



Overview

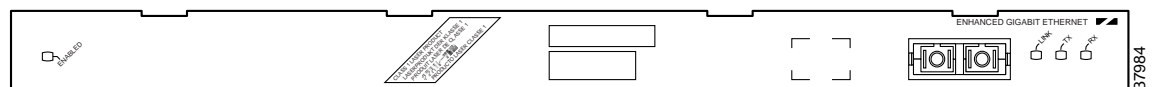
This chapter describes the GEIP+ and contains the following sections:

- [GEIP+ Overview, page 1-1](#)
- [IEEE 802.3z Gigabit Ethernet Overview, page 1-1](#)
- [Features, page 1-2](#)
- [Interface Specifications, page 1-3](#)
- [LEDs, page 1-8](#)
- [Cables and Connectors, page 1-8](#)
- [Interface Processor Locations on Cisco 7500 Series Routers, page 1-11](#)
- [Identifying Interface Addresses, page 1-13](#)

GEIP+ Overview

The GEIP+ (see [Figure 1-1](#)) is a single-port interface processor that, when combined with the appropriate optical fiber cable and a Gigabit Interface Converter (GBIC), provides one Gigabit Ethernet (GE) interface that is compliant with the IEEE 802.3z specification. The GE interface on a GEIP+ operates in full-duplex mode.

Figure 1-1 GEIP+—Faceplate View



IEEE 802.3z Gigabit Ethernet Overview

This section provides an overview of the IEEE 802.3z specification and Gigabit Ethernet. The term *Ethernet* is commonly used for all LANs that generally conform to Ethernet specifications, including Gigabit Ethernet under IEEE 802.3z, which is well suited to applications in which a local communication medium must carry heavy traffic at high peak data rates.

The IEEE 802.3z specification includes the following three physical layer protocols:

- 1000BaseCX—Full-duplex operation over copper wire
- 1000BaseSX—Full-duplex operation with short-wavelength (850-nanometer [nm]) devices over multimode optical fiber
- 1000BaseLX—Full-duplex operation with long-wavelength (1300-nm) devices over multimode or single-mode optical fiber



Note Cisco Systems offers another version of 1000BaseLX called *Long Haul* (LH), which complies with the IEEE 802.3z 1000BaseLX specification but extends the transmission distance up to 6.21 miles (10 km). The GEIP+ provides connection options for 1000BaseSX, 1000BaseLX, and Long Haul.

The GEIP+ does not support the 1000BaseCX physical layer protocol.

Each physical layer protocol has a name that summarizes its characteristics in the format speed/signaling method/segment length, where speed is the LAN speed in megabits per second (Mbps), signaling method is the signaling method used (either baseband or broadband), and segment length is typically the maximum length between stations in hundreds of meters. For example, 1000BaseSX specifies a 1000-Mbps baseband LAN, with maximum network segments (operating distances) as defined in [Table 1-1](#). [Table 1-2](#) and [Table 1-3](#) define maximum network segments for 1000BaseLX and Long Haul, respectively.

Features

The GEIP+ supports the following features:

- Applicable IEEE 802.3z standards; full-duplex operation only.
- IEEE 802.3x flow control.
- Layer 3 distributed services, including Route Processor (RP) Cisco Express Forwarding (CEF) switching, fast switching, flow switching, and Committed Access Rate (CAR).
- IEEE 802.1Q frames (in tagged or untagged modes).
- Maximum transmission unit (MTU) of 4,476 bytes.
- Ethernet Inter-Switch Link (ISL) encapsulation.
- Online insertion and removal of the GEIP+ and the Gigabit Interface Converter (GBIC).
- Support for 1000BaseSX (short wavelength—850 nm), 1000BaseLX (long wavelength—1300 nm), and Long-Haul (long wavelength—1300 nm) operation by way of GBICs. (For specific GBIC requirements, see the [“Gigabit Interface Converter”](#) section on page 1-8.)



Note For information about specific software and hardware requirements for the GEIP+, see the [“Software and Hardware Requirements”](#) section on page 2-2.



Note The GEIP+ does not support half-duplex operation; it supports only full-duplex operation.

Interface Specifications

This section provides information about Gigabit Ethernet interface specifications, which include interface distance limitations, power budget and how to evaluate it, and optical fiber characteristics.

Gigabit Ethernet Link Distance Limitations

The GEIP+ uses two types of optical fiber: single-mode and multimode. Modes can be thought of as bundles of light rays entering the fiber at a particular angle. Single-mode fiber allows only one mode of light to propagate through the fiber, whereas multimode fiber allows multiple modes of light to propagate through the fiber.

Multiple modes of light propagating through the fiber travel different distances depending on the entry angles, which cause them to arrive at the destination at different times (a phenomenon called modal dispersion). Single-mode fiber is capable of higher bandwidth and greater cable run distances than multimode fiber.

According to the IEEE 802.3z specification, power budget is defined as the minimum optical power available to overcome the sum of attenuation plus power penalties of the optical path between the transmitter and receiver calculated as the difference between the transmitter launch power (minimum) and the receiver power (minimum). Further, channel insertion loss is defined as the static loss of a link between a transmitter and a receiver. It includes the loss of the fiber, connectors, and splices, and it is used to calculate link distance.

Finally, for fiber-optic links, the power penalties of a link are not attributes of link attenuation. Power penalties include modal noise, relative intensity noise (RIN), intersymbol interference (ISI), mode partition noise, extinction ratio, and eye-opening penalties.

The following tables list worst-case power budgets and penalties by interface type:

- [Table 1-1](#)—1000BaseSX
- [Table 1-2](#)—1000BaseLX
- [Table 1-3](#)—1000BaseLH

[Table 1-4](#) lists optical fiber cable characteristics. [Table 1-5](#) lists minimum and maximum receive and transmit power parameters by transmission and optical fiber type.



Note

If the distance between two connected stations is greater than the maximum distances listed, significant signal loss can result, making transmission unreliable.

The minimum distance between two connected stations is 6.56 feet (2 meters).

A mode-conditioning patch cord is needed for 1000BaseLX and LH multimode connections if these connections are greater than 984.25 feet (300 meters). (For information on the mode-conditioning patch cord, see the [“Mode-Conditioning Patch Cord with a Multimode GBIC-LX and GBIC-LH”](#) section on [page 1-10](#).)

Table 1-1 Worst-Case 1000BaseSX Link Power Budget and Penalties

| Parameter ¹ | 62.5-Micron ² Multimode | | 50-Micron Multimode | |
|--|-------------------------------------|---------------------|-----------------------|-----------------------|
| | 160 MHz*km | 200 MHz*km | 400 MHz*km | 500 MHz*km |
| Modal bandwidth as measured at 850 nm (minimum, overfilled launch) | | | | |
| Link power budget | 7.5 dB | 7.5 dB | 7.5 dB | 7.5 dB |
| Operating distance | 721.78 feet (ft.) 220 meters (m) | 902.23 ft. 275 m | 1,640.42 ft. 500 m | 1,804.46 ft. 550 m |
| Channel insertion loss ^{3, 4} | 2.38 dB | 2.60 dB | 3.37 dB | 3.56 dB |
| Link power penalties ⁴ | 4.27 dB | 4.29 dB | 4.07 dB | 3.57 dB |
| Unallocated margin in link power budget ⁴ | 0.84 dB | 0.60 dB | 0.05 dB | 0.37 dB |

1. Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.
2. 10^{-6} meters (or 1 micrometer) = 1 micron (μ).
3. Operating distances used to calculate the channel insertion loss are the maximum values.
4. A wavelength of 830 nm is used to calculate channel insertion loss, link power penalties, and unallocated margin.

Table 1-2 Worst-Case 1000BaseLX Link Power Budget and Penalties

| Parameter ¹ | 62.5-Micron ² Multimode | 50-Micron Multimode | | 10-Micron Single-Mode |
|---|---------------------------------------|-----------------------|-----------------------|-------------------------|
| | 500 MHz*km | 400 MHz*km | 500 MHz*km | — |
| Modal bandwidth as measured at 1300 nm (minimum, overfilled launch) | | | | |
| Link power budget | 7.5 dB | 7.5 dB | 7.5 dB | 8.0 dB |
| Operating distance | 1,804.46 feet (ft.) 550 meters (m) | 1,804.46 ft. 550 m | 1,804.46 ft. 550 m | 16,404.20 ft. 5000 m |
| Channel insertion loss ^{3, 4} | 2.35 dB | 2.35 dB | 2.35 dB | 4.57 dB |
| Link power penalties ⁴ | 3.48 dB | 5.08 dB | 3.96 dB | 3.27 dB |
| Unallocated margin in link power budget ⁴ | 1.67 dB | 0.07 dB | 1.19 dB | 0.16 dB |

1. Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.
2. 10^{-6} meters (or 1 micrometer) = 1 micron (μ).
3. Operating distances used to calculate the channel insertion loss are the maximum values.
4. A wavelength of 1270 nm is used to calculate channel insertion loss, link power penalties, and unallocated margin.

Table 1-3 Worst-Case Long Haul Link Power Budget and Penalties

| Parameter ¹ | 10-Micron ² Single-Mode |
|------------------------|--|
| Link power budget | 10.5 dB |
| Operating distance | 32,808.4 feet (ft.) 10,000 meters (m) |

Table 1-3 Worst-Case Long Haul Link Power Budget and Penalties (continued)

| Parameter ¹ | 10-Micron ² Single-Mode |
|--|------------------------------------|
| Channel insertion loss ^{3, 4} | 7.8 dB |
| Link power penalties ⁴ | 2.5 dB |
| Unallocated margin in link power budget ⁴ | 0.2 dB |

1. Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.
2. 10^{-6} meters (or 1 micrometer) = 1 micron (μ).
3. Operating distances used to calculate the channel insertion loss are the maximum values.
4. A wavelength of 1280 nm is used to calculate channel insertion loss, link power penalties, and unallocated margin.

Table 1-4 Optical Fiber and Cable Characteristics

| Description | 62.5-Micron ¹ Multimode | | 50-Micron Multimode | | 10-Micron Single-Mode |
|--|------------------------------------|------------|---------------------|------------|-----------------------|
| | 850 nm ² | 1300 nm | 850 nm | 1300 nm | |
| Nominal fiber specification wavelength | | | | | 1300 nm |
| Fiber cable attenuation (maximum) | 3.75 dB/km ³ | 1.5 dB/km | 3.5 dB/km | 1.5 dB/km | 0.5 dB/km |
| Modal bandwidth (minimum, overfilled launch) | 160 MHz*km | 500 MHz*km | 400 MHz*km | 400 MHz*km | — |
| | 200 MHz*km | 500 MHz*km | 500 MHz*km | 500 MHz*km | — |
| Zero dispersion wavelength | 1320–1365 nm | | 1295–1320 nm | | 1300–1324 nm |

1. 10^{-6} meters (or 1 micrometer) = 1 micron (μ)
2. nm = nanometers
3. dB/km = decibels per kilometer

Table 1-5 *Minimum and Maximum Transmit and Receive Power by Transmission and Optical Fiber Types*

| Transmission Type and Optical Fiber Type | Wavelength | Transmit Power Minimum/Maximum | Receive Power Minimum/Maximum |
|--|-------------------------|--------------------------------|-------------------------------|
| 1000BaseSX | | | |
| 50-micron ¹ multimode | 770–860 nm ² | –9.5 dBm/–4 dBm ³ | –17 dBm/0 dBm |
| 62.5-micron multimode | 770–860 nm | –9.5 dBm/–4 dBm | –17 dBm/0 dBm |
| 1000BaseLX | | | |
| 50-micron multimode | 1270–1355 nm | –11.5 dBm/–3 dBm | –19 dBm/–3 dBm |
| 62.5-micron multimode | 1270–1355 nm | –11.5 dBm/–3 dBm | –19 dBm/–3 dBm |
| 10-micron single-mode | 1270–1355 nm | –11 dBm/–3 dBm | –19 dBm/–3 dBm |
| Long Haul | | | |
| 10-micron single-mode | 1280–1350 nm | –9.5 dBm/–3 dBm | –20 dBm/–3 dBm |

1. 10^{-6} meters (or 1 micrometer) = 1 micron (μ)

2. nm = nanometers

3. dBm = decibels per milliwatt

Evaluating the Power Budget

To design an efficient optical data link, you should evaluate the power budget. Proper operation of an optical data link depends on modulated light reaching the receiver with enough power to be correctly demodulated. Data link efficiency is affected by the losses introduced by splices and connectors.

The maximum operating distance listed in [Table 1-1](#), [Table 1-2](#), and [Table 1-3](#) is an estimate and is based on the following assumptions:

- Total loss from connectors and splices on multimode optical fiber is 1.5 dB.
- Total loss from connectors and splices on single-mode optical fiber is 2.0 dB.

Therefore, for a real network, you could adjust the operating distance as follows:

- If the total loss from connectors and splices is larger than that indicated in these assumptions, then you could use shorter optical fiber cable (as with the single-mode power margin example that follows).
- If the total loss from connectors and splices is smaller than that indicated in these assumptions, then you could use longer optical fiber cable.

You should note that exceeding the maximum operating distance is only feasible with single-mode optical fiber, *not* with multimode optical fiber (because of the penalty of the differential mode delay [DMD] associated with a laser source over multimode fiber). In all applications, we strongly recommend that you follow operating distance guidelines.

Multimode Power Margin Example with Sufficient Power for Transmission

Power margin (PM) is defined as channel insertion loss or cable loss (connector loss + splice loss). The result should be greater than or equal to 0 and is expressed in decibels (dB).

The following is an example of a power margin (PM) calculation for a 1000BaseSX interface over multimode optical fiber, based on the following variables:

- Type of multimode: 62.5 micron
- Modal bandwidth (BW) of multimode: 200 MHz*km
- Link length of 250 meters, with a loss of 3.75 dB per km (see [Table 1-4](#))
- Two connectors, each with a loss of 0.5 dB
- One splice, with a loss of 0.5 dB

Estimate the multimode power margin as follows:

From [Table 1-1](#), the channel insertion loss is 2.60 dB, so

$$\text{PM} = 2.60 \text{ dB} - 250 \text{ m} (3.75 \text{ dB/km}) - 2 (0.5 \text{ dB}) - 1 (0.5 \text{ dB})$$

$$\text{PM} = 2.60 \text{ dB} - 0.94 \text{ dB} - 1 \text{ dB} - 0.5 \text{ dB}$$

$$\text{PM} = 0.16 \text{ dB}$$

The positive value 0.16 dB indicates that this link has sufficient power for transmission.

Single-Mode Power Margin Example with Sufficient Power for Transmission

The following example of PM for a Long Haul interface over a single-mode optical fiber is based on two buildings, 5 kilometers apart (with a loss of 0.5 dB/km; see [Table 1-4](#)), connected through a patch panel in an intervening building with a total of 10 connectors (each with a loss of 0.5 dB).

Estimate the single-mode power margin as follows:

From [Table 1-3](#), the channel insertion loss is 7.8 dB, so

$$\text{PM} = 7.8 \text{ dB} - 5 \text{ km} (0.5 \text{ dB/km}) - 10 (0.5 \text{ dB})$$

$$\text{PM} = 7.8 \text{ dB} - 2.5 \text{ dB} - 5 \text{ dB}$$

$$\text{PM} = 0.3 \text{ dB}$$

The positive value of 0.3 dB indicates that this link has sufficient power for transmission.

Using Statistics to Estimate the Power Budget

Statistical models more accurately determine the power budget than the worst-case method. Determining the link loss with statistical methods requires accurate knowledge of variations in the data link components. Statistical power budget analysis is beyond the scope of this publication. For further information, refer to ITU-T standards and your equipment specifications.

Additional Power Budget and Attenuation References

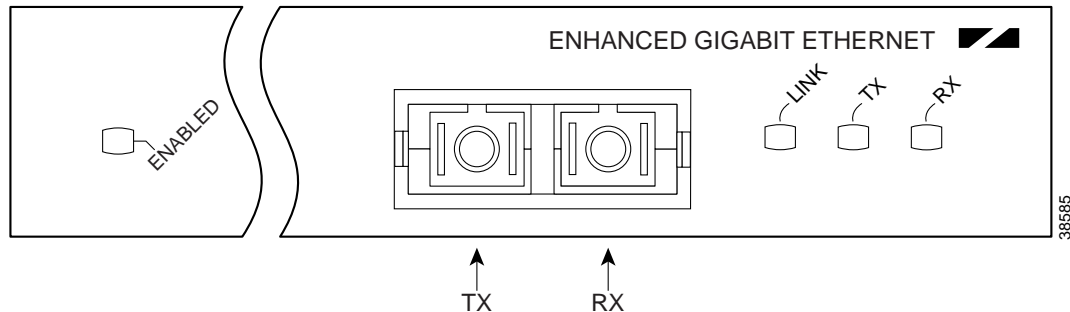
The following publications contain information on determining attenuation and power budget:

- T1E1.2/92-020R2 ANSI, the Draft American National Standard for Telecommunications entitled *Broadband ISDN Customer Installation Interfaces: Physical Layer Specification*
- *Power Budget Analysis*, AT&T Technical Note, TN89-004LWP, May 1989

LEDs

The GEIP+ contains the enabled LED for the interface processor and a bank of three status LEDs for the GE interface. (The LEDs are shown in [Figure 1-2](#).)

Figure 1-2 LEDs on a GEIP+—Partial Faceplate View



After system initialization, the enabled LED goes on to indicate that the GEIP+ has been enabled for operation.

The following conditions must be met before the enabled LED goes on:

- The GEIP+ is correctly connected and receiving power.
- The system bus recognizes the GEIP+.
- The system contains a valid microcode version that has been downloaded successfully.

If any of these conditions is not met, or if the initialization fails for other reasons, the enabled LED does not go on.

Following are the three status LEDs and an explanation of what each indicates:

| LED ¹ | Color | State | Indications |
|------------------|-------|---------------|---|
| LINK | Green | On | Interface is receiving a carrier signal from the network. |
| Transmit (TX) | Green | Flickering on | Data is being transmitted. |
| Receive (RX) | Green | Flickering on | Data is being received. |

1. If no cable is connected to the GBIC, or a GBIC is not installed, the TX, RX, and LINK LEDs blink on and off in sequence.

Cables and Connectors

This section provides information about the cables and connectors you must use with the GEIP+.

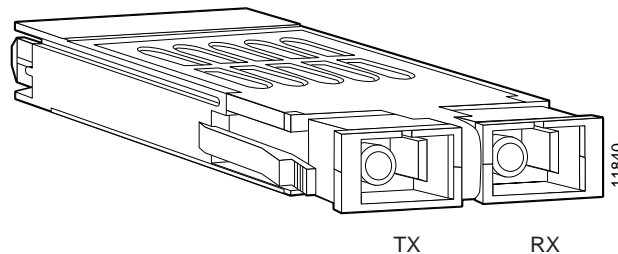
Gigabit Interface Converter

This section provides information about cabling and connectors for the Gigabit Interface Converter (GBIC) (see [Figure 1-3](#)), which is a required component with the GEIP+ and is installed between your GEIP+ and your 1000BaseX-based network.

**Caution**

To prevent system problems, do not use GBICs from third-party vendors. Use only the GBIC that shipped with your GEIP+.

Figure 1-3 Gigabit Interface Converter (GBIC)



The 1000BaseSX (GBIC-SX), 1000BaseLX (GBIC-LX), and Long Haul (GBIC-LH) GBICs have one optical interface in the form of an SC-type duplex receptacle that supports IEEE 802.3z interfaces compliant with the 1000BaseX standard. (See [Figure 1-3](#).)

**Note**

The GEIP+ ships with a GBIC installed. The GEIP+ assembly is a field-replaceable unit (FRU). The GBIC is a separate FRU.

Depending on the GBIC you plan to use, it contains a Class 1 laser of 850 nm for 1000BaseSX (short-wavelength) applications, a Class 1 laser of 1300 nm for 1000BaseLX (long-wavelength) applications, or a Class 1 laser of 1300 nm for Long Haul (long-wavelength) applications.

Optical Fiber Cables

This section provides information about the optical fiber cables you should use with the GEIP+. [Figure 1-4](#) and [Figure 1-5](#) show the simplex and duplex SC-type connectors on your multimode or single-mode optical fiber cables. For simplex connections, one cable is required for transmit (TX) and a second cable is required for receive (RX). For duplex connections, one cable is required for both TX and RX. You can use either simplex or duplex connections for the GEIP+. (Optical fiber cables are commercially available; they are not available from Cisco Systems.)

**Warning**

Because invisible laser radiation may be emitted from the aperture of the port when no fiber cable is connected, avoid exposure to laser radiation, and do not stare into open apertures.

**Warning**

Class 1 laser product.

The optical fiber cables you must use with the GBIC in a GEIP+ are as follows:

- 1000BaseSX—50/125-micron or 62.5/125-micron multimode optical fiber
- 1000BaseLX—9/125-micron or 10/125-micron single-mode optical fiber, or 50/125-micron or 62.5/125-micron multimode optical fiber where transmission distances are less than 984.25 feet (300 meters)
- Long Haul—9/125-micron or 10/125-micron single-mode optical fiber, or 50/125-micron or 62.5/125-micron multimode optical fiber where transmission distances are greater than 984.25 feet (300 meters)

Figure 1-4 Simplex SC-Type Connector

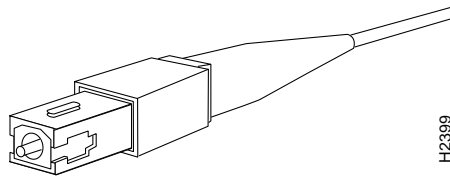
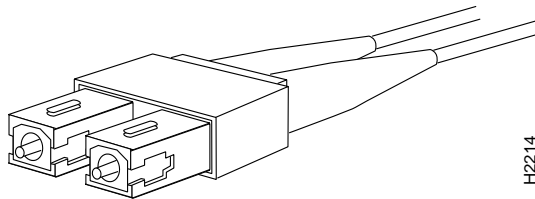


Figure 1-5 Duplex SC-Type Connector



Mode-Conditioning Patch Cord with a Multimode GBIC-LX and GBIC-LH

Both the GBIC-LX and the GBIC-LH option for the GEIP+ have a 1300-nm (long-wavelength) Class 1 laser as a light source and provide a connection to 50/125-micron or 62.5-micron multimode optical fiber.

When an unconditioned laser source designed for operation on single-mode optical fiber is directly coupled to a multimode optical fiber cable, an effect known as differential mode delay (DMD) might result in a degradation of the modal bandwidth of the optical fiber cable.

This degradation results in a decrease in the link span (the distance between a transmitter and a receiver) that can be supported reliably. The effect of DMD can be overcome by conditioning the launch characteristics of a laser source. A practical means of performing this conditioning is to use a device called a *mode-conditioning patch cord*.

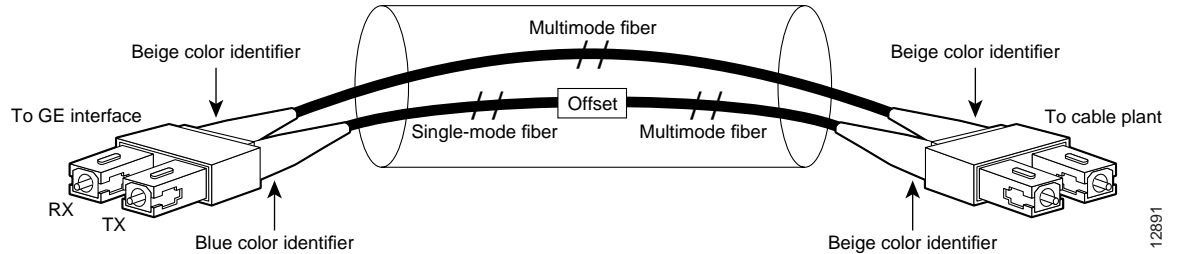
A mode-conditioning patch cord is an optical fiber cable assembly that consists of a pair of optical fibers terminated with connector hardware. Figure 1-6 shows a diagram of the mode-conditioning patch cord assembly. Specifically, the mode-conditioning patch cord is composed of a single-mode optical fiber permanently coupled off center to a graded-index multimode optical fiber. (See *Offset* in Figure 1-6.)



Note

The mode-conditioning patch cord is not required with 1000BaseSX multimode connections or 1000BaseLX single-mode or Long Haul single-mode connections.

Figure 1-6 Mode-Conditioning Patch Cord Assembly



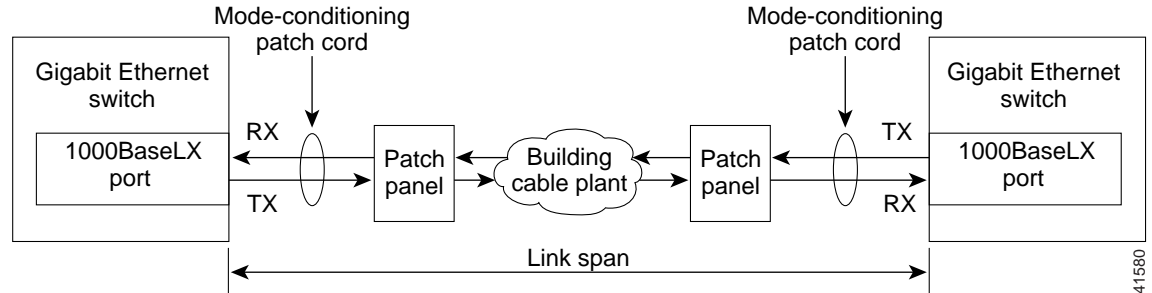
The mode-conditioning patch cord assembly is composed of duplex optical fibers, including a single-mode-to-multimode offset launch fiber connected to the transmitter, and a second conventional graded-index multimode optical fiber connected to the receiver. The use of a plug-to-plug patch cord maximizes the power budget of multimode 1000BaseLX and LH links.

**Caution**

If you plan to use a GBIC-LX or a GBIC-LH in your GEIP+ at distances greater than 984.25 feet (300 meters) over 50/125-micron or 62./125-micron multimode fiber, to prevent data transmission problems you *must* use the mode-conditioning patch cord. Do *not* use the procedure in this section. Instead, proceed to the “[Attaching a Mode-Conditioning Patch Cord to a GBIC-LX or GBIC-LH](#)” section on page 4-3.

A typical application of a mode-conditioning patch cord is shown in Figure 1-7.

Figure 1-7 Typical Application of the Mode-Conditioning Patch Cord



Interface Processor Locations on Cisco 7500 Series Routers

This section describes the interface processor slot numbering for the Cisco 7500 series routers. [Figure 1-8](#), [Figure 1-9](#), and [Figure 1-10](#) show the processor slot locations and numbering for the Cisco 7505, Cisco 7507, and Cisco 7513 routers.

Figure 1-8 Cisco 7505—Rear View

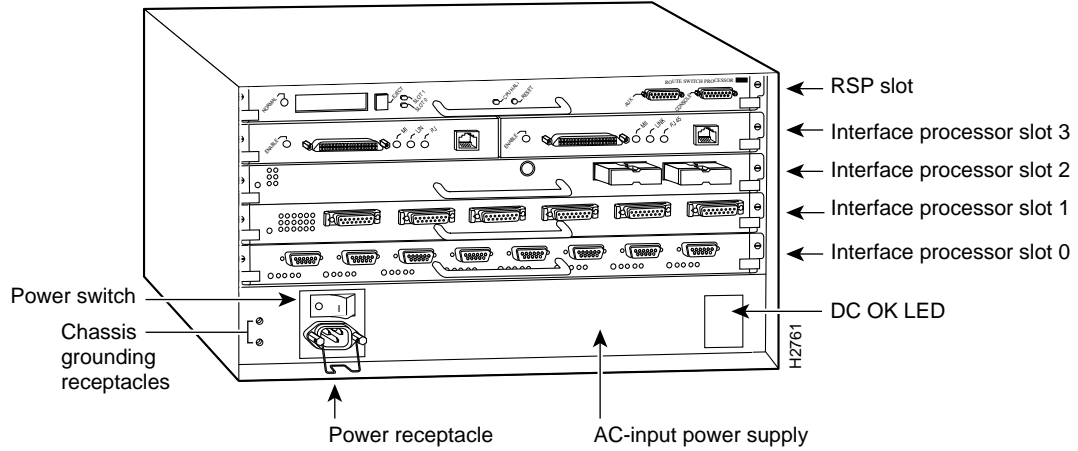


Figure 1-9 Cisco 7507—Rear View

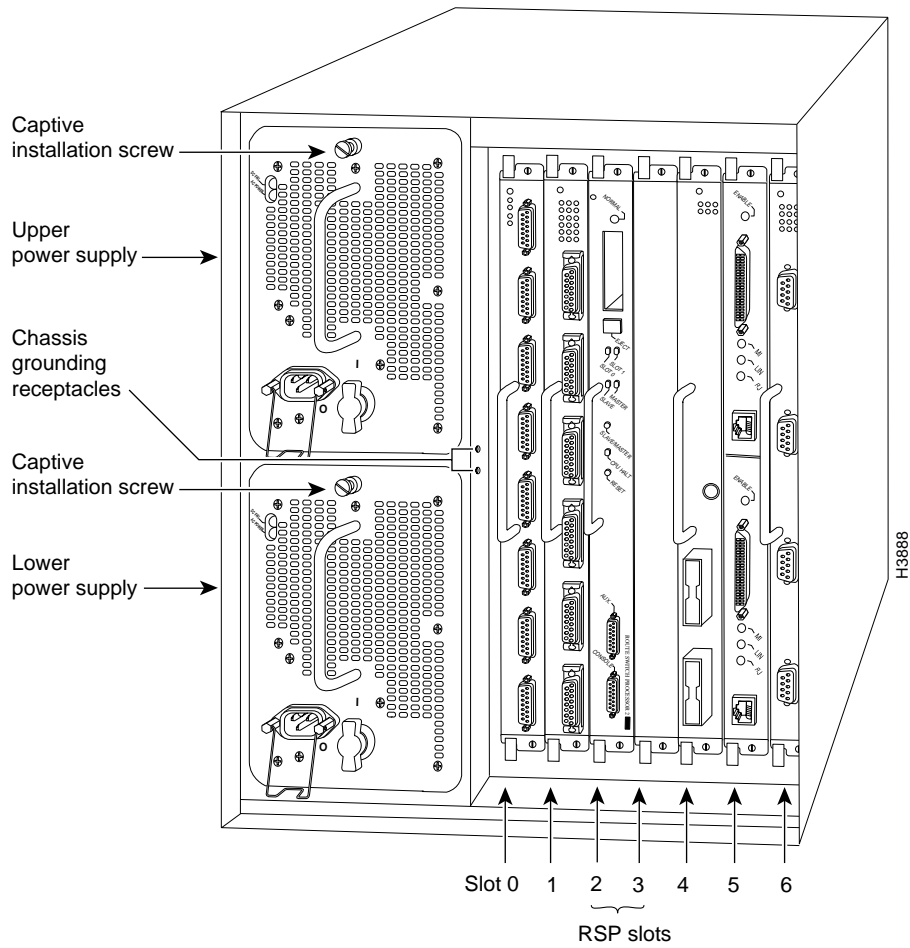
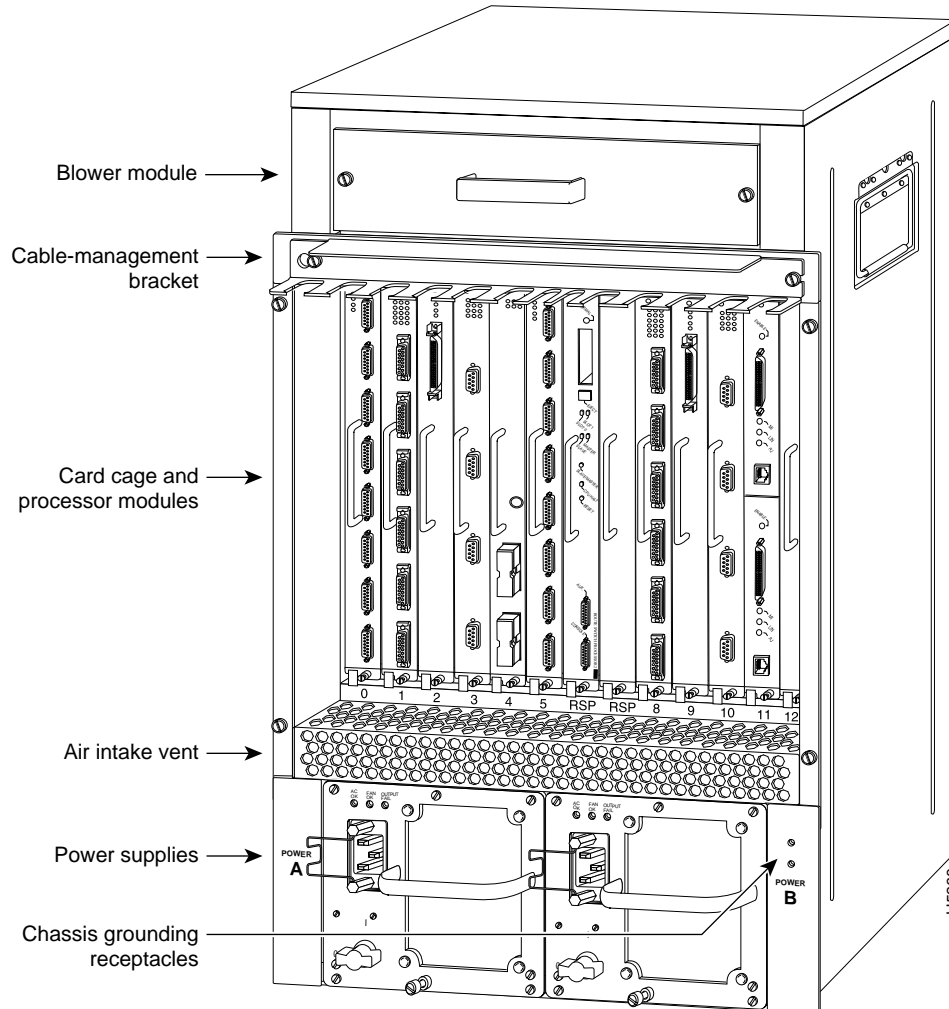


Figure 1-10 Cisco 7513—Rear View



Identifying Interface Addresses

This section describes how to identify the interface address for the GEIP+ in Cisco 7500 series routers. Interface addresses specify the actual physical location of each interface on a router or switch.

The interface address is composed of a three-part number in the format *interface-processor-slot number/port-adapter-slot-number/interface-port-number*. See [Table 1-6](#) for the interface address format. The GEIP+ is a dual-width interface processor with one interface; therefore, the port adapter slot number and the interface port number are always 0.

For a GEIP+ in interface processor slot 3 of a Cisco 7500 series router, the interface address of the GE interface is 3/0/0 (interface processor slot 3, port adapter slot 0, and interface 0). If you remove the GEIP+ from interface processor slot 3 and install it in interface processor slot 2, the interface address becomes 2/0/0.

**Note**

Although the processor slots in the 7-slot Cisco 7507 and 13-slot Cisco 7513 and Cisco 7576 are vertically oriented and those in the 5-slot Cisco 7505 are horizontally oriented, all Cisco 7500 series routers use the same method for slot and port numbering.

Table 1-6 explains how to identify interface addresses.

Table 1-6 *Identifying Interface Addresses*

| Platform | Interface | Numbers | Syntax |
|------------------------------------|--|---|--------|
| GEIP+ in Cisco 7500 series routers | Interface-processor-slot-number/ port-adapter-slot-number/ interface-port-number | Interface processor slot–0 through 12 (depends on the number of slots in the router) Port adapter slot–always 0 Interface port–always 0 | 3/0/0 |