APPENDIX A

Transceivers, Module Connectors, and Cable Specifications

Revised: October 13, 2011

This chapter describes the pluggable transceivers, connectors, and cables used with the Catalyst 6500 series switches. The chapter is divided into these sections:

Pluggable Transceivers

This section provides brief descriptions of the pluggable transceivers that install in Catalyst 6500 series modules and supervisor engines.

The section is divided into these topics:

100-MB Transceivers

100-MB Small Form-Factor Pluggable (SFP) transceivers are currently the only 100-MB transceivers that are supported on a Catalyst 6500 series Ethernet switching module. They are supported only on the WS-X6148-FE-SFP Ethernet module.

The 100-MB SFP transceiver module is shown in Figure A-1. Table A-1 lists the types of 100-MB SFP transceivers and their cabling distances.

Note The 100-MB and the 1-GB SFP transceivers share the same form factor, but are not interchangeable.

Figure A-1 100-MB SFP Transceiver Module

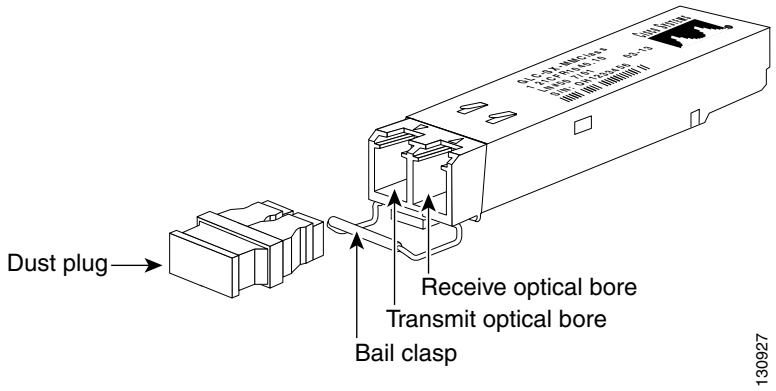


Table A-1 100-MB SFP Transceiver Cabling Specifications

100-MB SFP Transceiver Product Number	Description	Interface Connector	Nominal Wavelength (nm)	Network Cable Type	Fiber Core Size[1] (micron)	Cable Distance[2]
GLC-FE-100FX	100BASE-FX SFP for 100 Mb (Fast Ethernet) ports	Dual LC	1310	MMF	50/62.5	1.24 miles (2 km)
GLC-FE-100LX	100BASE-LX10 SFP for 100 Mb (Fast Ethernet) ports	Dual LC	1310	SMF	G.652[3]	6.21 miles (10 km)
GLC-FE-100BX-D	100BASE-FX SFP for 100 Mb (Fast Ethernet) ports	Single LC	1550 (receive) 1310 (transmit)	Single-strand SMF	G.652[3]	6.21 miles (10 km)
GLC-FE-100BX-U	100BASE-FX SFP for 100 Mb (Fast Ethernet) ports	Single LC	1310 (receive) 1550 (transmit)	Single-strand SMF	G.652[3]	6.21 miles (10 km)
GLC-FE-100EX	100BASE-EX for 100 Mb (Fast Ethernet) ports	Dual LC	1310	SMF	G.652[3]	24.86 miles (40 km)
GLC-FE-100ZX	100BASE-ZX for 100 Mb (Fast Ethernet) ports	Dual LC	1550	SMF	G.652[3]	49.7 miles (80 km)

1. The numbers given for multimode fiber-optic (MMF) cable refer to the core diameter.
2. Cable distances are based on fiber loss. Additional factors, such as the number of splices and the optical quality of the fiber, can affect cabling distances.
3. ITU-T G.652 SMF as specified by the IEEE 802.3z standard.

Note The minimum cable distance for all 100-MB SFP transceivers listed, both MMF and SMF (G.652), is 6.5 feet (2 meters).

Table A-2 lists the fiber loss budgets for the 100-MB SFP transceivers.

Table A-2 Fiber Loss Budgets for the 100-MB SFP Transceivers

100-MB SFP Transceiver Product Number	Transmit (dBm)	Receive (dBm)
GLC-FE-100FX	–14 (maximum) –20 (minimum)	–14 (maximum) –31 (minimum)
GLC-FE-100LX	–8 (maximum) –15 (minimum)	–8 (maximum) –28 (minimum)
GLC-FE-100BX-U	–8 (maximum) –14 (minimum)	–7 (maximum) –28.2 (minimum)
GLC-FE-100BX-D	–8 (maximum) –14 (minimum)	–7 (maximum) –28.2 (minimum)
GLC-FE-100EX	0 (maximum) –5 (minimum)	–8 (maximum) –28 (minimum)
GLC-FE-100ZX	2 (maximum) –3 (minimum)	–8 (maximum) –30 (minimum)

Table A-3 lists the physical and environmental specifications for the 100-MB SFP transceivers.

Table A-3 100-MB SFP Transceiver Physical and Environmental Specifications

Item	Specification
Dimensions (H x W x D)	0.04 x 0.53 x 2.22 in. (8.5 x 13.4 x 56.5 mm)
Operating temperature	32° to 122°F (0° to 50°C)
Storage temperature	–40° to 185°F (–40° to 85°C)

1-GB Transceivers

The 1-GB transceivers include the Gigabit Interface Converter (GBIC) transceiver and the SFP transceiver. The GBIC transceivers and SFP transceivers differ in both form-factor and in connector type; they are not interchangeable. Table A-4 lists both 1-GB transceiver types, the modules that support them, the applicable transceiver illustrations, and the applicable specification tables.

Table A-4 1-GB Transceiver Types

1-GB Transceiver Type	Supported on these Modules[1]	Transceiver Illustration	Transceiver Specification Table
GBIC	• WS-X6408A-GBIC • WS-X6416-GBIC • WS-X6516-GBIC • WS-X6516A-GBIC • WS-X6816-GBIC	Figure A-2 (1000BASE-T copper GBIC) Figure A-3 (1000BASE-X optical GBIC)	Table A-5 (cabling specifications) Table A-6 (fiber loss budgets) Table A-7 (environmental specifications)
SFP	• WS-X6724-SFP • WS-X6748-SFP • WS-SUP32-GE-3B • WS-SUP32P-GE • WS-SUP720 • WS-SUP720-3B • WS-SUP720-3BXL	Figure A-4 (1000BASE-T copper SFP) Figure A-5 (1000BASE-X optical SFP)	Table A-8 (cabling specifications) Table A-9 (fiber loss budgets) Table A-10 (environmental specifications)

1. Not all GBIC transceiver types or SFP transceiver types may be supported on your module. Refer to your software release notes to determine if a specific GBIC transceiver or SFP transceiver is supported on your module.

1-GB GBIC Transceivers

Figure A-2 shows a 1000BASE-T (copper) GBIC transceiver. Figure A-3 shows a 1000BASE-X (optical) GBIC transceiver. Table A-5 lists the cabling specifications for the GBIC transceivers.

Figure A-2 1000BASE-T GBIC Transceiver (WS-G5483)

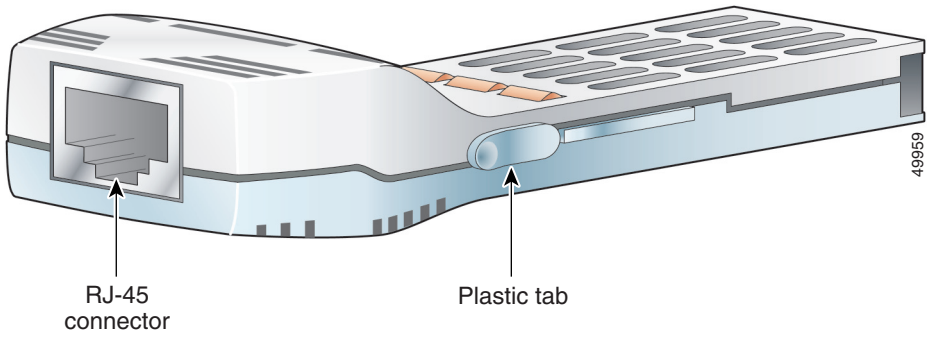


Figure A-3 1000BASE-X GBIC Transceiver Modules (WS-G5484, WS-G5486, and WS-G5487)

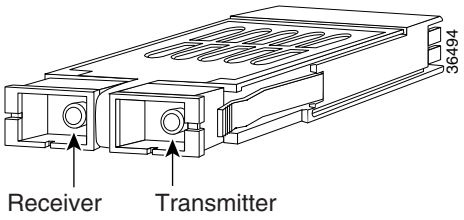


Table A-5 GBIC Transceiver Module Cabling Specifications

GBIC Transceiver Model and Product Number	Interface Connector	Nominal Wavelength (nm)	Network Cable Type	Fiber Core Size[1] (micron)	Modal Bandwidth (MHz km)	Cable Distance[2]
1000BASE-T (WS-G5483)	RJ-45	—		—	—	328 ft (100 m)
1000BASE-SX[3] (WS-G5484)	SC duplex	850	MMF	62.5	160	722 ft (220 m)
				62.5	200	902 ft (275 m)
				50.0	400	1640 ft (500 m)
				50.0	500	1804 ft (550 m)
1000BASE-LX/LH (WS-G5486)	SC duplex	1310	MMF[4]	62.5	500	1804 ft (550 m)
				50.0	400	1804 ft (550 m)
				50.0	500	1804 ft (550 m)
			SMF	G.652[5]	—	6.2 mi (10 km)
1000BASE-ZX[6] (WS-G5487)	SC duplex	1550	SMF	G.652[5]	—	43.5 mi (70 km)[8]
			SMF[7]	G.652[5]	—	62.1 mi (100 km)

1. The numbers given for multimode fiber-optic (MMF) cable refer to the core diameter.
2. Cable distances are based on fiber loss. Additional factors, such as the number of splices and the optical quality of the fiber, can affect cabling distances.
3. Use with MMF only.
4. Refer to the product bulletin for the usage of mode conditioning patch cords in 1000BASE and 10GBASE Ethernet laser-based transmissions at this URL: http://www.cisco.com/en/US/prod/collateral/modules/ps5455/product_bulletin_c25-530836.html
5. ITU-T G.652 SMF as specified by the IEEE 802.3z standard.
6. Use with SMF only.
7. Dispersion-shifted single-mode fiber-optic cable.
8. The minimum link distance for ZX GBICs is 6.2 miles (10 km), when an 8-dB attenuator is installed at each end of the link. Without attenuators, the minimum link distance is 24.9 miles (40 km).

Table A-6 lists the fiber loss budgets for the GBIC transceivers.

Table A-6 Fiber Loss Budgets for the 1-GB GBIC Transceivers

1-GB GBIC Transceiver Product Number	Transmit (dBm)	Receive (dBm)
WS-G5484 (1000BASE-SX)	–3 (maximum) –9.5 (minimum)	0 (maximum) –17 (minimum)
WS-G5486 (1000BASE-LX/LH)	–3 (maximum) –9.5 (minimum)	–3 (maximum) –19 (minimum)
WS-G5487 (1000BASE-ZX)	5 (maximum) 0 (minimum)	–3 (maximum) –23 (minimum)[1]

1. The 1000BASE-ZX GBIC transceiver provides a minimum optical power budget of 23 dB. To determine the supported link distance, you need to measure your cable plant with an optical loss test set to verify that the optical loss of the cable plant (including connectors and splices) is less than or equal to this value. The optical measurement must be performed with a 1550 nanometer light source.

Table A-7 lists the physical and environmental specifications for the GBIC transceivers.

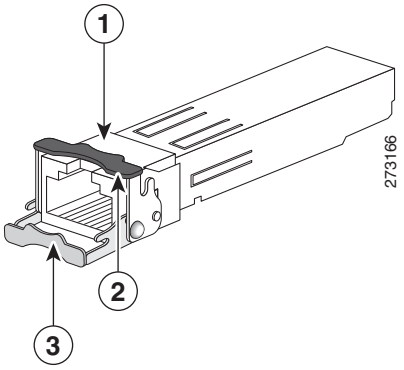
Table A-7 1-GB GBIC Transceiver Physical and Environmental Specifications

Item	Specification
Dimensions (H x W x D)	0.75 x 1.54 x 3.50 inches (19.0 x 39.1 x 88.9 mm)
Operating temperature	32° to 122°F (0° to 50°C)
Storage temperature	–40° to 185°F (–40° to 85°C)

1-GB SFP Transceivers

Figure A-4 shows a 1000BASE-T (copper) SFP transceiver. Figure A-5 shows a 1000BASE-X (optical) SFP transceiver. Table A-8 lists the cabling specifications for the SFP transceivers.

Figure A-4 1000BASE-T SFP Transceiver (GLC-T)



1	RJ-45 connector	**3**	Bale-clasp shown in the open (unlocked) position
2	Bale-clasp shown in the closed (locked) position		

Figure A-5 1000BASE-X SFP Transceivers

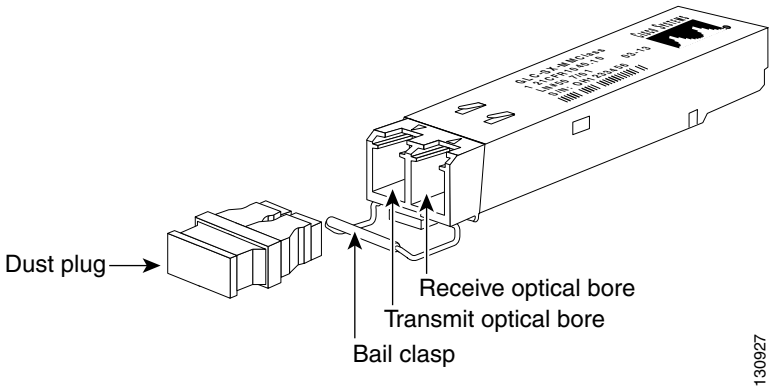


Table A-8 SFP Transceiver Cabling Specifications

SFP Transceiver Module and Product Number	Interface Connector	Nominal Wavelength (nm)	Network Cable Type	Fiber Core Size (micron)	Modal Bandwidth (MHz/km)	Cable Distance[1]
1000BASE-T (GLC-T=)	RJ-45	—	Category 5, 5e, or 6 UTP/FTP	—	—	328 ft (100 m)
1000BASE-SX (GLC-SX-MM=)	LC duplex	850	MMF	62.5 62.5 50.0 50.0	160 200 400 500	722 ft (220 m) 902 ft (275 m) 1640 ft (500 m) 1804 ft (550 m)
1000BASE-LX/LH (GLC-LH-SM=)	LC duplex	1300	MMF[2] SMF	62.5 50.0 50.0 G.652[3]	500 400 500 —	1804 ft (550 m) 1804 ft (550 m) 1804 ft (550 m) 6.21 mi (10 km)
1000BASE-ZX (GLC-ZX-SM=)	LC duplex	1550	SMF	G.652[3]	—	43.4 to 62 mi (70 to 100 km)[4]
1000BASE-BX-D (GLC-BX-D=)	LC single	1310	SMF	G.652[3]	—	6.21 mi (10 km)
1000BASE-BX-U (GLC-BX-U=)	LC single	1490	SMF	G.652[3]	—	6.21 mi (10 km)

1. Cable distances are based on fiber loss. Additional factors, such as the number of splices and the optical quality of the fiber, can affect cabling distances.
2. Refer to the product bulletin for the usage of mode conditioning patch cords in 1000BASE and 10GBASE Ethernet laser-based transmissions at this URL: http://www.cisco.com/en/US/prod/collateral/modules/ps5455/product_bulletin_c25-530836.html
3. ITU-T G.652 SMF as specified by the IEEE 802.3z standard.
4. 1000BASE-ZX SFP modules can reach up to 62 miles (100 km) by using dispersion-shifted SMF or low-attenuation SMF; the actual distance depends on the fiber quality, the number of splices, and the connectors.

Table A-9 lists the fiber loss budgets for the 1-GB SFP transceivers.

Table A-9 Fiber Loss Budgets for the 1-GB SFP Transceivers

1-GB SFP Transceiver Product Number	Transmit (dBm)	Receive (dBm)
GLC-SX-MM	–4 (maximum)	0 (maximum)
(1000BASE-SX)	–9.5 (minimum)	–17 (minimum)
GLC-LH-SM	–3 (maximum)	–3 (maximum)
(1000BASE-LX/LH)	–9.5 (minimum)	–20 (minimum)
GLC-ZX-SM	5 (maximum)	–3 (maximum)
(1000BASE-ZX)	0 (minimum)	–23 (minimum)
GLC-BX-U	–3 (maximum)	–3 (maximum)
	–9 (minimum)	–19.5 (minimum)
GLC-BX-D	–3 (maximum)	–3 (maximum)
	–9 (minimum)	–19.5 (minimum)

Table A-10 lists the physical and environmental specifications for the 1-GB SFP transceivers.

Table A-10 1-GB SFP Transceiver Physical and Environmental Specifications

Item	Specification
Dimensions (H x W x D)	0.04 x 0.53 x 2.22 in. (8.5 x 13.4 x 56.5 mm)
Operating temperature	32° to 122°F (0° to 50°C)
Storage temperature	–40° to 185°F (–40° to 85°C)

Note You can use any combination of SFP modules that your Cisco device supports. The only restrictions are that each SFP port must match the wavelength specifications on the other end of the cable and that the cable must not exceed the stipulated cable length for reliable communications.

10-GB Transceivers

The 10-GB transceivers include the XENPAK transceiver and the X2 transceiver. The XENPAK transceivers and X2 transceivers differ in form-factor; they are not interchangeable. Table A-11 lists both 10-GB transceiver types, the modules that support them, and the applicable transceiver illustrations and specification tables.

Table A-11 10-GB Transceiver Types and Module Support

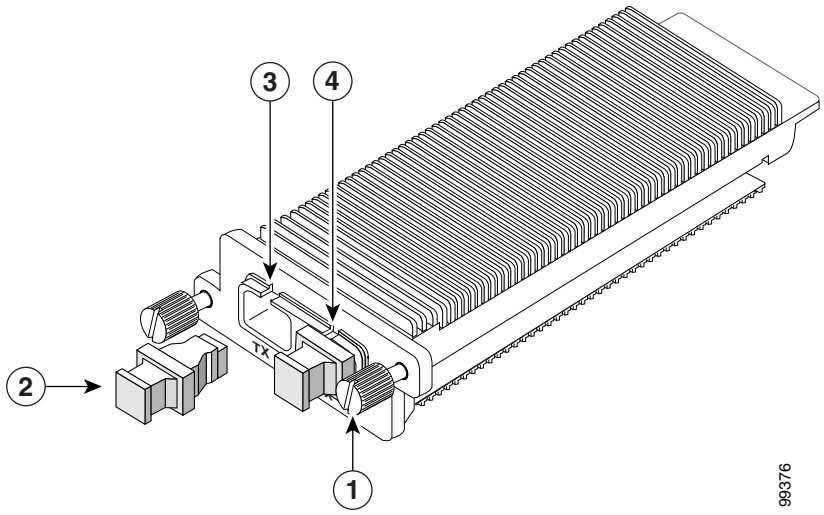
10-GB Transceiver Type	Supported on these Modules[1]	Transceiver Illustration	Transceiver Specification Table
XENPAK transceivers	• WS-X6704-10GE • WS-SUP32-10GE-3B • WS-SUP32P-10GE	Figure A-6	Table A-12 (cabling specifications) Table A-13 (fiber loss budgets) Table A-14 (environmental specifications)
X2 transceivers	• WS-X6708-10G-3C[2] • WS-X6708-10G-3CXL[2] • VS-S720-10G-3C • VS-S720-10G-3CXL	Figure A-7	Table A-15 (cabling specifications) Table A-16 (fiber loss budgets) Table A-17 (environmental specifications)

1. Not all 10-GB transceiver versions may be supported on your module. Refer to your software release notes to determine if a specific 10-GB transceiver is supported on your module.
2. Only X2 transceivers with part number revision -02 or later are supported on the module. Check the part number label on the X2 transceiver to verify its usability.

XENPAK Transceivers

Note The dual SC connector on the X2 transceivers support network interface cables with either Physical Contact (PC) or Ultra-Physical Contact (UPC) polished face types. The connectors do not support network interface cables with an Angle Polished Connector (APC)-polished face type.

Figure A-6 10-Gigabit XENPACK Transceiver



1	Captive installation screw	**3**	Transmit optical bore
2	Optical bore dust plug	**4**	Receive optical bore

Table A-12 10-GB XENPAK Transceiver Specifications and Cabling Distances

XENPAK	Connector	Nominal Wavelength	Network Fiber Type	Fiber Core Size (microns)	Modal Bandwidth (Mhz/km)	Maximum Cable Distance[1]
XENPAK-10GB-CX4	InfiniBand 4X	N/A	CX4 (copper)	—	—	49 ft (15 m)[2]
XENPAK-10GB-SR	SC duplex	850 nm	MMF	62.5	160	83.3 ft (25 m)
				62.5	200	108.3 ft (33 m)
				50.0	400	216.5 ft (66 m)
				50.0	500	269.0 ft (82 m)
				50.0	2000	984.3 ft (300 m)
XENPAK-10GB-LX4	SC duplex	1310 nm	MMF	62.5	500	984.3 ft (300 m)
				50.0	400	787.4 ft (240 m)
				50.0	500	984.3 ft (300 m)

Table A-12 10-GB XENPAK Transceiver Specifications and Cabling Distances (continued)

XENPAK	Connector	Nominal Wavelength	Network Fiber Type	Fiber Core Size (microns)	Modal Bandwidth (Mhz/km)	Maximum Cable Distance[1]
XENPAK-10GB-LR XENPAK-10GB-LW[3]	SC duplex	1310 nm	SMF	G.652[4]	—	6.2 mi (10 km)
XENPAK-10GB-ER[5]	SC duplex	1550 nm	SMF	G.652[4]	—	24.9 mi (40 km)
XENPAK-10GB-ZR	SC duplex	1550 nm	SMF	G.652	—	50 mi (80 km)

1. Cable distances are based on fiber loss. Additional factors, such as the number of splices and the optical quality of the fiber, can affect cabling distances. Minimum cabling distance for all types is 2 m according to the IEEE 802.3ae standard.
2. The Cisco XENPAK-10GB-CX4 transceiver supports link lengths of up to 49.2 feet (15 m) on CX4 cable. Cisco offers four CX4 cables: CAB-INF-28G-1= (1 meter cable), CAB-INF-28G-5= (5 meter cable), CAB-INF-28G-10= (10 meter cable), and CAB-INF-26G-15= (15 meter cable).
3. The XENPAK-10GB-LW (WAN PHY) supports a link length of 6.2 miles (10 km) on standard SMF (G.652). The WAN PHY allows
4. ITU-T G.652 SMF as specified by the IEEE 802.3z standard.
5. Requires a 5 db 1550 nm fixed loss attenuator for cable distances less than 12.43 miles (20 km). The attenuator is available from Cisco Systems (p/n WS-X6K-5DB-ATT=). The attenuator is installed on the receiver side of the transceiver.

Table A-13 lists the fiber loss budgets for the 10-GB XENPAK transceivers.

Table A-13 Fiber Loss Budgets for the 10-GB XENPAK Transceivers

10-GB XENPAK Transceiver Product Number	Transmit (dBm)	Receive (dBm)
XENPAK-10GB-SR	–1 (maximum) –7.3 (minimum)	–1 (maximum) –9.9 (minimum)
XENPAK-10GB-LX4	–0.5 per lane (maximum) –6.75 (minimum)	–0.5 per lane (maximum) –14.4 per lane (minimum)
XENPAK-10GB-LR XENPAK-10GB-LW	0.5 (maximum) –8.2(minimum)	0.5 (maximum) –14.4 (minimum)
XENPAK-10GB-ER	4 (maximum) –4.7 (minimum)	–1 (maximum) –15.8 (minimum)
XENPAK-10GB-ZR	4 (maximum) 0 (minimum)	–7 (maximum) –24 (minimum)

Table A-14 lists the physical and environmental specifications for the XENPAK transceivers.

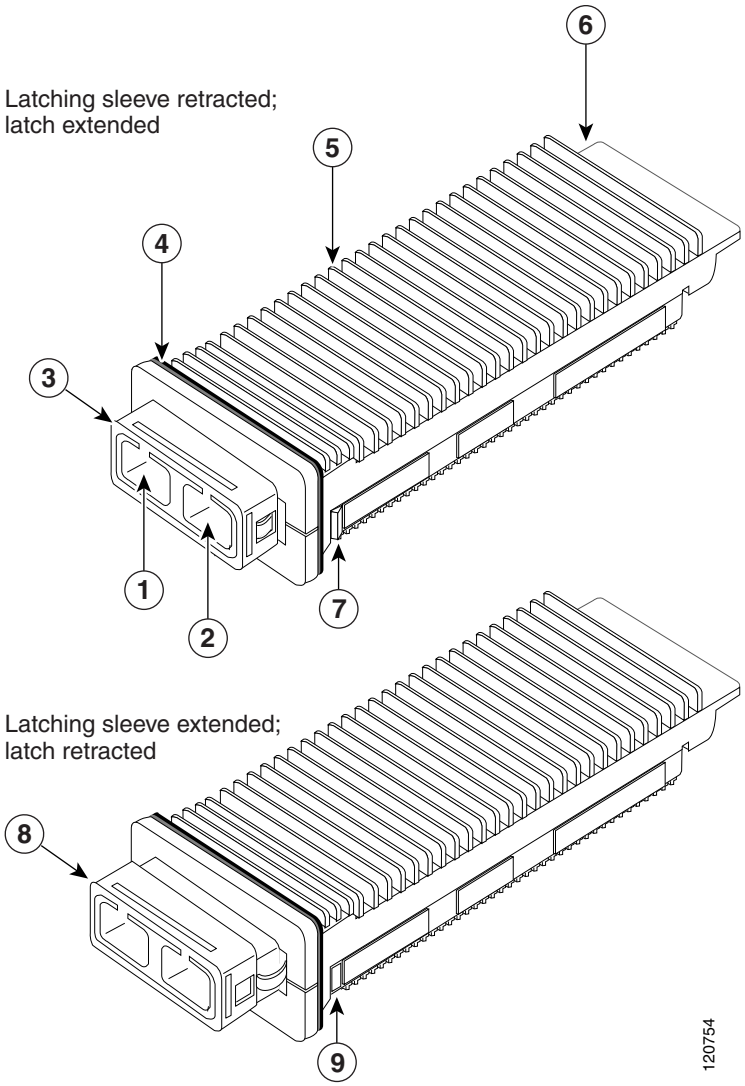
Table A-14 10-GB XENPAK Transceiver Physical and Environmental Specifications

Item	Specification
Dimensions (H x W x D)	0.47 x 1.42 x 4.76 in. (18 x 36 x 121 mm)
Operating temperature	32° to 122°F (0° to 50°C)
Storage temperature	–40° to 185°F (–40° to 85°C)

X2 Transceivers

Figure A-7 shows the X2 transceivers with the major features identified. Table A-15 lists the cabling specifications for the X2 transceivers.

Figure A-7 10-GB X2 Transceiver



1	Transmit optical bore	**6**	Module connector
2	Receive optical bore	**7**	Latch (extended)
3	Latching sleeve (retracted)	**8**	Latching sleeve (extended)
4	EMI gasket	**9**	Latch (retracted)
5	Transceiver heat sink		

Note X2 transceivers support patch cords with either PC or UPC connectors. The X2 transceivers do not support patch cords with APC connectors.

Table A-15 X2 Transceiver Cabling Specifications

X2 Transceiver Product Number	Connector Type	Wavelength (nm)	Cable Type	Core Size (microns)	Modal Bandwidth (MHz/km	Maximum Cabling Distance[1]
X2-10GB-SR	SC duplex	850	MMF	62.5	160	85.3 feet (26 m)
				62.5	200	108.3 feet (33 m)
				50.0	400	216.5 feet (66 m)
				50.0	500	269 feet (82 m)
				50.0	2000	984.3 feet (300 m)
X2-10GB-LR	SC duplex	1310	SMF	G.652 fiber	—	6.21 miles (10 km)
X2-10GB-ER	SC duplex	1550	SMF	G.652 fiber	—	24.84 miles (40 km)
X2-10GB-LX4	SC duplex	1310	MMF	62.5	500	984.3 feet (300 m)
				50.0	400	787.4 feet (240 m)
				50.0	500	984.3 feet (300 m)
X2-10GB-CX4	InfiniBand 4X	—	InfiniBand (copper)	—	—	49.2 feet (15 m)[2]
X2-10GB-LRM	SC duplex	1310	MMF	62.5	500	721.8 feet (220 m)
				50.0	400	328 feet (100 m)
				50.0	500	721.8 feet (220 m)

1. Cable distances are based on fiber loss. Additional factors, such as the number of splices and the optical quality of the fiber, can affect cabling distances.
2. The Cisco X2-10GB-CX4 transceiver supports link lengths of up to 49.2 feet (15 m) on CX4 cable. Cisco offers four CX4 cables: CAB-INF-28G-1= (1 meter cable), CAB-INF-28G-5= (5 meter cable), CAB-INF-28G-10= (10 meter cable), and CAB-INF-26G-15= (15 meter cable).

Table A-16 X2 Transceiver Optical Transmit and Receive Specifications

X2 Transceiver Product Number	Transceiver Type	Transmit Power (dBm)	Receive Power (dBm)	Transmit and Receive Wavelength (nm)
X2-10GB-SR	10GBASE-SR, 850-nm MMF	–1.2 (maximum)[1]	–1.0 (maximum)	840 to 860
		–7.3 (minimum)	–9.9 (minimum)	
X2-10GB-LR	10GBASE-LR, 1310-nm SMF	0.5 (maximum)	0.5 (maximum)	1260 to 1355
		–8.2 (minimum)	–14.4 (minimum)	
X2-10GB-ER	10GBASE-ER, 1550-nm SMF	4.0 (maximum)	–1.0 (maximum)	1530 to 1565
		–4.7 (minimum)	–15.8 (minimum)	

Table A-16 X2 Transceiver Optical Transmit and Receive Specifications (continued)

X2 Transceiver Product Number	Transceiver Type	Transmit Power (dBm)	Receive Power (dBm)	Transmit and Receive Wavelength (nm)
X2-10GB-LX4	10GBASE-LX4 WWWDM 1300-nm MMF	–0.5 per lane (maximum) –6.75 (minimum) per lane	–0.5 (maximum) –14.4 per lane	Four lanes; overall range: 1269 to 1356
X2-10GB-LRM	10GBASE-LRM 1310-nm	0.5 (maximum) –6.5 (minimum)	0.5 (maximum) –8.4 (minimum) (in average) –6.4 (minimum) in OMA)[2]	1260 to 1355

1. The launch power shall be the lesser of the class 1 safety limit or the maximum receive power. Class 1 laser requirements are defined by IEC 60825-1: 2001.
2. Both the average and the OMA specifications must be met simultaneously.

X2 transceivers are required for use on the WS-X6708-10GE and the WS-X6716-10GE 10-Gigabit Ethernet modules. Not all X2 transceiver types are supported unconditionally by these two modules; the following caveats apply:

- X2-10GB-CX4—10GBASE for CX4 (copper) cable. No restrictions for use. The Cisco X2-10GB-CX4 transceiver supports link lengths of up to 49.2 feet (15 m) on CX4 cable. Cisco offers four CX4 cables: CAB-INF-28G-1= (1 meter cable), CAB-INF-28G-5= (5 meter cable), CAB-INF-28G-10= (10 meter cable), and CAB-INF-26G-15= (15 meter cable).
- X2-10GB-ER—10GBASE-ER serial 1550-nm extended-reach, single-mode fiber (SMF), dispersion-shifted fiber (DSF). X2-10GB-ER transceivers labeled with a serial number that ends in -02 do not provide EMI compliance when they are installed in the WS-X6716-10GE module. (See Figure A-8 for the serial number location.)
- X2-10GB-LR—10GBASE-LR serial 1310-nm long-reach, single-mode fiber (SMF), dispersion-shifted fiber (DSF). X2-10GB-LR transceivers labeled with a serial number that ends in -02 do not provide EMI compliance when they are installed in the WS-X6716-10GE module. (See Figure A-8 for the serial number location.)
- X2-10GB-LRM—10GBASE-LRM for FDDI-grade multimode fiber (MMF). The X2-10GB-LRM is not supported by the **show idprom** command.
- X2-10GB-LX4—10GBASE-LX4 serial 1310-nm multimode fiber (MMF). X2-10GB-LX4 transceivers that are labeled with a serial number that ends with -01, -02, or -03 do not provide EMI compliance when they are installed in the WS-X6716-10GE. (See Figure A-8 for the serial number location.)
- X2-10GB-SR—10GBASE-SR serial 850-nm short-reach multimode fiber (MMF). No restrictions for use.

Figure A-8 X2 Transceiver Serial Number Label Locator

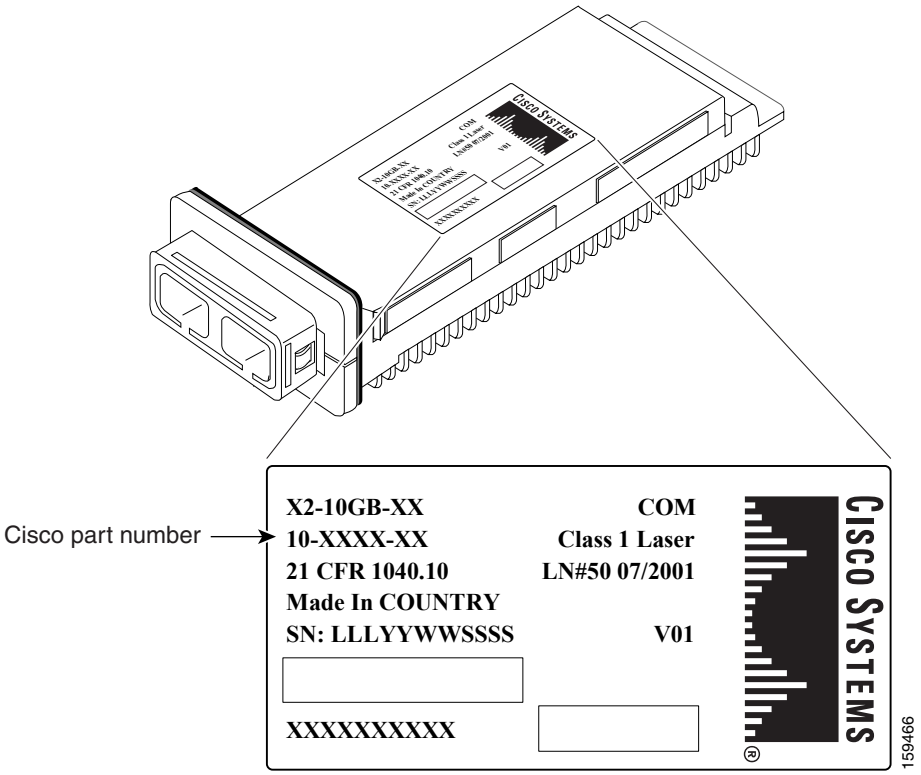


Table A-17 lists the physical and environmental specifications for the X2 transceiver.

Table A-17 10-GB X2 Transceiver Physical and Environmental Specifications

Item	Specification
Dimensions (H x W x D)	0.53 x 1.41 x 3.58 inches (13.46 x 36 x 91 mm)
Operating temperature	32° to 122°F (0° to 50°C)
Storage temperature	–40° to 185°F (–40° to 85°C)

WDM Transceivers

The WDM transceiver modules are listed in Table A-18 along with brief descriptions of the transceiver modules and illustration references.

Table A-18 WDM Transceivers

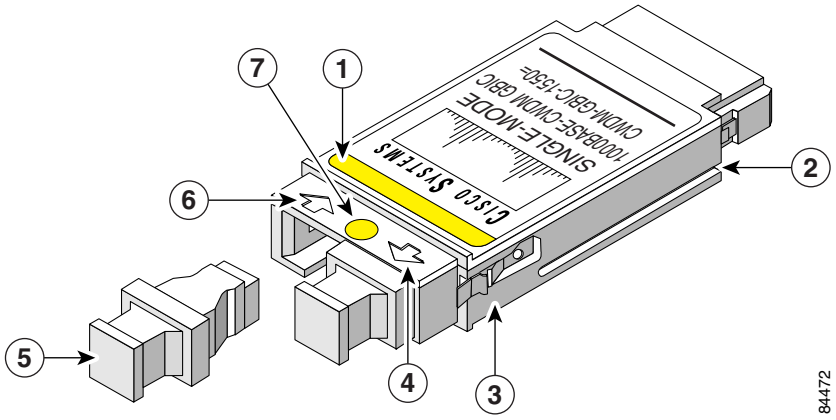
WDM Transceiver Type	Description	Supported on these Modules[1]	WDM Transceiver Illustration	WDM Transceiver Specification Table
CWDM GBIC	The CWDM GBIC transceivers provide 1000BASE-X full-duplex connectivity between the GBIC-compatible modules, supervisor engines, and the network. A set of eight CWDM GBICs are available for use with the CWDM Passive Optical System. The CWDM GBIC transceivers have a duplex SC connector.	• WS-X6408A-GBIC • WS-X6416-GBIC • WS-X6516-GBIC • WS-X6516A-GBIC • WS-X6816-GBIC	Figure A-9	Table A-19
DWDM GBIC	DWDM GBIC transceivers are used as part of a DWDM optical network to provide high-capacity bandwidth across an optical fiber network. There are 32 fixed-wavelength DWDM GBICs that support the International Telecommunications Union (ITU) 100 GHz wavelength grid. The DWDM GBIC transceivers have a duplex SC connector.	• WS-X6408A-GBIC • WS-X6416-GBIC • WS-X6516-GBIC • WS-X6516A-GBIC • WS-X6816-GBIC	Figure A-10	Table A-20
R/O WDM GBIC	The R/O WDM GBIC receiver (WDM-GBIC-REC) operates as a pluggable receiver on any unidirectional link in a CWDM or DWDM transport network; there is no transmitter in the GBIC. The receiver can be used for all wavelengths supported by Cisco CWDM and DWDM transceivers and can be used interchangeably with 1000BASE-SX, 1000BASE-LX/LH, and 1000BASE-ZX transceivers on a port-by-port basis. The W/O WDM receiver has a single SC connector.	• WS-X6408A-GBIC • WS-X6416-GBIC • WS-X6516-GBIC • WS-X6516A-GBIC • WS-X6816-GBIC	—	—

Table A-18 WDM Transceivers (continued)

WDM Transceiver Type	Description	Supported on these Modules[1]	WDM Transceiver Illustration	WDM Transceiver Specification Table
CWDM SFP	The Coarse Wavelength Division Multiplexing (CWDM) SFPs are hot-swappable, transceiver components that you plug into SFP-compatible modules and supervisor engines. The CWDM SFP transceiver uses an LC optical connector to connect to single-mode fiber-optic (SMF) cable. You can connect the CWDM SFPs to CWDM passive optical system optical add/drop multiplexer (OADM) modules or multiplexer/demultiplexer plug-in modules using single-mode fiber-optic cables.	• WS-X6724-SFP • WS-X6748-SFP	Figure A-11	Table A-21
DWDM XENPAK	DWDM XENPAK transceivers are used as part of a DWDM optical network to provide high-capacity bandwidth across an optical fiber network. There are 32 fixed-wavelength DWDM XENPAK transceivers that support the International Telecommunications Union (ITU) 100 GHz wavelength grid. The DWDM XENPAK transceivers have a duplex SC connector.	• WS-X6704-10GE	Figure A-12	Table A-22
R/O WDM XENPAK	The R/O WDM XENPAK receiver (WDM-XENPAK-REC) operates as a pluggable receiver on any unidirectional link in a CWDM or DWDM transport network; there is no transmitter in the XENPAK. The receiver can be used for all wavelengths supported by Cisco DWDM XENPAK transceivers. The W/O WDM receiver has a single SC connector.	• WS-X6704-10GE	—	—

1. Not all WDM transceivers may be supported on the modules. Refer to your software release notes for specific information on which WDM transceivers are supported and the software release level necessary to support them.

Figure A-9 CWDM GBIC Transceiver



1	Color arrow on label	**5**	Optical bore dust plug
2	Alignment groove	**6**	Receive optical bore
3	Spring clip	**7**	Color dot
4	Transmit optical bore		

Table A-19 CWDM GBIC Transceivers Wavelengths

Model Number	Color Code	CWDM GBIC Wavelength
CWDM-GBIC-1470=	Gray	1470 nm laser single-mode
CWDM-GBIC-1490=	Violet	1490 nm laser single-mode
CWDM-GBIC-1510=	Blue	1510 nm laser single-mode
CWDM-GBIC-1530=	Green	1530 nm laser single-mode
CWDM-GBIC-1550=	Yellow	1550 nm laser single-mode
CWDM-GBIC-1570=	Orange	1570 nm laser single-mode
CWDM-GBIC-1590=	Red	1590 nm laser single-mode
CWDM-GBIC-1610=	Brown	1610 nm laser single-mode

Figure A-10 DWDM GBIC Transceiver Module

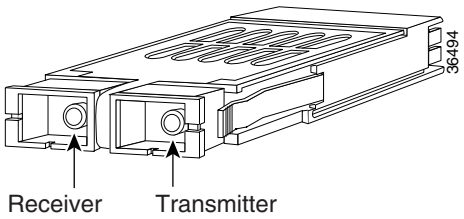


Table A-20 DWDM GBIC Transceiver Product Numbers and ITU Channel Numbers

DWDM GBIC Product Number	Description	ITU Channel
DWDM-GBIC-60.61	1000BASE-DWDM 1560.61 nm GBIC	21
DWDM-GBIC-59.79	1000BASE-DWDM 1559.79 nm GBIC	22
DWDM-GBIC-58.98	1000BASE-DWDM 1558.98 nm GBIC	23
DWDM-GBIC-58.17	1000BASE-DWDM 1558.17 nm GBIC	24
DWDM-GBIC-56.55	1000BASE-DWDM 1556.55 nm GBIC	26
DWDM-GBIC-55.75	1000BASE-DWDM 1555.75 nm GBIC	27
DWDM-GBIC-54.94	1000BASE-DWDM 1554.94 nm GBIC	28
DWDM-GBIC-54.13	1000BASE-DWDM 1554.13 nm GBIC	29
DWDM-GBIC-52.52	1000BASE-DWDM 1552.52 nm GBIC	31
DWDM-GBIC-51.72	1000BASE-DWDM 1551.72 nm GBIC	32
DWDM-GBIC-50.92	1000BASE-DWDM 1550.92 nm GBIC	33
DWDM-GBIC-50.12	1000BASE-DWDM 1550.12 nm GBIC	34
DWDM-GBIC-48.51	1000BASE-DWDM 1548.51 nm GBIC	36
DWDM-GBIC-47.72	1000BASE-DWDM 1547.72 nm GBIC	37
DWDM-GBIC-46.92	1000BASE-DWDM 1546.92 nm GBIC	38
DWDM-GBIC-46.12	1000BASE-DWDM 1546.12 nm GBIC	39
DWDM-GBIC-44.53	1000BASE-DWDM 1544.53 nm GBIC	41
DWDM-GBIC-43.73	1000BASE-DWDM 1543.73 nm GBIC	42
DWDM-GBIC-42.94	1000BASE-DWDM 1542.94 nm GBIC	43
DWDM-GBIC-42.14	1000BASE-DWDM 1542.14 nm GBIC	44
DWDM-GBIC-40.56	1000BASE-DWDM 1540.56 nm GBIC	46
DWDM-GBIC-39.77	1000BASE-DWDM 1539.77 nm GBIC	47
DWDM-GBIC-39.98	1000BASE-DWDM 1539.98 nm GBIC	48
DWDM-GBIC-38.19	1000BASE-DWDM 1538.19 nm GBIC	49
DWDM-GBIC-36.61	1000BASE-DWDM 1536.61 nm GBIC	51
DWDM-GBIC-35.82	1000BASE-DWDM 1535.82 nm GBIC	52
DWDM-GBIC-35.04	1000BASE-DWDM 1535.04 nm GBIC	53
DWDM-GBIC-34.25	1000BASE-DWDM 1534.25 nm GBIC	54
DWDM-GBIC-32.68	1000BASE-DWDM 1532.68 nm GBIC	56
DWDM-GBIC-31.90	1000BASE-DWDM 1531.90 nm GBIC	57
DWDM-GBIC-31.12	1000BASE-DWDM 1531.12 nm GBIC	58
DWDM-GBIC-30.33	1000BASE-DWDM 1530.33 nm GBIC	59

Table A-21 CWDM SFP Transceivers

Model Number	Color Code	CWDM GBIC Wavelength
CWDM-SFP-1470=	Gray	1470 nm laser, single-mode
CWDM-SFP-1490=	Violet	1490 nm laser, single-mode
CWDM-SFP-1510=	Blue	1510 nm laser, single-mode
CWDM-SFP-1530=	Green	1530 nm laser, single-mode
CWDM-SFP-1550=	Yellow	1550 nm laser, single-mode
CWDM-SFP-1570=	Orange	1570 nm laser, single-mode
CWDM-SFP-1590=	Red	1590 nm laser, single-mode
CWDM-SFP-1610=	Brown	1610 nm laser, single-mode

Figure A-11 CWDM SFP Transceiver

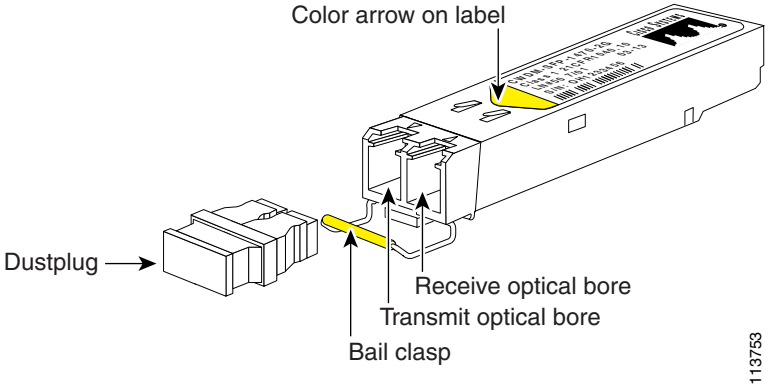


Table A-22 DWDM XENPAK Transceiver Module Product Numbers and ITU Channel Numbers

DWDM XENPAK Product Number	Description	ITU Channel
DWDM-XENPAK-60.61	1000BASE-DWDM 1560.61 nm XENPAK	21
DWDM-XENPAK-59.79	1000BASE-DWDM 1559.79 nm XENPAK	22
DWDM-XENPAK-58.98	1000BASE-DWDM 1558.98 nm XENPAK	23
DWDM-XENPAK-58.17	1000BASE-DWDM 1558.17 nm XENPAK	24
DWDM-XENPAK-56.55	1000BASE-DWDM 1556.55 nm XENPAK	26
DWDM-XENPAK-55.75	1000BASE-DWDM 1555.75 nm XENPAK	27
DWDM-XENPAK-54.94	1000BASE-DWDM 1554.94 nm XENPAK	28

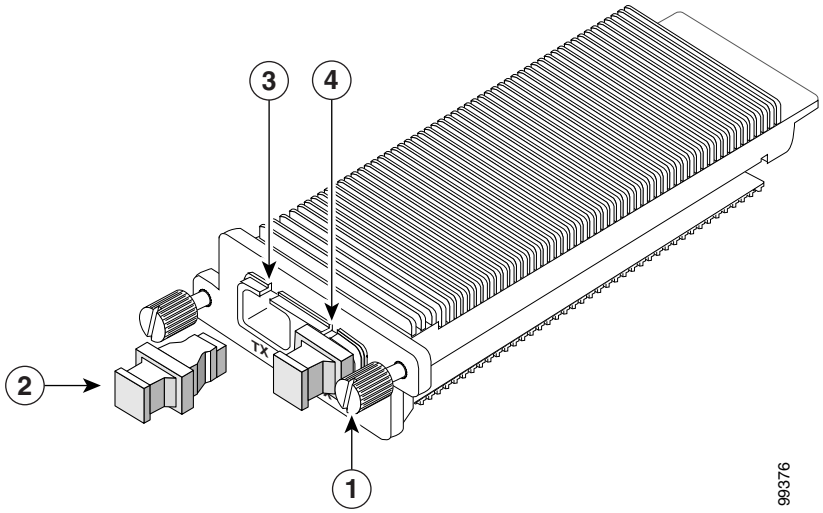
Table A-22 DWDM XENPAK Transceiver Module Product Numbers and ITU Channel Numbers (continued)

DWDM XENPAK Product Number	Description	ITU Channel
DWDM-XENPAK-54.13	1000BASE-DWDM 1554.13 nm XENPAK	29
DWDM-XENPAK-52.52	1000BASE-DWDM 1552.52 nm XENPAK	31
DWDM-XENPAK-51.72	1000BASE-DWDM 1551.72 nm XENPAK	32
DWDM-XENPAK-50.92	1000BASE-DWDM 1550.92 nm XENPAK	33
DWDM-XENPAK-50.12	1000BASE-DWDM 1550.12 nm XENPAK	34
DWDM-XENPAK-48.51	1000BASE-DWDM 1548.51 nm XENPAK	36
DWDM-XENPAK-47.72	1000BASE-DWDM 1547.72 nm XENPAK	37
DWDM-XENPAK-46.92	1000BASE-DWDM 1546.92 nm XENPAK	38
DWDM-XENPAK-46.12	1000BASE-DWDM 1546.12 nm XENPAK	39
DWDM-XENPAK-44.53	1000BASE-DWDM 1544.53 nm XENPAK	41
DWDM-XENPAK-43.73	1000BASE-DWDM 1543.73 nm XENPAK	42
DWDM-XENPAK-42.94	1000BASE-DWDM 1542.94 nm XENPAK	43
DWDM-XENPAK-42.14	1000BASE-DWDM 1542.14 nm XENPAK	44
DWDM-XENPAK-40.56	1000BASE-DWDM 1540.56 nm XENPAK	46
DWDM-XENPAK-39.77	1000BASE-DWDM 1539.77 nm XENPAK	47
DWDM-XENPAK-39.98	1000BASE-DWDM 1539.98 nm XENPAK	48
DWDM-XENPAK-38.19	1000BASE-DWDM 1538.19 nm XENPAK	49
DWDM-XENPAK-36.61	1000BASE-DWDM 1536.61 nm XENPAK	51
DWDM-XENPAK-35.82	1000BASE-DWDM 1535.82 nm XENPAK	52
DWDM-XENPAK-35.04	1000BASE-DWDM 1535.04 nm XENPAK	53

Table A-22 DWDM XENPAK Transceiver Module Product Numbers and ITU Channel Numbers (continued)

DWDM XENPAK Product Number	Description	ITU Channel
DWDM-XENPAK-34.25	1000BASE-DWDM 1534.25 nm XENPAK	54
DWDM-XENPAK-32.68	1000BASE-DWDM 1532.68 nm XENPAK	56
DWDM-XENPAK-31.90	1000BASE-DWDM 1531.90 nm XENPAK	57
DWDM-XENPAK-31.12	1000BASE-DWDM 1531.12 nm XENPAK	58
DWDM-XENPAK-30.33	1000BASE-DWDM 1530.33 nm XENPAK	59

Figure A-12 DWDM XENPACK Transceiver



1	Captive installation screw	3	Transmit optical bore
2	Dustplug	4	Receive optical bore

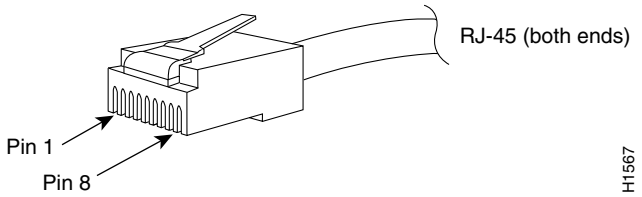
Module Connectors

This section covers the types of module connectors used with the Catalyst 6500 series switches:

RJ-45 Connector

The RJ-45 connector (shown in Figure A-13) is used to connect a Category 3, Category 5, Category 5e, or Category 6 foil twisted-pair or unshielded twisted-pair cable from the external network to the module interface connector.

Figure A-13 RJ-45 Interface Cable Connector



Caution Category 5e, Category 6 and Category 6a cables can store large levels of static electricity because of the dielectric properties of the materials used in their construction. Always ground the cables (especially in new cable runs) to a suitable and safe earth ground before connecting them to the module.

Caution To comply with GR-1089 intrabuilding, lightning immunity requirements, you must use foil twisted-pair (FTP) cable that is properly grounded at both ends.

RJ-21 Connector

The RJ-21 connectors (shown in Figure A-14) are used on telco modules. Each RJ-21 connector has pins for 12 ports.

Note The RJ-21 connector for the WS-X6624-FXS module has pins for 24 ports. See the "RJ-21 Connector (WS-X6624-FXS Only)" section on page A-27.

Warning **If the symbol of suitability with an overlaid cross appears above a port, you must not connect the port to a public network that follows the European Union standards. Connecting the port to this type of public network can cause severe personal injury or can damage the unit.** Statement 1031

To connect to 10/100BASE-TX RJ-21 telco interfaces, use Category 5 UTP cables with male RJ-21 connectors, as shown in Figure A-14. The WS-X6224-FXS analog interface module also uses an RJ-21 connector, but the pinout arrangement is different than the 10/100BASE-TX.

Figure A-14 RJ-21 Telco Interface Cable Connectors

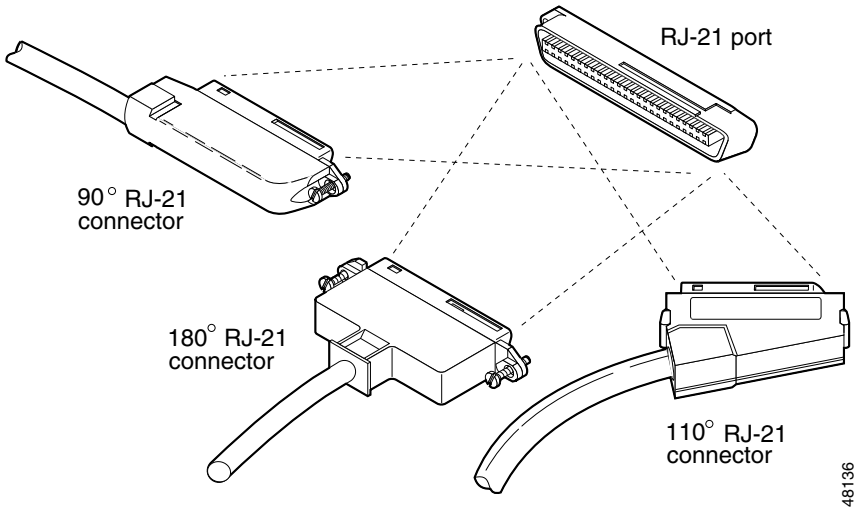


Table A-23 lists the output signals for the RJ-21 telco connector. The receive and transmit signals are polarized. One pin of each signal pair carries the positive (+) signal, and the other pin carries the negative (–) signal.

Note Table A-23 lists the *output signals* for the RJ-21 telco connector, not the *pinouts* of the cable connecting to the module.

Caution Category 5e and Category 6 cables can store large levels of static electricity because of the dielectric properties of the materials used in their construction. Always ground the cables (especially in new cable runs) to a suitable and safe earth ground before connecting them to the module.

Caution To comply with GR-1089 intrabuilding, lightning immunity requirements, you must use foil-twisted pair (FTP) cable that is properly grounded at both ends.

Table A-23 RJ-21 Connector Pinout

Ethernet Port No.	Connector Pin No.	Signal	Connector Pin No.	Signal
1	1 2	RxD (–) TxD (–)	26 27	RxD (+) TxD (+)
2	3 4	RxD (–) TxD (–)	28 29	RxD (+) TxD (+)
3	5 6	RxD (–) TxD (–)	30 31	RxD (+) TxD (+)
4	7 8	RxD (–) TxD (–)	32 33	RxD (+) TxD (+)
5	9 10	RxD (–) TxD (–)	34 35	RxD (+) TxD (+)
6	11 12	RxD (–) TxD (–)	36 37	RxD (+) TxD (+)
7	13 14	RxD (–) TxD (–)	38 39	RxD (+) TxD (+)
8	15 16	RxD (–) TxD (–)	40 41	RxD (+) TxD (+)
9	17 18	RxD (–) TxD (–)	42 43	RxD (+) TxD (+)
10	19 20	RxD (–) TxD (–)	44 45	RxD (+) TxD (+)
11	21 22	RxD (–) TxD (–)	46 47	RxD (+) TxD (+)
12	23 24	RxD (–) TxD (–)	48 49	RxD (+) TxD (+)
—	25	Gnd	50	Gnd

RJ-21 Connector (WS-X6624-FXS Only)

The pinout for the RJ-21 connector on the 24-port WS-X6624-FXS analog interface module is shown in Table A-24.

Table A-24 RJ-21 Connector Pinout (WS-X6224-FXS Analog Interface Module Only)

Port Number	Connector Pin Number	Signal	Port Number	Connector Pin Number	Signal
1	1 26	Ring Tip	13	13 38	Ring Tip
2	2 27	Ring Tip	14	14 39	Ring Tip
3	3 28	Ring Tip	15	15 40	Ring Tip
4	4 29	Ring Tip	16	16 41	Ring Tip
5	5 30	Ring Tip	17	17 42	Ring Tip
6	6 31	Ring Tip	18	18 43	Ring Tip
7	7 32	Ring Tip	19	19 44	Ring Tip
8	8 33	Ring Tip	20	20 45	Ring Tip
9	9 34	Ring Tip	21	21 46	Ring Tip
10	10 35	Ring Tip	22	22 47	Ring Tip
11	11 36	Ring Tip	23	23 48	Ring Tip
12	12 37	Ring Tip	24	24 49	Ring Tip
—	—	—	—	25, 50, 51, 52	GND

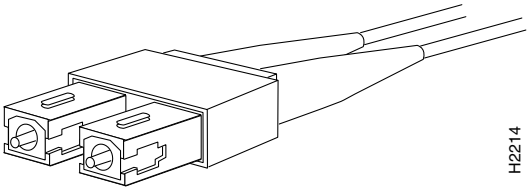
SC Connector

The SC connector, shown in Figure A-15, is used to connect fiber-optic module ports or transceivers with the external SMF or MMF network.

Warning **Invisible laser radiation may be emitted from disconnected fibers or connectors. Do not stare into beams or view directly with optical instruments.** Statement 1051

Note Make sure that the optical connectors are clean before making the connections. Contaminated connectors can damage the fiber and cause data errors. For information on cleaning the optical connectors, see the "Cleaning the Fiber-Optic Connectors" section on page A-38.

Figure A-15 SC Fiber-Optic Connector



Always insert the network connector completely into the socket. A secure connection is especially important when you are establishing a connection between a module and a long distance (1.24 miles) (2 km) network or a module and a suspected highly attenuated network. If the link LED does not light, try removing the network cable plug and reinserting it firmly into the module socket. It is possible that dirt or skin oils have accumulated on the plug faceplate (around the optical-fiber openings), generating significant attenuation and reducing the optical power levels below threshold levels so that a link cannot be made.

Caution Use extreme care when removing or installing connectors so that you do not damage the connector housing or scratch the end-face surface of the fiber. Always install protective covers on unused or disconnected components to prevent contamination. Always clean fiber connectors before installing them.

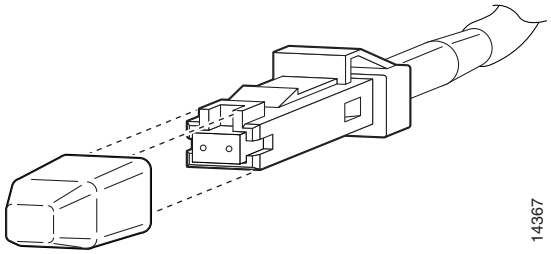
MT-RJ Connector

The MT-RJ connector is a small form-factor fiber-optic connector used to connect modules to a SMF or MMF optical network. (See Figure A-16.) The small size of the MT-RJ connector, as compared with the SC connector, allows for a greater port density on the modules. The MT-RJ connector is a two-fiber connector (transmit and receive) and has a form factor and clip lock retainer similar to the RJ-45 copper connector.

Warning **Invisible laser radiation may be emitted from disconnected fibers or connectors. Do not stare into beams or view directly with optical instruments.** Statement 1051

Note Make sure that the optical connectors are clean before making the connections. Contaminated connectors can damage the fiber and cause data errors. For information on cleaning the optical connectors, see the "Cleaning the Fiber-Optic Connectors" section on page A-38.

Figure A-16 MT-RJ Connector



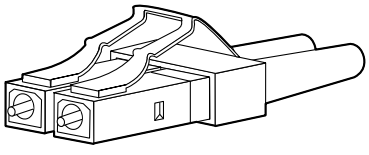
LC Connector

Warning **Invisible laser radiation may be emitted from disconnected fibers or connectors. Do not stare into beams or view directly with optical instruments.** Statement 1051

The LC fiber optic connector, shown in Figure A-17, is a small form-factor fiber-optic connector that provides high-density fiber connectivity. The LC connector can be used with either MMF cable or SMF cable. The LC connector uses a latching clip mechanism that is similar to the one used on the RJ-45 copper connector.

Note Make sure that the optical connectors are clean before making the connections. Contaminated connectors can damage the fiber and cause data errors. For information on cleaning the optical connectors, see the "Cleaning the Fiber-Optic Connectors" section on page A-38.

Figure A-17 LC Fiber Optic Connector



Cables

Table A-25 lists the connector pinouts and signal names for a 10/100BASE-T crossover (MDI-X) cable. Figure A-18 shows a schematic of the 10/100BASE-T crossover cable. Table A-26 lists the connector pinouts and signal names for a 1000BASE-T crossover (MDI-X) cable. Figure A-19 shows a schematic of the 1000BASE-T crossover cable.

Table A-25 10/100BASE-T Crossover Cable Pinout (MDI-X)

Side 1 Pin (Signal)	Side 2 Pin (Signal)
1 (RD+)	3 (TD+)
2 (RD–)	6 (TD–)
3 (TD+)	1 (RD+)
6 (TD–)	2 (RD–)
4 (Not used)	4 (Not used)
5 (Not used)	5 (Not used)
7 (Not used)	7 (Not used)
8 (Not used)	8 (Not used)

Figure A-18 Twisted-Pair Crossover 10/100BASE-T Cable Schematic

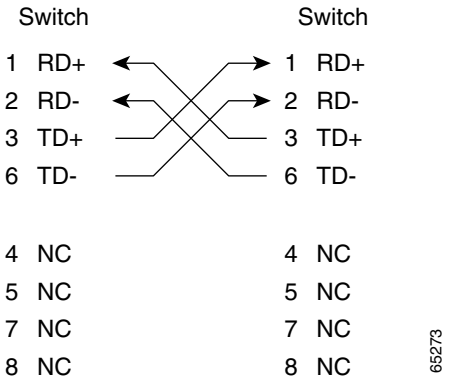
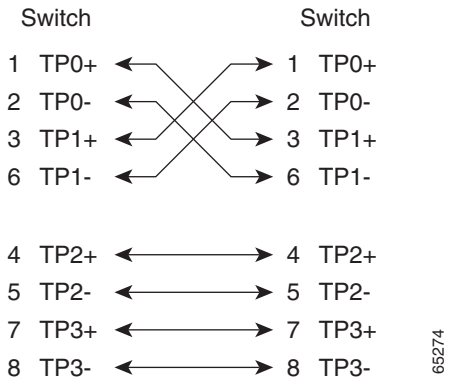


Table A-26 1000BASE-T Crossover Cable Pinout (MDI-X)

Side 1 Pin (Signal)	Side 2 Pin (Signal)
1 (TP0+)	3 (TP1+)
2 (TP0–)	6 (TP1–)
3 (TP1+)	1 (TP0+)
6 (TP1–)	2 (TP1–)
4 (TP2+)	7 (TP3+)
5 (TP2–)	8 (TP3–)
7 (TP3+)	4 (TP2+)
8 (TP3–)	5 (TP2–)

Figure A-19 Twisted-Pair Crossover 1000BASE-T Cable Schematic



Note Power over Ethernet (PoE), uses pairs 2 and 3 (pins 1, 2, 3, and 6) in a four-pair UTP cable to transmit power from the switch to a powered device. This method of supplying power is sometimes called "phantom power" because the PoE power travels over the same pairs of wires used to transmit the Ethernet signals. The PoE voltage is completely transparent to the Ethernet signals and does not interfere with their operation.

Catalyst 6500 series switches come with an accessory kit that contains the cable and adapters that you will need to connect a console (an ASCII terminal or PC running terminal emulation software) or modem to the console port. The accessory kit includes these items:

- RJ-45-to-RJ-45 rollover cable
- RJ-45-to-DB-9 female DTE adapter (labeled "Terminal")
- RJ-45-to-DB-25 female DTE adapter (labeled "Terminal")
- RJ-45-to-DB-25 male DCE adapter (labeled "Modem")

Console Port Mode Switch

The supervisor engine front-panel console port mode switch allows you to connect a terminal or modem to the console port as follows:

- Mode 1—Switch in the *in* position. Use this mode to connect a terminal to the console port using the RJ-45-to-RJ-45 rollover cable and DTE adapter (labeled "Terminal").

  You can also use this mode to connect a modem to the console port using the RJ-45-to-RJ-45 rollover cable and DCE adapter (labeled "Modem").

  See the "Console Port Mode 1 Signaling and Pinouts" section on page A-34.

- Mode 2—Switch in the *out* position. Use this mode to connect a terminal to the console port using the Catalyst 5000 family Supervisor Engine III console cable and the appropriate adapter for the terminal connection. (The cable and adapter are not provided.)

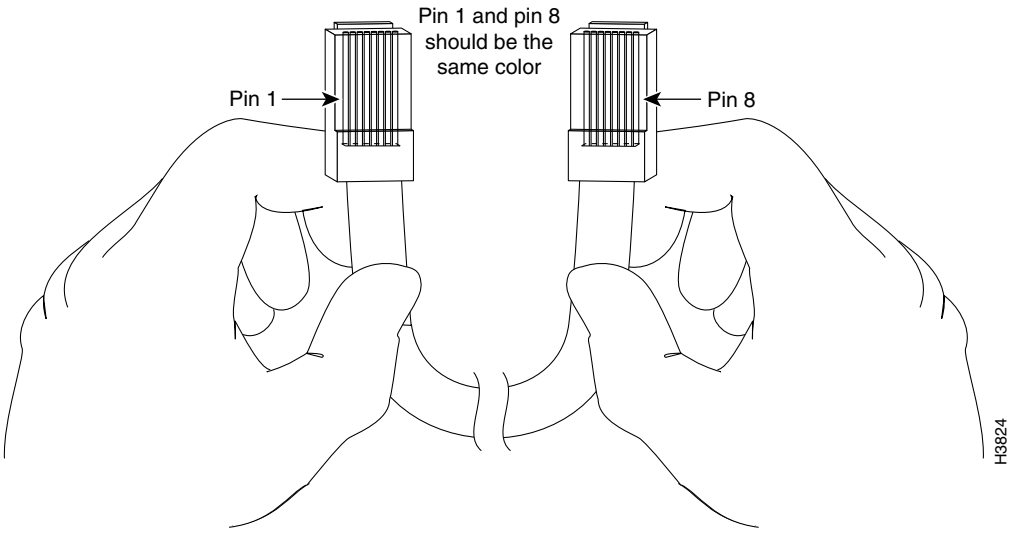
  See the "Console Port Mode 2 Signaling and Pinouts" section on page A-35.

Note Use a ballpoint pen tip or other small, pointed object to access the console port mode switch. The switch is shipped in the *in* position.

Identifying a Rollover Cable

You can identify a rollover cable by comparing the two ends of the cable. Holding the cables side by side, with the tab at the back, the wire connected to the pin on the outside of the left plug should be the same color as the wire connected to the pin on the outside of the right plug. (See Figure A-20.) If your cable was purchased from Cisco Systems, pin 1 will be white on one connector, and pin 8 will be white on the other. (A rollover cable reverses pins 1 and 8, 2 and 7, 3 and 6, and 4 and 5.)

Figure A-20 Identifying a Rollover Cable



Console Port Mode 1 Signaling and Pinouts

This section provides the signaling and pinouts for the console port in mode 1. (The port mode switch is in the *in* position.)

DB-9 Adapter (for Connecting to a PC)

Use the RJ-45-to-RJ-45 rollover cable and the RJ-45-to-DB-9 female DTE adapter (labeled "Terminal") to connect the console port to a PC running terminal emulation software. Table A-27 lists the pinouts for the asynchronous serial console port, the RJ-45-to-RJ-45 rollover cable, and the RJ-45-to-DB-9 female DTE adapter.

Table A-27 Port Mode 1 Signaling and Pinouts (DB-9 Adapter)

Console Port	RJ-45-to-RJ-45 Rollover Cable		RJ-45-to-DB-9 Terminal Adapter	Console Device
Signal	**RJ-45 Pin**	**RJ-45 Pin**	**DB-9 Pin**	**Signal**
RTS	1[1]	8	8	CTS
DTR	2	7	6	DSR
TxD	3	6	2	RxD
GND	4	5	5	GND
GND	5	4	5	GND
RxD	6	3	3	TxD
DSR	7	2	4	DTR
CTS	8[1]	1	7	RTS

1. Pin 1 is connected internally to Pin 8.

DB-25 Adapter (for Connecting to a Terminal)

Use the RJ-45-to-RJ-45 rollover cable and the RJ-45-to-DB-25 female DTE adapter (labeled "Terminal") to connect the console port to a terminal. Table A-28 lists the pinouts for the asynchronous serial console port, the RJ-45-to-RJ-45 rollover cable, and the RJ-45-to-DB-25 female DTE adapter.

Table A-28 Port Mode 1 Signaling and Pinouts (DB-25 Adapter)

Console Port	RJ-45-to-RJ-45 Rollover Cable		RJ-45-to-DB-25 Terminal Adapter	Console Device
Signal	**RJ-45 Pin**	**RJ-45 Pin**	**DB-25 Pin**	**Signal**
RTS	1[1]	8	5	CTS
DTR	2	7	6	DSR
TxD	3	6	3	RxD
GND	4	5	7	GND
GND	5	4	7	GND
RxD	6	3	2	TxD

Table A-28 Port Mode 1 Signaling and Pinouts (DB-25 Adapter) (continued)

Console Port	RJ-45-to-RJ-45 Rollover Cable		RJ-45-to-DB-25 Terminal Adapter	Console Device
Signal	**RJ-45 Pin**	**RJ-45 Pin**	**DB-25 Pin**	**Signal**
DSR	7	3	20	DTR
CTS	8[1]	1	4	RTS

1. Pin 1 is connected internally to Pin 8.

Modem Adapter

Use the RJ-45-to-RJ-45 rollover cable and the RJ-45-to-DB-25 male DCE adapter (labeled "Modem") to connect the console port to a modem. Table A-29 lists the pinouts for the asynchronous serial auxiliary port, the RJ-45-to-RJ-45 rollover cable, and the RJ-45-to-DB-25 male DCE adapter.

Table A-29 Port Mode 1 Signaling and Pinouts (Modem Adapter)

Console Port	RJ-45-to-RJ-45 Rollover Cable		RJ-45-to-DB-25 Modem Adapter	Modem
Signal	**RJ-45 Pin**	**RJ-45 Pin**	**DB-25 Pin**	**Signal**
RTS	1[1]	8	4	RTS
DTR	2	7	20	DTR
TxD	3	6	3	TxD
GND	4	5	7	GND
GND	5	4	7	GND
RxD	6	3	2	RxD
DSR	7	3	8	DCD
CTS	8[1]	1	5	CTS

1. Pin 1 is connected internally to Pin 8.

Console Port Mode 2 Signaling and Pinouts

This section provides the signaling and pinouts for the console port in mode 2. (The port mode switch in the *out* position.) (See Table A-30 for the pinouts.)

Table A-30 Port Mode 2 Signaling and Pinouts (Port Mode Switch Out)

Console Port	Console Device
Pin (signal)	**Input/Output**
1 (RTS)[1]	Output
2 (DTR)	Output
3 (RxD)	Input

Table A-30 Port Mode 2 Signaling and Pinouts (Port Mode Switch Out) (continued)

Console Port	Console Device
4 (GND)	GND
5 (GND)	GND
6 (TxD)	Output
7 (DSR)	Input
8 (CTS)[1]	Input

1. Pin 1 is connected internally to Pin 8.

Mode-Conditioning Patch Cord

When using the long wavelength/long-haul (LX/LH) GBIC with 62.5-micron diameter MMF, you must install a mode-conditioning patch cord (Cisco product number CAB-GELX-625 or equivalent) between the GBIC and the multimode fiber (MMF) cable on both the transmit and receive ends of the link. A mode-conditioning patch cord is required for 1000BASE-LX/LH applications over FDDI-grade, OM1, and OM2 fiber cable types. Mode-conditioning patch cords should not be used for applications over OM3 fiber cable (laser-optimized fiber cable). For additional information on mode-condtioning patch cords, refer to the *Use of Mode Conditioning Patch Cables in Gigabit Ethernet and 10 Gigabit Ethernet Laser-Based Transmissions* bulletin at:

http://www.cisco.com/en/US/prod/collateral/modules/ps5455/product_bulletin_c25-530836.html

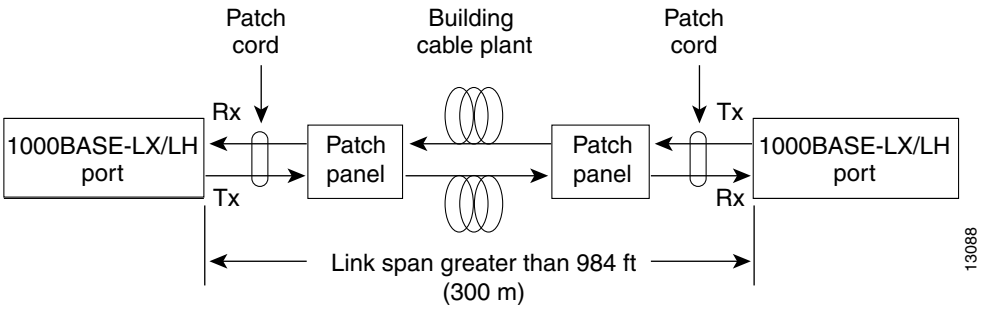
Note We do not recommend using the LX/LH GBIC and MMF without the patch cord for very short link distances of 33 to 328 feet (10 to 100 meters). The result could be an elevated bit error rate (BER).

The patch cord is required to comply with IEEE standards. IEEE found that link distances could not be met with certain types of fiber-optic cable due to a problem in the center of some fiber-optic cable cores. The solution is to launch light from the laser at a precise offset from the center by using the patch cord. At the output of the patch cord, the LX/LH GBIC complies with the IEEE 802.3z standard for 1000BASE-LX.

Patch Cord Configuration Example

Figure A-21 shows a typical configuration using the patch cord.

Figure A-21 Patch Cord Configuration

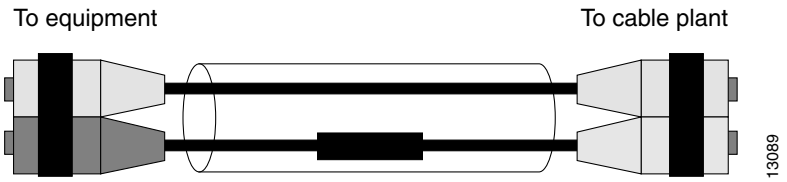


Patch Cord Installation

Warning **Invisible laser radiation may be emitted from disconnected fibers or connectors. Do not stare into beams or view directly with optical instruments.** Statement 1051

Plug the end of the patch cord labeled "To Equipment" into the GBIC. (See Figure A-22.) Plug the end labeled "To Cable Plant" into the patch panel. The patch cord is 9.8 feet (3 meters) long and has duplex SC male connectors at each end.

Figure A-22 Patch Cord Installation



Differential Mode Delay

When an unconditioned laser source designed for operation on an SMF cable is directly coupled to an MMF cable, differential mode delay (DMD) might occur. DMD can degrade the modal bandwidth of the fiber-optic cable. This degradation causes a decrease in the link span (the distance between the transmitter and the receiver) that can be reliably supported.

The Gigabit Ethernet specification (IEEE 802.3z) outlines parameters for Ethernet communications at a gigabit-per-second rate. The specification offers a higher-speed version of Ethernet for backbone and server connectivity using existing deployed MMF cable by defining the use of laser-based optical components to propagate data over MMF cable.

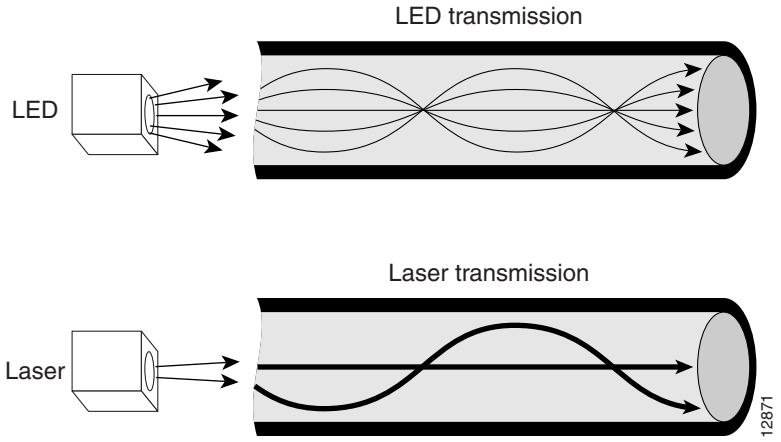
Lasers function at the baud rates and longer distances required for Gigabit Ethernet. The 802.3z Gigabit Ethernet Task Force has identified the DMD condition that occurs with particular combinations of lasers and MMF cable. The results create an additional element of jitter that can limit the reach of Gigabit Ethernet over MMF cable.

With DMD, a single laser light pulse excites a few modes equally within an MMF cable. These modes, or light pathways, then follow two or more different paths. These paths might have different lengths and transmission delays as the light travels through the cable. With DMD, a distinct pulse propagating down the cable no longer remains a distinct pulse or, in extreme cases, might become two independent pulses. Strings of pulses can interfere with each other making it difficult to recover data.

DMD does not occur in all deployed fibers; it occurs with certain combinations of worst-case fibers and worst-case transceivers. Gigabit Ethernet experiences this problem because of its very high baud rate and its long MMF cable lengths. SMF cable and copper cable are not affected by DMD.

MMF cable has been tested for use only with LED sources. LEDs can create an *overfilled launch condition* within the fiber-optic cable. The overfilled launch condition describes the way LED transmitters couple light into the fiber-optic cable in a broad spread of modes. Similar to a light bulb radiating light into a dark room, the generated light that shines in multiple directions can overfill the existing cable space and excite a large number of modes. (See Figure A-23.)

Figure A-23 LED Transmission Compared to Laser Transmission



Lasers launch light in a more concentrated fashion. A laser transmitter couples light into only a fraction of the existing modes or optical pathways present in the fiber-optic cable. (See Figure A-23.)

The solution is to condition the laser light launched from the source (transmitter) so that it spreads the light evenly across the diameter of the fiber-optic cable making the launch look more like an LED source to the cable. The objective is to scramble the modes of light to distribute the power more equally in all modes and prevent the light from being concentrated in just a few modes.

An unconditioned launch, in the worst case, might concentrate all of its light in the center of the fiber-optic cable, exciting only two or more modes equally.

A significant variation in the amount of DMD is produced from one MMF cable to the next. No reasonable test can be performed to survey an installed cable plant to assess the effect of DMD, so you must use the mode-conditioning patch cords for all uplink modules using MMF when the link span exceeds 984 feet (300 meters).

For link spans less than 984 feet (300 meters), you can omit the patch cord. (We do not recommend using the LX/LH GBIC and MMF without a patch cord for very short link distances of 33 to 328 feet [10 to 100 meters]. The result could be an elevated bit error rate [BER].)

Cleaning the Fiber-Optic Connectors

Fiber-optic connectors are used to connect two fibers together. When these connectors are used in a communications system, proper connection becomes a critical factor.

Fiber-optic cable connectors can be damaged by improper cleaning and connection procedures. Dirty or damaged fiber-optic connectors can result in communication that is not repeatable or inaccurate.

Fiber-optic connectors differ from electrical or microwave connectors. In a fiber-optic system, light is transmitted through an extremely small fiber core. Because fiber cores are often 62.5 microns or less in diameter, and dust particles range from a tenth of a micron to several microns in diameter, dust and any contamination at the end of the fiber core can degrade the performance of the connector interface where the two cores meet. The connector must be precisely aligned, and the connector interface must be absolutely free of trapped foreign material.

Connector loss, or insertion loss, is a critical performance characteristic of a fiber-optic connector. Return loss is also an important factor. Return loss specifies the amount of reflected light; the lower the reflection, the better the connection. The best physical contact connectors have return losses greater than –40 dB, although –20 to –30 dB is more common.

The connection quality depends on two factors: the type of connector and the proper cleaning and connection techniques. Dirty fiber connectors are a common source of light loss. Keep the connectors clean at all times, and keep the dust covers installed when the connectors are not in use.

Before installing any type of cable or connector, use a lint-free alcohol pad from a cleaning kit to clean the ferrule, the protective white tube around the fiber, and the end-face surface of the fiber.

As a general rule, whenever there is a significant, unexplained loss of light, clean the connectors.

Caution Use extreme care when removing or installing connectors so that you do not damage the connector housing or scratch the end-face surface of the fiber. Always install protective covers on unused or disconnected components to prevent contamination. Always clean fiber connectors before installing them.

To clean the optical connectors, use a CLETOP cassette cleaner (type A for SC connectors or type B for MT-RJ connectors) and follow the product directions. If a CLETOP cassette cleaner is not available, follow these steps:

Step 1 Use a lint-free tissue soaked in 99 percent pure isopropyl alcohol to gently wipe the faceplate. Wait five seconds for the surfaces to dry, and repeat.

Step 2 Remove any residual dust from the faceplate with clean, dry, oil-free compressed air.

Warning **Invisible laser radiation may be emitted from disconnected fibers or connectors. Do not stare into beams or view directly with optical instruments.** Statement 1051

Step 3 Use a magnifying glass or inspection microscope to inspect the ferrule at an angle. Do not look directly into the aperture. Repeat the process if any contamination is detected.

The connectors used inside the system have been cleaned by the manufacturer and connected to the adapters in the proper manner. The operation of the system should be error free if the customer provides clean connectors on the application side, follows the previous directions, and follows these guidelines:

- Clean the connectors using either a CLETOP cassette cleaner (Type A for SC connectors and Type B for MT-RJ connectors) or lens tissues before connecting to the adapters. Use pure alcohol to remove contamination.
- Do not clean the inside of the connector adapters.
- Do not use force or quick movements when connecting the fiber-optic connectors in the adapters.
- Cover the connectors and adapters to keep the inside of the adapters or the surface of the connectors from getting dirty when you are not using the connectors or while you are cleaning the chassis.