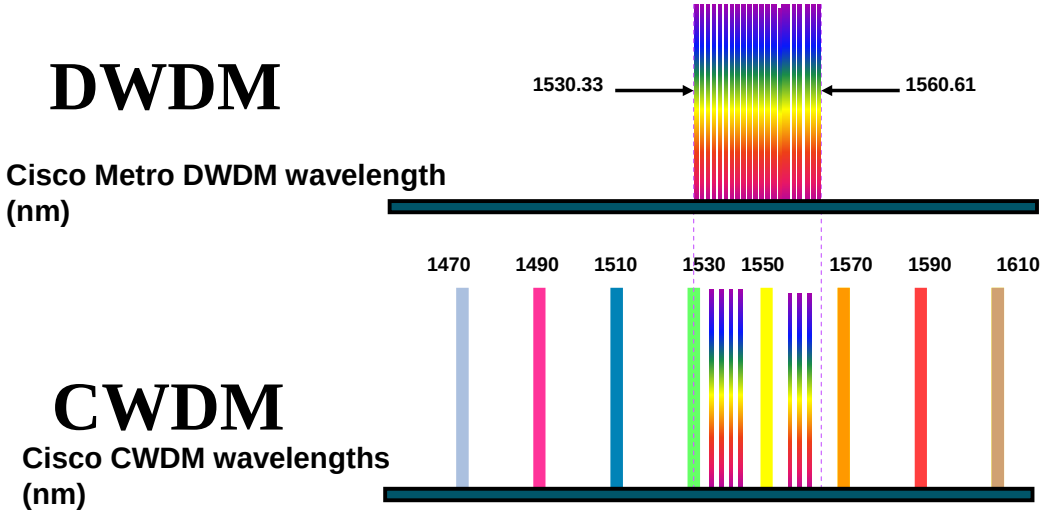
Cisco Enhanced Wavelength Division Multiplexing Product Line

The Cisco® enhanced wavelength-division multiplexing (EWDM) product line allows users to scale the speed and capacity of the services offered in a coarse wavelength-division multiplexing (CWDM) network by offering the ability to insert up to 8 dense wavelength-division multiplexing (DWDM) wavelengths to the existing 8-wavelength CWDM channel plan.

Product Overview

The Cisco EWDM product line provides the ability to overlay up to 8 DWDM wavelengths with the 8 CWDM channels (1470, 1490, 1510, 1530, 1550, 1570, 1590, and 1610 nm). The principle is very simple, yet it is a unique approach in that the 8 DWDM wavelengths are inserted in between CWDM channels. EWDM allows 5 DWDM channels to be multiplexed between the 1530-nm and 1550-nm CWDM wavelengths and 3 DWDM channels between the 1550-nm and 1570-nm CWDM wavelengths. A total of 8 CWDM plus 8 DWDM wavelengths can be supported on the same fiber infrastructure (See Figure 1).

Figure 1. Cisco EWDM Concept



The Cisco EWDM product line is composed of three passive units and an optical amplifier designed for EWDM applications (Figure 2). The three passive units support 8 DWDM channels (EWDM-MUX8=), 4 DWDM channels (EWDM-OADM-4=), and 2 DWDM channels (EWDM-OADM-2=), giving customers the flexibility to add 8, 4, or 2 DWDM channels to a CWDM network.

The channel plan for the EWDM channels is depicted in Figure 3. Since CWDM passive series filters tolerate for a drift of as much as +/-6 nm around the CWDM center wavelength, the 8 DWDM channels are selected such that they do not interfere with the CWDM spectral range.

Figure 2. EWDM Passive Units Front Panel

EWDM-MUX8=
(8-channels MUX/DEMUX)

EWDM-OADM4=
(4-channels OADM)

EWDM-OADM2=
(2-channels OADM)

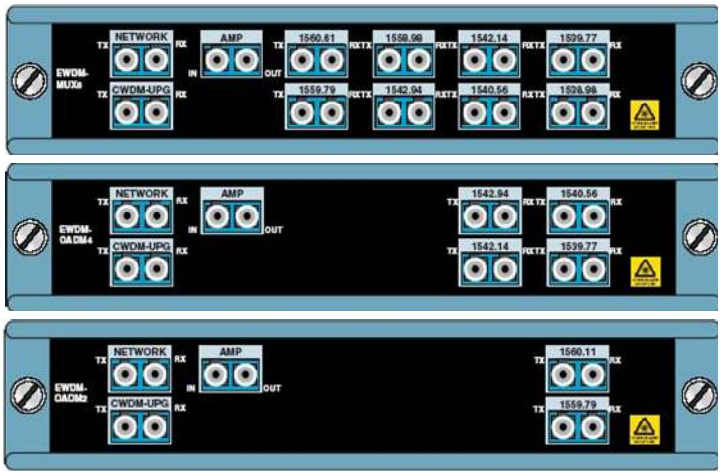
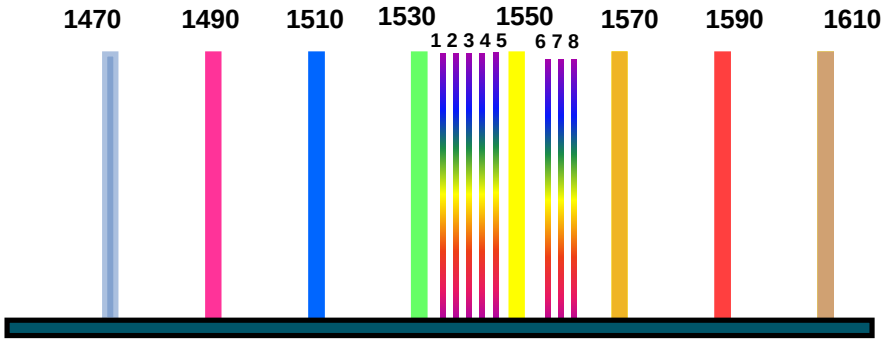


Figure 3. Cisco EWDM Channel Plan

Channel ID	Wavelength (nm)	EWDM-MUX8=	EWDM-OADM4=	EWDM-OADM2=
1	1538.98	*		
2	1539.77	*	*	
3	1540.56	*	*	
4	1542.14	*	*	
5	1542.94	*	*	
6	1558.98	*		
7	1559.79	*		*
8	1560.61	*		*



The optical amplifier (EWDM-OA=) is an Erbium Doped Fiber Amplifier (EDFA) designed to boost 10-Gbps wavelengths enough to compensate for their lower power budget compared to CWDM 1/2-Gbps transceivers. Cisco EWDM is designed with the goal to support 10-Gbps upgrades of CWDM networks, and the optical amplifier enables users to deploy 10-Gbps DWDM optics along with lower speed signals without sacrificing the total network reach. Note that the optical amplifier works in conjunction with the passive units to boost the power of only the DWDM wavelengths. (See Figure 4.)

Figure 4. EWDM Optical Amplifier

EWDM-OA=

Each EWDM component is compatible with the CWDM-CHASSIS-2=, the metal enclosure used for all other Cisco CWDM products.

Benefits of Cisco EWDM

The approach of Cisco EWDM at mixing CWDM and DWDM signals as well as the introduction of a custom designed amplifier yields the following benefits to end users:

- EWDM is built from the start with 10 Gbps in mind: customers can use DWDM technology to scale the speed of the services supported in a CWDM network.
- Customers can grow existing CWDM infrastructures to 16 total wavelengths. Adding DWDM channels does not sacrifice any of the 8 CWDM wavelengths.
- While upgrading to 10 Gbps, customers do not have to sacrifice the reach of their networks because of the reduced performance of 10-Gbps optics. The optical amplifier, designed for plug-and-play operations, will boost the power of 10-Gbps channels to match to total power budget available on CWDM lower speed services.

Applications

EWDM can be used to retrofit or expand a CWDM network with 10 Gigabit Ethernet capabilities while protecting 100 percent of the investment in the CWDM infrastructure. The EWDM components in the sample point-to-point configuration in Figure 5 are designed to interoperate transparently with the existing CWDM infrastructure to scale the total number of wavelengths to 16, with potentially up to 8 10 Gigabit Ethernet channels.

Figure 5. Example Deployment Scenario (West-to-East Direction Only Shown)

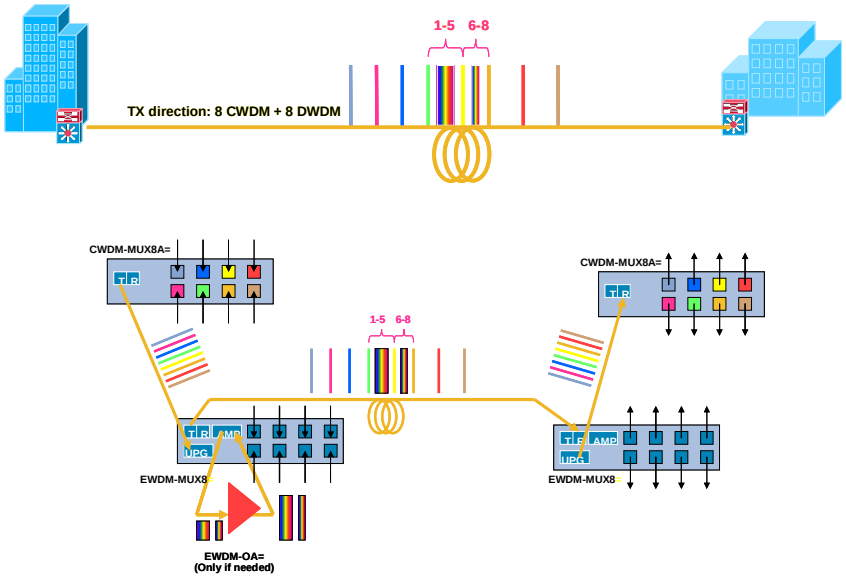


Figure 5 shows a configuration with 8 CWDM and 8 DWDM channels. Going west to east, this is how an EWDM configuration is deployed:

1. The CWDM “NETWORK TX” port, carrying the 8 CWDM wavelengths, is connected to the “CWDM-UPG RX” port of the EWDM unit. (The CWDM wavelengths are now ready to be multiplexed together with the DWDM wavelengths.)
2. 2. At the same time, the EWDM passive device receives from its DWDM client ports the signals from 10 Gigabit Ethernet transceivers, multiplexes them together, and routes them out of the “AMP IN” port.
    a. If the overall loss experienced by the 10 Gigabit Ethernet wavelengths can be accommodated within the power budget of the 10 Gigabit Ethernet DWDM transceiver (for example, a DWDM Xenpak has 20 dB of power budget after ~80 km, taking into account dispersion penalties), simply use the single-mode simplex LC patch cord provided with the EWDM device to connect the “AMP IN” to the “AMP OUT.” This way the DWDM wavelengths are fed back into the EWDM device ready to be multiplexed together with the CWDM signals.
    b. If the 10 Gigabit Ethernet channels require extra power to match the power budget of the CWDM GBIC/SFP devices, then the DWDM wavelengths out of the “AMP IN” port have to be injected into the “IN” port of the EWDM-OA=. The “OUT” port of the amplifier then feeds back the amplified signals into the “AMP OUT” port of the EWDM passive device. This way the DWDM wavelengths are fed back into the EWDM device ready to be multiplexed together with the CWDM signals.
3. At this stage the EWDM unit performs the multiplexing operation of CWDM and DWDM wavelengths. The aggregate CWDM plus DWDM signal is then sent out of the EWDM “NETWORK TX” port connected to the “metro” fiber.
4. At the receiving end, the “metro” fiber is connected to the EWDM “NETWORK RX” port, which receives all the CWDM and DWDM wavelengths. The DWDM wavelengths are demultiplexed and routed to the client “TX” ports connected to the 10 Gigabit Ethernet transceivers (hosted in a Cisco Catalyst® line card, for example). The CWDM wavelengths pass through the EWDM device transparently and are directed out of the “CWDM-UPG TX” port.
5. The “CWDM-UPG TX” port is connected to the “NETWORK RX” port of the CWDM units in Figure 5. The CWDM device demultiplexes the CWDM wavelengths and directs them to the receivers of the CWDM transceivers (hosted in a Cisco Catalyst or MDS line card, for example).

Other Possible Applications

In addition to mixing up to 8 DWDM channels over a CWDM network, the EWDM solution can be used in other possible applications: point-to-point DWDM, point-to-point amplified DWDM, small optical rings, and CWDM over DWDM.

Point-to-point DWDM link

Figure 6 shows an unamplified DWDM link with the 8-channel EWDM filters. Similar topology is supported with the 2-channel and 4-channel filters.

Figure 6. Unamplified 8-Channel DWDM Link (West to East Only Shown)

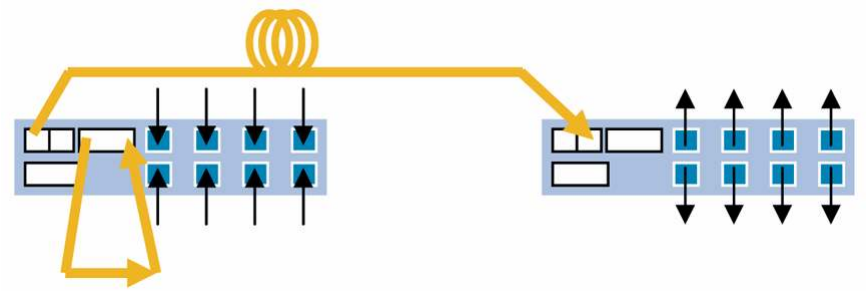
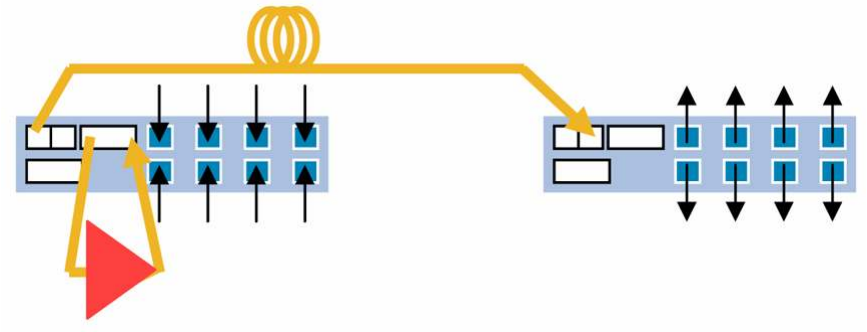


Figure 7 shows an amplified DWDM link with the 8-channel EWDM filters. Similar topology is supported with the 2-channel and 4-channel filters.

Figure 7. Amplified 8-Channel DWDM Link (West to East Only Shown)



In unamplified point-to-point links, 1-Gigabit DWDM traffic can typically achieve distances around 80km, and 10-Gigabit DWDM traffic can typically reach 60km. In amplified point-to-point links, 1-Gigabit DWDM traffic can typically achieve distances between 100 and 120km, and 10-Gigabit DWDM traffic can typically reach 80km (limited by chromatic dispersion).

Small all-optical hubs and rings

With EWDM filters it is possible to design small optical rings or hub and spoke topologies. This is made possible by reinserting a dropped channel into a separate filter module. Figures 8 and 9 show, respectively, a linear and a ring topology. Note that the distances in such designs will be limited by the insertion losses introduced when channels are dropped and inserted back into the network.

Figure 8. 2-Channel Hub and Spoke Topology (West to East Only Shown)

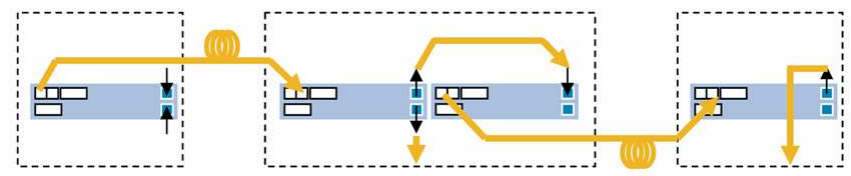
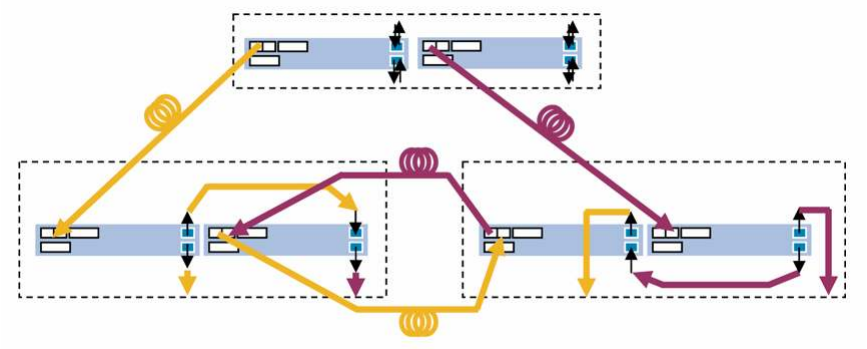


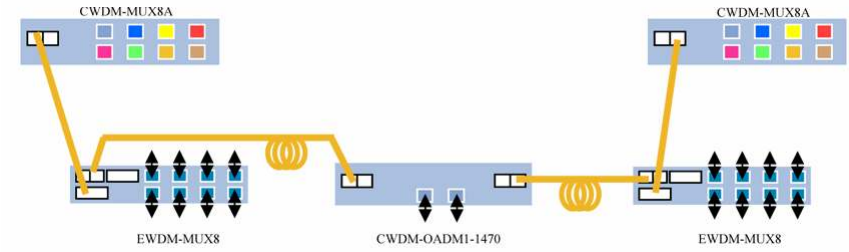
Figure 9. 2-Channel Protected Ring Topology (Drop Path Shown in Each Direction)



CWDM over DWDM

With an appropriate choice of CWDM wavelengths, it is possible to add and drop CWDM channels at an intermediate site between two EWDM filters. Figure 10 shows a possible solution with a 1470-nm CWDM channel.

Figure 10. CWDM Channel Dropped Between 2 EWDM Filters (Drop Path Shown in Each Direction)



EWDM Passive Unit Product Specifications

Figure 11 shows the EWDM passive unit front panel layout.

Figure 11. EWDM Passive Unit Front Panel Layout

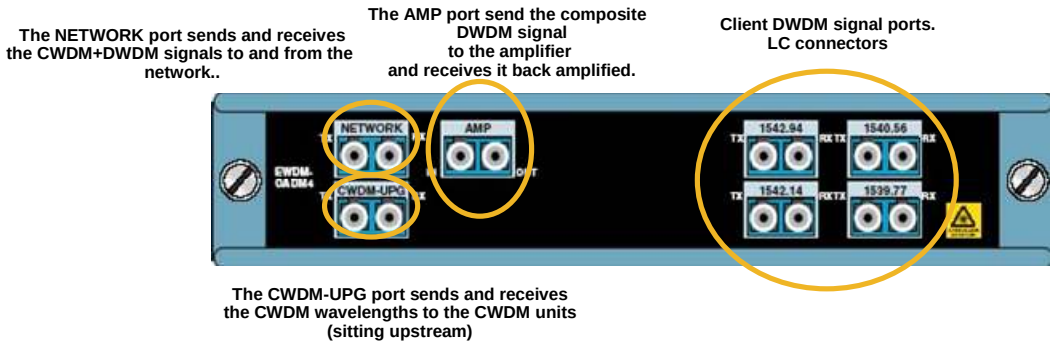


Table 1 shows the EWDM-MUX8 passive unit optical specifications.

Table 1. EWDM-MUX8 Passive Unit Optical Specifications

Parameter	Path	Min	Max	Unit
Operating Band		1460-1620		Nm
Channel Spacing		100		GHz
DWDM Channel 0.5 dB Bandwidth		-0.12	+0.12	Nm
DWDM Channel		1 to 8		
Insertion Loss	Mux DWDM (channel)		3.5	dB
	Demux DWDM (channel)		2.5	
	Mux CWDM (band)		1	
	Demux CWDM (band)		1.5	
	Combined Mux Demux DWDM (same channel)		4.7	
Isolation	Pass Port Isolation (In band Isolation)	15 mux		dB
	Adjacent channels Isolation (DWDM Channels over DWDM or CWDM channels)	30 demux		
Return Loss		45		dB
Directivity		50		dB
PDL	All Paths		0.2	dB
PMD	All Paths		0.2	ps
Optical Loss Uniformity			1.5	dB
Max Optical Input Power			300	mW

Table 2 shows the EWDM-OADM4 passive unit optical specifications.

Table 2. EWDM-OADM4 Passive Unit Optical Specifications

Parameter	Path	Min	Max	Unit
Operating Band		1460-1620		Nm
Channel Spacing		100		GHz
DWDM Channel 0.5 dB Bandwidth		-0.12	+0.12	nm
DWDM Channel		2,3,4,5		
Insertion Loss	Mux DWDM (channel)		3.5	dB
	Demux DWDM (channel)		2.5	
	Mux CWDM (band)		1	
	Demux CWDM (band)		1.5	
	Combined Mux Demux DWDM (same channel)		3.7	
Isolation	Pass Port Isolation (In band Isolation)	15 mux 30 demux		dB
	Adjacent channels Isolation (DWDM Channels over DWDM or CWDM channels)	30		

Return Loss		45		dB
Directivity		50		dB
PDL	All Paths		0.2	dB
PMD	All Paths		0.2	ps
Optical Loss Uniformity			1	dB
Max Optical Input Power			300	mW

Table 3 shows the EWDM-OADM2 passive unit optical specifications.

Table 3. EWDM-OADM2 Passive Unit Optical Specifications

Parameter	Path	Min	Max	Unit
Operating Band		1460-1620		Nm
Channel Spacing		100		GHz
DWDM Channel 0.5 dB Bandwidth		-0.12	+0.12	nm
DWDM Channel		7 and 8		
Insertion Loss	Mux DWDM (channel)		2	dB
	Demux DWDM (channel)		2	
	Mux CWDM (band)		1	
	Demux CWDM (band)		1	
	Combined Mux Demux DWDM (same channel)		3.1	
Isolation	Pass Port Isolation (In band Isolation)	15 mux 30 demux		dB
	Adjacent channels Isolation (DWDM Channels over DWDM or CWDM channels)	30		
Return Loss		45		dB
Directivity		50		dB
PDL	All Paths		0.2	dB
PMD	All Paths		0.2	ps
Optical Loss Uniformity			1	dB
Max Optical Input Power			300	mW

Table 4 shows a summary of the total add/drop loss suffered per channel with the EWDM passive units

Table 4. EWDM Passive Unit Add/Drop losses

Model	Maximum Insertion Loss (dB)		
	Add+Drop DWDM	Add CWDM	Drop CWDM
EWDM-MUX8=	4.7[1]	1	1.5
EWDM-OADM4=	3.7[2]	1	1
EWDM-OADM2=	3.1[3]	1	1

Table 5 shows the EWDM passive unit environmental conditions.

Table 5. EWDM Passive Unit Environmental Conditions

Parameter	Min/Max Value
Operating Temperature	-5 ~ 55ºC
Storage Temperature	-40 to 85ºC
Operating Humidity	5 to 95%RH

EWDM Optical Amplifier Unit Product Specifications

Figure 12 illustrates the EWDM amplifier front panel layout.

Figure 12. EWDM Amplifier Front Panel Layout

The front panel includes:

- 3 LEDs to report the status of the device (Table 6)
- A hardware reset button (next to the alarm LED) (Table 7)
- An RS-232 interface with RJ45 connector (Table 8)
- An AC power plug (Table 9)
- The optical input and output ports based on LC connectors (Table 10)

[1] If the link is terminated with another EWDM-MUX8= device. If a different EWDM device terminates the link, the “DWDM ADD” insertion loss is 3.5 dB, and the “DWDM DROP” insertion loss is 2.5 dB.
[2] If the link is terminated with another EWDM-OADM4= device. If a different EWDM device terminates the link, the “DWDM ADD” insertion loss is 2.5 dB, and the “DWDM DROP” insertion loss is 2.5 dB.
[3] If the link is terminated with another EWDM-OADM2= device. If a different EWDM device terminates the link, the “DWDM ADD” insertion loss is 2 dB, and the “DWDM DROP” insertion loss is 2 dB.

Table 6. EWDM Front Panel LED State

Functionality	Possible State	Comment
Power	Ok	Green
	Starting up	Green
	Failure	Red
Input power alarm	In range	Green
	Out of range	Red
Alarm LED	Normal condition	Green
	Minor problem	Orange
	Severe problem	Red

Table 7. EWDM Amplifier Unit Optical Specifications

Parameter	Min	Typ	Max	Unit
Total operating signal wavelength range	1538.2		1561.4	nm
Total output power			17.5	dBm
Total input power	-4.5		9.5	dBm
Per channel input power	-4.5		2.5	dBm
Single channel output power	3.5		12	dBm
Gain	7.5	8	8.5	dB
Gain flatness	-0.5		+0.5	dB
Noise figure			10	dB
Return loss			40	dB
PDG	-0.25		+0.25	dB
PMD			0.3	ps

Table 8. RS-232 Requirements

Parameter	Value
Data bits	8
Parity	No parity
Stop bits	1
Speed	9600

Table 9. Console Port Signaling and Cabling

Item	Comment	Min	Type	Max	Unit
External voltage supply		85	110 or 220	265	V
Power consumption				10	W
Cold startup time: Electrical				5	S
Maximum inrush power dissipation	Max 3 minutes			40	W
Maximum inrush power current	@ 100 VAC, @ 25C			15	A
	@ 200 VAC, @ 25C			30	A

Table 10. Console Port Signaling and Cabling

Console Port (DTE)	RJ-45-to-RJ-45 Rollover Cable		Console Device
Signal	**RJ-45 Pin**	**RJ-45 Pin**	**Signal**
RTS1	1	8	CTS2
No connection	2	7	DSR
TxD3	3	6	RxD4
GND5	4	5	GND
GND	5	4	GND
RxD	6	3	TxD
No connection	7	2	DTR6
CTS	8	1	RTS

Ordering Information

To place an order, visit the Cisco Ordering Homepage. Table 11 lists ordering information for the Cisco EWDM products.

Table 11. Ordering Information

Product Name	Part Number
Cisco EWDM MUX/DEMUX 8 wavelengths	EWDM-MUX8=
Cisco EWDM MUX/DEMUX and OADM 4 wavelengths	EWDM-OADM4=
Cisco EWDM MUX/DEMUX and OADM 2 wavelengths	EWDM-OADM2=
Cisco EWDM optical amplifier	EWDM-OA=

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