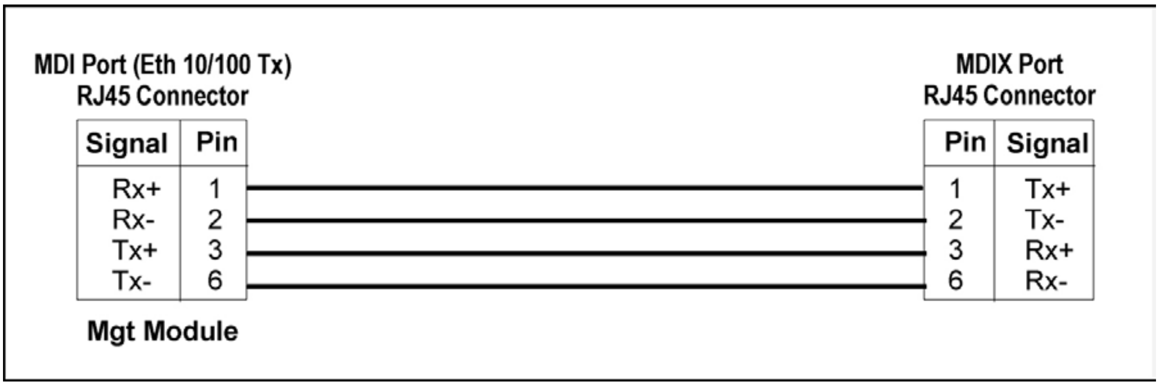


Figure 87: Ethernet Straight Cable Wiring

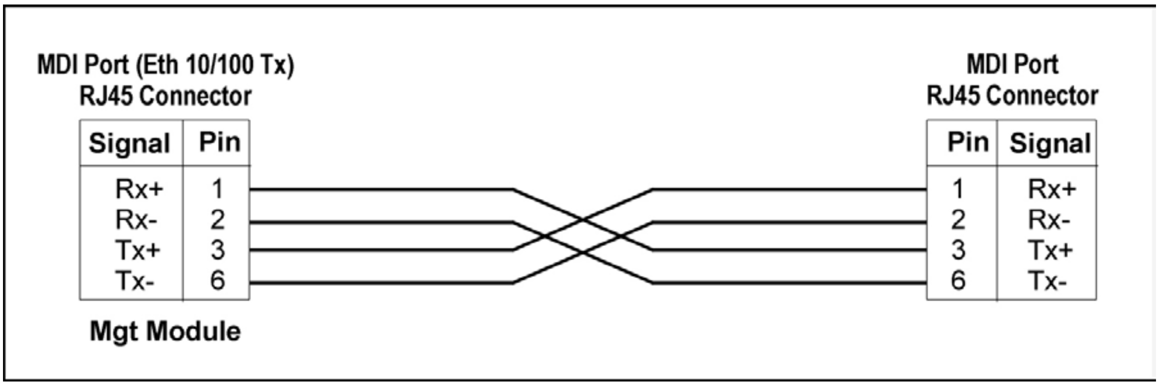


Figure 88: Ethernet Cross Cable Wiring

Appendix E:
Cleaning Optical Connectors

General

Intrusions (e.g., dust, grease, etc.) at the interface of two optical fibers, such as at a pair of coupled connectors, attenuate the signal through the fiber. Consequently, optical connectors must be clean before they are coupled with other connectors.

Tools and Equipment

Following are tools and equipment required for cleaning connectors.

- **Dust caps**
  Caps for protecting the connector from intrusions. A cap is usually made from flexible plastic. When placing a cap over a connector, avoid pressing it against the fiber ferula surface in the connector so as to prevent contamination.
- **Isopropyl alcohol**
  Solvent for contaminants.
- **Tissues**
  Soft multi-layered fabric made from non-recycled cellulose.

Procedure

The procedure for cleaning connectors is as follows:

1. If no stains are present, using a new clean dry tissue, gently rub, in small circular motions, the exposed fiber surface and surrounding area in the connector to remove dust.
2. If stains are present, moisten a new clean dry tissue with isopropyl alcohol and gently rub, in small circular motions, the exposed fiber surface and surrounding area in the connector to remove the stains.

   Using a new clean *dry* tissue, gently rub, in small circular motions, the exposed fiber surface and surrounding area in the connector to remove the dissolved stains and excess isopropyl alcohol.
3. If a connector is not to be coupled with another immediately, cover it with a dust cap.

Appendix F: Modem Setup and Installation

General

This appendix describes how to set up and install a dial-up modem via which the LD1600 can be managed from a remote station.

Requirements

LD1600 Side

- External dial-up modem to be connected to the LD1600. The modem must be able to operate at 9600 baud speed
- Null-modem RS-232 cable (*Figure 86*)
- ASCII terminal/emulator (for modem setup only)
- Possibly modem software installed in the ASCII terminal/emulator

Management Side

- Internal or external dial-up modem to be connected to the ASCII terminal/emulator. The modem must be able to operate at 9600 baud speed
- PC with available serial port and appropriate software for dialing on modem (e.g., Microsoft Window's HyperTerminal)

Setup

	**Note** The setup procedure needs to be performed only once since the setup configuration is stored in non-volatile memory.

LD1600 Side

1. Set the modem as follows:
   - *Auto-Answer* – (This setting is necessary to enable the modem to answer incoming calls.)
   - *No echo* – (This is necessary to prevent echo.)
   - Suppress results code
   - *9600 baud* – (This baud rate setting is necessary for operability with the LD1600
2. Save the configuration in the modem's non-volatile memory.

Management Side

Set up the modem according to the instruction manual of the modem.

Installation

Build the network shown in Figure 89.

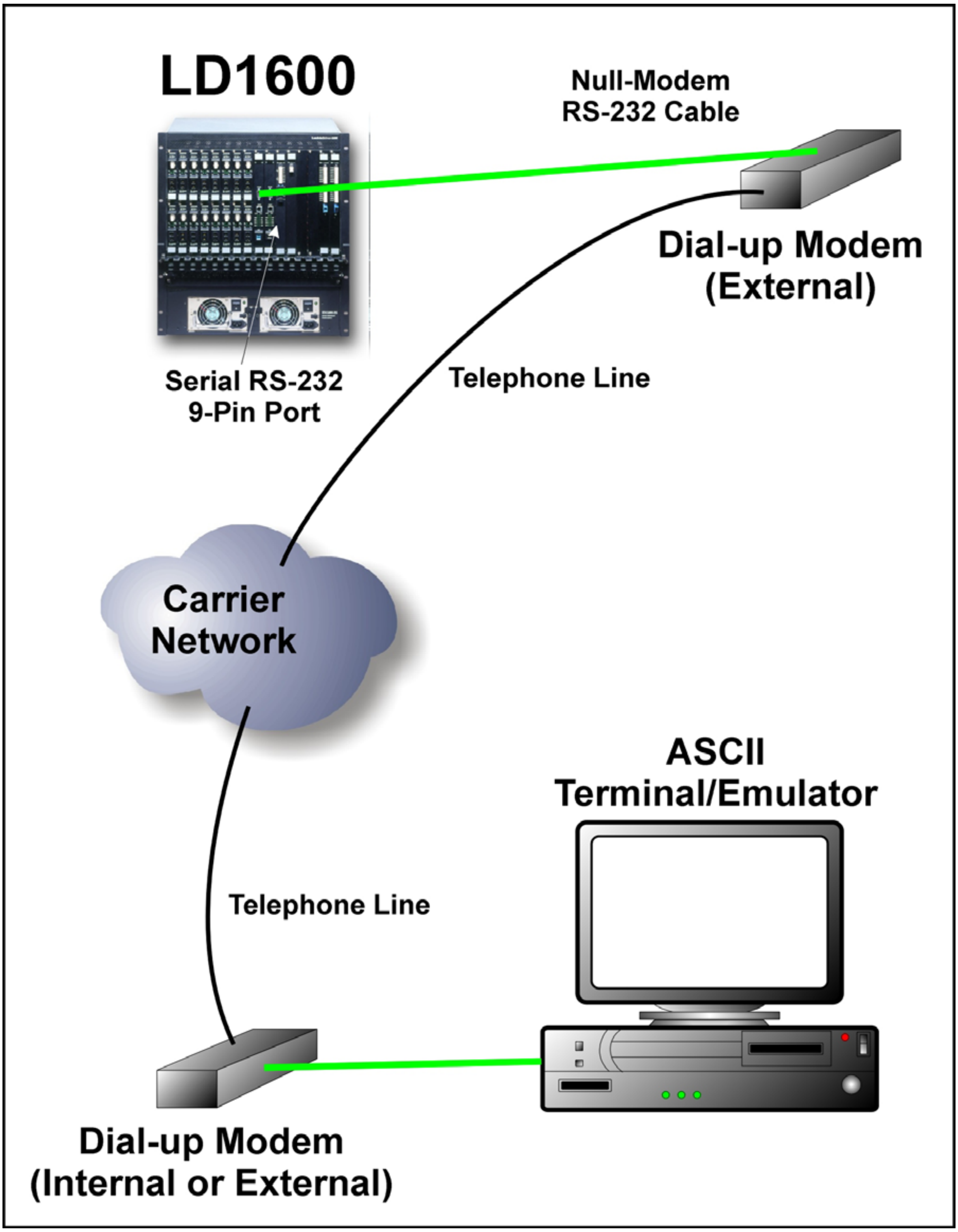


Figure 89: ASCII Terminal/Emulator Connection to LD1600 *via Modem*

Appendix G: Replacing a Module

General

This appendix shows how to replace modules in the LD1600 chassis.

Tools

- 6-inch flat-tip screwdriver
- 6-inch posidrive screwdriver
- Replacement module

Procedure

Network Module

The procedure for replacing a network module (Transponder, Mux, Demux, Management, Service, 1+1, OADM, OA, ESCON, or GM2) of the LD1600 is as follows:

1. With a 6-inch posidrive screwdriver, undo the two Mounting Screws (*Figure 2*).
2. Push down the Handle/Ejector/Extractor, and slide out the module.
3. Holding the *new* module by the panel, place it between the top and bottom rails in the slot. Then slide it until its panel is *almost* level with the front panel of the LD1600. (This assures that the module's connector is inserted into place.) Pull up the handle/ejector/extractor to lock the module in position.
4. Fasten the module with the two Mounting Screws using a 6-inch posidrive screwdriver.

Power Supply Module

The procedure for replacing a Power Supply module of the LD1600 is as follows:

1. Ensure that *all* power to the LD1600 is cut off. Specifically, disconnect all LD1600 power cords from the power line (mains).
2. With reference to *Figure 1, u*sing a 6-inch flat-tip screwdriver remove the Safety Plate (*Figure 40*) at the bottom of the LD1600 chassis by undoing the two captive screws. (This step also releases the Blank Panel, if present, covering the Power Supply slot.)
3. With one hand, move the spring latch (*Figure 17* or *Figure 18)* to the left; with the other hand pull out the Power Supply module by its handle.
4. Holding the *new* Power Supply module by the handle (*Figure 17* or *Figure 18*), slide it into the slot until the spring latch (*Figure 17* or *Figure 18)* locks into the chassis. (This assures that the module's connector is inserted into place.)
5. Fasten the safety plate to the chassis with the two captive screws making sure that the screws are fully tightened.

SFP Module

The procedure for replacing an SFP in a network module is as follows:

1. If the SFP module has a latching mechanism, while holding the SFP module with one hand gently release the latch with the other hand. Usually, the latch handle is a wire frame around the SFP module. To release the latch, swing down the wire frame.
2. Pull out the SFP module.
3. Swing up the latch handle around the SFP module and put it away.
4. Holding the *new* SFP module with the right side up, slide it about half-way into the SFP receptacle.

5. If the SFP module has a latching mechanism, while holding the SFP module with one hand gently release the latch with the other hand. Usually, the latch handle is a wire frame around the SFP module. To release the latch, swing down the wire frame.
6. With the index finger and thumb pressed against the face edges of the SFP module, gently slide it as far into the SFP receptacle as possible. Holding the SFP module in this position, swing up the latch handle around the SFP module to latch it.

Appendix H:
Servicing the Fan Module

Tools

- 6-inch flat-tip screwdriver
- Possibly a replacement Fan module

Procedure

The procedure for cleaning/replacing the Fan module of the LD1600 is as follows:

1. Slightly loosen the two captive screws fastening the jumper cable guide – see *Figure 1* – slide the guide to the top of the rails, then tighten the screws to hold the guide in position.
2. Remove the panel with vents by loosening the four captive screws.
3. Carefully remove the pad (air filter) that is on the inside of the panel. If the pad is dirty, wash it with water and dry it. Return the pad to its place.
4. To replace the fan, loosen the two captive screws and pull out the fan tray. Check/replace the fan tray.
5. Fasten the fan tray with the two captive screws that were loosened in step *4*.
6. Fasten the panel that was removed in step *2* with the four screws.
7. Slightly loosen the two captive screws that fasten the jumper cable guide, slide the guide to the bottom of the rails, then tighten the screws to hold the guide in position.

Appendix I:
Redundancy Protection Networks

General

Redundancy Protection Network Topologies have site disaster recovery capability. They provide a backup for elements (e.g., transponder, OADM, cable, etc.) of the network so that no single failed element will prevent the network from operating properly. The Parallel-path and Cross-path redundancy applications (shown in *Figure 90*, *Figure 91*, *Figure 92*, and *Figure 93*) enable the network to continue to operate properly even if failures occur in several redundant elements, provided at least one element of each and every redundancy pair is OK. *Figure 94* and *Figure 95* provide redundancy only for the trunk fiberoptic cabling.

These topologies are superior to dual networks in the following respects:

– Unlike dual networks which collapse even if just two elements, one in each network, fail, networks with these topologies will continue to operate properly even if several elements fail provided their redundant counterparts are OK

– Considerably lower in cost

– Easier to manage and maintain

– Less bulky

Using the TM2-SFP (two transponders in one module of size 1-slot), a single LD1600 chassis fitted with 16 dual transponders can serve as a multiplexer system consisting of *16* full-duplex WDM channels and having mutual redundancy protection among all the transponders!

Topologies

Point-to-Point with Inclusive End-to-End Total Redundancy

- Applicable to Terminal Equipment (TE) having redundancy I/Os
- Parallel-path and Cross-path redundancy
- Redundancy includes TE I/Os
- Primed and unprimed elements are mutually redundant
- Either primed or unprimed TE ports switched/enabled by the TE
- Dual I/O OADMs
- 2 transponder modules per channel per LD1600 node per link

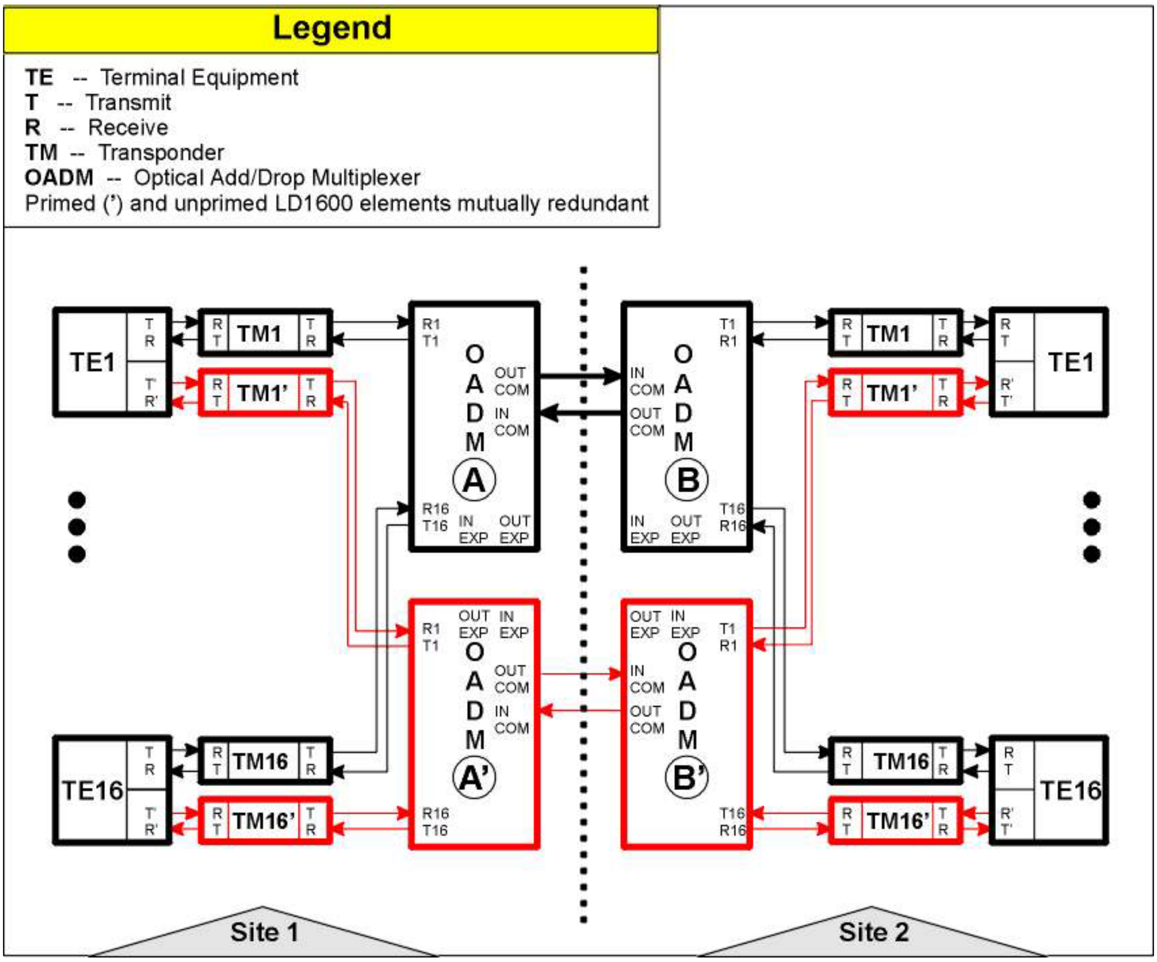


Figure 90: Point-to-Point with Inclusive End-to-End Total Redundancy

Ring with Inclusive End-to-End Total Redundancy

- Applicable to TEs having redundancy I/Os
- Parallel-path and cross-path redundancy
- Redundancy includes TE I/Os
- Primed and unprimed elements are mutually redundant
- Either primed or unprimed TE ports switched/enabled by the TE
- Dual I/O OADMs
- 2 transponder modules per channel per LD1600 node per link

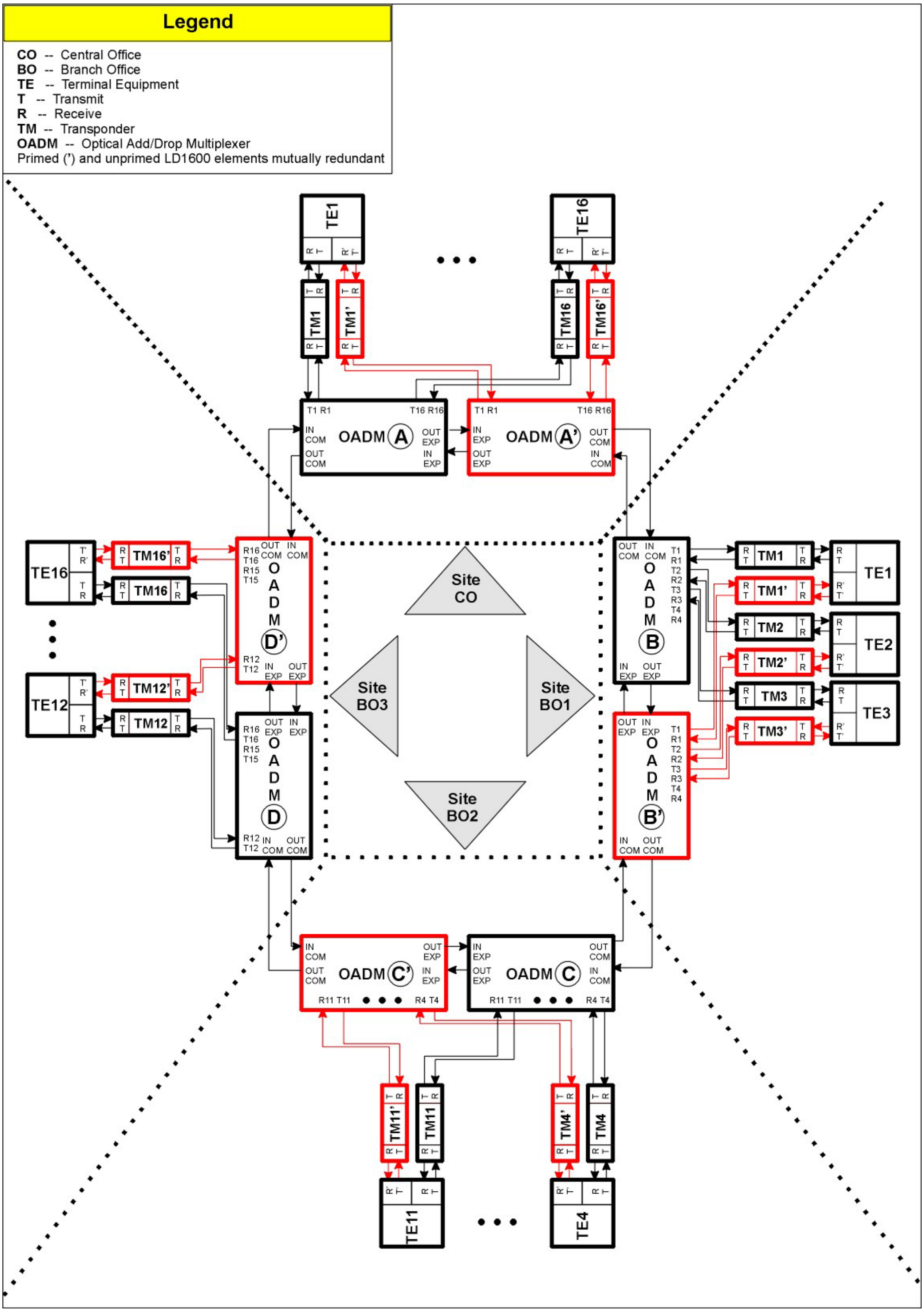


Figure 91: Ring with Inclusive End-to-End Total Redundancy

Point-to-Point with Exclusive End-to-End Total Redundancy

- Parallel-path and cross-path redundancy
- No redundancy for TE I/Os

- Primed and unprimed elements are mutually redundant
- Either primed or unprimed elements switched/enabled by the LD1600
- Dual I/O OADMs
- Y-cables for connecting TEs
- 2 transponder modules per channel per LD1600 node per link

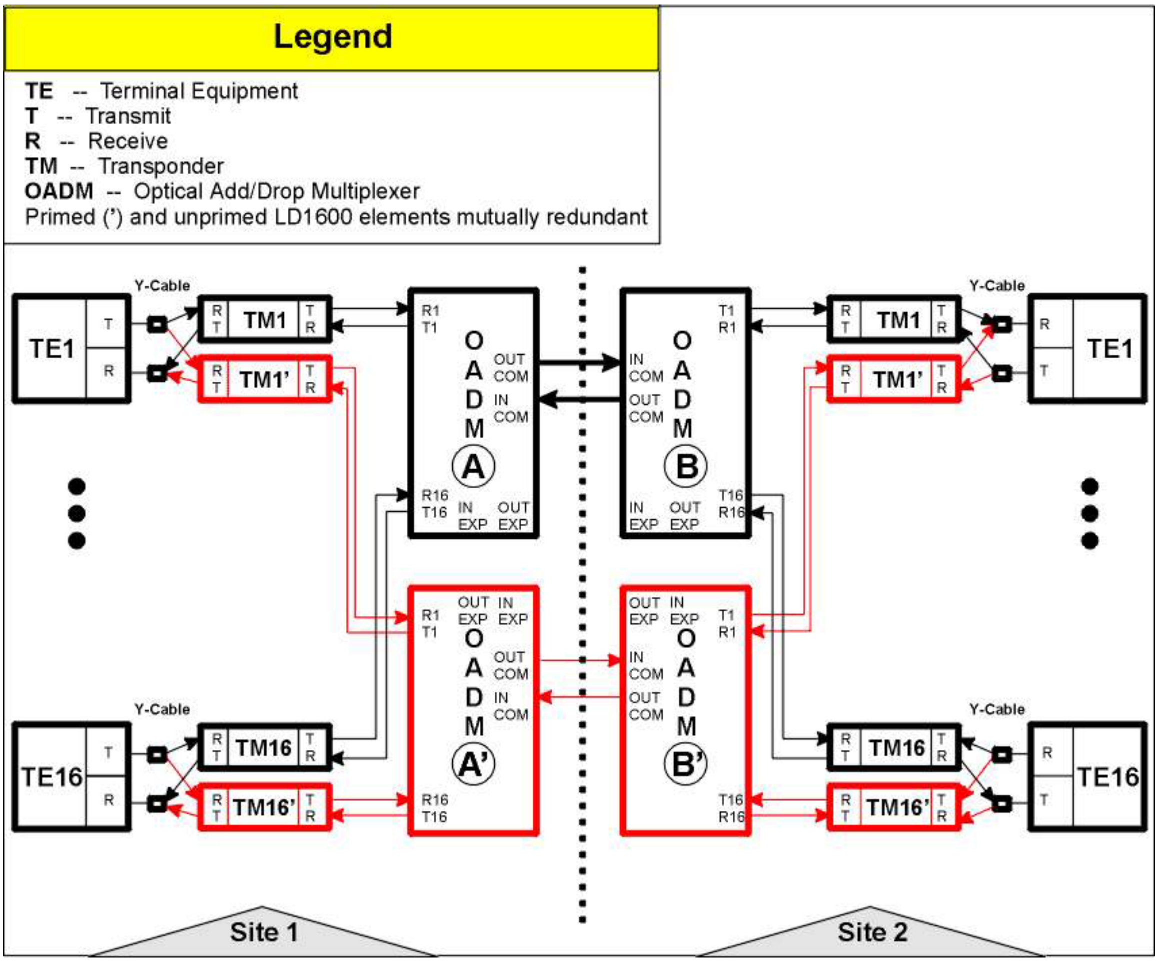


Figure 92: Point-to-Point with Exclusive End-to-End Total Redundancy

Ring with Exclusive End-to-End Total Redundancy

- Parallel-path and cross-path redundancy
- No redundancy for TE I/Os
- Primed and unprimed elements are mutually redundant
- Either primed or unprimed elements switched/enabled by the LD1600
- Dual I/O OADMs
- Y-cables for connecting TEs
- 2 transponder modules per channel per LD1600 node per link

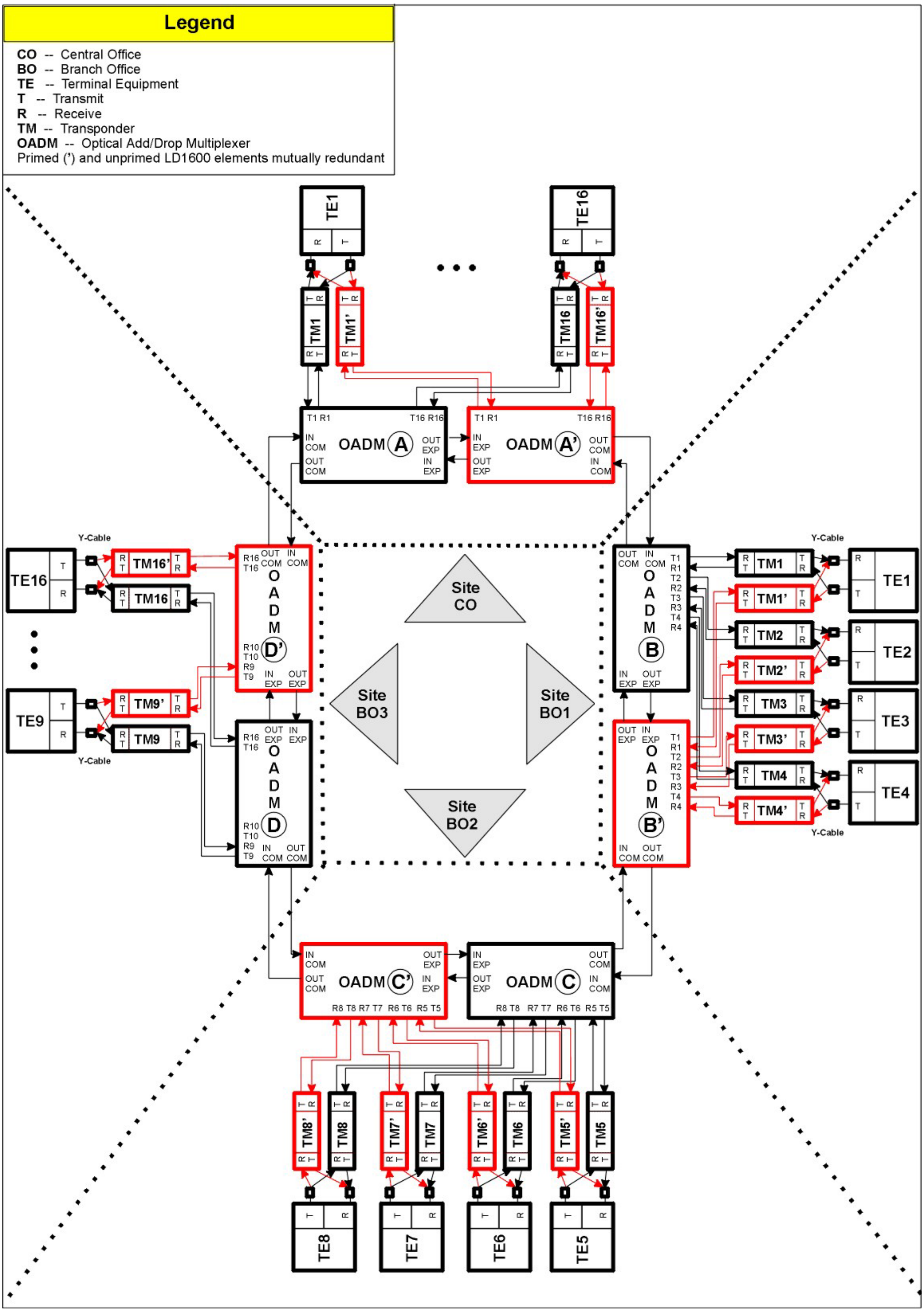


Figure 93: Ring with Exclusive End-to-End Total Redundancy

Point-to-Point with Fiber-only Redundancy

- No redundancy for TE I/Os
- Primed and unprimed elements are mutually redundant

- Either primed or unprimed TE ports switched/enabled by the TE
- Dual I/O OADMs
- 1 OADM module per channel per LD1600 node
- 1 transponder module per channel per LD1600 node per link

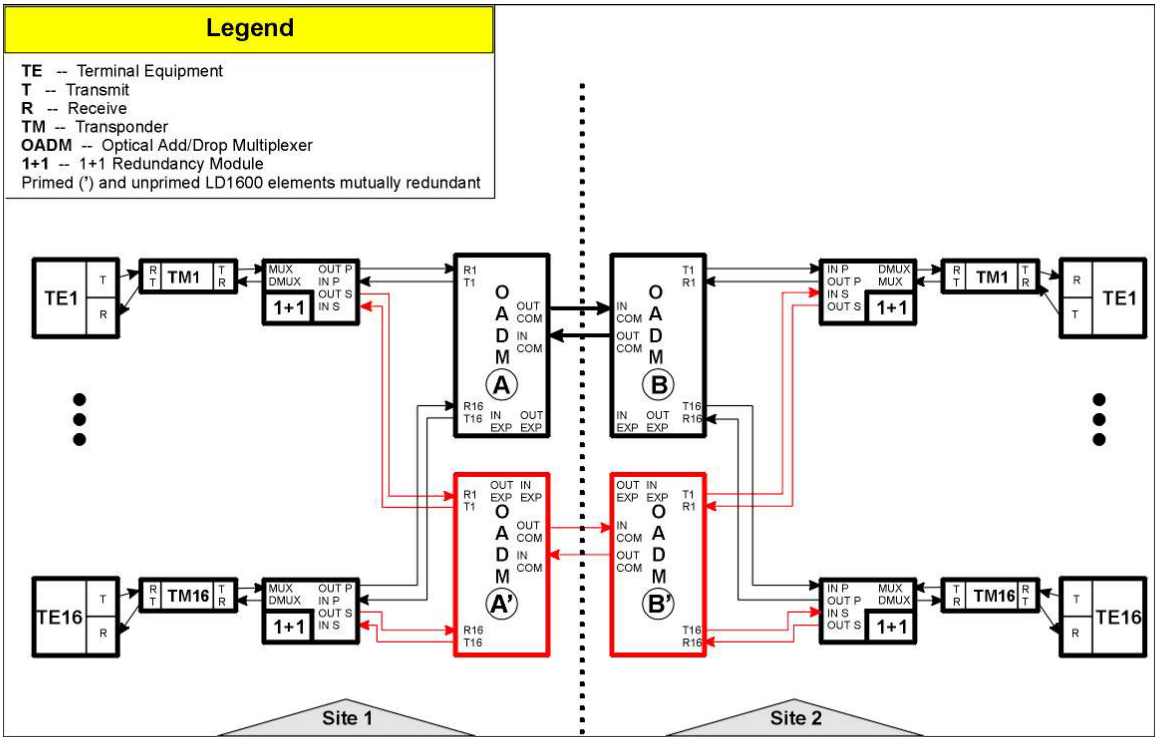


Figure 94: Point-to-Point with Fiber-only Redundancy

Ring with Fiber-only Redundancy

- No redundancy for TE I/Os
- Primed and unprimed elements are mutually redundant
- Either primed or unprimed TE ports switched/enabled by the TE
- Dual I/O OADMs
- 2 transponder modules per channel per LD1600 node per link

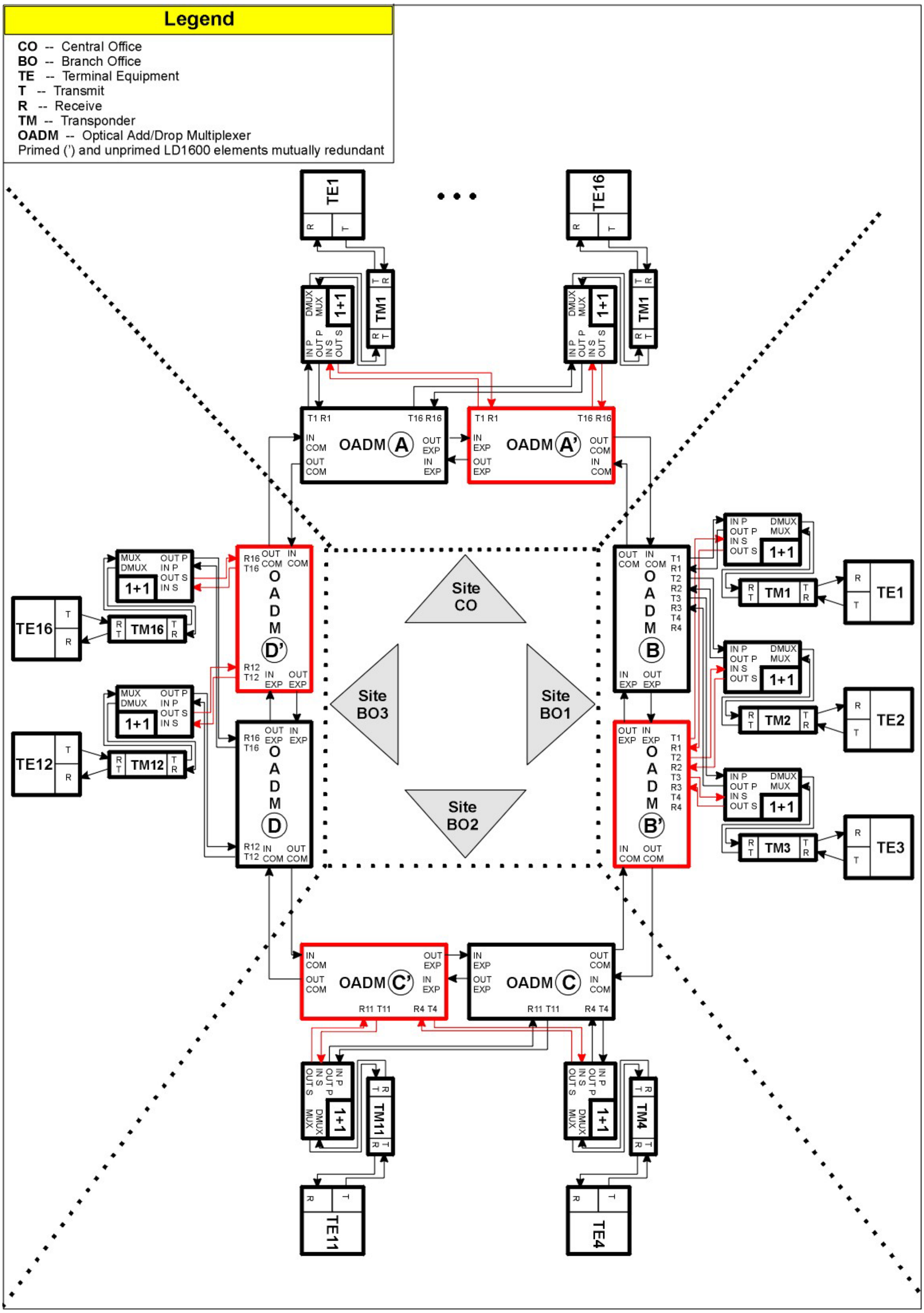


Figure 95: Ring with Fiber-only Redundancy

Installation

The installation described in the *Chapter 3: Installation* applies for all redundancy network topologies. In performing the installation steps, ensure, in particular, the following:

TM-SFP Transponders:

1. Jumper JP7 is set in the RED position, as shown in *Table 7* on page *113*.
2. Two mutually redundant transponders operating with the same channel (wavelength) and connected with a Y-cable must be placed in two adjacent slots, so that the odd-number slot has the smaller number. Valid slot pairs are: 1,2 and 3,4 and 5,6 and 7,8 and 9,10.

TM2-SFP Transponders:

1. Jumper JP2 is set in the TRANS-RED position, as shown in *Table 11* on page *116.* *(*As noted there, Transponders 1 and 2 of the TM2-SFP transponder module will operate in mutual redundancy mode.)

TM-DXFP Transponders:

1. DIP switch SW1 toggle 1 is set in the RED position, as shown in *Table 15* on page *120*.
2. Two mutually redundant transponders operating with the same channel (wavelength) and connected with a Y-cable must be placed in two adjacent slots, so that the odd-number slot has the smaller number. Valid slot pairs are: 1,2 and 3,4 and 5,6 and 7,8 and 9,10.

Appendix J: Product Specification

Applications	
Protocols	Fast Ethernet, Gigabit Ethernet, ATM or SONET/SDH at OC-1, OC-3, OC-12, OC-48, STM1, STM4, STM16, Fiber Channel, ESCON, Video and other proprietary protocols.
Network Topologies	Point-to-point, Ring, Star, Multipoint – with and without redundancy network protection
Operation	
Data Rate Range Per Channel	8 Mbps to 2.7 Gbps
Operating Distance (max) (LD1600 to LD1600, outband or inband)	100 km (62.1 mi) without compensation (e.g., OAs)
Link protection switchover time (max)	25 ms
WDM Wavelength Grid	
CWDM:	16 channels from 1310 to 1610 nm (with 20 nm spacing)
DWDM:	16 channels from 1529.55 to 1560.61 nm (with 0.8 nm or 1.6 nm spacing and 100 or 200 GHz frequency bandwidth)
Power Budget (max)	
WDM (LD1600 to LD1600)	
Transponder to Transponder:	Per the Transponder power budget, which depends on whether CWDM or DWDM and also channel bandwidth (Data Rate Range)
ESCON to ESCON	Per the ESCON SFP
Access (LD1600 to Access Equipment)	
Transponder to Access Equipment:	Per the Transponder SFP
ESCON to Access Equipment	Per the ESCON power budget
BER	10^{-12}
Compliance	
Safety	Certified to UL 1950; CSA 22.2 No. 950; FCC Part 15, Class B; CE-89/336/EEC, 73/23/EEC

Management Ethernet Port	IEEE 802.3/Ethernet, IEEE 802.3u/Fast Ethernet
Wavelength Grid DWDM: CWDM:	 ITU G694.1 ITU G694.2
Interface Ports	
Optical	Per the module
Electrical	
Serial/RS-232:	**RS-232**: (DB-9 9-pin shielded male connector)
Ethernet 100Base-TX:	**ETH**: (RJ45 8-pin shielded female connector)
Management	
Web-Based	Using MegaVision ® management application or MIB Browser
SNMP	Using MegaVision ® management application or any other SNMP manager
TELNET	Using a TELNET station
Serial/RS-232	Using craft terminal (e.g., VT100 Terminal or PC with ASCII terminal/emulator software)
Optical Supervisory Channel	
Speed:	100 Mbps (Fast Ethernet)
Wavelength:	1310 nm
Power	
Input:	
AC:	100 to 120 Vac, 8 A, 60 Hz (or 200 to 240 Vac, 3 A, 50 Hz)
DC:	-48 to -60 Vdc
Consumption:	
AC:	310 W
DC:	310 W
Electrical Cabling	
Serial Port (**RS-232**)	
Cable Type:	RS-232
Length (max):	15 m (~ 50 ft)
Connector Type:	D-type female 9-pin shielded connector
Connector Pinout:	2 → Rx

	3 → Tx 5 → Gnd
Ethernet Port	
Cable Type:	Category 5
Length (max):	100 m (330 ft)
Connector Type:	RJ45 male 8-pin shielded connector
Connector Pinout:	***MDI***: 1 → Rx+ 2 → Rx- 3 → Tx+ 6 → Tx-
Fiberoptic Cabling	
Inter-LD1600	Singlemode 9/125 µm
Intra-LD1600	Singlemode 9/125 µm
Components	
Chassis; Transponders; Muxes, Demuxes, OADMs, Power Supplies; Service; 1+1 Redundancy; Management, ESCON Multiplexer, Optical Amplifier	
Environmental	
Temperature	
Operating:	0 to 45 °C (32 to 113 °F)
Storage:	-10 to 70 °C (14 to 158 °F)
Humidity (non-condensing)	Less than 85%
Dust	Less than 10^6 particles/m^3 (~ 30,000 particles/ft^3)
Physical	
Dimensions (W x H x D)	
With Mounting Brackets:	482 x 511 or 11.5U[33] x 299 mm ^{3} (19 x 20.1 or 11.5U x 11.8 in ^{3})
Without Mounting Brackets:	446 x 511 or 11.5U x 299 mm ^{3} (17.5 x 20.1 or 11.5U x 11.8 in ^{3})
Weight (with full load)	35 kg (77 lb)
Mounting	Desktop or 19-inch (482 mm) rack per EIA RS-310C standard

[33] 1U = 1¾ inch or 44.45 mm

Appendix K: Small Form-factor Pluggables (SFPs)

The SFP transceiver option offers a very wide selection of interfaces in respect of protocol (e.g., 10/100/1000Base-TX or 1000Base-FX), cable media type (e.g., fiber or copper), carrier wavelength, fiber type, and operating range to tailor suit the application and terminal equipment. This endows the LD1600 modules that can host SFPs with flexible connectivity and minimizes cost of investment on upgrades and deviations since to change any one or more of the interface attributes, only the SFP needs to be replaced and not the entire LD1600 module. An additional useful quality of SFPs is that they are pluggable and hot-swappable.

Ordering Code	Description	C/O
Plug-In Interfaces		
GBIC - Gigabit Interface Converter		
Gigabit Ethernet Copper (RJ-45 Connectors)		
GBIC-GA-RJ	GBIC 1000Base-TX, RJ-45, auto-negotiating	US
Gigabit Ethernet/Fibre Channel		
GBIC-SX	GBIC 1000Base-SX, MM, 850nm, 0-550m.	US
GBIC-MMX	GBIC 1000Base-SX,Extended MM, 1310nm, 2km.	US
GBIC-LX	GBIC 1000Base-LX, SM, 1310nm, 10km.	US
GBIC-XD	GBIC 1000Base-XD, SM, 1550nm, 50km.	US
GBIC-ZX	GBIC 1000Base-ZX, SM, 1550nm, 80km. *Please inquire for longer distances.	US
CWDM Gigabit Ethernet/ Fibre Channel		
GBIC-CWZX-XX	GBIC 1000Base-ZX, SM CWDM,(XX=Wavelength 1470 - 1610nm), 80km. *Please inquire for longer distances.	US
SFP - Small Form Factor Pluggable (LC Connectors)		
Ethernet Copper (RJ-45 Connectors)		
SFP-EFG	SFP Copper (10/100/1000) RJ45 (must be used in pairs with MRV Pluggable Optical Modules)	US
Fast Ethernet Multimode & Single-Mode (LC Connectors)		
	Please see the SFP OC-3 section for Fast Ethernet SFP	
Gigabit Ethernet/Fibre Channel		
SFP-G-SX	SFP 1000Base-SX, MM, 850nm, 0-550m.	US
SFP-G-MMX	SFP 1000Base-SX, Extended MM, 1310nm, 0-2km.	US
SFP-G-LX	SFP 1000Base-LX, SM, 1310nm, 10km.	US
SFP-GD-LX	SFP 1000Base-LX, SM, 1310nm. 10km, with Digital Diagnostics.	US

SFP-GD-ELX	SFP 1000Base-ELX, SM, 1310nm, 25km, with Digital Diagnostics.	US
SFP-GD-XD	SFP 1000Base-XD, SM, 1550nm, 50km, with Digital Diagnostics.	US
SFP-GD-ZX	SFP 1000Base-ZX, SM, 1550nm, 80km, with Digital Diagnostics.	US
SFP-GD-EZX	SFP 1000Base-EZX, SM 1550nm, 120km, with Digital Diagnostics. * Call for availablity	US
CWDM Gigabit Ethernet/Fibre Channel		
SFP-GCWXD-XX	SFP 1000Base-XD, SM CWDM (XX=Wavelength 1470-1610nm), 50km, CWDM	US
SFP-GDCWXD-XX	SFP 1000Base-XD, SM CWDM (XX=Wavelength 1470 - 1610nm), 50km, with Digital Diagnostics.	US
SFP-GDCWZX-XX	SFP 1000Base-ZX, SM CWDM (XX=Wavelength 1470-1610nm), 80km, CWDM with Digital Diagnostics.	US
SFP-GDCWEZX-XX	SFP 1000Base-EZX, SM CWDM (XX=Wavelength 14710-1610nm) 120km with Digial Diagnostics. * Call for availablity	US
Fibre Channel Dual Rate (1&2Gbps) (LC Connectors)		
SFP-DGD-SX	SFP Dual Rate 1/2.1 Gbps SX, MM, 850nm, 0-550m, with Digital Diagnostics.	US
SFP-DGD-LX	SFP Dual Rate 1/2.1 Gbps LX, SM, 1310nm, 2km, with Digital Diagnostics	US
OC-3 (LC Connectors)		
SFP-O3D-LR1	SFP Fast Ethernet XD or OC-3 LR1, up to 155Mbps, 1310nm, 40km, with Digital Diagnostics.	US
SFP-O3D-LR2	SFP Fast Ethernet EZX or OC-3 LR2, up to 155Mbps, 1550nm, 100km, with Digital Diagnostics.	US
OC-12 (LC Connectors)		
SFP-DRO12D-IR1	SFP Dual Rate OC-3/OC-12 IR1, 155/622Mbps, 1310nm, 15km, with Digital Diagnostics.	US
SFP-O12D-LR1	SFP OC-12 LR1, 622Mbps, 1310nm, 40km, with Digital Diagnostics.	US
SFP-O12D-LR2	SFP OC-12 LR2, 622Mbps, 1550nm, 100km, with Digital Diagnostics.	US
OC-48 (LC Connectors)		
SFP-OC48-IR2	SFP OC48 IR2, SM,1550nm, 50km	US
SFP-OC48-MMX	SFP OC48, Extended MM, 1310nm, 0-2km.	US
SFP-OC48D-SR1	SFP OC48 SR1, 1310nm, 2km, with Digital Diagnostics.	US
SFP-OC48D-IR1	SFP OC48 IR1, SM, 1310nm, 15km with Digital Diagnostics.	US
SFP-OC48D-IR2	SFP OC48 IR2, SM,1550nm, 50km with Digital Diagnostics.	US
SFP-OC48D-LR2	SFP OC-48 IR2, SM 1550nm, 80km, with Digital Diagnostics.	US
CWDM OC-48 (LC Connectors)		

SFP-48DCWIR-XX	SFP OC-48 IR, SM CWDM (XX=Wavelength 1470-1610nm), 50km, with Digital Diagnostics.	US
SFP-48DCWLR-XX	SFP OC-48 LR, SM CWDM (XX=Wavelength 1470-1610nm), 80 km, with Digital Diagnostics.	US
Protocol Independent (LC Connectors)		
SFP-MR27D-SR1	SFP Multi-rate SR1, 100-2700Mbps, SM,1310nm, 2km with Digital Diagnostics.	US
SFP-MR27D-IR1	SFP Multi-rate IR1, 100-2700Mbps, SM,1550nm, 15km with Digital Diagnostics.	US
SFP-MR27D-IR2	SFP Multi-rate IR2, 100-2700Mbps, SM,1550nm, 50km with Digital Diagnostics.	US
CWDM Protocol Independent (LC Connectors)		
SFP-27DCWEIR-XX	SFP Multi-rate EIR, 100-2700Mbps, SM CWDM (XX=Wavelength 1470-1610nm), 60 km, with Digital Diagnostics.	US
SFP-27DCWLR-XX	SFP Multi-rate LR, 100-2700Mbps, SM CWDM (XX=Wavelength 1470-1610nm), 100 km, with Digital Diagnostics.	US

*** xx** represents the two middle digits of the wavelength : "47" - 1470nm, "49" - 1490nm, "51" - 1510nm, "53" - 1530nm. "55" - 1550nm, "57" - 1570nm, "59" - 1590, "61" - 1610nm

Glossary

ALS/APR	ALS/APR is a special algorithm-&-sensor mechanism that regularly checks link integrity on the access *and* trunk (WDM) side. If either of the links is broken (when for e.g., the fiberoptic cable on the access *or* trunk side is disconnected), the LD1600 performs Automatic Laser Shutdown (ALS/APR) on the WDM link. As a result, power is reduced to the safety level. After the links are reestablished, the LD1600 automatically reactivates the laser.
CWDM	A technology for multiplexing *widely* differing wavelengths on a single optical fiber. The range of wavelengths is typically 1470 to 1610 nm and the gap between the wavelengths are usually integral multiples of 20 nm.
DWDM	A technology for multiplexing *narrowly* spaced wavelengths on a single optical fiber. The wavelengths are in the infrared range, typically about 1550 nm and differ from one another usually by integral multiples of 0.2 to 0.8 nm.
LIN	**LIN** feature notifies Terminal Equipment of link failure by cutting off laser power on the access side whenever no power is received from the WDM side, and vice versa. Specifically, power at the transponder **WDM TX** port is cut off when no power is received at the **ACCESS RX** port. Also, power at the transponder **ACCESS TX** port is cut off when no power is received at the **WDM RX** port. LIN is permanently enabled.
OA	A device that directly amplifies an optical signal without first converting it into an electrical signal.
OADM	Optical multiplexing device that enables specific wavelengths to be added to or dropped from a WDM link while passing all other wavelengths to the next node on the link.
OSC (Service)	An optical supervisory channel for carrying management data between two WDM nodes. The wavelength of the channel is different from those of the WDM channels. The traffic in the OSC is multiplexed along with the traffic in the WDM channels on the same physical fiber.
Transponder	Device for converting a wave of one specific wavelength into a wave of a different wavelength.
Virtual Fiber	A virtual fiber is infrared light of a specific wavelength. In the LD1600, the virtual fibers are selected in the 1550 nm region for maximum operating distance through fiber.