Doc. No. 78-1000-16

Installing Network Processor Modules in the Cisco 4000 Series

Cisco Product Numbers:

NP-1E=	**NP-1F-D-SS=**	**NP-4B=**
NP-2E=	**NP-1A-SM=**	**NP-4GB=**
NP-6E=	**NP-1A-MM=**	**NP-4GU=**
NP-1RV2=	**NP-1A-DS3=**	**NP-8B=**
NP-2R=	**NP-1A-E3=**	**NP-CT1=**
NP-1F-D-MM=	**NP-2T=**	**NP-CE1B=**
NP-1F-S-M=	**NP-4T=**	**NP-CE1U=**

This document contains instructions for installing and configuring network processor modules in the Cisco 4000 series routers: the original Cisco 4000, the memory-enhanced Cisco 4000-M, the Cisco 4500, the memory-enhanced Cisco 4500-M, the Cisco 4700, and the memory-enhanced Cisco 4700-M.

This document includes the following sections, which contain step-by-step procedures for installing or replacing and configuring your new network processor modules:

Note All Cisco technical documentation and selected marketing materials are available on the Cisco Connection Documentation, Enterprise Series CD, Cisco's online library of product information. Enterprise Series CD is updated and shipped monthly, and may be more current than the printed documentation. It is available both as a single CD and as an annual subscription. To order the Enterprise Series CD, contact your local sales representative or Customer Service.

Warning Before working on a chassis or working near power supplies, unplug the power cord on AC units; disconnect the power at the circuit breaker on DC units.

Note Warnings appear throughout this document whenever a procedure or action involves danger to the user. Warnings signal that bodily injury is possible, and alert you to the hazards of working with electrical circuitry. Translations of all safety warnings appear in the appendix "Translated Safety Warnings" in the *Cisco 4000 Series Installation Guide*.

Caution To avoid damaging ESD-sensitive components, ensure that you have discharged all static electricity from your body before opening the chassis. Before performing procedures described in this document, review the sections "Safety Recommendations" and "Safety with Electricity" on page 5, and "Tools and Equipment Required"on page 6.

Note Cautions appear throughout this document, and are intended to prevent equipment damage and data loss.

Warning Before opening the chassis, disconnect the telephone-network cables to avoid contact with telephone-network voltages.

Warning Do not work on the system or connect or disconnect cables during lightning activity.

Warning The ports labeled “Ethernet,” “10BaseT,” “Token Ring,” “Console,” and “AUX” are safety extra-low voltage (SELV) circuits. SELV circuits should only be connected to other SELV circuits. Because the BRI circuits are treated like telephone-network voltage, avoid connecting the SELV circuit to the telephone network voltage (TNV) circuits. \Full ISDN Safety and Compliance Conditions are found in the publication “Cisco 4000 Series Public Network Certification.”

Warning Read the installation instructions before you connect the system to its power source.

Network Interface Module Options

Available network processor module interface options are listed in Table 1.

Table 1 Network Processor Module Interface Options

Interface Options	Available Ports Per Module
Ethernet	Single port, dual port, or six port
Synchronous serial	Dual port[1] or four port
Token Ring	Dual port or single port
Multimode FDDI[2]	Single attachment or dual attachment
Single-mode FDDI	Dual attachment
BRI[3]	Four port or eight port
G.703	Four port (balanced or unbalanced)[4]
Channelized CT1/ISDN[5] PRI[6]	Single channelized CT1/PRI port
Channelized E1/ISDN PRI	Single channelized E1/PRI port
ATM[7] OC3	Single ATM port [8]
ATM DS-3	Single ATM DS-3 port
ATM E3	Single ATM E3 port

1. Serial interfaces include EIA/TIA-232, EIA/TIA-449, V.35, X.21, NRZ/NRZI, DTE/DCE; EIA-530 DTE, and G.703.
2. FDDI = Fiber Distributed Data Interface
3. BRI = Basic Rate Interface (ISDN BRI S/T RJ-45).
4. For G.703//G.704 connections, balanced or unbalanced ports must be matched with the corresponding balanced or unbalanced cable.
5. ISDN = Integrated Services Digital Network
6. PRI = Primary Rate Interface
7. ATM = Asynchronous Transfer Mode.
8. STS-3C/STM-1 at 155 MHz (single-mode and multimode).

System Prerequisites

The Cisco 4000 series can support up to three network processor modules at a time, including Ethernet, Token Ring, ATM, ISDN BRI, ISDN PRI, serial, and multimode and single-mode FDDI interfaces. You can place network processor modules in any of the three available positions in any combination.

The different models in the Cisco 4000 series routers support different combinations of network processor modules. The following list addresses router-module and module-module compatibility issues, and slot placement considerations:

- The original Cisco 4000 and Cisco 4000-M can support only one FDDI module in combination with any two other types of network processor modules (except ATM). Additionally, the 4000 and 4000-M do not accommodate the six-port Ethernet or ATM modules.
- The Cisco 4500, Cisco 4500-M, and Cisco 4700 and Cisco 4700-M support all network processor modules except the single-port Ethernet network processor module and the early versions of the single and dual Token Ring, dual Ethernet, and FDDI modules.
- Each of these models will support two FDDI modules, a single ATM interface, and up to three six-port Ethernet modules.
- The BRI four-port and eight-port modules, when configured for ISDN PRI, are incompatible with the CT1/ISDN PRI or E1/ISDN PRI modules.
- If an FDDI module is present, install it in the center slot position for optimum heat dissipation.

Note Attempting to install an unsupported module in the systems mentioned will result in the display of an error message on an attached console terminal and in the error message log.

Memory Requirements

To successfully operate a multimode FDDI module, or six or more ports, the system must contain at least 4 MB of shared memory—standard on the Cisco 4000-M, Cisco 4500, Cisco 4500-M, Cisco 4700, and Cisco 4700-M. (The standard shared-memory configuration for the original Cisco 4000 was 1 MB.)

To successfully operate Cisco IOS Release 11.0 or 11.1, 16 MB of main memory are required. A Cisco 4500 running IPX requires 16 MB of main memory DRAM.

To successfully operate an ISDN BRI, ATM, channelized T1/ISDN PRI, or channelized E1/ISDN PRI module, the system requires at least 8 MB of main memory DRAM (16 MB in the original Cisco 4000) and 4 MB of shared memory.

To install new boot ROMs in a Cisco 4000 or Cisco 4000-M, refer to the section “Replacing Boot ROMs.”

Note The Cisco 4500, Cisco 4500-M, Cisco 4700, and Cisco 4700-M have no boot ROMs. The boot helper image is stored in boot Flash memory.

Software Compatibility

Network processor modules must be supported by the appropriate level of system software. The minimum system software version for the original Cisco 4000 is Software Release 9.1; for the Cisco 4000-M, Software Release 9.14. For the Cisco 4500, Cisco 4500-M, and Cisco 4700 and 4700-M, the minimum software version is Cisco Internetwork Operating System (Cisco IOS) Release 10.2.

Table 2 lists the minimum system software versions for network processor modules.

Table 2 Minimum Software Release Version

Network Processor Module Type	Minimum Software Release Version
Multimode FDDI	Software Release 9.14(1)
Dual Ethernet	Software Release 9.14(2)
Six-port Ethernet	Cisco IOS Software Release 10.3(6)
Single-mode FDDI	Software Release 9.14(3)
Dual and Version 2 Token Ring	Software Release 9.14(5)
Four-port serial	Software Release 9.14(6)
ISDN BRI	Cisco IOS Software Release 10.2
G.703	Cisco IOS Software Release 10.2(7)
Channelized CT1/ISDN PRI	Cisco IOS Software Release 10.3(4)
Channelized E1/ISDN PRI	Cisco IOS Software Release 10.3(4)
ATM	Cisco IOS Software Release 10.3(4)

Note Neither the Cisco 4000 nor the Cisco 4500 can be ordered any longer, but each supports several different software releases. The Cisco 4000 supports Software Releases 9.1 and 9.14, and CIsco IOS Releases 10.0, 10.2, and 10.3. The Cisco 4500 supports Cisco IOS Releases 10.1, 10.2, and 10.3.

Safety Recommendations

Follow these guidelines to ensure general safety:

- Keep the chassis area clear and dust-free during and after installation.
- Put the removed chassis cover in a safe place.
- Keep tools away from walk areas where they may become dangerous obstructions.
- Do not wear loose clothing that may get caught in the chassis. Fasten ties and scarfs and roll up your sleeves.
- Wear safety glasses when working under any conditions that might be hazardous to your eyes.
- Do not perform any action that creates a potential hazard to people or makes the equipment unsafe.

Safety with Electricity

Warning Before working on equipment that is connected to power lines, remove jewelry (including rings, necklaces, and watches). Metal objects will heat up when connected to power and ground and can cause serious burns or can weld to the terminals.

Follow these guidelines when working on equipment powered by electricity:

- Locate the emergency power-off switch in the room in which you are working. If an electrical accident should occur you can quickly shut the power off.
- Before working on the system, turn off the power and unplug the power cord.
- Disconnect all power before doing the following:
  - — Installing or removing a router chassis
  - — Working near power supplies
  - — Performing a software upgrade
- Always disconnect module cables before opening the router chassis.
- Do not work alone if potentially hazardous conditions exist.
- Never assume that power is disconnected from a circuit. Always check.
- Look carefully for possible hazards in your work area, such as moist floors, ungrounded power extension cables, and missing safety grounds.
- If an electrical accident occurs, proceed as follows:
  - — Use caution; do not become a victim yourself.
  - — Turn off power to the system.
  - — If possible, send another person to get medical aid. Otherwise, determine the condition of the victim and then call for help.
  - — Determine if the person needs rescue breathing or external cardiac compressions; then take appropriate action.

Preventing Electrostatic Discharge Damage

Electrostatic discharge (ESD) can damage equipment and impair electrical circuitry, causing intermittent or total failures. It occurs when electronic printed circuit cards are improperly handled.

Always follow ESD prevention procedures when removing and replacing cards. Observe the following guidelines:

- Ensure that the router chassis is electrically connected to earth ground.
- Wear an ESD-preventive wrist strap, ensuring that it makes good skin contact. The wrist strap and cord must operate effectively to guard against ESD damage and shocks. If no wrist strap is available, ground yourself by touching the metal part of the chassis.
- Connect the clip to an unpainted surface of the chassis frame to safely channel unwanted ESD voltages to ground.

Caution For safety, periodically check the resistance value of the antistatic strap, which should be between 1 and 10 megohms (Mohms).

Tools and Equipment Required

You need the following tools and equipment for removing and installing Cisco 4000 series network processor modules.

- An ESD cord and wrist strap
- Screwdrivers, Number 1 and Number 2 Phillips
- One serial cable for each serial port to connect the port to the remote device or network

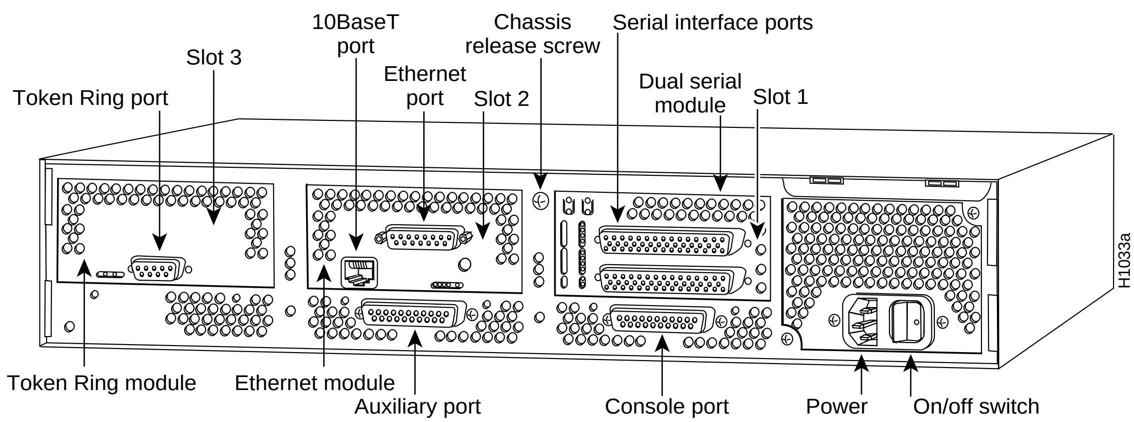
The following additional external equipment may be required, depending upon the specific module to be removed or installed:

- A data service unit (DSU) to connect each serial port to an external network
- A CT1 channel service unit/data service unit (CSU/DSU), which converts the High-Level Data Link Control (HDLC) synchronous serial data stream into a CT1 data stream with the correct framing and ones density. (The term *ones density* refers to a minimum requirement of “1” bits in the data stream.) Several CT1 CSU/DSU devices are available, and most provide either a V.35, EIA/TIA-449, or EIA-530 electrical interface.
- A CSU to connect the CT1/PRI module to a CT1 line U. A DSU is not needed because the CT1 module converts the signal to a CT1 data stream.
- An Ethernet transceiver
- A Token Ring media attachment unit (MAU)
- An Optical bypass switch or concentrator for multimode FDDI connections
- NT1 (Network Termination 1) for BRI connections in North America
- Before installing a network processor module with E1-G.703/G.704 interfaces, be sure that you have one of the following adapter cables:
  - 75-ohm, unbalanced adapter cable (CAB-E1-BNC-3M) or
  - 120-ohm, balanced adapter cable (CAB-E1-TWINAX-3M)

Preparing to Make Connections

The power cable and power switch are on the lower right side of the rear panel of the router. The system console port, auxiliary port, and network processor module ports are located to the left of the power cable and switch. (See Figure 1.)

Figure 1 Cisco 4000 Series—Rear View Showing Slot Numbering and Interface Ports

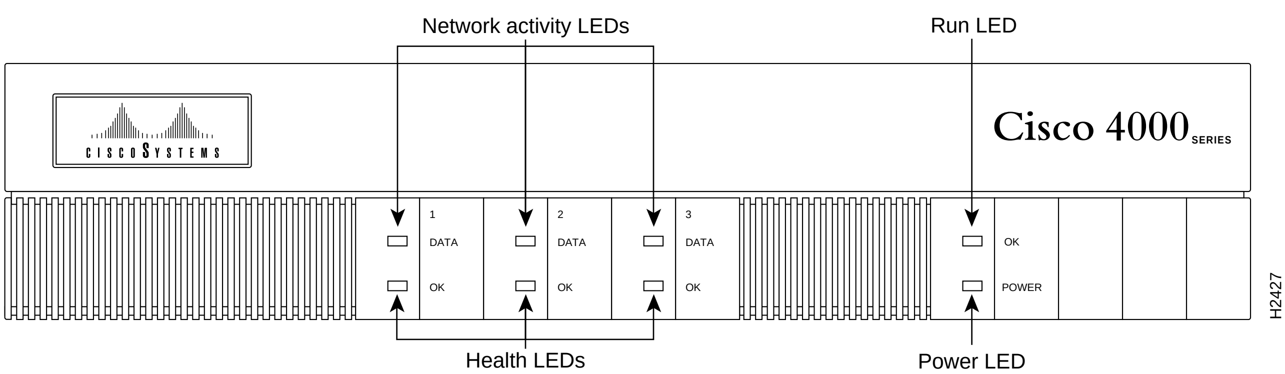


Slot Numbering

The chassis contains slots for three network processor modules. Numbers for each are printed on the front panel of the chassis. (See Figure 2.) Slot numbers reflect the order in which the system scans the network processor modules.

The location of network processor modules is not slot dependent; you can move a module to any available slot. However, the air flow cooling for specific modules such as the FDDI module is enhanced when the module is installed in a specific slot. The center slot is the preferred location for air flow maximization.

Figure 2 Cisco 4000 Series—Front View



Unit Numbering

Unit numbering on the chassis rear panel allows the system to differentiate between two interfaces of the same type. The system assigns unit number addresses to these network processor modules by starting with zero for each module interface type and numbering from right to left and from bottom to top. The lowest unit number for an interface type is the module closest to the power supply. (See Figure 3.)

For example, the unit number addresses for the modules in Figure 1 are as listed in Table 3. However, if the Token Ring module were replaced by a second Ethernet module, the unit addresses would be as listed in Table 4.

Table 3 Unit Number Addresses for Dual-Port Serial, Ethernet, and Token Ring Modules

Slot	Interface Type	Address
1	Serial port (top)	1
	Serial port (bottom)	0
2	Ethernet	0
3	Token Ring	0

Table 4 Unit Number Addresses for Dual-Port Serial and Two Ethernet Modules

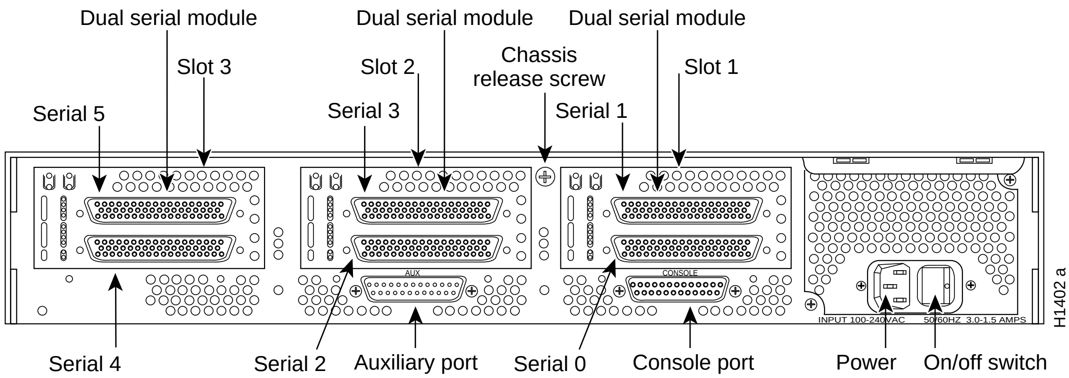
Slot	Interface Type	Address
1	Serial port (top)	1
	Serial port (bottom)	0
2	Ethernet	0
3	Ethernet	1

Figure 3 shows a chassis configured with three dual-port serial modules. The unit numbering of these modules is listed in Table 5.

Table 5 Unit Number Addresses for Three Dual-Port Serial Modules

Slot	Interface Type	Address
1	Serial port (top)	1
	Serial port (bottom)	0
2	Serial port (top)	3
	Serial port (bottom)	2
3	Serial port (top)	5
	Serial port (bottom)	4

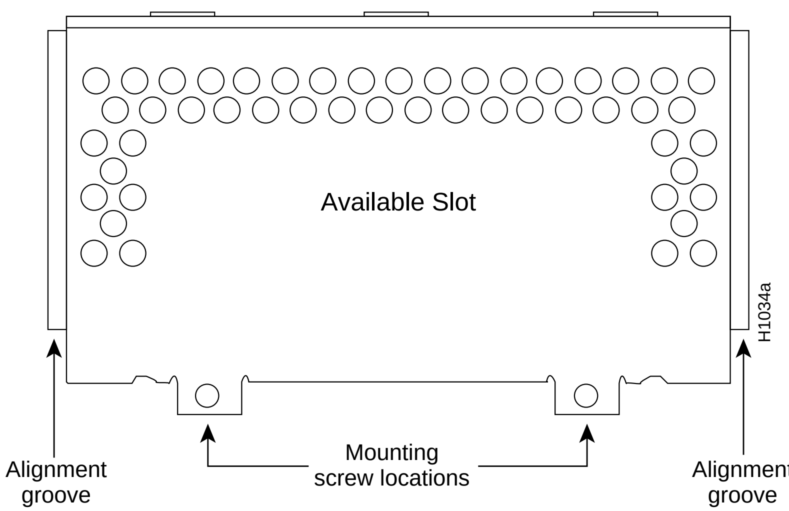
Figure 3 Cisco 4000 Series Router—Rear View Showing Serial Port Unit Numbering



Use of the Slot Filler Panel

If the router is configured with fewer than three network processor modules, you must place a slot filler panel in the open slot to ensure proper airflow. (See Figure 4.)

Figure 4 Slot Filler Panel



Accessing the Network Processor Modules

To access the network processor modules, you must remove the component tray.

Warning Do not touch the power supply when the power cord is connected. In systems with a power switch, line voltages are present within the power supply even when the cord is connected and the switch is off. For systems without a power switch, line voltages are present within the power supply when the power cord is connected.

Removing the Component Tray

Some Cisco 4000 series routers have a safety latch tab on the chassis that affects the removal of the component tray. (See Figure 5 and Figure 6.)

If you have a chassis with a safety latch tab, follow the procedure in the section "Removing the Component Tray from a Chassis with a Safety Latch."

If you have a chassis without a safety latch tab, follow the procedure in the section "Removing the Component Tray from a Chassis without a Safety Latch."

Removing the Component Tray from a Chassis with a Safety Latch

Take the following steps to remove the component tray from a chassis with a safety latch:

Step 1 Turn OFF the system power.

Step 2 Attach your ESD-preventive wrist strap.

Step 3 Remove all network and power cables.

Step 4 Loosen the nonremovable chassis release screw on the rear panel of the chassis. (See Figure 5.)

Step 5 Slide the component tray out of the chassis shell while facing the rear panel, pulling the handle on the far right side of the chassis until the safety latch catches. (See Figure 5.)

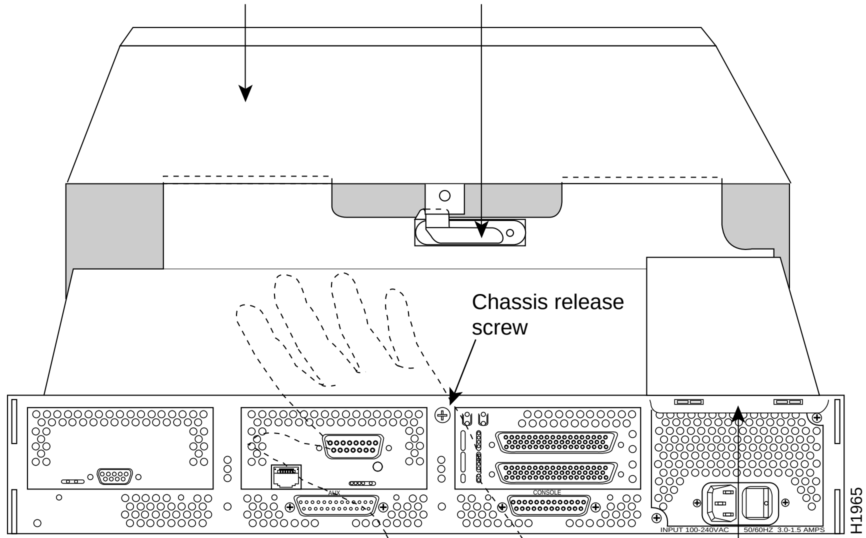
Warning Before releasing the safety latch, support the component tray from underneath, either on your work surface or with your hands, to prevent personal injury. (See Figure 5.)

Step 6 Support the component tray with one hand, and push down on the safety latch tab while completely pulling out the component tray.

Step 7 Set the component tray on your work surface.

Proceed with "Removing Network Processor Modules" on page 12.

Figure 5 Component Tray Removal for Chassis with a Safety Latch



Removing the Component Tray from a Chassis without a Safety Latch

Take the following steps to remove the component tray from a chassis without a safety latch:

Step 1 Turn OFF the system power.

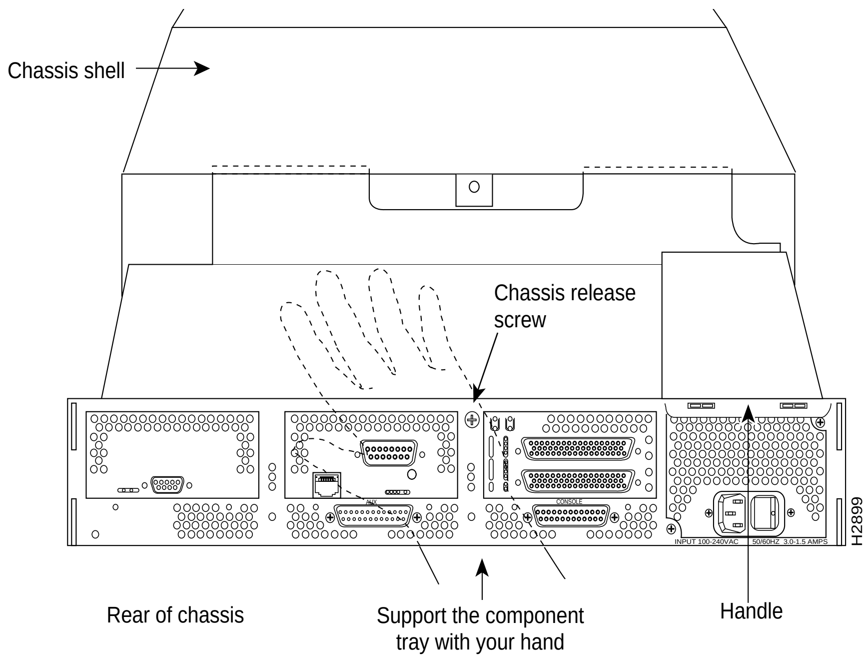
Step 2 Attach your ESD-preventive wrist strap.

Step 3 Remove all network and power cables.

Step 4 Loosen the nonremovable chassis release screw on the rear panel of the chassis. (See Figure 6.)

Warning Support the component tray from underneath to prevent it from falling. (See the hand in Figure 6.)

Figure 6 Component Tray Removal for Chassis without a Safety Latch



Step 5 While facing the rear panel, pull the handle on the right side of the router while you support the component tray with one hand. Slide the component tray out of the chassis shell.

Step 6 Set the component tray on your work surface.

Removing Network Processor Modules

After you have removed the component tray from the chassis, you can remove the network processor modules from the chassis.

Caution Some network processor modules are secured to the rear of the chassis with two external screws. These screws must be removed before the module can be safely lifted out of the chassis.

Take the following steps to remove a network processor module:

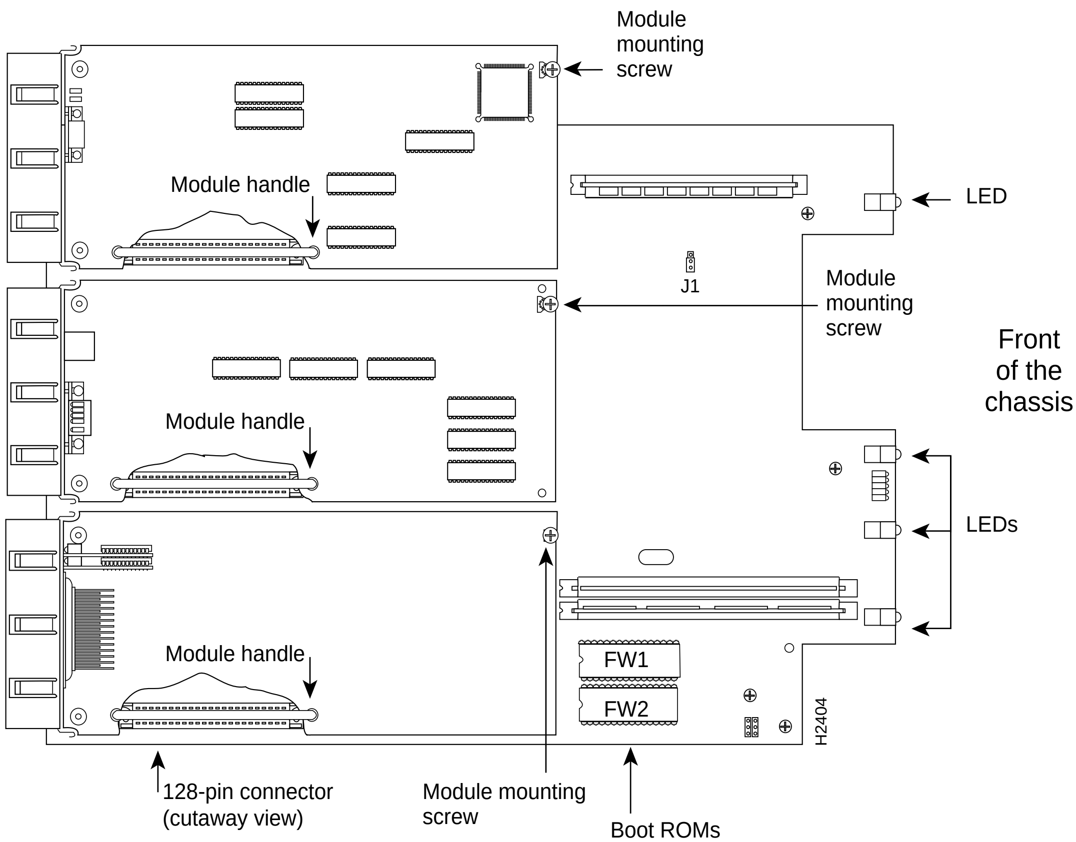
Step 1 Orient the component tray as shown in Figure 7, then remove the module mounting screw and the two external rear mounting screws, if these are present. Remove the rear mounting screws and set them aside.

Step 2 Grasp the network processor module handle and pull straight up to lift the module out its connector (See Figure 8).

Step 3 Place the module on an ESD mat.

Caution Do not wiggle the handle of the network processor module or exert any side-to-side pressure because the handle might work loose and damage the network processor module.

Figure 7 Cisco 4000-M Component Tray—Typical of Cisco 4000 Series



Caution If any of the network processor modules have daughter cards projecting at right angles to the module (see Figure 9), be careful not to bend the module and disconnect the daughter cards. Reseat any disconnected card carefully, handling the edges without touching module components.

Note For network connection pinout information, refer to the *Cisco 4000 Series Installation Guide* on the Cisco Connection Documentation, Enterprise Series CD-ROM or the printed publication. The CD is updated and shipped monthly, and is available both as a single CD and as an annual subscription. Contact your local sales representative or call Customer Service to order.

Figure 8 Network Processor Module Components

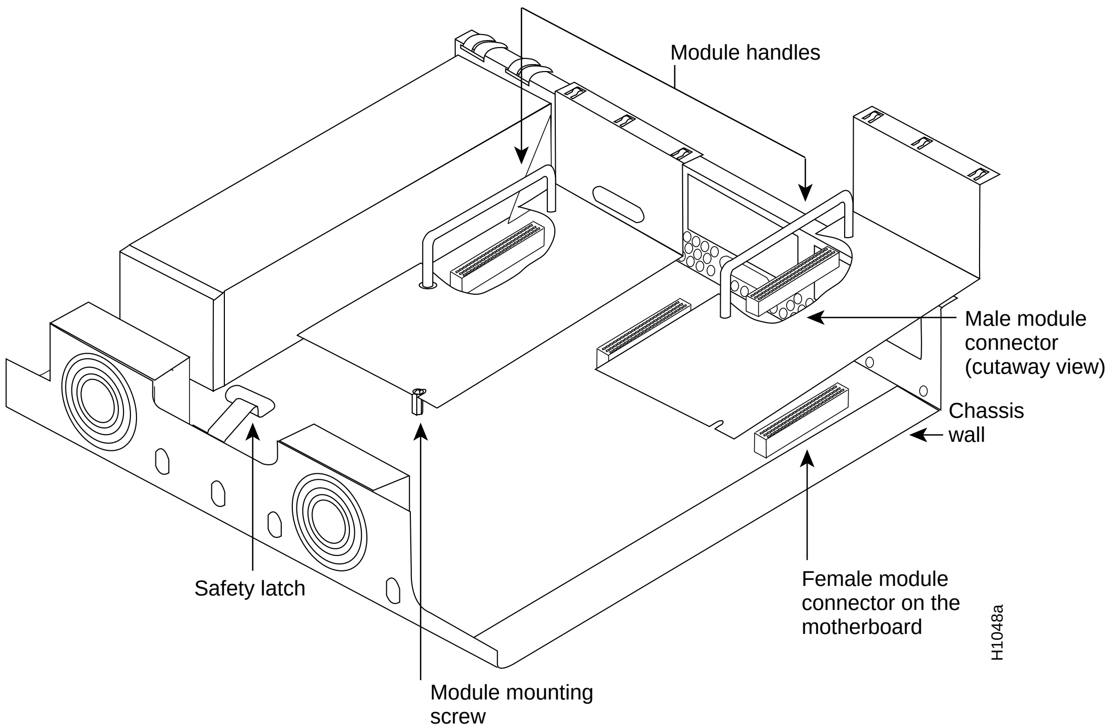
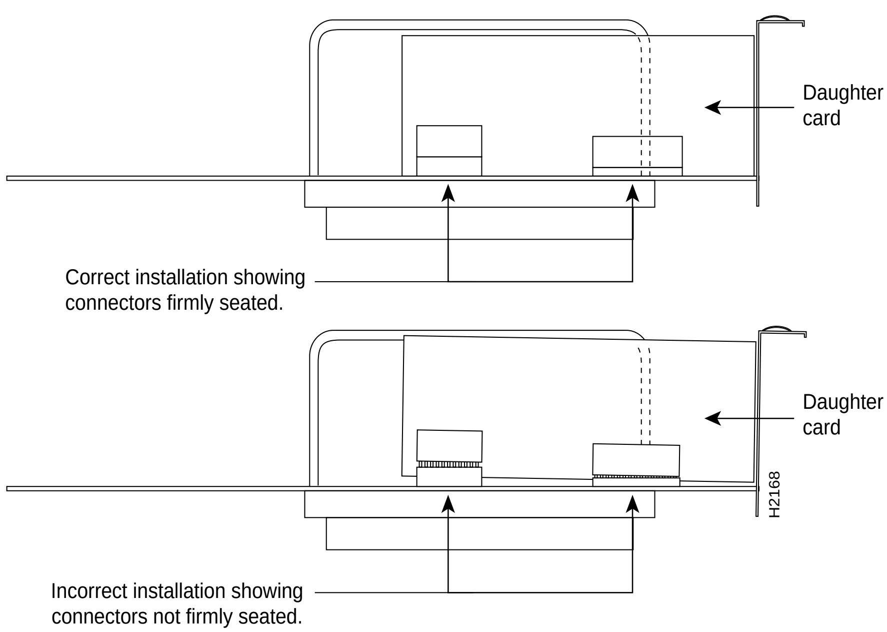


Figure 9 Network Processor Module Daughter Card Installation



Reading Front Panel LEDs

Figure 2 shows the Cisco 4000 series chassis front view, including network activity, health indicators, and run and power LEDs.

When you face the front of the chassis, the three LEDs (labeled OK) on the lower left correspond to the network processor modules present. (See Figure 2.) If a slot is empty, the corresponding LED will be off.

When on, these LEDs indicate that the modules are operational. The LEDs and their functions are as follows:

- The upper LEDs (labeled DATA) blink to reflect network activity on the respective interfaces.
- The LED labeled POWER goes on to indicate that the system power is on.
- The LED labeled OK is activated to indicate that the system processor is working.

Note The network processor module LEDs are visible through the cutouts in the rear of the chassis.

Ethernet Network Processor Modules

Three network processor modules provide Ethernet interfaces. The single-port and dual-port network processor modules provide one and two Ethernet interfaces, respectively. Both an attachment unit interface (AUI) and 10BaseT ports are provided for each interface.

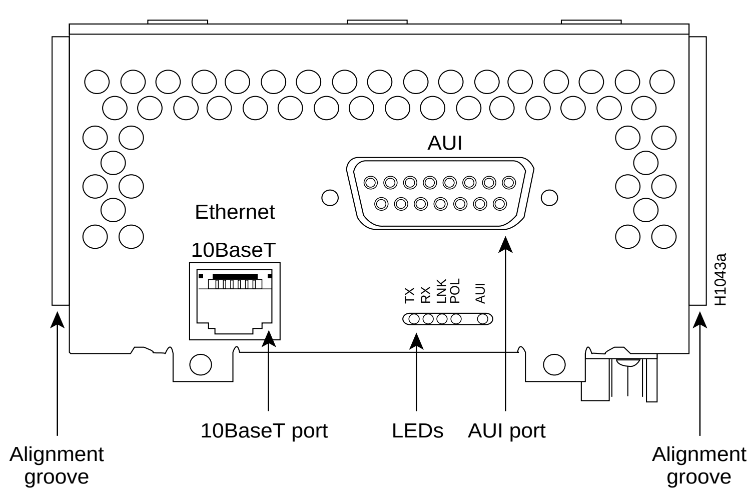
The six-port Ethernet network processor module provides six 10BaseT ports, but does not support Ethernet AUI connections.

Single-Port Ethernet Module

The single-port Ethernet module has an Ethernet AUI connector and a 10BaseT connector. (See Figure 10.) Only one connector on the module can be used at a time. Use either an IEEE 802.3 AUI or a 10BaseT cable to make the connection.

To select either 10BaseT or AUI, see the section "Selecting the Media Type" on page 19.

Figure 10 Single-Port Ethernet Network Processor Module

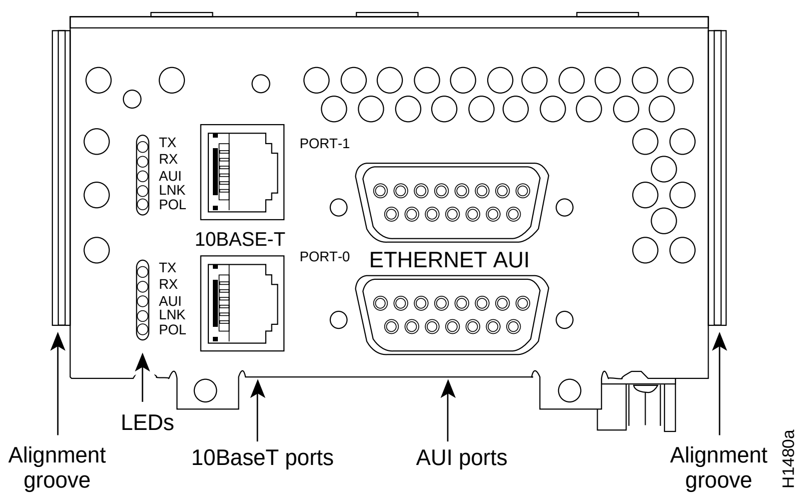


Dual-Port Ethernet Module

The dual-port Ethernet network processor module has ports for two network connections. (See Figure 11.) You can use either the AUI connector or the 10BaseT connector, but not both. For example, Ethernet port 0 can be attached to either a 10BaseT connector or to an AUI connector. At the same time, Ethernet port 1 can also be attached to a 10BaseT connector or an AUI connector.

To select the 10BaseT or AUI connection, see the section “Selecting the Media Type” on page 19.

Figure 11 Dual-Port Ethernet Network Processor Module

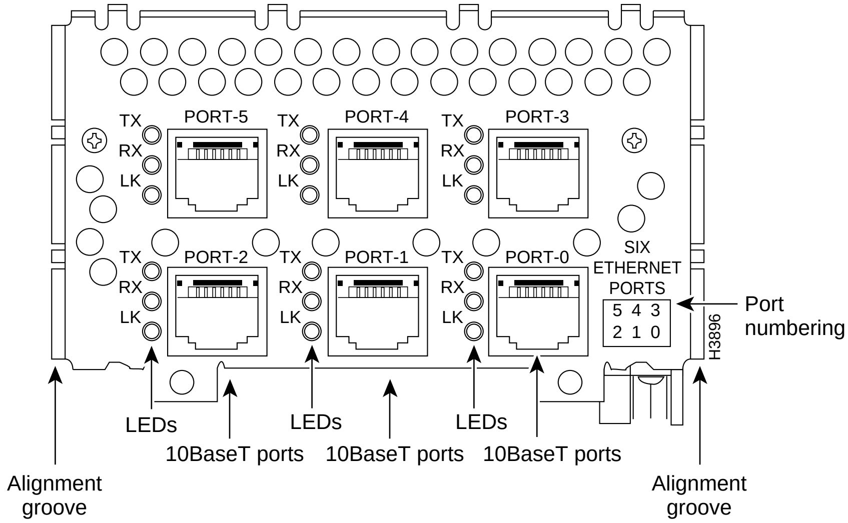


Six-Port Ethernet Module

The six-port Ethernet module has ports for six network connections. (See Figure 12.) The port numbering is as shown on the label on the lower right of the module. Only 10BaseT connections are supported on the six-port module.

Note The six-port Ethernet module is supported on all Cisco 4000 series routers except the Cisco 4000 and Cisco 4000-M.

Figure 12 Six-Port Ethernet Network Processor Module



Making Ethernet Connections

On single-port Ethernet modules, connect either the Ethernet AUI or the 10BaseT connector. (See Figure 13.)

On dual-port Ethernet modules, connect *either* the Ethernet AUI connector or the 10BaseT connector on a given Ethernet port (see Figure 14.)

The six-port Ethernet module can support connections on any combination of its six ports.

Figure 13 Unsupported and Supported Single-Port Ethernet Module Connections

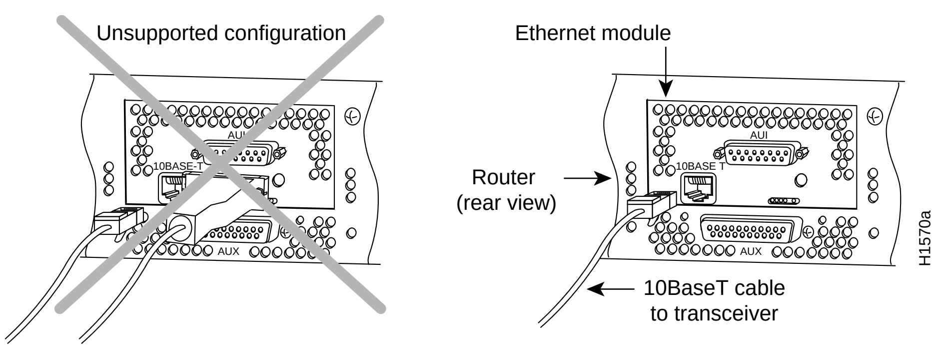
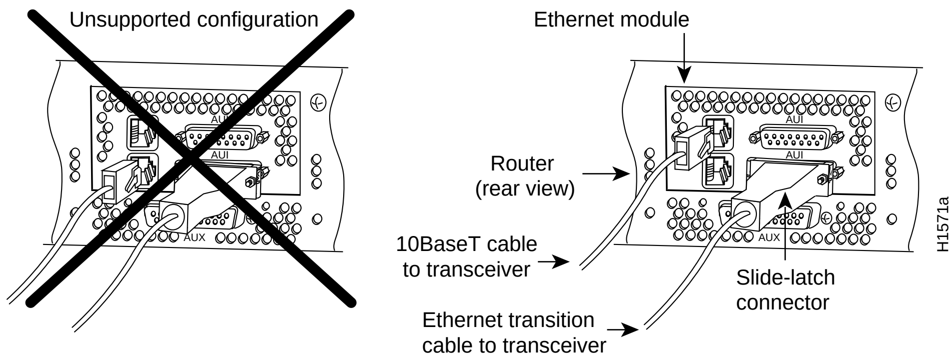


Figure 14 Unsupported and Supported Dual-Port Ethernet Module Network Connections



Selecting the Media Type

For the single-port and dual-port Ethernet modules, enter the **media** command in the router's configuration file to select AUI or 10BaseT on the desired interface. The syntax of the **media** command is as follows:

media-type aui

media-type 10baset

The following is an example of configuring the Ethernet 0 interface for a media type AUI connection:

```
router> ena
Password:
router# configure terminal
Enter configuration commands, one per line.
Edit with DELETE, CTRL/W, and CTRL/U; end with CTRL/Z
interface ethernet 0
media-type aui
^z
router# write memory
```

Note If you are using Cisco IOS Release 11.0 Release or earlier, see the *Router Products Command Reference* for detailed information on the **media** command. If you are using Cisco IOS Release 11.1 or later, refer to the *Configuration Fundamentals Command Reference*.

Making Ethernet AUI Connections

An Ethernet transceiver cable with thumbscrew connectors can be connected directly to the router port by replacing the slide-latch with a jackscrew (provided in a separate bag). Figure 15 shows a single-port Ethernet module with an Ethernet AUI connection to a transceiver.

Figure 15   Ethernet Network Processor Module AUI Port Connection

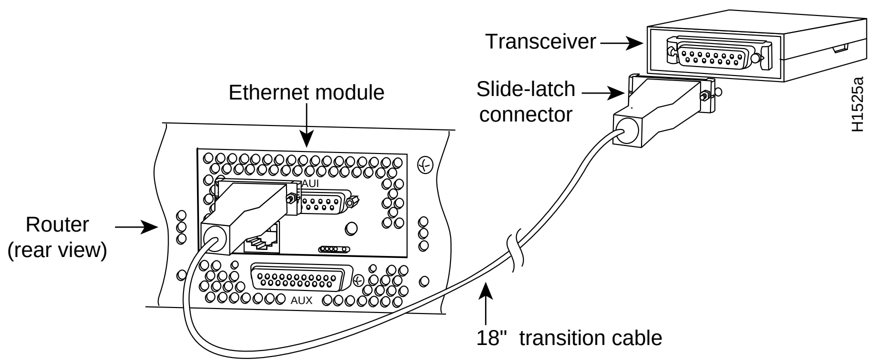
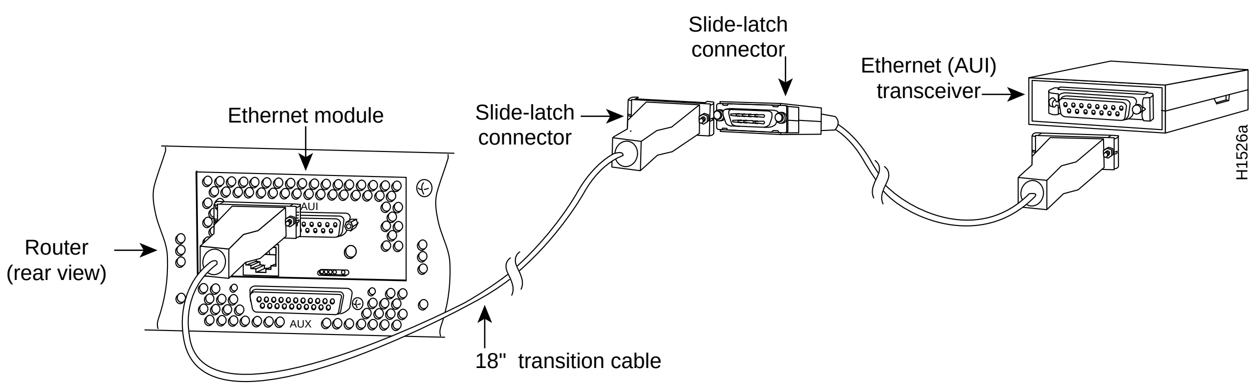


Figure 16 shows the transition cable used as a flexible extension of the Ethernet port, enabling an Ethernet transceiver cable with a slide-latch connector to mate with the female end of the 18-inch transition cable.

Figure 16   Extending the Transition Cable From the Ethernet Port



Take the following steps to make AUI connections:

Step 1 Connect the 15-pin D-type Ethernet port labeled AUI to the Ethernet AUI transition cable. (See Figure 13 and Figure 14.)

Step 2 Attach the slide-latch connector of the same cable to your transceiver or hub.

Step 3 Repeat Steps 1 and 2 to make AUI connections for the second port.

Step 4 Continue with the section “Replacing the Final Connections to the Router” on page 70.

Making 10BaseT Connections

A 10BaseT transition cable can directly connect the router to your network. (See Figure 17.)

Take the following steps to make your 10BaseT connections:

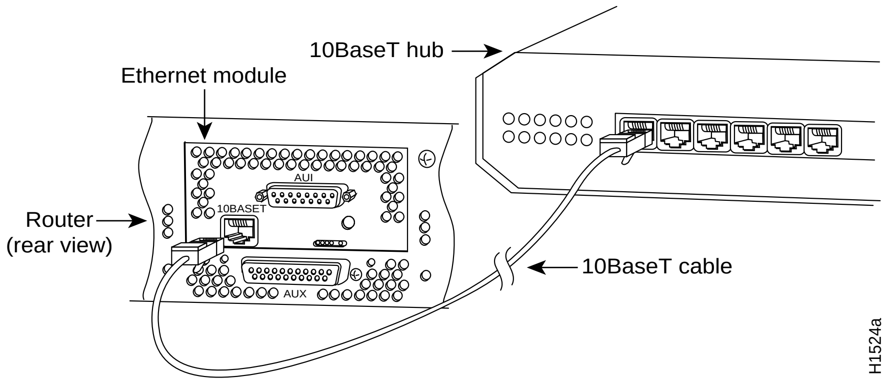
Step 1 Connect the 10BaseT port labeled 10BaseT to the 10BaseT cable. (See Figure 13 and Figure 14.)

Step 2 Attach the other end of the 10BaseT cable to your network.

Step 3 Repeat Steps 1 and 2 for the remaining ports.

Step 4 When all your network connections are complete, continue with the section "Replacing the Final Connections to the Router" on page 70.

Figure 17 Ethernet Network Processor Module 10BaseT Connection



Ethernet Network Processor Module LEDs

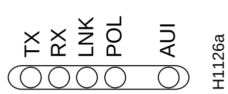
There are five LEDs for the Ethernet network processor module. The following definitions describe the function of the LED when on:

- TX (transmit)—Indicates that the system is sending Ethernet transmissions.
- RX (receive)—Means that the system is receiving data from the line.
- AUI—Indicates that the AUI connection is selected by the **media** command. See the section "Selecting the Media Type" on page 19.

  When AUI is selected, none of the remaining LEDs on the network processor module will be on. Additional LEDs are activated when the connected media type is 10BaseT .
- LNK or LK (link)—10BaseT is selected and the link is available.
- POL (polarity)—The autopolarity reading has detected defective polarity and has switched the polarity to correct the problem.

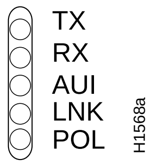
When viewed from the rear of the chassis, the LEDs on the single-port Ethernet module are labeled as shown in Figure 18:

Figure 18 Single-Port Ethernet Network Processor Module LEDs



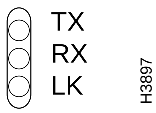
When viewed from the rear of the chassis, the LEDs on the dual-port Ethernet module are labeled as shown in Figure 19.

Figure 19 Dual-Port Ethernet Network Processor Module LEDs



When viewed from the rear of the chassis, the LEDs on the six-port Ethernet module are labeled as shown in Figure 20.

Figure 20 Six-Port Ethernet Network Processor Module LEDs



FDDI Network Processor Modules

FDDI module options are as follows:

- Multimode dual attachment
- Multimode single attachment
- Single-mode dual attachment

The multimode FDDI network processor module consists of two cards, each with a multimode transceiver, with one card fitting on top of the other. Each FDDI module provides its own combination of attachment stations. Multimode FDDI modules provide either a Dual Attachment Station (DAS) or a single attachment station (SAS), The bottom card is the SAS and contains the PHY-A port. If the DAS option is included, the PHY-B port is located on the module's top card.

The single-mode FDDI network processor modules also provide a DAS.

Distance Limitations for FDDI Connections

The single-mode transmitter and the multimode transceiver each provide 11 dB of optical power. If the distance between two connected stations is greater than the maximum distance shown, significant signal loss can result. Distance limitations for single-mode and multimode FDDI stations are listed in Table 6.

Table 6 FDDI Maximum Transmission Distances

Transceiver Type	Maximum Distance Between Stations
Single-mode	Up to 10 kilometers (6.2 miles)
Multimode	Up to 2 kilometers (1.25 miles)

FDDI Cable Connections

Older versions of the single-mode network processor module use simplex FC-type connectors (see Figure 21) for the transmit and receive ports. Newer versions of the single-mode network processor module use simplex SC-type connectors. (See Figure 22.) The connector accepts standard 8.7 to 10/125-micron single-mode fiber-optic cable. The single-mode interface supports connections at distances up to 6 miles (10 kilometers).

Figure 21 Older Version Single-Mode FDDI Network Interface Connector, FC Type

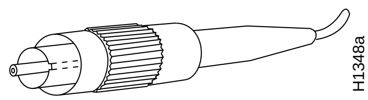
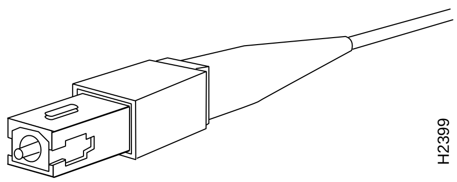


Figure 22 Newer Version Single-Mode FDDI Network Interface Connector, SC Type



Newer versions of the single-mode module are shipped with an FC-to-SC adapter that lets the module be used with cables installed for the earlier version of the module. (See Figure 23 and Figure 24.)

Figure 23 Single-Mode FDDI Network Interface FC-to-SC Adapter, FC End

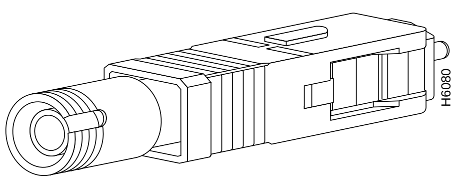
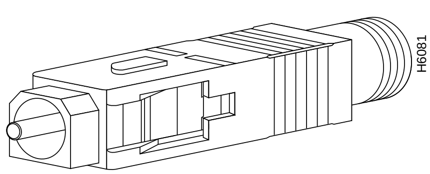


Figure 24 Single-Mode FDDI Network Interface FC-to-SC Adapter, SC End

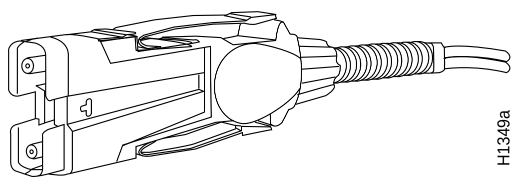


The single-mode transmitter uses a small laser to transmit the light signal to the ring. Keep the transmit port covered whenever a cable is not connected to it.

Warning Invisible laser radiation may be emitted from the aperture ports of the single-mode FDDI products when no fiber cable is connected. *Avoid exposure and do not stare into open apertures*. This product meets the Class 1 Laser Emission Requirement from the Center for Devices and Radiological Health (CDRH) FDDI.

The multimode network processor module connectors are FDDI-standard physical sublayer (PHY) connectors. The media interface connector (MIC) connects to FDDI standard 62.5/125-micron multimode fiber-optic cable. Figure 25 shows the MIC typically used for network and chassis connections in multimode FDDI applications.

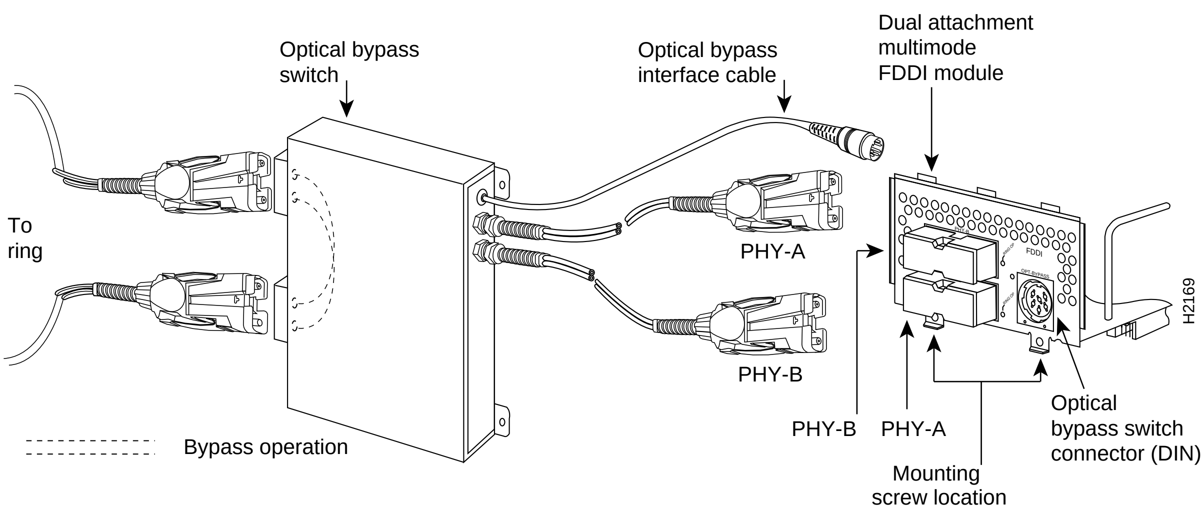
Figure 25 Multimode FDDI Network Interface Connector, MIC Type



A dual attachment module configuration requires two connections: one to the primary ring and one to the secondary ring. The PHY-A port is the bottom port and the PHY-B port is the top port on both the multimode and single-mode modules.

To connect to another DAS, connect PHY-A on the module to PHY-B on the DAS, and PHY-B on the module to PHY-A on the DAS. (See Figure 26.)

Figure 26 Dual Attachment FDDI Connections



The standard connection scheme for a DAS has the primary ring signal entering the router on the PHY-A receive port and returning to the primary ring from the PHY-B transmit port. The secondary ring signal enters the router on the PHY-B receive port and returns to the primary ring from the PHY-A transmit port. The single attachment module's PHY-S port can be connected through a concentrator to a single attachment ring, or directly to another device.

Caution Failure to observe these guidelines will prevent the FDDI interface from initializing correctly.

Optical Bypass Switch Connections

An optical bypass switch is a passive optical device powered by the FDDI module. If a fault in the router occurs or if power is lost, the bypass switch is automatically enabled and the ring is unaffected. The system software can also enable the switch if a problem is detected or if the router is taken out of the ring. Both FDDI multimode modules have an optical bypass switch connector.

Note The optical bypass switch is not included with the FDDI module and must be ordered separately.

To connect the FDDI module to an external optical bypass switch (not included), connect the interface cable from the optical bypass switch to the six-pin circular DIN connector on the FDDI module panel. (See Figure 26.)

Additional Required Parts and Tools

In addition to the parts and tools listed in the section "Tools and Equipment Required" on page 7, you need the following to install an FDDI module:

- External FDDI network interface cables, single-mode or multimode
- Optional optical bypass switch that can connect to the multimode modules

Caution FDDI modules are fastened to the rear of the chassis with two external screws. (See Figure 27, Figure 28, Figure 29, and Figure 30.) These screws must be removed before an FDDI module can be safely lifted out of the chassis.

Figure 27 Dual Attachment Multimode FDDI Network Processor Module—End View

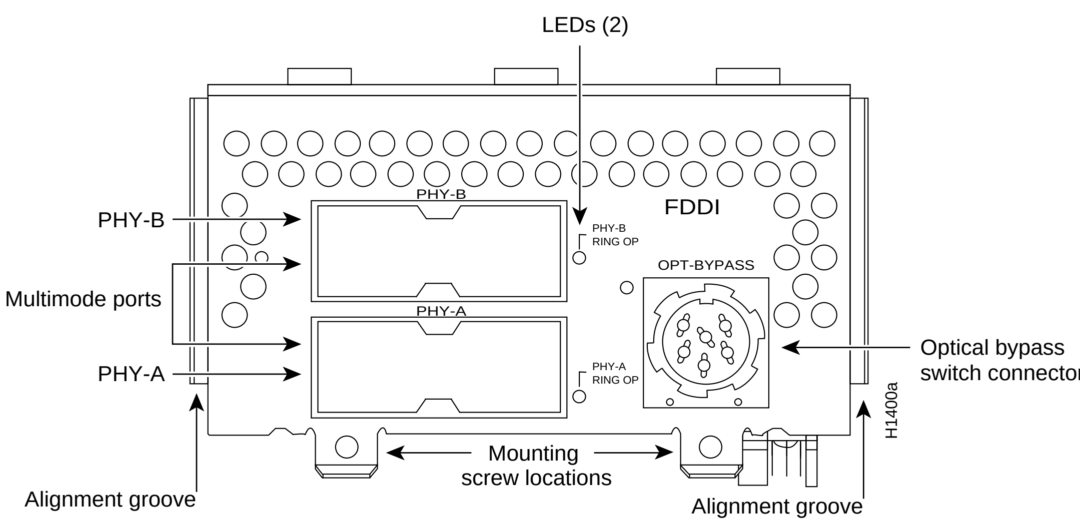


Figure 28 Single Attachment Multimode FDDI Network Processor Module—End View

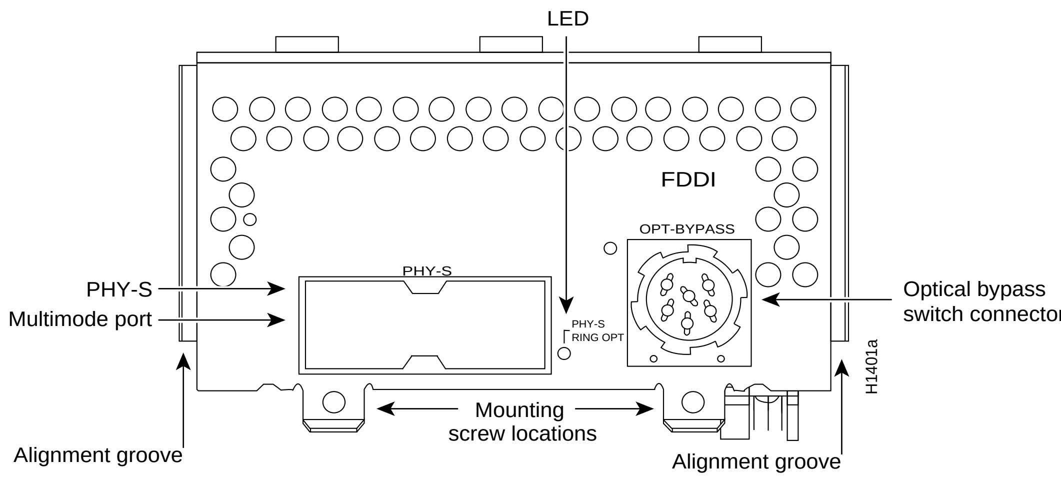


Figure 29 Dual Attachment Single-Mode FDDI Network Processor Module with FC-type Connectors—End View

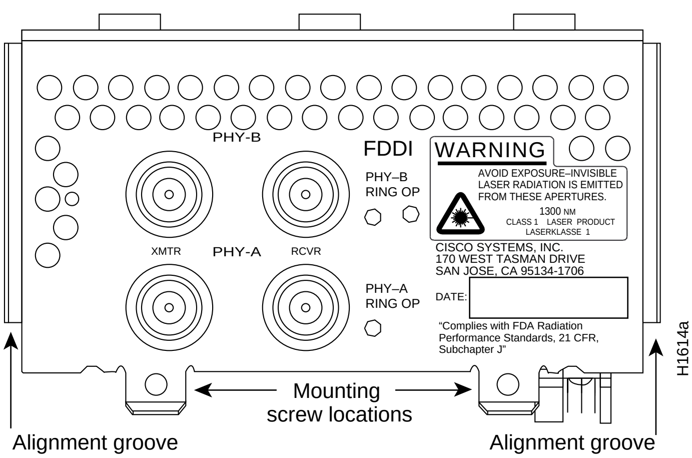
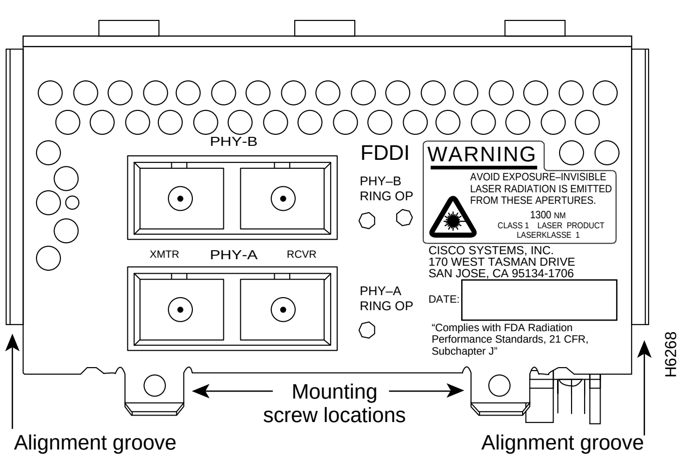


Figure 30 Dual Attachment Single-Mode FDDI Network Processor Module with SC-type Connectors—End View



Making Multimode FDDI Network Connections

Multimode uses one integrated transmit/receive cable for each physical interface (one for PHY-A and one for PHY-B). Accordingly, you need one multimode cable for a single attachment connection, and two cables for a dual attachment connection. Follow the procedures described in this section to make multimode FDDI connections.

Dual Attachment Multimode Connections

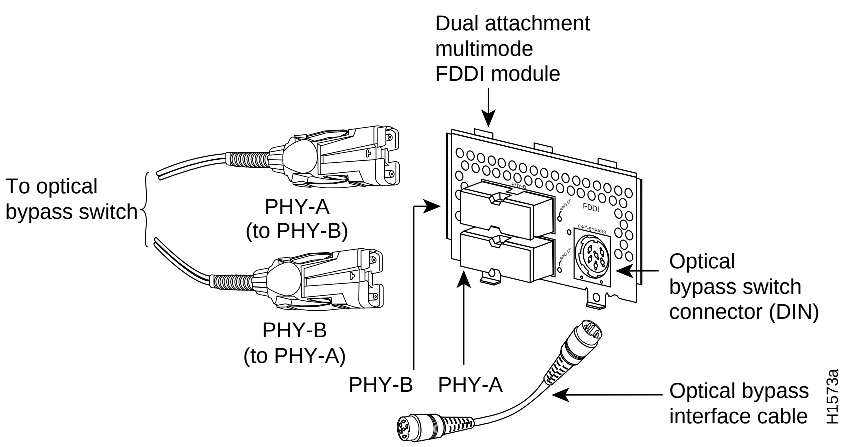
Take the following steps to connect a dual attachment multimode module:

Step 1 Connect PHY-A on the FDDI module to PHY-B on the other DAS using a multimode fiber-optic cable. (See Figure 31.)

Step 2 Connect PHY-B on the FDDI module to PHY-A on the other DAS.

Step 3 When all your network connections are complete, proceed to the section "Connecting an Optical Bypass Switch to a Multimode FDDI Network Processor Module" on page 28.

Figure 31 Dual Attachment Multimode FDDI Connections



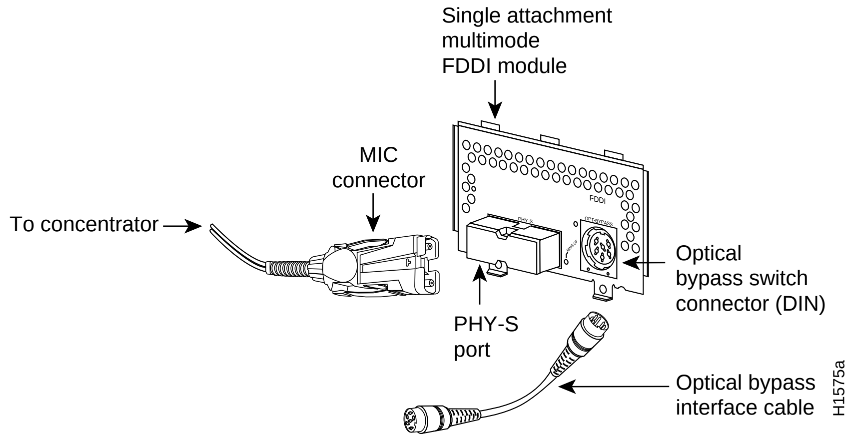
Single Attachment Multimode FDDI Connections

Take the following steps to connect a single-attachment multimode module:

Step 1 Using a multimode fiber-optic cable, connect the single attachment module's PHY-S port through a concentrator to a single attachment ring, or connect it point-to-point directly to another device. (See Figure 32.)

Step 2 When all your network connections are complete, proceed to the section "Connecting an Optical Bypass Switch to a Multimode FDDI Network Processor Module" on page 28.

Figure 32 Making Single Attachment Multimode FDDI Connections



Connecting an Optical Bypass Switch to a Multimode FDDI Network Processor Module

Take the following steps to connect the FDDI module to an external optical bypass switch:

Step 1 Connect the optical bypass switch to the ring. Observe the same guidelines for connecting the PHY-A and PHY-B ports on the bypass switch that apply for direct ring-to-module connections unless the documentation that accompanies the switch indicates otherwise.

Step 2 Using the Receive label on the cable MIC connectors as a key, connect the cables to the network (ring) side of the bypass switch. Connect the cable coming in from the primary ring (*from* PHY-B at the preceding station) to the PHY-A receive port on the network (ring) side of the bypass switch. This also links the outgoing signal to the secondary ring to the PHY-A transmit port.

Step 3 Connect the cable coming in from the secondary ring (*from* PHY-A at the preceding station) to the PHY-B receive port on the network (ring) side of the bypass switch. This also connects the outgoing signal to the primary ring to the PHY-B transmit port.

Consider the bypass an extension of the module ports and connect PHY-A to PHY-A and PHY-B to PHY-B. The network cables are already connected to the bypass switch according to the standard PHY-B-to-PHY-A and PHY-A-to-PHY-B scheme.

Step 4 Connect an interface cable between the PHY-A port on the module side of the bypass switch and the module's PHY-A port.

Step 5 Connect an interface cable between the PHY-B port on the module side of the bypass switch and the module's PHY-B port.

Step 6 Connect the control cable from the optical bypass switch to the six-pin circular DIN connector on the FDDI module panel. (See Figure 26, Figure 27, and Figure 28.)

Proceed to the section "FDDI Network Processor Module LEDs."

Making Single-Mode FDDI Network Connections

Take the following steps to connect a single-mode FDDI module:

Step 1 Connect the cable from the primary ring (from PHY-B at the primary ring upstream station) to the module’s PHY-A Receive port, labeled RCVR on the module. (See Figure 29, Figure 30, Figure 33, and Figure 34.)

Step 2 Connect the cable to the primary ring (to PHY- A at the primary ring downstream station) to the module’s PHY- B transmit port, labeled XMTR.

Step 3 Connect the incoming cable from the secondary ring to the module’s PHY- B receive port.

Step 4 Connect the outgoing cable to the secondary ring to the module’s PHY- A transmit port, labeled XMTR.

Step 5 Proceed to the next section.

FDDI Network Processor Module LEDs

The following information will help you to use the FDDI module LEDs:

- Dual attachment FDDI modules have one LED per port, which is located adjacent to the corresponding port on the module panel (see Figure 27 [multimode], Figure 29 [single-mode], and Figure 30 [single-mode]);
- Single attachment modules have one LED, located next to the single port on the module panel. (See Figure 28.)
- When on, a module LED indicates a “ring up” condition.
- Dual attachment FDDI module LEDs indicate which PHY on the module is inserted into the ring; the PHY not in the ring is off.
- On a single attachment module, the LED indicates ring up when on; if the LED is off, then the module is not inserted into a ring.

Figure 33 Single-Mode Dual Attachment FDDI Connections with FC-Type Connectors

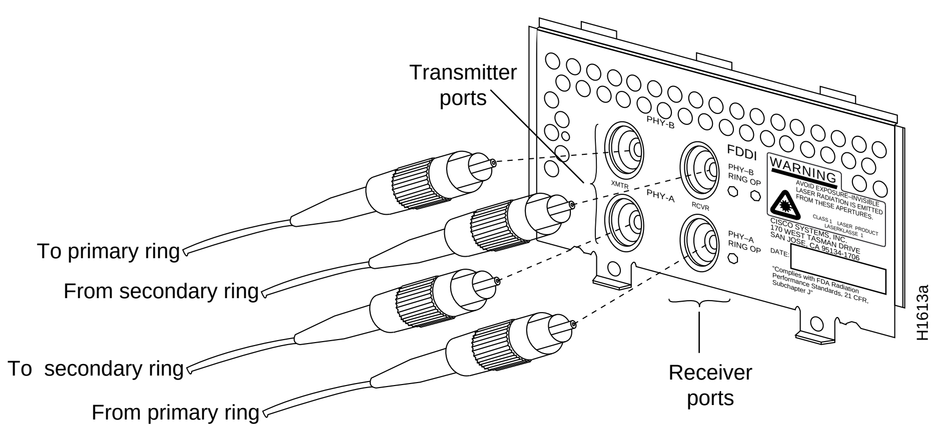
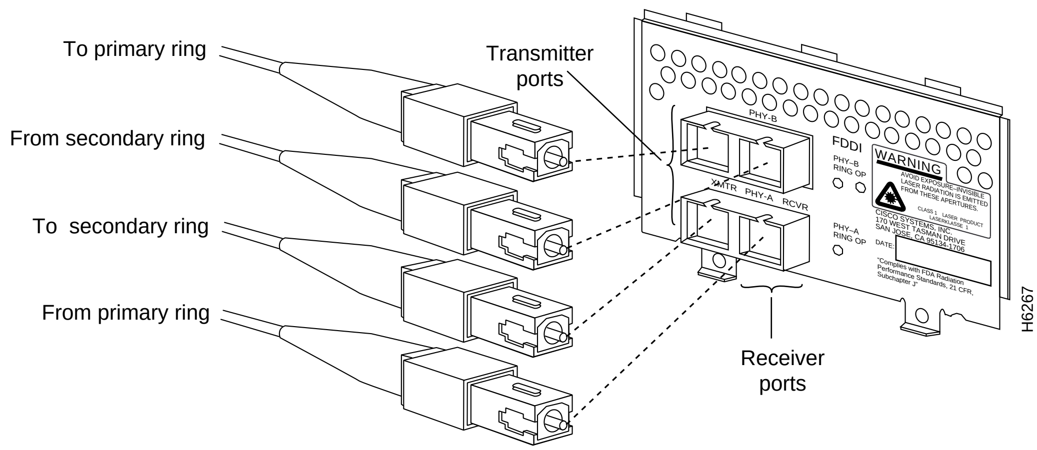


Figure 34 Single-Mode Dual Attachment FDDI Connections with SC-Type Connectors



Token Ring Network Processor Modules

The dual-port Token Ring network processor module has two standard DB-9 connectors (see Figure 35); the single-port modules have one. (See Figure 36 and Figure 37.) On the dual-port module, Port 0 (closest to the power supply) is labeled RING A and Port 1 is labeled RING B. See the section “Slot Numbering” on page 8 for a description of slot numbering.

Figure 35 Dual-Port Token Ring Network Processor Module Network Connectors

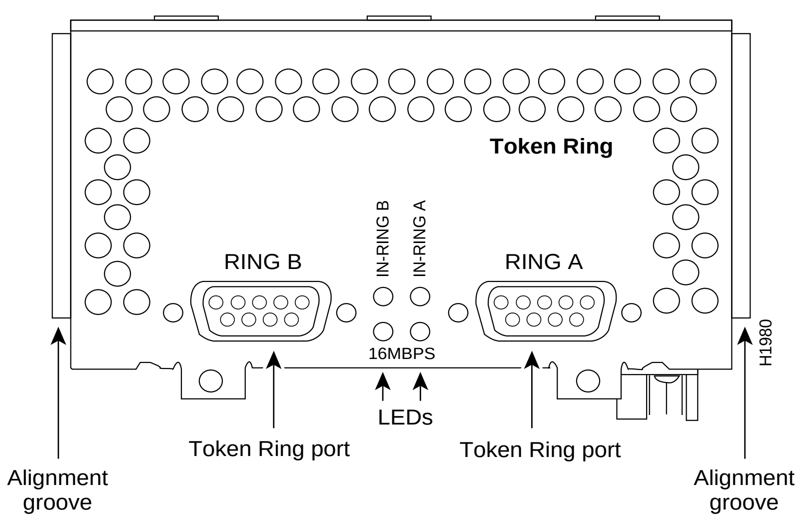


Figure 36 Version 2 Single-Port Token Ring Network Processor Module Network Connector

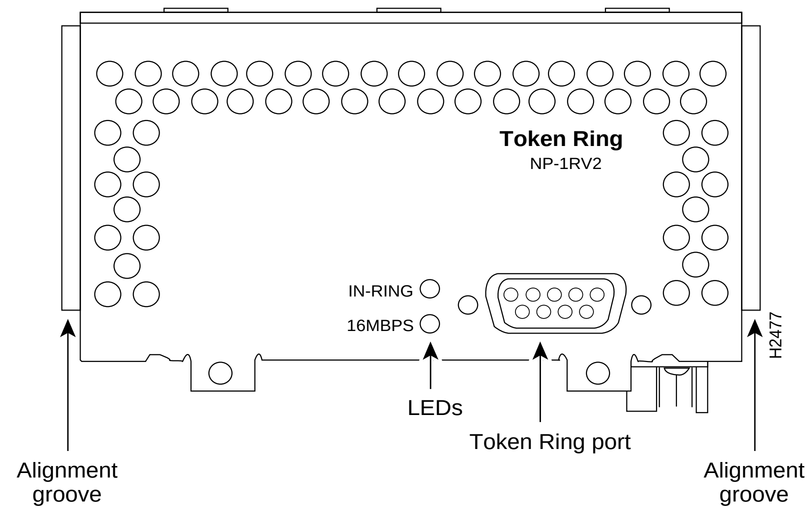
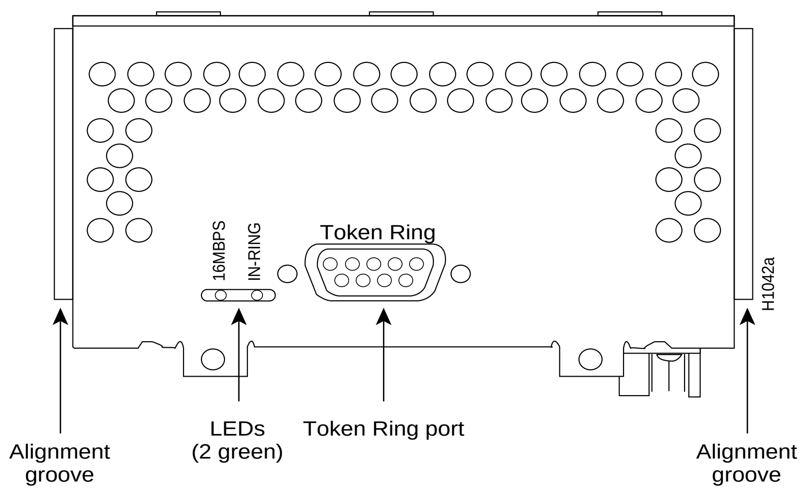
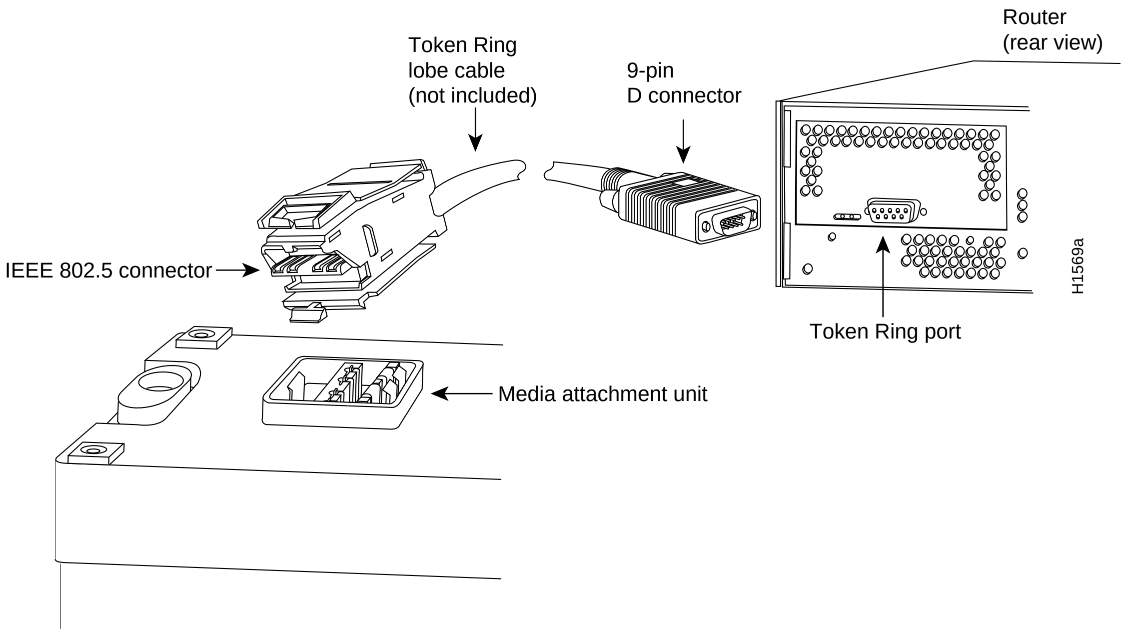


Figure 37 Original Version Single-Port Token Ring Network Processor Module Network Connector



Use a standard nine-pin Token Ring lobe cable to connect each Token Ring port directly to a media attachment unit (MAU). (See Figure 38.)

Figure 38 Token Ring Cable Connections

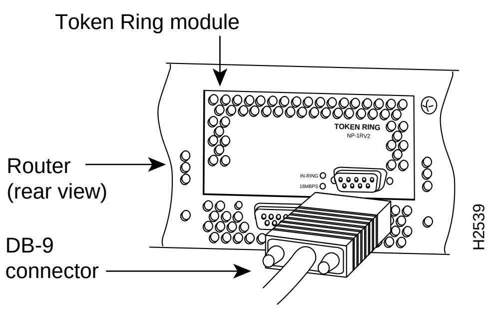


Making Token Ring Connections

Take the following steps to connect the router to a Token Ring MAU:

Step 1 Attach the DB-9 connector of the Token Ring cable to the network processor module connector. (See Figure 39.)

Figure 39 Making Token Ring Connections



Step 2 Attach the IEEE 802.5 connector end to the MAU. (See Figure 38.)

Step 3 When you have completed all the network connections, proceed to the section “Replacing the Final Connections to the Router” on page 70.

Token Ring Network Processor Module LEDs

For each port on the Token Ring module, there are two green LEDs, labeled 16MBPS and IN-RING. (See Figure 35, Figure 36, and Figure 37.) On the dual-port module, each set of LEDs corresponds to either the ring A or the ring B port. (See Figure 35.)

The LED labeled 16MBPS, when on, indicates ring speed. When off, it indicates a ring speed of 4 Mbps. The LED labeled IN-RING, when on, indicates that the network processor module is inserted into the ring. The LED is off when no module is not inserted into the ring.

Note When the in-ring LED is off, you can unplug the Token Ring cable without causing network problems.

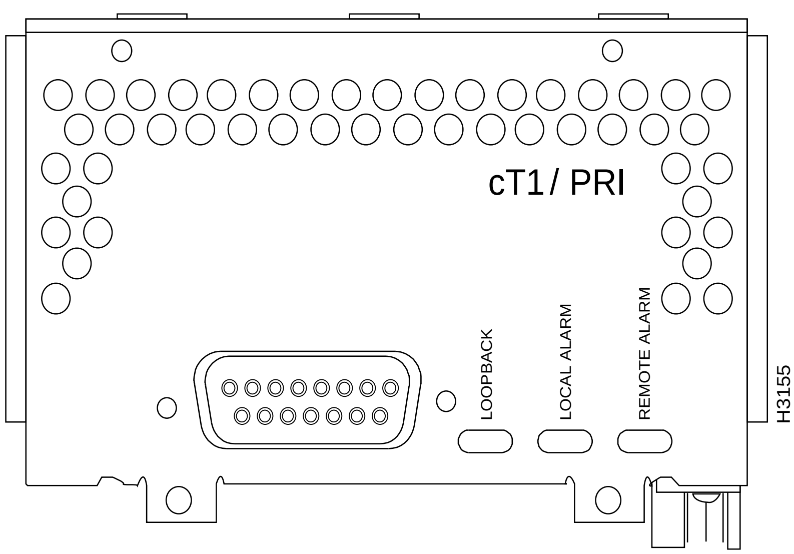
Channelized T1/ISDN PRI Network Processor Module

The Cisco 4000 series router supports a channelized T1/ISDN PRI (CT1) network processor module which provides one T1 connection via a serial cable to a channel service unit (CSU). The CT1/PRI controller provides up to 24 virtual channels. The system sees each as a serial interface that can be configured individually. This interface is the physical media that supports ISDN PRI.

Caution The CT1/PRI module cannot be used in the same chassis with the BRI four-port and eight-port network processor modules.

The CT1/PRI module, shown in Figure 40, provides a controller for transmitting and receiving bidirectional data at the CT1 rate of 1.544 Mbps. The CT1/PRI module can function as a concentrator for remote sites in WANs.

Figure 40 Channelized CT1/ISDN PRI Network Processor Module



Following are the CT1/PRI specifications:

- Transmission bit rate: 1.544 Mbps ± 50 ppm
- Output pulse amplitude: 3.0 volts (V) ± 0.6V measured at DSX
- Output pulse width: 324 nanoseconds (ns) ± 54 ns
- Compliance with all AT&T Accunet TR 62411 specifications

CT1/PRI Network Processor Module LEDs

The three LEDs on the CT1/PRI front panel indicate the following:

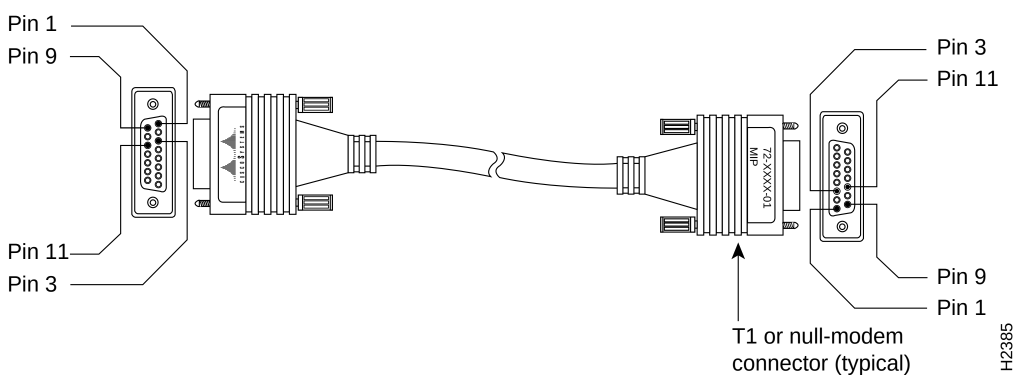
- Loopback—Controller local loopback.
- Local alarm—A loss of signal or frame, or module unavailability resulting from excessive errors.
- Remote alarm—An alarm originating on the remote end has been received.

CT1 Cabling

Two standard CT1 serial cables are available for the CT1/PRI module from Cisco Systems: null-modem (part number 72-0800-xx) and straight-through (part number 72-0799-xx). Null modem cables are used for back-to-back operation and testing. A straight-through cable connects your router to an external CSU (Channel Service Unit).

The interface cable has two 15-pin DB connectors, one at each end, to connect the CT1 network processor module with the external CT1 CSU. Figure 41 shows the interface cable, connectors, and pinouts.

Figure 41 CT1 Interface Cable



CT1 Cable Pinouts

The CT1/PRI interface cables have two male 15-pin DB connectors (one at each end) to connect the CT1 network processor module with the external CSU. Table 7 lists the pinouts for the null-modem CT1 cable, while Table 8 lists the pinouts for the straight-through CT1 cable.

Table 7 CT1 Null-Modem Cable Pinouts

15-Pin DB Connector			15-Pin DB Connector
Signal	**Pin**	**Pin**	**Signal**
Transmit Tip	1	3	Receive Tip
Receive Tip	3	1	Transmit Tip
Transmit Ring	9	11	Receive Ring
Receive Ring	11	9	Transmit Ring

Table 8 CT1 Straight-Through Cable Pinouts

15-Pin DB Connector			15-Pin DB Connector
Signal	**Pin**	**Pin**	**Signal**
Transmit Tip	1	1	Transmit Tip
Transmit Ring	9	9	Transmit Ring
Receive Tip	3	3	Receive Tip
Receive Ring	11	11	Receive Ring

Configuring the CT1 Network Processor Module Interface

You must enter configuration mode to configure a new CT1 network processor module or to change the configuration of an existing controller.

If you have replaced a previously configured CT1 network processor module, the system will recognize the new module and bring it up in the previous configuration.

Note You will always use the privileged-level **configure** command to configure a new CT1 module.

When you verify that the new CT1 module is recognized by the router, have the following information ready to begin the configuration procedure:

- CT1 information; for example clock source, line code, and framing type
- Channel group information and time slot mapping
- Protocols and encapsulations applicable to the new interfaces
- Internet protocol (IP) addresses if you plan to configure the interfaces for IP routing
- Whether the new interface will use bridging

The following steps describe a basic CT1 configuration. Press **Return** after each configuration step.

Step 1 At the privileged-level prompt (Router #), enter configuration mode and specify that the console terminal will be the source of the configuration commands, as follows:

```
Router# conf t
Enter configuration commands, one per line. End with CNTL/Z. Router(config)#
```

Step 2 Specify the controller to configure by entering the command **cont CT1** and the unit number. The following example is for the CT1 module unit number 1:

```
Router(config)# cont CT1 1
```

Step 3 Specify the clock source for the controller. The **clock source** command will configure the module to accept the clock from the line or to generate the clock from an internal source:

```
Router(config-controller)# clock source line
```

Note The clock source should be set to use the internal clocking only for testing the network or if the full CT1 line is used as the channel group. Only one end of the CT1 line should be set to internal.

Step 4 Specify the **framing** type, which can be D4 SuperFrame (sf) or Extended Super Frame (esf). This example shows the **esf** framing type selected:

```
Router(config-controller)# framing esf
```

Step 5 Specify the **linecode** format as **b8zs** or **ami**:

```
Router(config-controller)# linecode b8zs
Router(config-controller)#
%CONTROLLER-3-UPDOWN: Controller CT1 1, changed state to up
Router(config-controller)#
```

Step 6 Enter the **channel-group** command, channel group, and time slots to be mapped. The channel-group command is used to group individual DS0 slots as a single subinterface. The example shows channel group 0 and time slots 1, 3 through 5, and 7 selected for mapping:

```
Router(config-controller)# channel-group 0 timeslots 1,3-5,7
Router(config-controller)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1:0, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1:0, changed state to up
Router(config-controller)#
Router(config-controller)#
```

Step 7 Specify the interface, serial, unit number, and channel group to modify:

```
Router(config-controller)# int serial 1:0
```

Step 8 Assign an IP address and subnet mask to the interface using the **ip address** command, as in the following example:

```
Router(config-if)# ip address 1.1.15.1 255.255.255.0
Router(config-if)#
```

Step 9 Add any additional configuration commands required to enable routing protocols and adjust the interface characteristics.

Step 10 When you have entered all the configuration commands, press **Ctrl-Z** to exit configuration mode.

Step 11 Write the new configuration to memory, as follows:

```
Router# write memory
```

The system will display an OK message when the configuration is stored.

Step 12 Exit the privileged level and return to the user level by entering **disable** at the prompt, as follows:

```
Router# disable

Router>
```

Step 13 Check the interface configuration using **show** commands.

Note If you are using Cisco IOS Software Release 11.0 or earlier, refer to the *Router Products Configuration Guide* for a summary of available configuration options and instructions. If you are using Cisco IOS Software Release 11.1 or later, refer to the *Configuration Fundamentals Configuration Guide*.

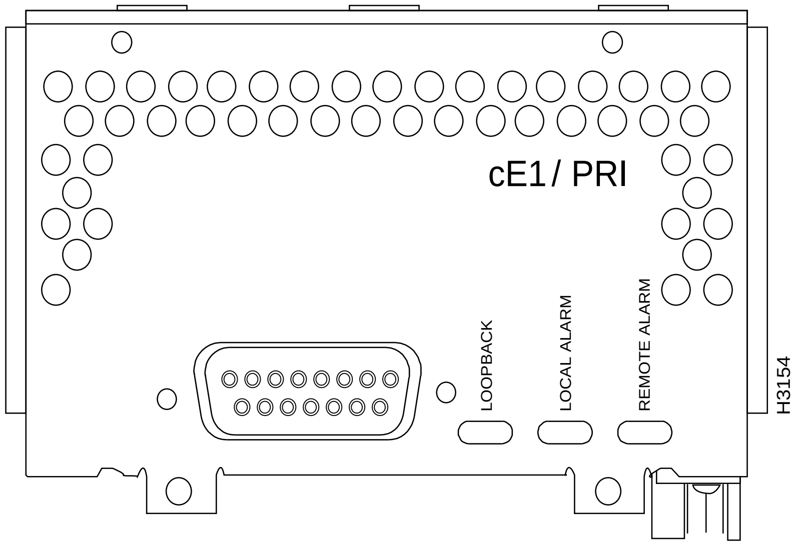
CE1/PRI Network Processor Module

The Cisco 4000 series router supports a channelized E1/PRI network processor module with one E1 interface. This interface is the physical media that supports ISDN PRI. This CE1/PRI module provides one channelized E1 connection to a Channel Service Unit (CSU) using a serial cable. The module can function as a concentrator for remote sites in WANs.

The CE1/PRI module controller, shown in Figure 42, facilitates transmission and receipt of bidirectional data at the E1 rate of 2.048 Mbps. The controller provides up to 31 virtual channels. Each channel appears to the system as a serial interface that can be configured individually.

Caution The CE1/PRI module will not function in the same chassis with the BRI four-port and eight-port network processor modules.

Figure 42 Channelized E1/ISDN PRI Network Interface Processor



Following are the E1 specifications:

- Transmission bit rate: 2.048 Mbps ± 50 ppm
- Output port specifications: see G.703/Section 6.2 (ITU-T specification)
- Input port specifications: see G.703/Section 6.3 (ITU-T specification)
- Jitter attenuation starting at 6 hertz (Hz), which meets or exceeds G.823 for E1

Note The International Telecommunication Union Telecommunication Standardization Sector (ITU-T) now carries out the functions of the former Consultative Committee for International Telegraph and Telephone (CCITT).

CE1 LEDs

The three LEDs on the front panel of the CE1/PRI module indicate the following:

- Loopback—A controller local loopback.
- Local alarm—A loss of signal, a loss of frame, or unavailability because of excessive errors.
- Remote alarm—An alarm has occurred on the remote end and has been received by the router.

CE1 Jumper Settings

The jumpers on the CE1/PRI module set capacitive coupling between the transmit (Tx) or receive (Rx) shield and chassis ground and the cable resistance (120-ohm or 75-ohm). By default, the module is set with capacitive coupling between the Rx shield and chassis ground. This provides direct current (DC) isolation between the chassis and external devices, as stated in the G.703 specification. Jumper J2 (see Figure 43) controls this function. To set capacitive coupling between the Tx shield and chassis ground, set jumper J2 as described in Table 9.

Figure 43 also shows the location of jumpers J1, J3, J4, J5, and J7. These jumpers set the cable impedance to 120 ohm or 75 ohm. The jumper settings in Figure 43 show the cable impedance set to 120 ohm.

Figure 43 Location of Jumpers on the CE1/PRI module

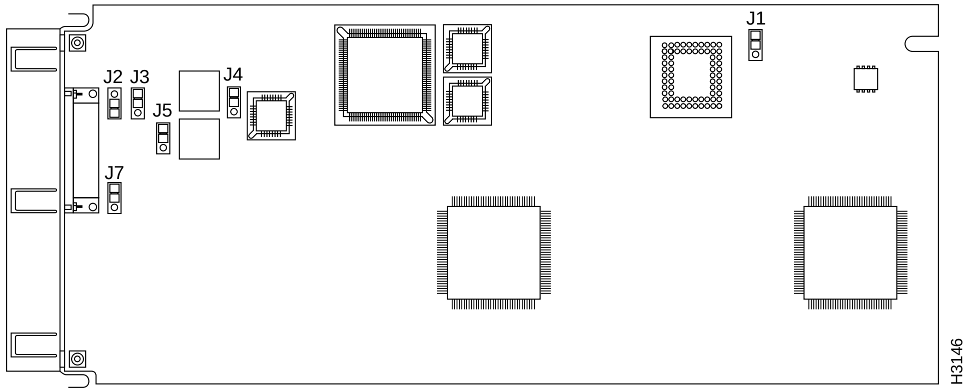


Table 9 Jumper Settings and Functions

Jumper	Position	Function
J2	1 and 2	Connects the Rx shield to chassis ground (default setting)
	2 and 3	Connects the Rx shield through capacitive coupling to chassis ground
J1, J3, J4, J5, J7[1]	1 and 2	Sets cable impedance to 75 ohm
	2 and 3	Sets cable impedance to 120 ohm (default setting)

1. All these jumpers must be set to the same impedance.

Warning For either impedance option, a jumper installed at J2 bypasses the AC-decoupling capacitor to ground, coupling the interface directly to AC. This is a setting that might pose a risk of severe injury. By default and for safety, J2 is configured with no ground. To prevent interface problems and to reduce the potential for injury, jumper J2 should be configured by trained personnel *only.*

E1 Cabling

Four serial cables are available for the CE1/PRI modules. All four have DB-15 connectors on the CE1/PRI end, and BNC, DB-15, Twinax, or RJ-45 connectors on the network end. Figure 44, Figure 45, Figure 46, and Figure 47 show the CE1 interface cables.

Figure 44 E1 Interface Cable for 75 ohm, Unbalanced Connections (with BNC Connectors)

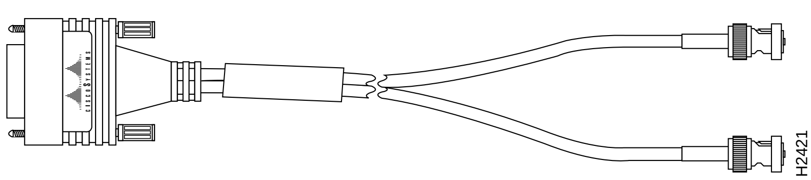


Figure 45 E1 Interface Cable for 120 ohm, Balanced Connections (with DB-15 Connectors)

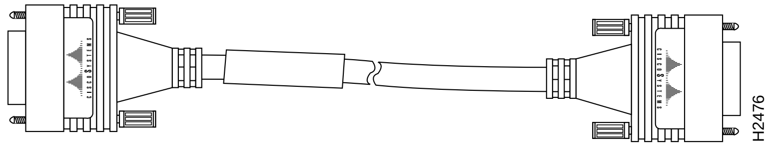


Figure 46 E1 Interface Cable for 120 ohm, Balanced Connections (with Twinax Connectors)

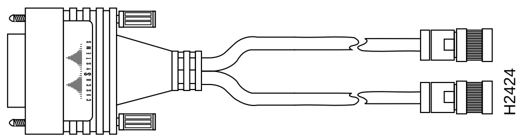
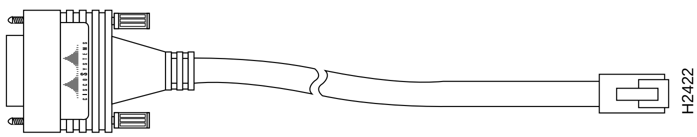


Figure 47 E1 Interface Cable for 120 ohm, Balanced Connections (with RJ-45 Connector)



E1 Cable Pinouts

The E1 interface cables have male 15-pin DB connectors at each end for connecting the CE1/PRI module to network equipment. Table 10 lists the pinouts for the E1 interface cables.

Table 10 E1 Interface Cable Pinouts

CE1 End		Network End						
DB-15[1]		BNC	DB-15		Twinax		RJ-45	
Pin	Signal	Signal	Pin	Signal	Pin	Signal	Pin	Signal
9	Tx Tip	Tx Tip	1	Tx Tip	Tx-1	Tx Tip	1	Tx Tip
2	Tx Ring	Tx Shield	9	Tx Ring	Tx-2	Tx Ring	2	Tx Ring
10	Tx Shield	–	2	Tx Shield	Shield	Tx Shield	3	Tx Shield
8	Rx Tip	Rx Tip	3	Rx Tip	Rx-1	Rx Tip	4	Rx Tip
15	Rx Ring	Rx Shield	11	Rx Ring	Rx-2	Rx Ring	5	Rx Ring
7	Rx Shield	–	4	Rx Shield	Shield	Rx Shield	6	Rx Shield

1. Any pins not described in this table are not connected.

Configuring the CE1/PRI Interface

You must enter configuration mode when you install a new CE1/PRI network processor module or to change the configuration of an existing controller. If you replace a previously configured CE1/PRI module, the system will recognize the new module and bring it up in the existing configuration.

After you have verified that the system recognizes the new CE1/PRI module, configure it using the privileged-level **configure** command. Keep the following information available:

- E1 information; for example, line code and framing type (provided by your E1 carrier)
- Channel group information and time slot mapping (provided by your E1 carrier)
- Protocols and encapsulations you plan to use on the new interfaces
- IP addresses if you plan to configure the interfaces for IP routing
- Whether the new interface will use bridging

The following steps describe a basic E1 configuration. Press **Return** after each step.

Step 1 At the privileged-level prompt (Router #), enter configuration mode and specify that the console terminal will be the source of the configuration commands, as follows:

```
Router# conf t
Enter configuration commands, one per line. End with CNTL/Z. Router(config)#
```

Step 2 Specify the controller to configure by entering the command **cont e1** and the unit number. The following example is for the CE1/PRI module unit number 1:

```
Router(config)# cont e1 1
```

Step 3 Specify the **framing** type:

```
Router(config-controller)# framing crc4
```

Step 4 Enter the **channel-group** command, channel group, and time slots to be mapped. The example shows channel group 0 and time slots 1, 3 through 5, and 7 selected for mapping:

```
Router(config-controller)# channel-group 0 timeslots 1,3-5,7
Router(config-controller)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1:0, changed state to down
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial1:0, changed state to up
Router(config-controller)#
Router(config-controller)#
```

Step 5 Specify the serial, interface, unit number, and channel group to modify:

```
Router(config-controller)# int serial 1:0
```

Step 6 Assign an IP address and subnet mask to the interface with the **ip address** command, as in the following example:

```
Router(config-if)# ip address 1.1.15.1 255.255.255.0
Router(config-if)#
```

Step 7 Add any additional configuration commands required to enable routing protocols and adjust the interface characteristics.

Step 8 When you have entered all the configuration commands, press **Ctrl-Z** to exit configuration mode.

Step 9 Write the new configuration to memory as follows:

```
Router# write memory
```

The system will display an OK message when the configuration is stored.

Step 10 Exit the privileged level and return to the user level by entering **disable** at the prompt as follows:

```
Router# disable
Router>
```

Step 11 Check the interface configuration using **show** commands.

Note If you are using Cisco IOS Release 11.0 or earlier, refer to the *Router Products Configuration Guide* and *Router Products Command Reference* publications for additional instructions. If you have Cisco IOS Release 11.1 or later, refer to the *Configuration Fundamentals Configuration Guide* and *Configuration Fundamentals Command Reference*.

ATM Network Processor Modules

The ATM processor module for the Cisco 4500, Cisco 4500-M, Cisco 4700, and 4700-M routers provides a User Network Interface (UNI) between the router and an ATM network. This interface to ATM switching fabrics enables the transmitting and receiving data at rates of up to 155 Mbps in each direction (Rx and Tx). The actual rate is determined by the physical layer interface module (PLIM) and the specific physical ATM network layer. All ATM interfaces are full-duplex.

Four ATM network processor modules are available that support PLIMs connecting to the following physical layers:

- SONET/SDH 155-Mbps single-mode fiber-optical—STS-3c or STM-1 (see Figure 48)
- SONET/SDH 155-Mbps multimode fiber-optical—STS-3c or STM-1 (see Figure 49)
- E3 34-Mbps coaxial cable (see Figure 50)
- DS-3 45-Mbps coaxial cable (see Figure 50)

An ATM network processor module can be installed in any available network processor slot. Unless the middle slot is occupied by an FDDI module, install the ATM network processor module there. You must use the appropriate ATM interface cable and accessories to connect the ATM module with an external ATM network. The cable connects your router to an ATM switch or joins two ATM router interfaces back to back.

For a description of the common ATM terms and acronyms, see the publication *Internetworking Terms and Acronyms*.

Figure 48 ATM Network Processor Module with STS-3c/STM-1 Single Mode PLIM

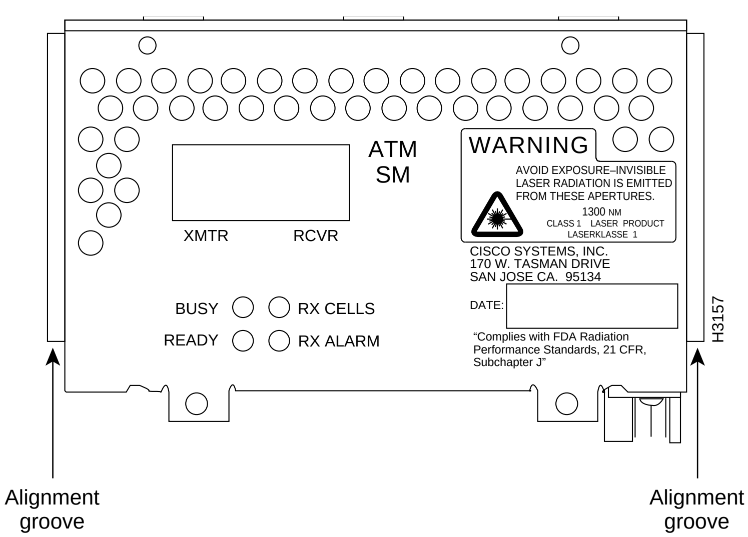


Figure 49 ATM Network Processor Module with STS-3c/STM-1 Multimode PLIM

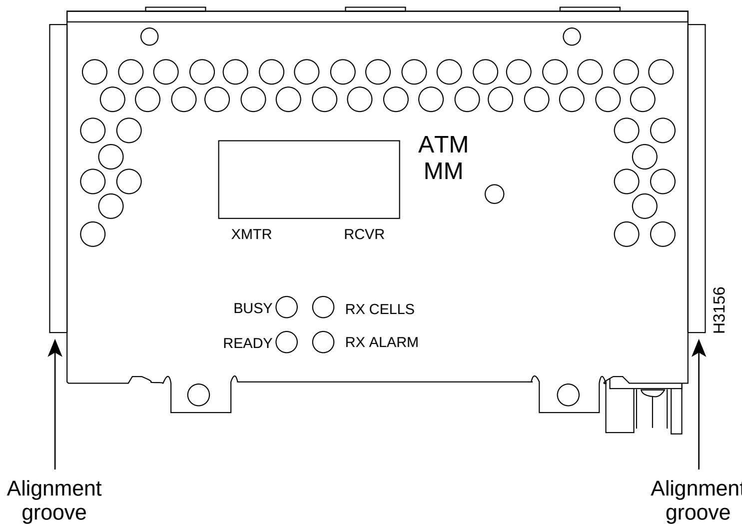
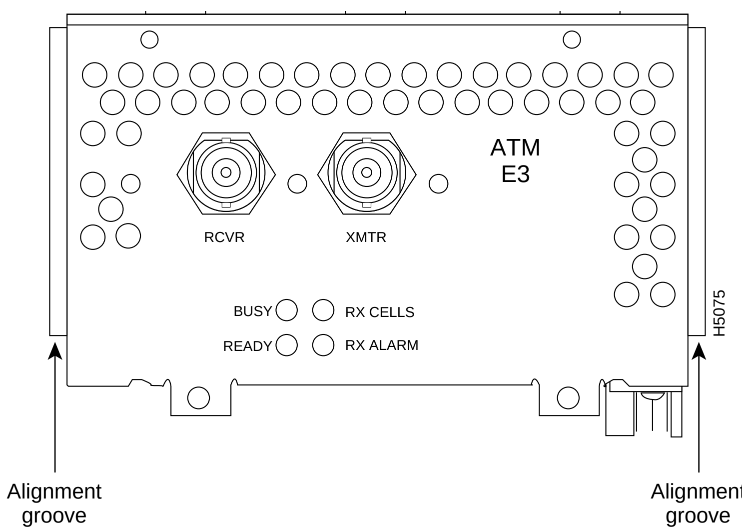


Figure 50 ATM Network Processor Module With E3/DS-3 PLIM



Note Traffic from multiple ATM interfaces may exceed available router bandwidth, causing packets to be dropped. Accordingly, the Cisco 4500, 4500-M, 4700, and 4700-M routers now support only one ATM module.

ATM Network Processor Module Features

The ATM network processor modules support the following features:

- Multiple rate queues (up to four).
- Reassembly of up to 192 buffers simultaneously. Each buffer represents a packet.
- Up to 1,023 virtual circuits.
- Both ATM adaptation layer 5 (AAL5) and 3/4 (AAL3/4).

ATM Network Processor Module LEDs

Four LEDs on the front panel of the ATM module indicate the following:

- Busy—Not applicable in normal use
- Ready—When on, the configuration is complete and the module is ready for use
- Rx cells—The module is receiving traffic (cells)
- Rx alarm—Error condition: loss of signal or remote alarm

ATM Cable Connections

For single-mode or multimode SONET connections, connect the fiber cable to the SC-style receptacle on the front panel of the module. The SONET SC-duplex receptacle is shipped with a dust plug. To remove the plug, squeeze the sides as you pull on it.

For SONET/SDH multimode connections, use one multimode duplex SC connector (see Figure 51) or two single SC connectors. (See Figure 52.)

Figure 51 Duplex SC Connector

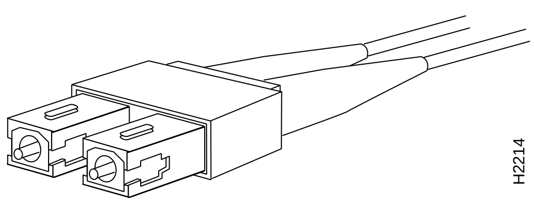
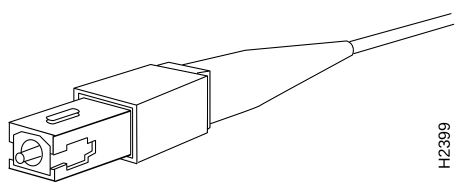


Figure 52 Simplex SC Connector

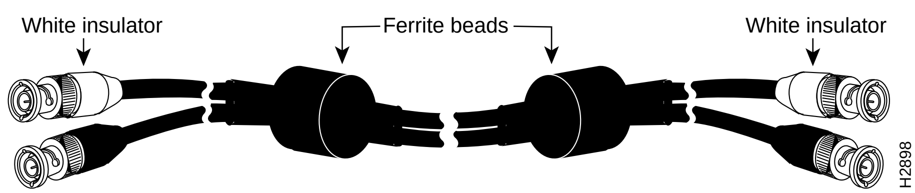


Note The ATM network processor module for Cisco 4000 series routers uses identical duplex SC connectors for single-mode and multimode SONET connections. The front panels are similar in appearance; look for the yellow laser warning label on the single-mode module's front panel, or the specific part number visible on the upper surface of all PLIMs.

Warning Invisible laser radiation can be emitted from the aperture ports of the single-mode ATM products when no fiber-optic cable is connected. *Avoid exposure and do not stare into open apertures*. This product meets the Class 1 Laser Emission Requirement from CDRH FDDI.

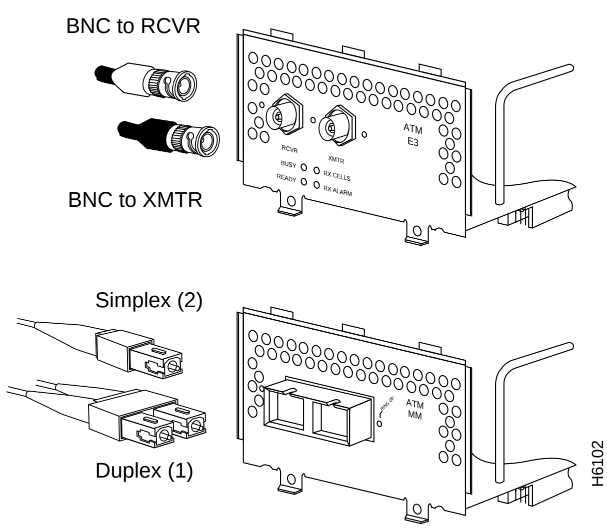
For E3 and DS-3 connections, use the 75 ohm, RG-59, coaxial cable, CAB-ATM-DS3/E3, which has bayonet-style, twist-lock (BNC) connectors and ferrite beads. (See Figure 53.) The E3 and DS-3 PLIMs both require cable CAB-ATM-DS3/E3. Ensure that the transmit and receive portions of the cable are connected to the appropriate module connector.

Figure 53 CAB-ATM-DS3/E3 Cable—RG-59 Coaxial Cable with BNC Connectors



Connect the ATM module interface cables as shown in Figure 54.

Figure 54 ATM Module Connections



Caution To ensure compliance with electromagnetic interference (EMI) standards, the E3 PLIM connection requires an EMI filter clip (CLIP-E3-EMI) on both the receive and transmit ports (respectively labeled RCVR and XMTR); the DS-3 PLIM connection does not require this clip. Figure 55 shows the required EMI filter clip assembly. *Do not* operate the E3 PLIM without this assembly.

Take these steps to install the CAB-ATM-DS3/E3 cable and EMI filter assembly for an E3 PLIM:

Step 1 Attach the CAB-ATM-DS3/E3 cable to the transmit (XMTR) and receive (RCVR) ports on the E3 PLIM. (See Figure 55, part A.)

One portion of the cable has a white insulator on both ends to ensure that the receive-to-transmit and transmit-to-receive relationship between the E3 PLIM and the ATM switch are maintained.

Step 2 Hold the EMI filter clip as shown in Figure 55, part B and attach it to the receive cable. (See Figure 55, part C.)

Step 3 When attached, one pair of fingers should clip over the front panel receptacle, and the other pair of fingers should clip over the cable connector.

Step 4 Hold the second EMI filter clip as shown in part B of Figure 55, and attach it to the *transmit* cable. The result should look like part D of Figure 55.

ATM SONET Distance Limitations

The SONET specification for fiber-optic transmission defines two types of fiber: single mode and multimode. Single-mode fiber is capable of higher bandwidth and greater cable run distances than multimode fiber.

The typical maximum distances for single-mode and multimode transmissions, as defined by SONET, are in Table 11. If the distance between two connected stations is greater than these maximum distances, significant signal loss can result, making transmission unreliable.

Table 11 SONET Maximum Fiber-Optic Transmission Distances

Transceiver Type	Maximum Distance between Stations[1]
Single-mode	Up to 9 miles (15 kilometers)
Multimode	Up to 1.5 miles (3 kilometers)

1. This table gives typical results. You should use the power budget calculations to determine the actual distances. See the section “Approximating the Power Margin” on page 47.

Power Budget

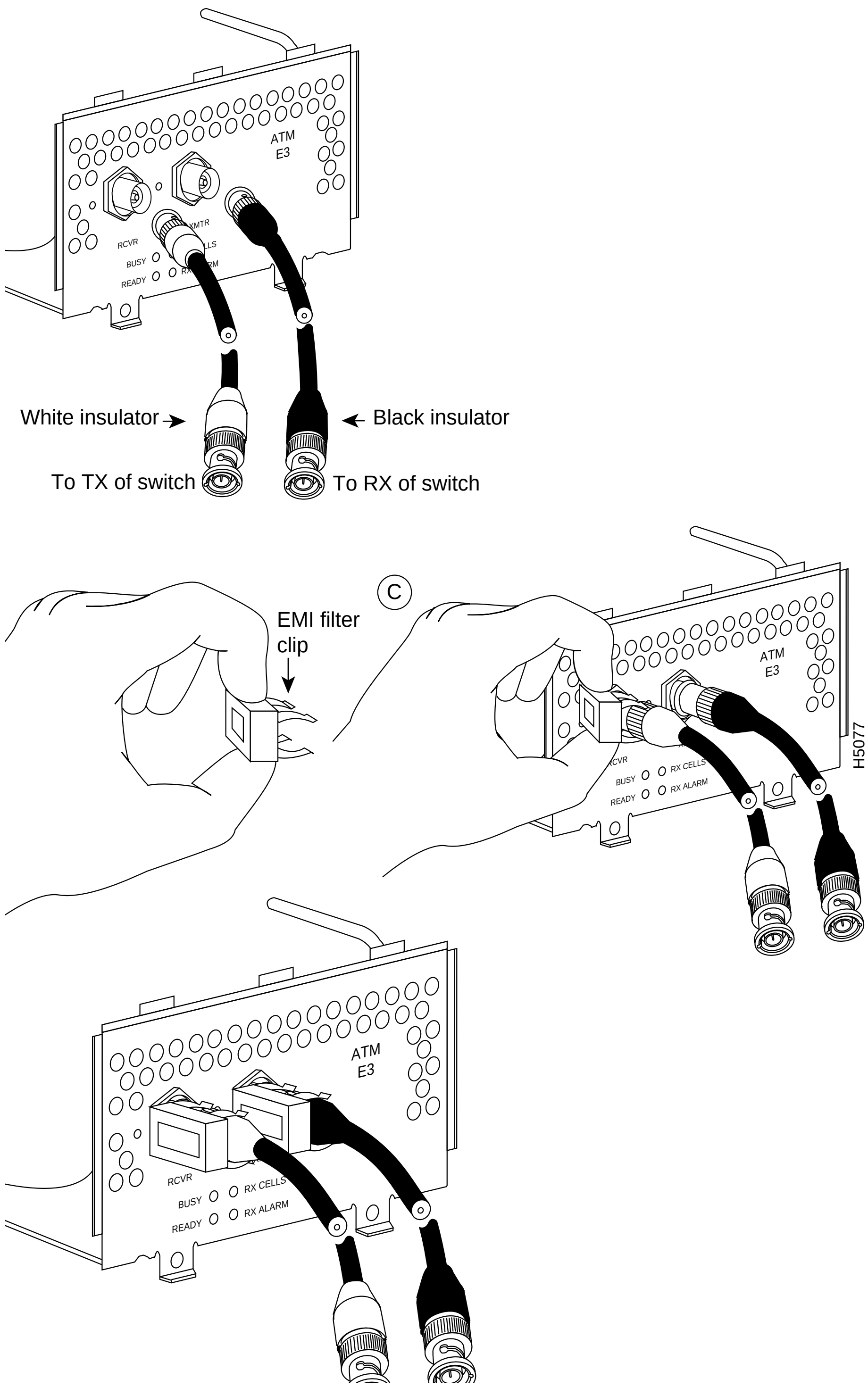
To design an efficient optical data link, you must evaluate the power budget. Proper operation of an optical data link depends on modulated light reaching the receiver with enough power to be correctly demodulated.

The power budget is defined in two ways:

- The amount of light available to overcome attenuation in the optical link; and
- The minimum amount of light needed to enable the receiver to operate within specifications.

Note Attenuation, caused by the passive media components (cables, cable splices, and connectors), is common to both multimode and single-mode transmission.

Figure 55 Installing the CAB-ATM-DS3/E3 Cable and EMI Filter Clip Assembly



The following variables reduce the power of the signal (light) transmitted to the receiver in multimode transmission:

- Chromatic dispersion (spreading of the signal in time because of the different speeds of light wavelengths)
- Modal dispersion (spreading of the signal in time because of the different propagation modes in the fiber)

Attenuation is significantly lower for optical fiber than for other media. For multimode transmission, chromatic and modal dispersion reduce the available system power by the combined dispersion penalty, measured in decibels (dB). The power lost over the data link is the sum of the component, dispersion, and modal losses.

Table 12 lists the factors of attenuation and dispersion limit for typical fiber-optic cable.

Table 12 Typical Fiber-Optic Link Attenuation and Dispersion Limits

Limits	Single-Mode	Multimode
Attenuation	0.5 dB	1.0 dB/km
Dispersion	No limit	500 MHz/km[1]

1. The product of bandwidth and distance must be less than 500 MHz/km.

Approximating the Power Margin

The LED used for a multimode transmission light source creates multiple propagation paths of light, each with a different path length and time requirement to cross the optical fiber, causing signal dispersion (smear). Higher order mode loss (HOL) results from light from the LED entering the fiber and radiate into the fiber cladding.

A worst-case estimate of power margin (PM) for multimode transmissions assumes minimum transmitter power (PT), maximum link loss (LL), and minimum receiver sensitivity (PR). In a worst-case situation, not all parts of an actual system will operate at the worst-case levels.

The power budget (PB) is the maximum possible amount of power transmitted. The following equation lists the calculation of the power budget:

PB = PT – PR

PB = –18.5 dBm – (–30 dBm)

PB = 11.5 dB

The power margin calculation is derived from the power budget and subtracts the link loss:

PM = PB – LL

Table 13 lists the factors that contribute to link loss and the estimate of the link loss value attributable to those factors.

After calculating the power budget minus the data link loss, the result should be greater than zero. Results less than zero may have insufficient power to operate the receiver. If the power margin is positive, as a rule, the link will work.

For SONET versions of the ATM module, the signal must meet the worst-case parameters listed in Table 14.

Table 13 Estimating Link Loss

Link Loss Factor	Estimate of Link Loss Value
Higher order mode losses	0.5 dB
Clock recovery module	1 dB
Modal and chromatic dispersion	Dependent on fiber and wavelength used
Connector	0.5 dB
Splice	0.5 dB
Fiber attenuation	1 dB/km

Table 14 SONET Signal Requirements

Category	Single-Mode	Multimode
PT	–18.5	–15
PR	–30	–28
PB	–11.5	–13

Multimode Power Budget Example with Sufficient Power for Transmission

The following is an example multimode power budget calculated based on the following variables:

Length of multimode link = 3 kilometers (km)

4 connectors

3 splices

Higher order loss (HOL)

Clock recovery module (CRM)

Estimate the power budget as follows:

PB = 11.5 dB – 3 km (1.0 dB/km) – 4 (0.5 dB) – 3 (0.5 dB) – 0.5 dB (HOL) – 1 dB (CRM)

PB = 11.5 dB – 3 dB – 2 dB – 1.5 dB – 0.5 dB – 1 dB

PB = 2.5 dB

The value of 2.5 dB indicates that this link would have sufficient power for transmission.

Multimode Power Budget Example of Dispersion Limit

Following is an example with the same parameters as the previous example, but with a multimode link distance of 4 km:

PB = 11.5 dB – 4 km (1.0 dB/km) – 4 (0.5 dB) – 3 (0.5 dB) – 0.5 dB (HOL) – 1 dB (CRM)

PB = 11.5 dB – 4 dB – 2 dB – 1.5 dB – 0.5 dB – 1 dB

PB = 1.5 dB

The value of 1.5 dB indicates that this link would have sufficient power for transmission. because of the dispersion limit on the link (4 km x 155.52 MHz > 500 MHz/km), this link will not work with multimode fiber. In this case, single-mode fiber would be the better choice.

Single-Mode Transmission

The single-mode signal source is an injection laser diode. Single-mode transmission is useful for longer distances because the single transmission path exists within the fiber eliminates smear. In addition, chromatic dispersion is reduced because laser light is essentially monochromatic.

The maximum overload specification on the single-mode receiver is –14 dB. The single-mode receiver can be overloaded when using short lengths of fiber because the transmitter can transmit up to –8 dB, while the receiver could be overloaded at –14 dB, but no damage to the receiver will result. To prevent overloading the receiver connecting short fiber links, insert a 5 to 10 dB attenuator on the link between any single-mode SONET transmitter and the receiver.

SONET Single-Mode Power Budget Example

The following example of a single-mode power budget is of two buildings, 11 kilometers apart, connected through a patch panel in an intervening building with a total of 12 connectors.

Length of single-mode link = 11 km

12 connectors

Estimate the power budget as follows:

PB = 11.5 dB – 11 km (0.5 dB/km) – 12 (0.5 dB)

PB = 11.5 dB – 5.5 dB – 6 dB

PB = 2.5 dB

The value of 2.5 dB indicates that this link would have sufficient power for transmission and is not in excess of the maximum receiver input power.

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. Because statistical power budget analysis is beyond the scope of this document, you can refer to UNI Forum specifications, ITU-T standards, and your equipment specifications.

For Further Reference

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

- CT1E1.2/92-020R2 ANSI, the Draft American National Standard for Telecommunications entitled “Broadband ISDN Customer Installation Interfaces: Physical Layer Specification.”
- *Power Margin Analysis, AT&T Technical Note,* TN89-004LWP, May 1989

Configuring the ATM Network Processor Module Interface

You must enter configuration mode each time you install a new ATM module to change the configuration of an existing module.

If you have replaced a previously configured ATM module, the system will recognize the new module and bring it up in the existing configuration.

When you have verified that the new ATM network processor module is recognized by the router, use the privileged-level **configure** command to configure the new module. You should have the following information available:

- ATM transceiver framing type (STS-3c, STM-1, DS-3, or E3)
- Network protocol addresses
- Permanent virtual circuit (PVC) connections and their attributes
- Static address mappings (address lists)

The following steps describe a basic ATM configuration using just PVCs. Press **Return** after each step.

Step 1 At the privileged-level prompt (Router #), enter configuration mode and specify that the console terminal will be the source of the configuration commands:

```
Router# conf t
```

Step 2 Specify the unit to configure by entering the command **int atm** and the unit number. The following example is for ATM unit 0:

```
Router(config)# int atm 0
```

Step 3 Specify the framing type.

If you are using a SONET interface, there is only one framing type, stm-1, which is the default and need not be entered:

```
Router(config-if)#atm sonet stm-1
```

If you are specifying the framing type for an E3 interface, there are two framing types: G.751 ADM (entered as g751adm) and G.832 ADM (entered as g832adm).

```
Router(config-if)#atm framing g832adm
```

If you are specifying the framing type for a DS-3 interface, there are three framing types: C-bit PLCP (entered as cbitplcp), M23 ADM (entered as m23adm), and M23 PLCP (entered as m23plcp).

```
Router(config-if)#atm framing m23adm
```

Step 4 Assign protocol addresses to the interface:

```
Router(config-if)# ip address 1.1.1.1 255.255.255.0
```

Step 5 Create the PVCs. A PVC requires the whole path from source to destination to be set up manually. If there are any switches in the path, they have to be properly configured also. The PVC command has the format **atm pvc** *vc-id vpi vci encap* [*peak-rate sustained-rate burst-size*]:

```
Router(config-if)# atm pvc 1 1 32 aal5snap
Router(config-if)# atm pvc 2 1 33 aal5snap
```

Note VCI values 0 to 31 are reserved by ITU-T and the ATM Forum.

Step 6 Assign the appropriate map list to the interface:

```
Router(config-if)# map-group lisCT1
```

Step 7 Enable the interface:

```
Router(config-if)# no shut
```

Step 8 Create the mapping of protocol addresses to PVCs. Map-lists are used to assign protocol addresses to virtual circuits (VCs):

```
Router(config-if)# map-list lisCT1
Router(config-map-list)# ip 1.1.1.2 atm-vc 1 broadcast
Router(config-map-list)# ip 1.1.1.3 atm-vc 2 broadcast
```

Step 9 Press **Ctrl-Z** to complete the configuration.

Step 10 Write the new configuration to memory:

```
Router# write memory
```

Step 11 Exit the privileged level and return to the user level:

```
Router# disable
```

The following example shows a basic configuration using switched virtual circuits (SVCs). Press **Return** after each step.

Step 1 At the privileged-level prompt (Router #), enter configuration mode and specify that the console terminal will be the source of the configuration commands:

```
Router# conf t
```

Step 2 Specify the unit to configure by entering the command **int atm** and the unit number. The following example is for ATM unit 0:

```
Router(config)# int atm 0
```

Step 3 Specify the framing type.

If you are using a SONET interface, there is only one framing type, stm-1, which is the default and need not be entered:

```
Router(config-if)#atm sonet stm-1
```

If you are specifying the framing type for an E3 interface, there are two framing types: G.751 ADM (entered as g751adm) and G.832 ADM (entered as g832adm).

```
Router(config-if)#atm framing g832adm
```

If you are specifying the framing type for a DS-3 interface, there are three framing types: C-bit PLCP (entered as cbitplcp), M23 ADM (entered as m23adm) and M23 PLCP (entered as m23plcp).

```
Router(config-if)#atm framing m23adm
```

Step 4 Assign protocol addresses to the interface:

```
Router(config-if)# ip address 2.1.1.1 255.255.255.0
```

Step 5 Create the signaling PVC, which is required by the signaling software to communicate with a switch in order to dynamically set up SVCs. The signaling virtual channel uses VPI 0 and VCI 5.

```
Router(config-if)# atm pvc 1 0 5 qsaal
```

Step 6 Configure the ATM network service access point (NSAP) address:

```
Router(config-if)# atm nsap-address nsap-addr
```

where *nsap-addr* could be:

```
AB.CDEF.01.234567.890A.BCDE.F012.3456.7890.1234.12
```

Step 7 Assign the appropriate map list to the interface:

```
Router(config-if)# map-group list2
```

Step 8 Enable the interface:

```
Router(config-if)# no shut
```

Step 9 Create the mapping of protocol addresses to ATM NSAP addresses, as follows:

```
Router(config-if)# map-list list2
Router(config-map-list)# ip 2.1.1.2 nsap-addr nsap-addr  br
Router(config-map-list)# ip 2.1.1.3 nsap-addr nsap-addr  br
```

Step 10 Press **Ctrl-Z** to complete the configuration.

Step 11 Write the new configuration to memory:

```
Router# write memory
```

Step 12 Exit the privileged level and return to the user level:

```
Router# disable
```

Serial Data Network Processor Modules

The Cisco 4000 series routers support the following serial interface data communications connections: EIA/TIA-232, EIA/TIA-449, X.21, V.35, and EIA-530. The Cisco 4000 series also supports an E1-G.703/G.704 network processor module with many features and functions common to four-port serial interface data communication interfaces.

Note See the section “Configuring G.703/G.704 Interfaces” on page 73 for E1-G.703/G.704 features that differ from those for the data communications interfaces.

Two types of serial modules are available: the four-port serial with four 60-pin D-type connectors, and the dual-port serial with two 50-pin D-subconnectors to attach to the transition cable.

Each port requires a serial adapter cable, which provides the interface between the high-density port and the standard connectors for each electrical interface type. The adapter cable determines the electrical interface type and mode (data terminal equipment [DTE] or data communications equipment [DCE]) of the port to which it is connected.

Note Because the serial modules use a special high-density port connector that requires special adapter cables for each electrical interface type, we recommend that you obtain serial interface cables from the factory.

For most interface types, the adapter cable for DTE mode uses a plug at the network end, and the cable for DCE mode uses a receptacle at the network end. Exceptions are V.35 adapter cables, which are available with either a V.35 plug or a receptacle for either mode, and the EIA-530 adapter cable, which is available only in DTE mode with a DB-25 plug at the network end. The mode (DCE or DTE) is labeled on the molded plastic connector shell at the ends of all cables except V.35 (which uses the standard Winchester block-type connector instead of a molded plastic D-shell).

Following are the available interface cable options for the mode and network-end connectors for each cable:

- EIA/TIA-232: DTE mode with a DB-25 plug; DCE mode with a DB-25 receptacle
- EIA/TIA-449: DTE mode with a 37-pin D-shell plug; DCE mode with a 37-pin D-shell receptacle
- V.35: DTE mode or DCE mode with a 34-pin Winchester-type V.35 plug; DTE mode or DCE mode with a 34-pin Winchester-type V.35 receptacle
- X.21: DTE mode with a DB-15 plug; DCE mode with a DB-15 receptacle
- EIA-530: DTE mode with a DB-25 plug

Caution For proper router operation, both ends of the EIA/TIA-232 serial DCE cable, and secondary attached cable must be connected. If you must detach this cable, detach the router end first. The line connection will “flap” if you first detach the cable end away from the router, generating interrupts and potentially causing the device to shut down.

Clocking and Aggregate Four-Port Serial Module Throughput

Two configuration requirements must be met for proper operation of the four-port serial module:

- No individual port can be clocked at a rate higher than 4 Mbps.
- The aggregate throughput of the module cannot exceed 16.384 Mbps.

Three example configurations that meet these requirements follow:

- Example 1
  - — Four full-duplex ports operating at CT1 rates
  - — Ports clocked at 1.544 Mbps
  - — Total throughput of 12.352 Mbps (unframed)
- Example 2
  - — Four full-duplex ports operating at E1 rates
  - — Ports clocked at 2.048 Mbps
  - — Total throughput of 16.384 Mbps (unframed)
- Example 3
  - — Two full-duplex ports clocked at 4 Mbps

— Total throughput of 16 Mbps

Note that the Example 3 configuration requires that two of the four ports remain unused.

The data rate depends on the type of electrical interface used. Use EIA/TIA-232 for speeds up to 64 kbps; use X.21, EIA/TIA-449, V.35, or EIA-530 for higher speeds.

When connecting serial devices, consider the adapter cables as an extension of the router for external connections. Therefore, use DTE cables to connect the router to remote DCE devices such as modems or DSUs, and DCE cables to connect the router to remote DTE devices such as hosts or another router.

Serial Distance Limitations

Serial signals can travel a limited distance at any given bit rate; generally, the slower the baud rate, the greater the distance. All serial signals are subject to distance limits, beyond which a signal degrades significantly or is completely lost. Table 15 lists the recommended maximum speeds and distances for each serial interface type from the IEEE EIA/TIA-449 specification.

You may produce good results at speeds and distances greater than those listed if you compensate for potential electrical problems. For example, the recommended maximum rate for V.35 is 2 Mbps, but 4 Mbps is commonly used. If you elect to use variable rate settings different than the IEEE specifications, do so at your own risk.

Table 15 IEEE Standard EIA/TIA-449 Transmission Speed Versus Distance

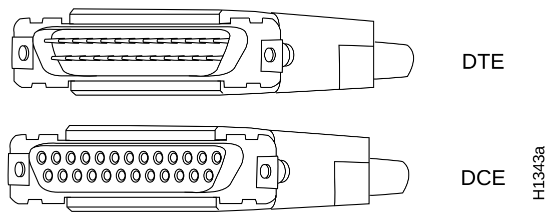
Data Rate	EIA/TIA-232 Distances		EIA/TIA-449, X.21, V.35, EIA-530 Distances	
bps	**Feet**	**Meters**	**Feet**	**Meters**
2400	200	60	4100	1250
4800	100	30	2050	625
9600	50	15	1025	312
19200	25	7.6	513	156
38400	12	3.7	256	78
56000	8.6	2.6	102	31
1544000 (CT1)	N/A	N/A	50	15

Balanced drivers enable EIA/TIA-449 signals to travel greater distances than EIA/TIA-232 signals. The recommended distance limits for EIA/TIA-449 are also valid for V.35, X.21, and EIA-530. Typically, EIA/TIA-449 and EIA-530 support 2-Mbps rates, and V.35 can support 4-Mbps rates.

EIA/TIA-232 Connections

EIA/TIA-232, the most common interface standard in the United States, supports unbalanced circuits at signal speeds up to 64 kbps. The network end of the adapter cable is a standard 25-pin D-shell connector (known as a DB-25). (See Figure 56.) The router console and auxiliary ports also use EIA/TIA-232 connections; however, the serial module ports support synchronous connections, while the console and auxiliary ports support asynchronous connections.

Figure 56 EIA/TIA-232 Adapter Cable Connectors, Network End



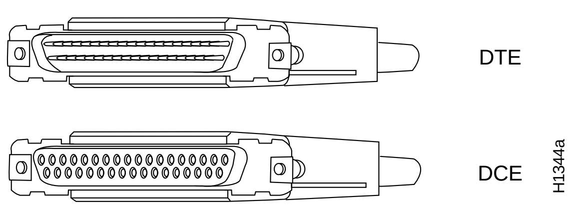
EIA/TIA-449 Connections

EIA/TIA-449, which supports balanced (EIA/TIA-422) and unbalanced (EIA/TIA-423) transmissions, is a faster (up to 2 Mbps) version of EIA/TIA-232 that provides more functions and supports transmissions over greater distances.

Note The EIA/TIA-449 standard was intended to replace EIA/TIA-232, but has not been widely adopted because of the large installed base of DB-25 hardware and the reduced number of connections resulting from the greater size of the EIA/TIA-449 connectors.

The network end of the EIA/TIA-449 adapter cable provides a standard 37-pin D-shell connector. (See Figure 57.) EIA/TIA-449 cables are available as either DTE (DB-37 plug) or DCE (DB-37 receptacle).

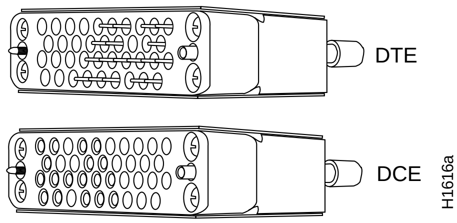
Figure 57 EIA/TIA-449 Adapter Cable Connectors, Network End



V.35 Connections

The V.35 interface is recommended for speeds up to 48 kbps (although it is effectively used at speeds of 4 Mbps). The network end of the V.35 adapter cable provides a standard 34-pin Winchester-type connector. (See Figure 58.) V.35 cables are available with a standard V.35 plug or receptacle in either DTE or DCE mode.

Figure 58 V.35 Adapter Cable Connectors, Network End

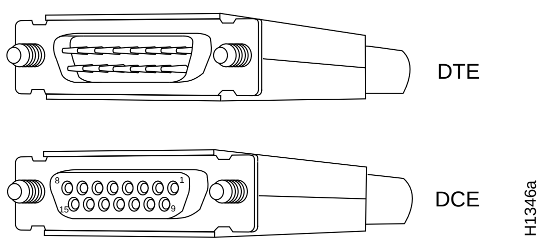


X.21 Connections

The X.21 interface uses a 15-pin connection for balanced circuits and is commonly used in the United Kingdom to connect public data networks. X.21 relocates some of the logic functions to the DTE and DCE interfaces and requires fewer circuits and a smaller connector than EIA/TIA-232.

The network end of the X.21 adapter cable is a standard DB-15 connector. (See Figure 59.) X.21 cables are available as either DTE (DB-15 plug) or DCE (DB-15 receptacle).

Figure 59 X.21 Adapter Cable Connectors, Network End



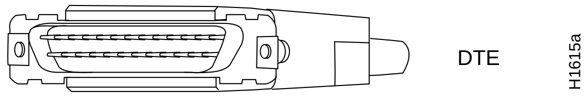
EIA-530 Connections

EIA-530 supports balanced transmission and provides the increased functionality, speed, and distance of EIA/TIA-449 on the smaller, DB-25 connector used for EIA/TIA-232. The EIA-530 standard was created to support the more sophisticated circuitry of EIA/TIA-449 on the existing EIA/TIA-232 (DB-25) hardware instead of the larger, 37-pin connectors used for EIA/TIA-449.

Like EIA/TIA-449, EIA-530 refers to the electrical specifications of EIA/TIA-422 and EIA/TIA-423. Although the EIA-530 specification recommends a maximum speed of 2 Mbps, it is used successfully at 4 Mbps or faster speeds over short distances.

The EIA-530 adapter cable is available in DTE mode only. The network end of the EIA-530 adapter cable is a standard DB-25 plug commonly used for EIA/TIA-232 connections. Figure 60 shows the DB-25 connector at the network end of the adapter cable.

Figure 60 EIA-530 Adapter Cable Connector, Network End (Available in DTE Only)

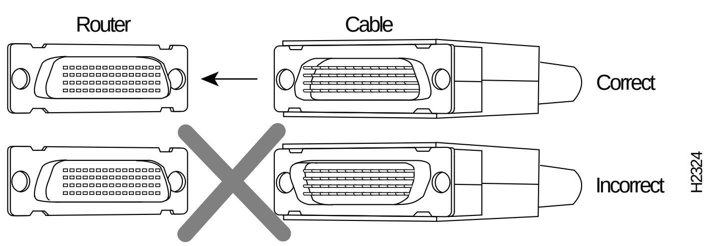


Making Serial Connections

The 60-pin D-subconnector is standard on the four-port serial module except the G.703/G.704, which has a 15-pin D-subconnector. The 50-pin D-subconnector is standard on the dual-port serial modules. Use the specific serial transition cable for the module type and the correct EIA/TIA standard connector for your modem or CSU/DSU. (See Figure 62 and Figure 63.)

Caution The connector on the four-port serial module is upside down. The cable should match that orientation. Ensure that the 60-pin connectors on the cable and the network processor modules match. Do not force the cable into the connector upside down. (See Figure 61.)

Figure 61 60-Pin Serial Port Cable Connections

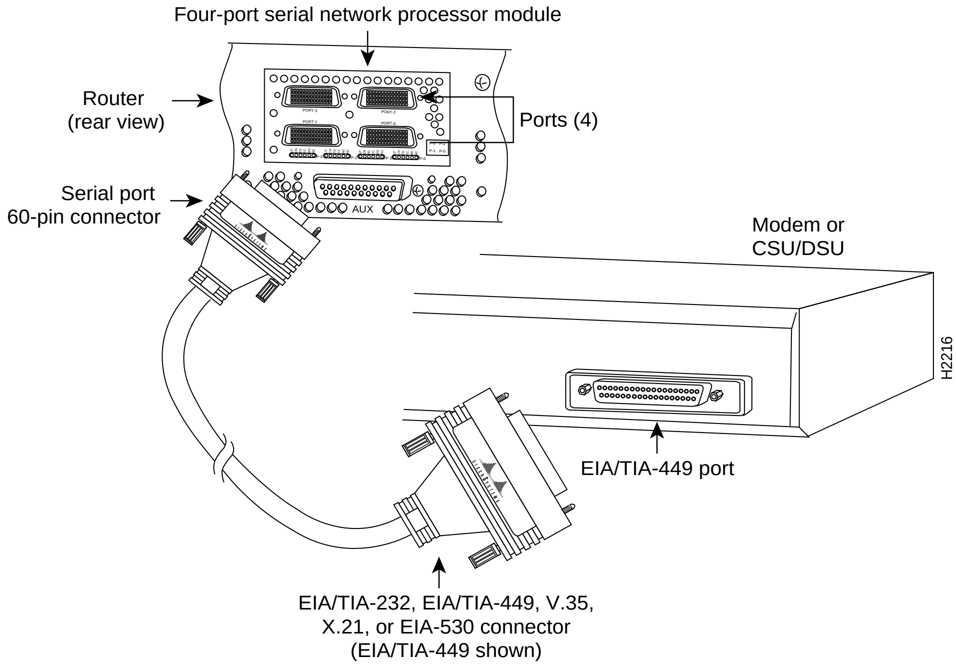


Step 1 Attach the ends of your serial transition cables to the synchronous serial ports of the serial modules. (See Figure 62 and Figure 63.)

Step 2 Attach the EIA/TIA-232, EIA/TIA-449, V.35, X.21, or EIA-530 end of the cable to the CSU/DSU or modem.

Step 3 If all your network connections are complete, proceed to the section “Replacing the Final Connections to the Router” on page 70.

Figure 62 Making Serial Connections to the Four-Port Serial Network Processor Module



Configuring Serial Connections

The four-port serial module ports are 60-pin D-subconnectors; the G.703/G.704 module ports are 15-pin D-subconnectors. On the four-port serial module, the port numbering is as shown on the label on the lower right in Figure 64. The dual-port module ports are 50-pin D-subconnectors. (See Figure 64, Figure 65, and Figure 66.) Serial ports can be configured as DTE or DCE, depending on the special serial cable used.

Figure 63 Making Serial Connections to the Dual-Port Serial Module

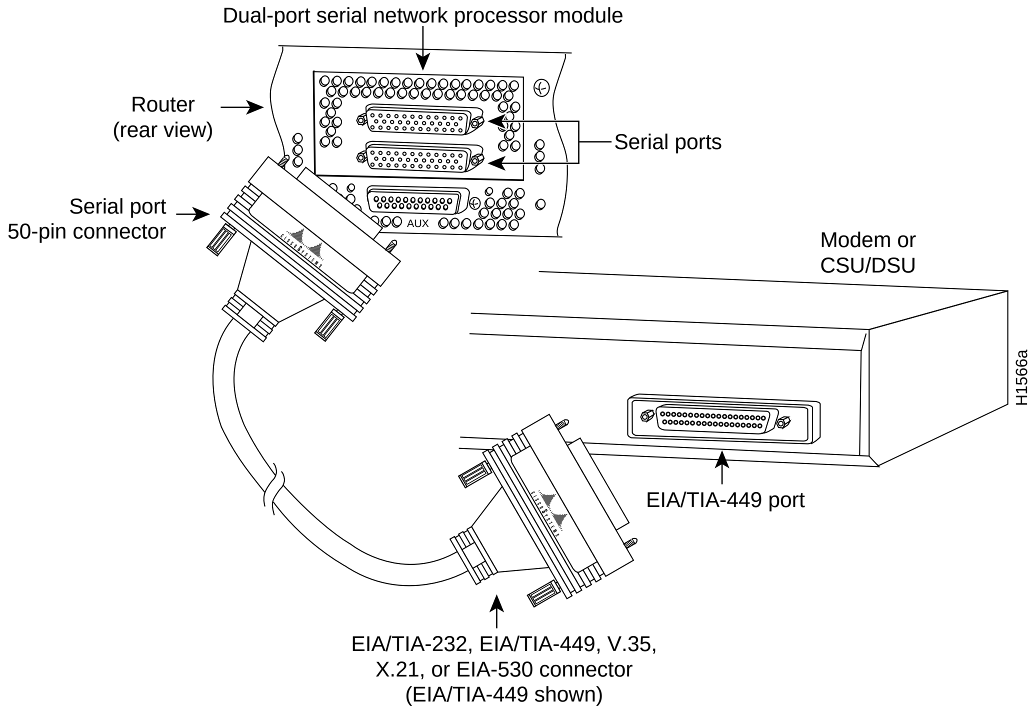
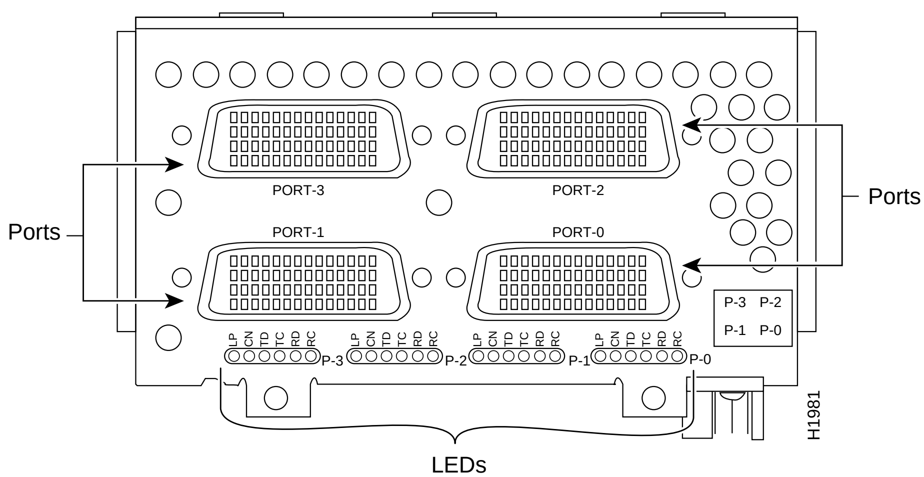
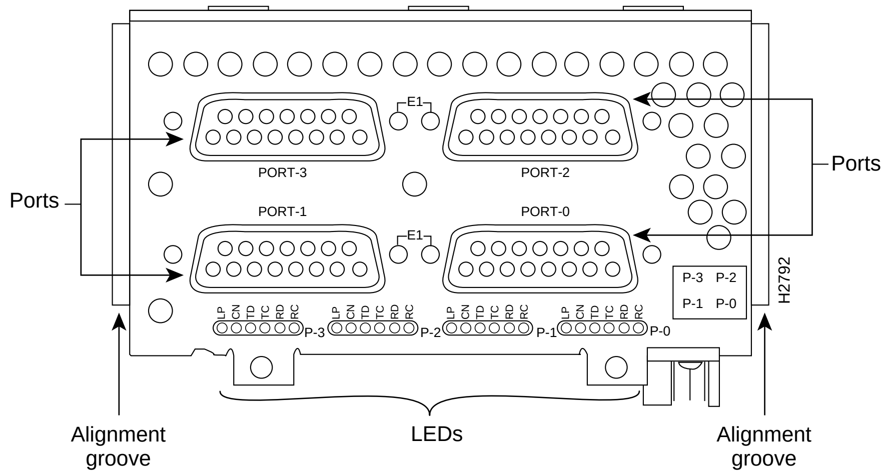


Figure 64 Four-Port Serial Network Processor Module Ports



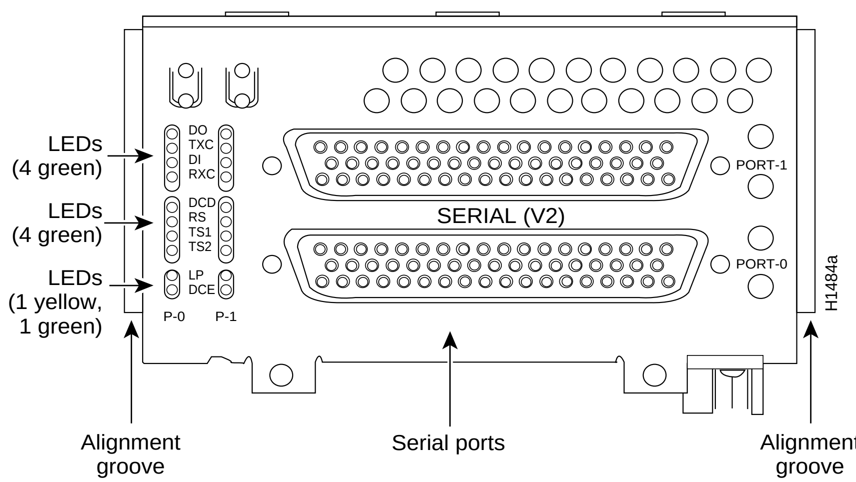
On the G.703/G.704 network processor module, the port numbering is as shown on the lower right in Figure 65.

Figure 65 G.703/G.704 Serial Network Processor Module Ports (DB-15)



On the dual-port serial module, the port numbering is as shown on the right in Figure 66.

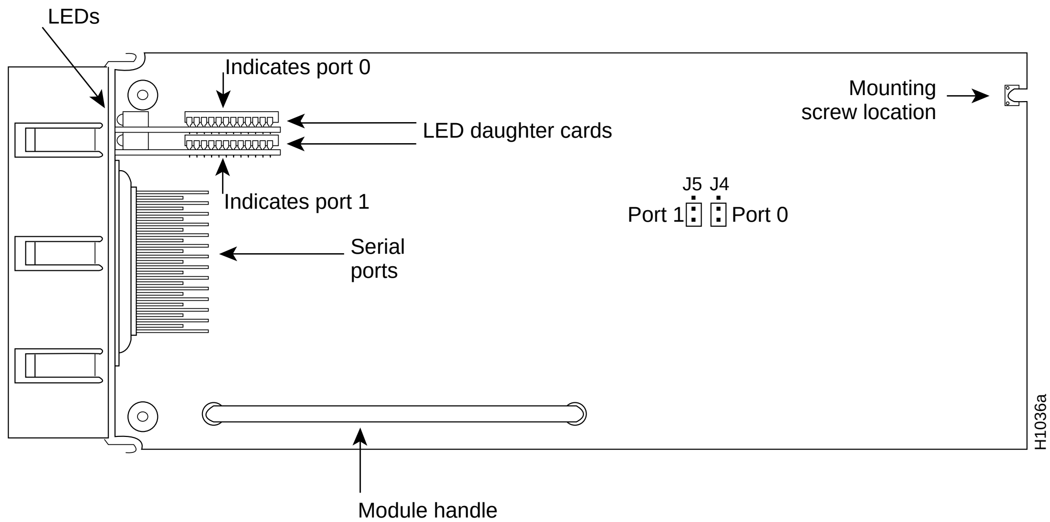
Figure 66 Dual-Port Serial V2 Network Processor Module Port



Dual-Port Serial Module LED Daughter Cards

Two LED daughter cards are attached to the front of the dual-port serial module. (See Figure 67.)

Figure 67 Dual-Port Serial Network Processor Module—Top View



Dual-Port Serial Module Jumper Settings

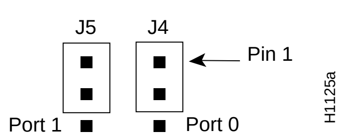
The dual-port serial module contains two jumpers, J4 and J5 (see Figure 67), which determine whether the ports are configured for nonreturn to zero (NRZ) or nonreturn to zero inverted (NRZI). The factory-configured (default) jumper setting connects pins 2 and 3 for NRZ.

To configure for NRZI mode on each port, the jumper must connect pins 1 and 2 of the respective jumper locations. (See Figure 68.) J-4 configures serial port 0, and J-5 configures serial port 1. (For NRZ only, the jumpers that connect pins 2 and 3 can be removed.)

If the module is operating as DTE in NRZI mode, the sense of the **dte-invert-timing** command has to be manually changed. For example, if the command **no dte-invert-timing** was previously entered in the configuration file, then **dte-invert-timing** must be configured for the module to operate as DTE in NRZI mode. (See the section "Configuring the Serial Interfaces" on page 71.)

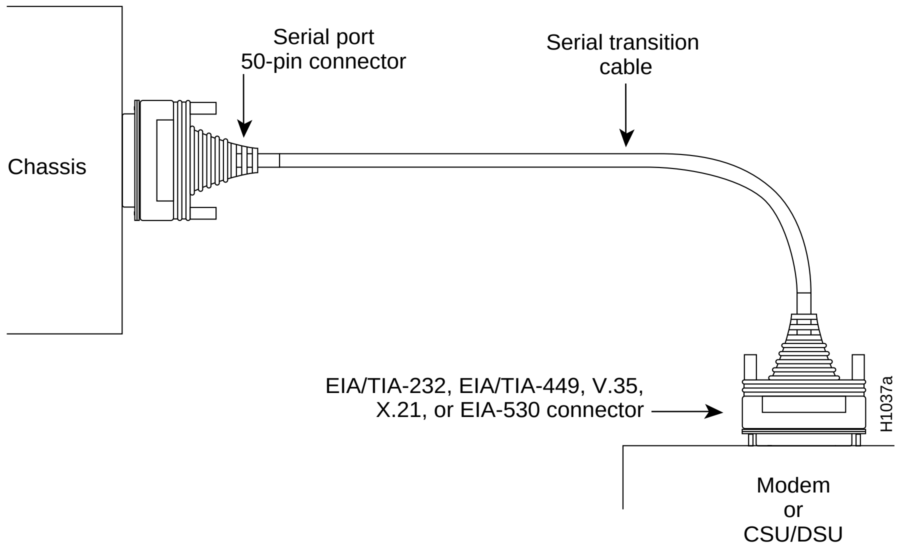
To set the jumpers for NRZI, move the jumpers to the position shown in Figure 68.

Figure 68 Dual-Port Serial Network Processor Module Jumpers, J-4 and J-5—NRZI Setting



You must use a special serial transition cable to connect Cisco 4000 series routers to a modem, CSU/DSU, or other device, as shown in Figure 69. This cable, which is available from your customer service representative, is normally ordered with the system. In all, nine different serial cables are available for the two versions of serial modules: DTE and DCE versions of V.35, EIA/TIA-232, EIA/TIA-449, and X.21, plus a DTE version of EIA-530. *The cables for the two versions are not interchangeable.*

Figure 69 Cisco 4000 Series Serial Cable Connections (50-Pin Connector Cable Shown)



Serial ports configured as DCE must also be configured with the **clockrate** command. An error message will be generated if there is a mismatch between the cable and the software configuration of the port—for example, if the cable is DTE and clock rate is set, or if the cable is DCE and clock rate is not configured.

Note If you have Cisco IOS Software Release 11.0 or earlier, refer to the *Router Products Configuration Guide* for more information on software commands. If you are using Cisco IOS Software Release 11.1 or later, refer to the *Configuration Fundamentals Configuration Guide* for more information.

Four-Port Serial Module and G.703/G.704 Module LEDs

The four-port serial module (including the G.703/G.704 module) has six LEDs per port. LEDs and colors are explained in Table 16. The LEDs on the four-port serial module have different functions than those on the dual-port serial module.

The LEDs are named in accordance with standard serial interface naming conventions. For example, TD is always associated with the data that is driven by the DTE whether the port on the serial module is a DTE or a DCE. TD will reflect output data when the port is a DTE and input data when the port is a DCE. RD is controlled in a similar way. TC and RC are always associated with the clocks that are driven by the DCE: outputs for a DCE port and inputs for a DTE.

The TC, RC, TD, RD LEDs are on only when the associated line is changing state; if a line remains high or low, the LED is off.

Table 16 Four-Port Serial Network Processor Module LEDs

LED	Color	Indication
LP	Yellow	Loop
CN	Green	Connect (DSR, DTR, DCD, RTS, CTS)
TD	Green	Transmit Data
TC	Green	Transmit Clock
RD	Green	Receive Data
RC	Green	Receive Clock

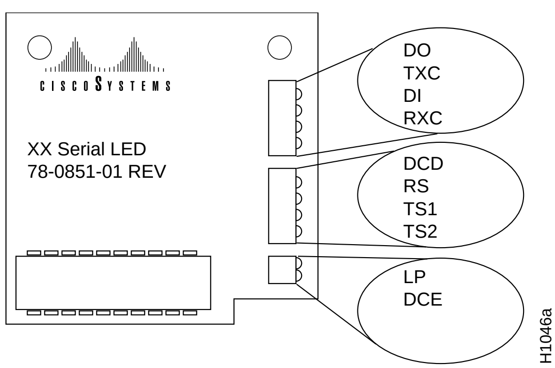
Dual-Port Serial Module LEDs

The dual-port serial module has two LED cards and ten LEDs per port (see Figure 70), and can be configured for either DTE or DCE. Viewed from the connector end of the module, the left card is labeled P-0 (for port 0), and the right card is labeled P-1 (for port 1). The lower serial port is port 0, and the upper serial port is port 1, as shown on the labels.

Figure 67 shows the top view of the dual-port serial module. Note the locations of the LED daughter cards and the ports that they indicate.

When DCE cables are used, the bottom LED will go on.

Figure 70 Dual-Port Serial LED Card—Side View



The dual-port serial module LEDs are described in Table 17.

Table 17 Dual-Port Serial Network Processor Module LEDs

Serial LED Card Outer Labels	Indication	DTE	DCE
DO	Data Out	TXD	RXD
TXC	Transmit Clock		
DI	Data In	RXD	TXD
RXC	Receive Clock		
DCD	Data Carrier Detect		
RS	Receive Signaling	CTS	RTS
TS1	Transmit Signaling 1	RTS	CTS
TS2	Transmit Signaling 2	DTR	DRS
LP	Loop		
DCE	On if network processor module is DCE		

For information on configuring the serial interfaces, proceed to the section "Configuring the Serial Interfaces" on page 71.

BRI Network Processor Module

The BRI network processor modules (see Figure 71 and Figure 72) support either four or eight BRI ports. Each BRI port is an RJ-45 8-pin connector. Use an appropriate cable to connect the BRI module directly to the ISDN through an ISDN CSU/DSU called the NCT1. In all locations except North America, the common carrier will provide the NCT1 connection. In the U.S. and Canada, NCT1 is owned by the customer.

Caution The BRI four-port and eight-port network processor modules can not be used with the CT1/PRI module or the CE1/PRI module.

Warning Network hazardous voltages are exposed in the BRI cable. If you detach this cable, *detach the end away from the router first to avoid possible electric shock.* Hazardous voltages are also exposed on the BRI module near the BRI port (RJ-45 connector), even when power is turned OFF. (See Figure 71 and Figure 72.)

Specifications for the BRI cable are listed in Table 18.

Figure 71   Eight-Port BRI Network Processor Module

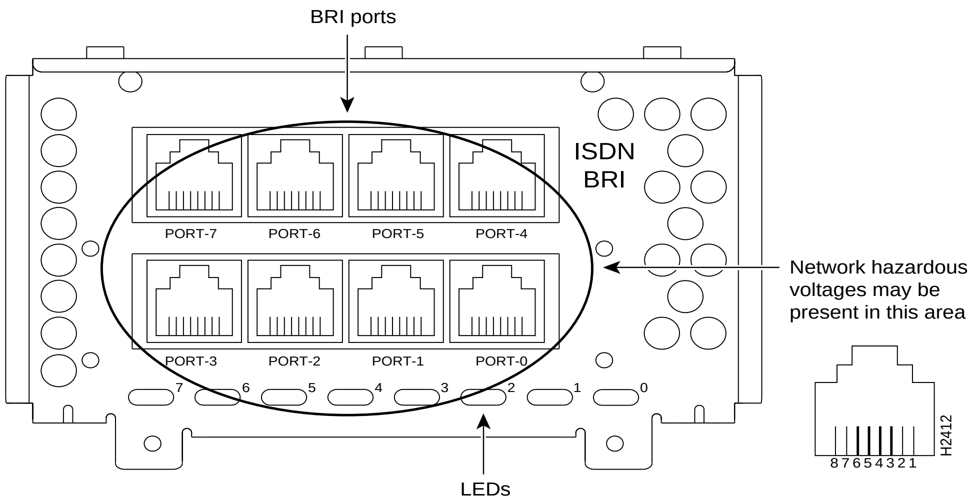


Figure 72   Four-Port BRI Network Processor Module

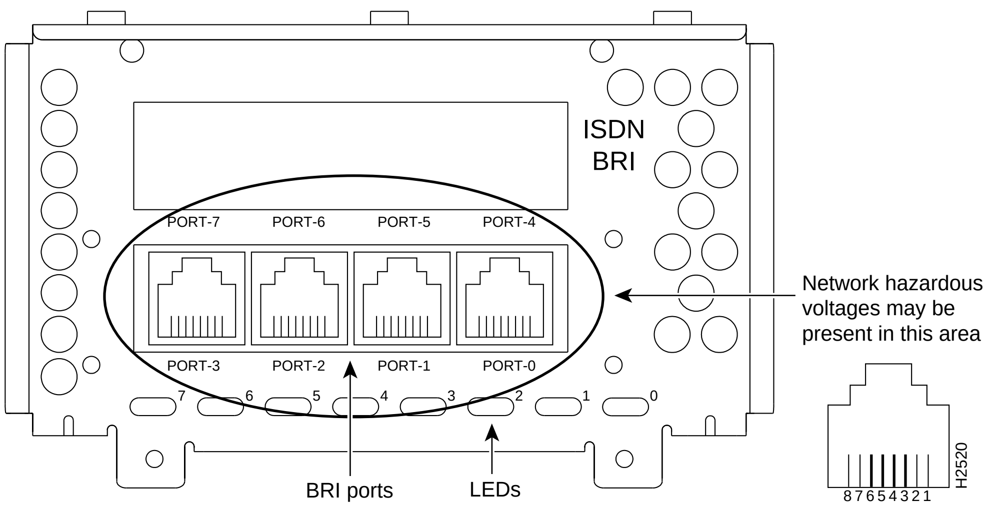


Table 18   BRI Cable Specifications

Parameter	High-Capacitance Cable	Low-Capacitance Cable
Resistance (@ 96 kHz[1])	160 ohms/km	160 ohms/km
Capacitance (@ 1 kHz)	120 nF/km[2]	30 nF/km
Impedance (@ 96 kHz)	75 ohms	150 ohms
Wire diameter	0.024" (0.6 mm)	0.024" (0.6 mm)
Distance limitation	32.8' (10 m)	32.8' (10 m)

1. kHz = kilohertz.
2. nF = nanofarad.

Note All the interfaces on the multiport BRI module must connect to the same carrier or from carriers with synchronized master clocks. If the BRI module connects to ISDN interfaces that have an unsynchronized master clock, the module interfaces will occasionally lose some packets.

Making BRI Connections

The BRI module supports point-to-point operation at OSI Layer 1. Only one source (the transmitter) and one sink (the receiver) are actively transmitting at any time in each direction at an S interface (ITU-T specification I.430 section 3.1). The BRI module does not support a point-to-multipoint wiring configuration, so D-channel access procedures are not implemented.

BRI Pinout

The BRI interface port pinout is listed in Table 19.

Table 19 BRI Port Pinout (RJ-45)

8 Pin[1]	TE[2]	NT[3]	Polarity
3	Transmit	Receive	+
4	Receive	Transmit	+
5	Receive	Transmit	–
6	Transmit	Receive	–

1. Pins 1, 2, 7, and 8 are not used.
2. TE refers to terminal terminating layer 1 aspects of TE1, TA, and NT2 functional groups.
3. NT refers to network terminating layer 1 aspects of NCT1 and NT2 functional groups.

Caution To prevent damage to the system, make certain that you connect the BRI cable to the BRI connector *only* and not to any other RJ-45 connector.

Testing the BRI Interface

An external loopback RJ-45 connector, which is useful for isolating hardware problems on an individual BRI port, can be constructed by taking the following steps:

Step 1 Connect pin 3 to pin 4. (See Figure 71 and Figure 72.)

Step 2 Connect pin 5 to pin 6.

Step 3 Connect a 50 ohm resistor across pin 3 and pin 5.

Note Pins 1, 2, 7, and 8 are not connected.

With the loopback RJ-45 connector plug installed in a BRI port, use the **test interface** command to verify that the hardware is functioning correctly.

BRI Network Processor Module LEDs

When on, the multiport BRI module status LEDs indicate a Layer 1 connection on the corresponding port. When off, the LEDs indicate that a link is not established on the port.

Replacing Boot ROMs

The Cisco 4000 series routers provide an alternative boot image called the boothelper, which is a subset of the full Cisco IOS image. The boot helper image enables you to netboot a new image to Flash memory if the image in Flash memory is inadvertently erased.

The original Cisco 4000 and the Cisco 4000-M use boot ROMs for storing the boothelper Cisco IOS image. To upgrade the boot ROM software to a new image in these models, the existing boot ROMs must be replaced. In the Cisco 4500, Cisco 4500-M, Cisco 4700, and Cisco 4700-M, the boothelper image is stored in Flash memory and can be upgraded while the full Cisco IOS image is operating.

Caution The correct placement of the boot ROMs is crucial. Improper positioning can damage new components when the system is powered ON. To prevent damage to the ROMs from ESD (when handling the system and its components), follow the ESD procedures described in "Safety with Electricity" on page 6. Be careful not to damage or scratch the printed circuit card under the ROMs. Read through all of the instructions in this section before proceeding.

Take the following steps to replace existing boot ROMs:

Step 1 Open the chassis and expose the boot ROMs using the procedures described in the section "Accessing the Network Processor Modules" on page 10.

Step 2 When the boot ROMs, FW1 and FW2, on the system card are exposed (see Figure 7 and Figure 73), follow the procedures in this section to replace the ROMs.

Note It is not necessary to remove the Flash erasable programmable read-only memory (EPROM) card for this upgrade procedure.

Step 3 Locate the boot ROMs, FW1 and FW2. (See Figure 73 for the Cisco 4000-M and Figure 74 for the Cisco 4000.)

Step 4 Using an EPROM extraction tool or a small flat-blade screwdriver, gently remove the boot ROMs and set them aside.

Step 5 Insert the new boot ROMs in their respective sockets in the orientation shown in Figure 73, being careful not to bend or crush any of the bottom pins. To straighten out a bent pin, use needlenose pliers. Align the notch in the new ROM with the notch in the ROM socket, ignoring the orientation of the label.

Step 6 If you have a Cisco 4000-M, jumpers J7 and J8 must be set to designate the capacity of the Boot ROMs.

- For boot ROMs version Cisco IOS Release10.2(8) and higher short pins 2 and 3 on both jumper locations, J7 and J8 as shown in the 8 MB boot ROMs position.
- To short pins 2 and 3 on J7 and J8, install the jumper block over the two pins located away from the Flash memory SIMMs, as shown in the 8 MB boot ROMs position on Figure 73.

— For 4 MB boot ROMs, prior to Cisco IOS Release10.2(8), install the jumper on the upper two pins at J8 and the lower two pins at J7.

Step 7 If you have a Cisco 4000, jumpers J5 and J6 must be set to designate the capacity of the boot ROMs.

— For boot ROMs Cisco IOS Release 10.2(8) and higher short pins 2 and 3 on both jumper locations, J5 and J6 as shown in the 8 MB boot ROMs position.

— To short pins 2 and 3 on J5 and J6, install the jumper block over the two pins located away from the Flash EPROM card, as shown in the 8 MB boot ROMs position on Figure 74.

— For 4 MB boot ROMs, which are prior to Cisco IOS 10.2(8), install the jumper on the upper two pins at J6 and the lower two pins at J5.

Step 8 Proceed to the section, “Replacing the Component Tray.”

Figure 73 Cisco 4000-M Boot ROM and Boot ROM Jumper Locations

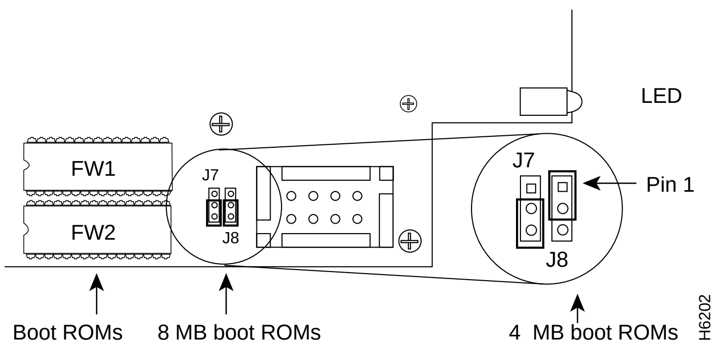
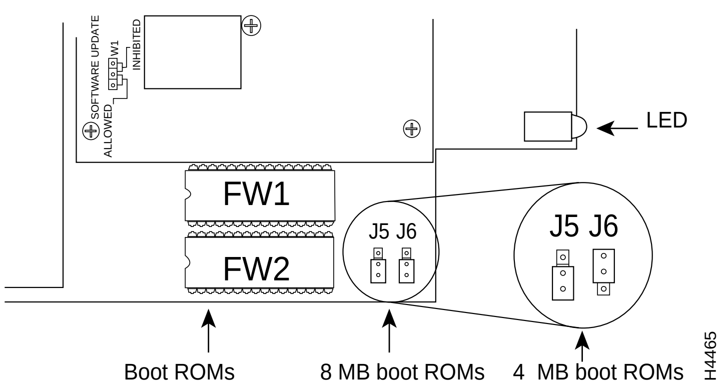


Figure 74 Cisco 4000 Boot ROM and Boot ROM Jumper Locations



Replacing or Adding Network Processor Modules

Take the following steps to replace or add a network processor module:

Step 1 Hold the module by its handle, align it with the grooves in the chassis (not shown) and over its connector, and push the module lightly against the chassis wall. (See Figure 8.)

Step 2 Push the network processor module into place without bending the connector pins, inserting the male module connector into the female connector on the motherboard.

Step 3 Replace the module mounting screw in its place on the end of the module. (See Figure 7.)

Step 4 Replace any required external rear mounting screws to attach the module to the rear of the chassis.

Caution Do not overtorque the screws because you may damage the network processor module or the underlying motherboard. The maximum screw torque is 7-inch-lb.

Replacing the Component Tray

Take the following steps to replace the component tray in the chassis shell:

Step 1 Reinsert the component tray into the shell, pushing on the back of the tray while pressing on the chassis release screw with the thumb of your right-hand.

Step 2 Retighten the chassis release screw.

Replacing the Final Connections to the Router

Take the following steps to make the final connections to the router:

Step 1 Plug the system power cord into a 3-terminal, single-phase power source that provides power within the acceptable range (200W, 85 to 264 VAC, 50 to 60 Hz or 40 to 72 VDC).

Step 2 Turn ON the system power switch. The POWER LED on the front should go ON. (See Figure 2.)

Step 3 Check the OK LED on the right side of the front panel (see Figure 2) to verify that it goes ON after a few seconds delay when booting.

Configuring the Router

If you have installed a new network processor module or want to change the configuration of an existing interface, you must enter configuration mode. If you replaced a previously configured module, the system will recognize the new interfaces and bring up each in the existing configuration.

When the new module is installed correctly, use the privileged-level **configure** command to configure the new interfaces.

Note The **configure** command requires privileged-level access to the EXEC command interpreter, which usually requires a password. Contact your system administrator to obtain access if necessary.

You should have available the following information:

- Protocols you plan to route on each new interface
- IP addresses if you will configure the interfaces for IP routing
- Whether the new interfaces will use bridging
- Timing source for each new interface and clock speeds for external timing

---

Note You can find additional software configuration information by referring to the appropriate documentation. If you have Cisco IOS Software Release 11.0 or earlier, refer to the *Router Products Configuration Guide* and *Router Products Command Reference*s. If you are using Cisco IOS Software Release 11.1 or later, refer to the *Configuration Fundamentals Configuration Guid*e and the *Configuration Fundamentals Command Reference*.

Configuring the Serial Interfaces

The following sections describe the commands for configuring an external clock signal for a DCE interface and for configuring a port for NRZI encoding or 32-bit cyclic redundancy check (CRC). Configuration commands are entered at the privileged level of the EXEC command interpreter.

For more information on clock signal and NRZI encoding, see the section "Dual-Port Serial Module Jumper Settings" on page 62. For G.703/G.704 interface configuration, see the section "Configuring G.703/G.704 Interfaces" on page 73.

Configuring Timing (Clock) Signals for Serial Interfaces

All serial interfaces support both DTE and DCE modes, depending on the mode of the interface cable attached to the port. Follow these guidelines to set DTE and DCE modes:

- To use a port as a DTE interface, connect a DTE adapter cable to the port. When the system detects the DTE mode cable, it automatically uses the external timing signal.
- To use a port in DCE mode, you must connect a DCE interface cable and set the clock speed with the **clockrate** configuration command.

Setting the Clock Rate on Serial Interfaces

All DCE interfaces require a noninverted internal transmit clock signal, which is generated by the serial module. The default operation on a DCE interface is for the DCE device to generate its own clock signal (TXC) and send it to the remote DTE. The remote device returns the clock signal to the DCE. The **clockrate** command specifies the rate as a bits-per-second value. In the following example, the clock rate for the top serial interface on a dual-port serial module is defined as 72 kbps:

```
interface serial 1
clockrate 72000
```

Use the **no clockrate** command to remove the clock rate for DTE operation. Following are the acceptable clock rate settings:

1200	125000
2400	148000
4800	500000
9600	800000
19200	1000000
38400	1300000
56000	2000000
64000	4000000
72000	

Speeds above 64 kbps (64000) are not supported for EIA/TIA-232. On all interface types, if your cable is too long, faster speeds might not work.

Inverting the Clock Signal on Serial Interfaces

Systems that use long cables may experience high error rates when operating at the higher transmission speeds. Slight variances in cable construction, temperature, and other factors can cause the clock and data signals to shift out of phase. If a DCE port is reporting a high number of error packets, a phase shift might have occurred. Inverting the clock can often correct this shift.

When a port is operating in DCE mode, the default operation is for the attached DTE device to return the clock signal (SCTE) to the DCE port. The DCE sends SCT and SCR clock signals to the DTE, and the DTE returns an SCTE clock signal to the DCE. If the DTE device does not return SCTE, use the **dce-terminal-timing-enable** command to configure the DCE port to use its own clock signal in place of the SCTE signal normally returned from the DTE device.

To configure an interface to accept the serial interface internal clock in place of the SCTE clock, specify the interface followed by the **dce-terminal-timing-enable** command. In the example that follows, the serial 0 port has been configured to accept the internal clock signal:

```
interface serial 0
dce-terminal-timing-enable
```

To turn off this command, use the **no dce-terminal-timing-enable** command.

When the serial port is a DTE, the **invert-txc** command inverts the TXC clock signal it receives from the remote DCE. When the serial port is a DCE, this command inverts the clock signal to the remote DTE port. Use the **no invert-txc** command to change the clock signal back to its original phase. The **no invert-txc** command is redundant with the four-port serial module because the module will automatically discover the polarity of the clock and invert the signal.

Configuring NRZI Format on Serial Interfaces

All interfaces support both NRZ and NRZI formats; which use two different voltage levels for transmission. NRZ signals maintain constant voltage levels with no signal transitions (no return to a zero voltage level) during a bit interval and are decoded using absolute values (0 and 1). NRZI uses the same constant signal levels but interprets the presence of data at the beginning of a bit interval as a signal transition and the absence of data as no transition. NRZI uses differential encoding to decode signals, rather than determining absolute values.

NRZ format, the factory default on all interfaces, is the most common. NRZI format is commonly used with EIA/TIA-232 connections in IBM environments. To enable NRZI encoding on any interface, specify the port address of the interface followed by the command **nrzi-encoding**. In the example that follows, serial port 0 is configured for NRZI encoding:

```
router# configure terminal
interface serial 0
nrzi-encoding
^Z
```

Note To disable NRZI encoding on a port, specify the port and use the **no nrzi-encoding** command. For complete command descriptions and instructions, refer to *Router Products Command Reference* if you are using Cisco IOS Software Release 11.0 or earlier. Refer to *Configuration Fundamentals Command Reference* if you are using Cisco IOS Software Release 11.1 or later.

Calculating CRCs on Cisco 4000 Series Serial Interfaces

All Cisco 4000 series router serial interfaces support CRC-ITU-T, a 16-bit CRC. CRC is an error-checking technique that uses a calculated numeric value to detect errors in transmitted data. The sender of a data frame divides the bits in the frame message by a predetermined number to calculate a remainder or frame check sequence (FCS). Before it sends the frame, the sender appends the FCS value to the message so that the frame contents are exactly divisible by the predetermined number. The receiver divides the frame contents by the predetermined number. If the result is not 0, the receiver assumes that a transmission error occurred and issues a request to the sender to resend the frame.

The designator 16 indicates the number of check digits per frame that are used to calculate the FCS. CRC-16, which transmits streams of 8-bit characters, generates a 16-bit FCS. Both the sender and the receiver must use the same setting of 16.

The default for all serial interfaces is for 16-bit CRC.

Configuring G.703/G.704 Interfaces

This section provides configuration guidelines for the Cisco 4000 series G.703/G.704 network processor module (balanced and unbalanced). The E1-G.703/G.704 interface supports both framed (G.704) and unframed (G.703) modes of operation; the default is for unframed operation.

The E1-G.703/G.704 interface is a 2.048-Mbps E1 telecommunications interface.

Many of the G.703/G.704 network processor module features and functions are common to synchronous serial data communications interfaces; this section describes the E1-G.703/G.704 features that differ from data communications interfaces features.

Caution If you are installing a new E1-G.703/G.704 interface in an installed system, ensure that your system configuration meets the minimum requirements for the new interfaces. Refer to the section “System Prerequisites” on page 4 for a description of these prerequisites.

The E1-G.703/G.704 interface mounts on the G.703/G.704 network processor module and connects Cisco 4000 series routers with 2.048-Mbps leased-line services. The E1-G.703/G.704 interface supports both framed and unframed modes of operation, a loopback test, and a four-bit CRC. The interface can operate with either a line-recovered or an internal clock signal.

Note The interface eliminates the need for a separate, external data termination unit to convert a standard serial interface (such as V.35) to a G.703/G.704/G.732 interface.

Two versions of the E1-G.703/G.704 interface are available: one supports balanced mode, and the other supports unbalanced mode.

The G.703/G.704 network processor module uses a 15-pin port that supports the E1-G.703/G.704 telecommunications interface. Figure 65 shows the E1-G.703/G.704 interface ports.

E1-G.703/G.704 Overview

G.703 is an International Telecommunication Union Telecommunication Standardization Sector (ITU-T) electrical and mechanical specification for connections between telecommunications interfaces and DTE.

Typically, G.703 provides a means of connecting standard serial interfaces such as V.35 to telephone lines or Postal Telephone and Telegraph (PTT) networks.

The E1-G.703/G.704 port supports point-to-point connections to Cisco 4000 series routers from 2.048-Mbps, E1 leased-line services, and eliminates the need for a separate, external data termination unit that is typically used to convert standard serial interfaces, such as V.35, to E1-G.703/G.704.

Balanced and Unbalanced Modes

The E1-G.703/G.704 interface is available in either balanced or unbalanced mode. Balanced interfaces typically use three conductors and three signal states: high, low, and ground. The high and low signals mirror each other. Unbalanced interfaces use only two signals: signal and ground.

A unique port supports each type. Neither the modes nor the cables are interchangeable; you cannot configure a balanced port to support an unbalanced line, nor can you attach an interface cable intended for a balanced port to an unbalanced port.

In addition to the agency approval label on each G.703/G.704 network processor module port, the **show controllers** command shows the mode of each interface. The fourth line of the following example shows that this is output from an unbalanced G.703/G.704 network processor module:

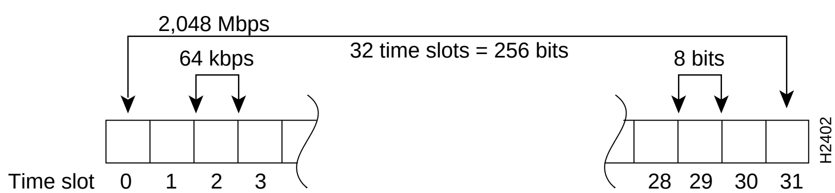
```
Router# show controller serial 0
HD unit 0, NIM slot 1, NIM type code 12, NIM version 1
idb = 0x8C18, driver structure at 0x4B7A30, regaddr = 0x8100000
buffer size 1524  G.703 Unbalanced
cpb = 0x3, eda = 0xA80, cda = 0x800
RX ring with 32 entries at 0x6030800
00 bd_ptr=0x0800 pak=0x4B7ADC ds=0x603018C status=80 pak_size=0
01 bd_ptr=0x0814 pak=0x4B7C30 ds=0x60315A0 status=80 pak_size=0
02 bd_ptr=0x0828 pak=0x4B7D84 ds=0x6031C24 status=80 pak_size=0
[text ellided from example]
32 bd_ptr=0x0A80 pak=0x4BA55C ds=0x603DF9C status=80 pak_size=0
cpb = 0x3, eda = 0x1000, cda = 0x1000
TX ring with 8 entries at 0x6031000
00 bd_ptr=0x1000 pak=0x000000 ds=0x000000 status=80 pak_size=0
01 bd_ptr=0x1014 pak=0x000000 ds=0x000000 status=80 pak_size=0
02 bd_ptr=0x1028 pak=0x000000 ds=0x000000 status=80 pak_size=0
[text ellided from example]
08 bd_ptr=0x10A0 pak=0x000000 ds=0x000000 status=80 pak_size=0
0 missed datagrams, 0 overruns, 0 bad frame addresses
0 bad datagram encapsulations, 0 memory errors
0 transmitter underruns
```

Framed and Unframed Operation

The E1-G.703 interface is divided into 32 time slots or frames. (See Figure 75.) Each of the 32 time slots is an 8-bit frame that transmits data at 64 kbps. Each of these time slots can be configured to carry data or to remain empty. (The E1-G.703/G.704 port inserts an idle pattern into empty time slots.) Observe the following guidelines for framed and unframed operation:

- Time slot 0, or the first 8 bits, is reserved as overhead.
- The remaining 248 bits (31 frames with 8 bits each) are designated time slots 1 through 31.
- Time slot 16 is also designated as a framing slot when using framed mode. When you use the default unframed mode (G.703), you can configure time slot 16 to carry data and operate as any of the other slots; time slot 0 must be designated as a framing signal; time slot 16 can be configured for either data or framing.
- Unframed mode uses all 32 time slots for data (data is also called payload). None of the 32 time slots are used for framing signals. This enables each of the 32 time slots to transmit at 64 kbps. (For example, 32 time slots x 64 kbps = 2.048 Mbps.)

Figure 75 Time Slot Diagram



Framed mode (G.704) enables you to specify a bandwidth for the interface by designating some of the 32 time slots for data and reserving others for framing (timing). When you use framed mode, you must designate start and stop time slots; the slots within these boundaries are used for data, and the remaining slots are left idle. For example, on an interface with framing set on time slots 1 through 8, the interface will carry data within the specified 8 frames, and frames 9 through 31 will remain idle. Because each time slot transmits at 64 kbps, the interface will operate at 512 kbps (8 frames x 64 kbps = 512 kbps).

By configuring 16 of the time slots to carry data and 16 to remain empty, you configure the interface for 1.024 Mbps (by leaving half of the time slots empty and unable to carry data). The G.703/G.704 network processor module inserts an idle pattern into unused time slots, identifying them as overhead (unused for data). Only one contiguous time slot range can be used.

In PBX systems, time slot 16 is always left unused. By default, time slot 16 is *not* enabled for data in the G.703/G.704 network processor module E1-G.703/G.704 interface. Time slot 16 is used for data if it is within the specified range of data slots. The command **timeslot 16** overrides the default and enables time slot 16 to carry data.

Unframed mode is the default mode. You can specify unframed mode with the command **timeslot 0**, which specifies time slot 0 as the start slot with no stop (ending) time slot; therefore, all slots are used for data. The **no timeslot** command also restores the default of unframed mode.

CRC4

Framed mode supports a four-bit CRC, which you enable with a software command. The default is for no CRC. Refer to the section “Configuring CRC-4 for E1-G.703/G.704 Interfaces” on page 79.

Clock Source

The E1-G.703/G.704 interface, which is a Telecommunications interface, does not operate in the DTE and DCE modes that are typical of data communications interfaces. The E1-G.703/G.704 interface operates with either a line-recovered or an internal clock signal.

The default is to use the clock signal that the interface recovers from the received data stream. The interface can also operate with an internal clock signal. The E1-G.703/G.704 port generates the internal clock signal, and does not use the module-generated clock.

Note Because the E1-G.703/G.704 interfaces operate at a default clock rate of 2.048 Mbps (E1 speed), we recommend that you shut down a single module port to avoid exceeding the 8 Mbps maximum *per* module when all four ports are running in unframed mode. However, in framed mode, the data rate automatically declines to 4 x 1.984 Mbps; eliminating the need to shut down any ports.

Ports and Cables

The G.703/G.704 network processor module is configured at the factory with four E1-G.703/G.704 interface ports. Each port provides one 15-pin, D-shell (DB-15) receptacle, which supports only E1-G.703/G.704 interfaces. (See Figure 65.)

The G.703/G.704 network processor module uses a DB-15 receptacle for both the balanced and unbalanced ports. You must connect the correct type of interface cable for the port to operate.

The G.703/G.704 network processor module end of all E1-G.703/G.704 adapter cables is a DB-15 connector. At the network end, the adapter cable for unbalanced connections uses a BNC connector. The adapter cables for balanced mode are available with several connector types to accommodate connection standards in different countries.

You must use the proprietary cables to connect the E1-G.703/G.704 port to your network. Cables for balanced and unbalanced mode are available with the following types of network-end connectors:

- Unbalanced (75 ohm) coaxial cables with BNC connectors at the network end (used primarily for connection in the United Kingdom), see Figure 76.
- Balanced (120 ohm) with a DB-15 connector at the network end, see Figure 77.
- Balanced (120 ohm) twinaxial split cable at the network end, with separate transmit and receive cables, each with a twinax connector, see Figure 78.

In addition to these cables, some connections require bare-wire connections directly to terminal posts.

Model Numbers

Table 20 lists the model numbers and descriptions of the E1-G.703/G.704 ports and cables.

Table 20 Model Numbers and Descriptions of E1-G.703/G.704 Ports and Cables

Port and Cable Model Numbers	Description
NP-4GB=[1]	Four-port E1-G.703/G.704, 120 ohm, balanced
NP-4GU=	Four-port E1-G.703/G.704, 75 ohm, unbalanced
CAB-E1-TWINAX=	E1 cable, TWINAX, 120 ohm, balanced, 5 m
CAB-E1-DB15=	E1 cable, DB-15, 120 ohm, balanced, 5 m
CAB-E1-BNC=	E1 cable, BNC, 75 ohm, unbalanced, 5 m

1. The appended equal sign (=) indicates a spare part.

G.703/G.704 Maximum Cable Lengths

Unbalanced G.703 interfaces allow for a longer maximum cable length than those specified for balanced circuits. Table 21 lists the maximum cable lengths for each E1-G.703/G.704 cable type by the connector used at the network end (away from the network processor module).

Table 21 E1-G.703/G.704 Maximum Cable Lengths

Connection Type	BNC	Twinax
Balanced	–	300 m
Unbalanced	600 m	–

G.703/G.704 Cable Connections

Figure 76, Figure 77, and Figure 78 show the unbalanced and balanced cables used for connection between the E1-G.703/G.704 port and your network. The port adapter end of each cable has a DB-15 connector.

Figure 76 E1-G.703/G.704 Interface Cable for Unbalanced Connections (with BNC Connectors and Coaxial Cables)

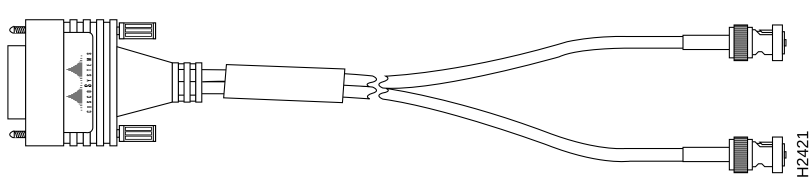


Figure 77 E1-G.703/G.704 Interface Cable for Balanced Connections (with DB-15 Connectors on Both Ends)

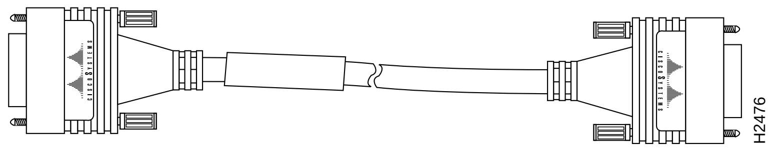
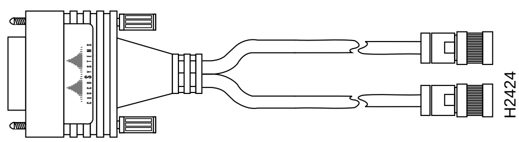


Figure 78 E1-G.703/G.704 Interface Cable for Balanced Connections (with Twinax Connectors and Cables)



Caution It is a requirement of the statutory approval of the E1-G.703/G.704 interface that the jackscrews of the connector backshell are securely screwed down while the E1-G.703/G.704 network processor module is operating.

Configuring the G.703/G.704 Interfaces

This section describes the commands for configuring individual interfaces for framed or unframed mode, four-bit CRC, and loopback, and for specifying a clock source.

When you have verified that the new G.703/G.704 network processor modules are installed correctly (the enabled LED goes on), use the privileged level **configure** command to configure the new interfaces.

You should have available the information you will need, such as the following:

- Timing source for each new interface (a line-derived or internal clock signal)
- A decision to use framed or unframed mode on E1-G.703/G.704 interfaces

The following are the default settings for all E1-G.703/G.704 interfaces; each can be enabled or disabled with software commands:

- Unframed mode
- No CRC enabled
- Time slot 16 is not used for payload
- No loopback
- Clock source operation (line or internal)

Note Always enter the **clear interface** command after you change interface configuration, particularly after you change time slot or CRC4 settings.

Configuring Framed and Unframed Mode for E1-G.703/G.704 Interfaces

The E1-G.703/G.704 interfaces support both framed (G.704) and unframed (G.703) modes of operation; the default is for unframed operation. To enable framed operation, you must specify the start and stop slots, separated by a hyphen, as follows:

```
[no] timeslot 0/start-slot-31/stop_slot
```

Following is a sample display of the **timeslot** command with a start slot of 1 and a stop slot of 13:

```
router# timeslot 1-13
```

Invalid combinations of start and stop slots will be ignored and the interface will be left unchanged.

The system default is not to use time slot 16 for data. To use slot 16 for data, use the **timeslot 16** command. To restore the system default, use the **no timeslot 16** command.

Configuring Timing (Clock) Signals for E1-G.703/G.704 Interfaces

The E1-G.703/G.704 port operates either with an external clock signal that it recovers from the received data stream (the default clocking) or with its own internal clock signal. To specify the clock source, use the **clock source** {**line** | **internal**} command.

To change the default and use the internal clock, use the **clock source internal** command.

To return the interface to the default state, use the **clock source line** command. (You can also negate either of these commands to change a setting; for example, the **no clock source internal** command also returns the interface to the default state.) All E1-G.703/G.704 interfaces operate at a default clock rate of 2.048 Mbps; the clock rate cannot be configured.

Configuring CRC-4 for E1-G.703/G.704 Interfaces

CRC-4 is a 4-bit error checking technique that uses a calculated numeric value to perform an ongoing data integrity check and detect errors in transmitted data. The E1-G.703/G.704 network processor module supports CRC in framed mode only. By default, CRC-4 is not enabled.

To enable CRC-4 on the E1 interface, specify the port address of the interface followed by the command **crc4**. Press **Ctrl-Z** after altering the configuration and before exiting the configuration mode.

In the example that follows, serial 3 on an E1-G.703/G.704 network processor module is configured for CRC:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router (config)# interface serial 3
(config-if)# crc4
(config-if)# ^Z
```

To disable CRC and return to the default of no CRC error checking, specify the port and use the **no crc4** command. Refer to the appropriate documentation for additional information on software configuration.

Alarms on E1-G.703/G.704 Interfaces

Following are definitions and descriptions of the five alarms used with the E1-G.703/G.704 interface:

- AIS—The alarm indication signal occurs and a failure is declared (for E1 links) when 64 consecutive ones occur on the Receive Data (RD) line between the unit number and the network processor module.
- RAI—The remote alarm indication (also called the far end alarm and distant alarm for E1 links) is sent by the remote end of the link to indicate failure at the remote end. This failure is declared (for E1 links) when 32 contiguous pulse positions have no pulse of either positive or negative polarity.
- LOS—The loss of signal alarm occurs and a failure is declared (for E1 links) when more than ten consecutive zeros are detected.
- LOF—The loss of frame alarm occurs and a failure is declared (for E1 links) when an out-of-frame (OOF) defect has persisted for T seconds, where $2 \leq T \leq 10$. This failure is cleared when there have been no OOF defects during a period T seconds, where $0 \leq T \leq 20$.
- SQ—The signal quality alarm occurs and a failure is declared (for E1 links) when the bit error rate (BER) is greater than 10^{-3} on the RD line on the interface.

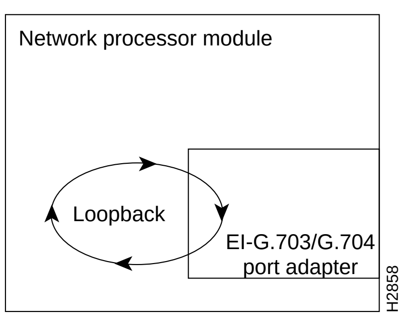
Loopback

The E1-G.703/G.704 network processor module supports the same local loopback test as the other (data communications) Cisco 4000 series serial interfaces. Loopback functions enable you to check the integrity of the physical data path between the module and the E1 port with the **loopback** command. The **no loopback** command disables all loopback tests on the interface.

Because the E1-G.703/G.704 interfaces uses a default clock rate of 2.048 Mbps, you do not have to configure a clock signal on the interface before performing a loopback test.

On the E1 port, the loopback signal follows this path regardless of whether or not a cable is attached to the port. Figure 79 shows the path of the loopback function.

Figure 79 Loopback Path for G.703/G.704 Network Processor Module E1-G.703/G.704



E1-G.703/G.704 Cable Pinouts

Table 22 lists the signal pinouts for each type of E1-G.703/G.704 interface cable. All cables use a DB-15 connector at the G.703/G.704 network processor module end.

Table 22 E1-G.703/G.704 Adapter Cable Connector Pinouts

E1-G.703/G.704 Network Processor Module End		Network End				
DB-15[1]		DB-15	Null Modem DB-15	BNC	Twinax	
Pin	Signal[2]	Pin	Pin	Signal	Pin	Signal
9	Tx Tip	1	3	Tx tip	Tip	Signal
2	Tx Ring	9	11	Tx shield	Ring	Signal
10	Tx Shield	2	4	–	Shield	Shield
8	Rx Tip	3	1	Rx tip	Tip	Signal
15	Rx Ring	11	9	Rx shield	Ring	Signal
7	Rx Shield	4	2	–	Shield	Shield

1. Any pins not listed are not connected.
2. Tx = transmit; Rx = receive.

Checking the Router Configuration

When you have configured the serial interfaces, use the **show interface** command to check the network interface statistics. Options to the **show interface** command include the type of interface (for example, *serial*), and its unit number. The following example shows the output of **show interface** *serial 0*:

```
router> show interface serial 0

Serial 0 is up, line protocol is up
  Hardware is HD64570
  Internet address is 193.195.74.236, subnet mask is 255.255.255.248
 MTU 1500 bytes, BW 1544 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation HDLC, loopback not set, keepalive not set
  Last input 0:00:01, output 0:00:10, output hang never
  Last clearing of “show interface” counters never
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  Five minute input rate 0 bits/sec, 0 packets/sec
  Five minute output rate 0 bits/sec, 0 packets/sec
     2922 packets input, 5844 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 0 giants
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     145 packets output, 185562 bytes, 0 underruns
     0 output errors, 0 collisions, 1 interface resets, 0 restarts
     880 carrier transitions
```

To display the current internal status of an interface module, use the **show controller** command with the interface type and unit number options. (Note in the example that universal serial means the four-port serial module.) The following example shows the output of the **show controller** *serial 2* command:

```
router# show controller s 2
HD unit 2, idb 0x246AAC, ds 0x248240
buffer size 2108  Universal Serial: No cable
DCD=0  DSR=0  DTR=0  RTS=0  CTS=0
cpb = 0x4, eda = 0xDA18, cda = 0xD798
RX ring with 32 entries at 0x604D798
00 bd_ptr=0xD798 pak=0x604E728 ds=0x604E87C status=80 pak_size=0
01 bd_ptr=0xD7AC pak=0x604EEAC ds=0x604F000 status=80 pak_size=0
02 bd_ptr=0xD7C0 pak=0x604F630 ds=0x604F784 status=80 pak_size=0
(some screen output deleted)
32 bd_ptr=0xDA18 pak=0x605D7A8 ds=0x605D8FC status=80 pak_size=0
cpb = 0x4, eda = 0xE1E0, cda = 0xE1E0
TX ring with 8 entries at 0x604E1E0
00 bd_ptr=0xE1E0 pak=0x000000 ds=0x000000 status=80 pak_size=0
01 bd_ptr=0xE1F4 pak=0x000000 ds=0x000000 status=80 pak_size=0
02 bd_ptr=0xE208 pak=0x000000 ds=0x000000 status=80 pak_size=0
03 bd_ptr=0xE21C pak=0x000000 ds=0x000000 status=80 pak_size=0
04 bd_ptr=0xE230 pak=0x000000 ds=0x000000 status=80 pak_size=0
05 bd_ptr=0xE244 pak=0x000000 ds=0x000000 status=80 pak_size=0
06 bd_ptr=0xE258 pak=0x000000 ds=0x000000 status=80 pak_size=0
07 bd_ptr=0xE26C pak=0x000000 ds=0x000000 status=80 pak_size=0
08 bd_ptr=0xE280 pak=0x000000 ds=0x000000 status=80 pak_size=0
0 missed datagrams, 0 overruns, 0 bad frame addresses
0 bad datagram encapsulations, 0 memory errors
0 transmitter underruns
```

Note that in the previous example, the cable type is shown as no cable. If a cable is attached to the port, the cable type would be shown, as in the following example:

```
buffer size 2108  Universal Serial: DTE V.24 (RS-232) cable
```

If the cable is DCE, the output of the **show controller** command displays the clock rate.

Note For complete descriptions and instructions, refer to the *Router Products Command Reference* publications if you are using Cisco IOS Software Release 11.0 or earlier, or to the *Configuration Fundamentals Command Reference* if you have Cisco IOS Software Release 11.1 or later.

Problem Solving

Use the information in this section to help isolate problems. The key to problem solving in this system is to isolate the problem to a specific subsystem. By comparing what the system is doing to what it should be doing, the task of isolating a problem is greatly simplified.

Whether or not you locate the source of your problem, you can contact a service representative for information on how to proceed. Before you call, have the following information ready:

- Chassis type and serial number
- Maintenance agreement or warranty information
- Type of software and version number
- Date you received the new chassis
- Brief description of your problem
- Brief explanation of steps you took to isolate the problem

When problem solving, consider the following subsystems of the router:

- Power system—This subsystem includes the power supply and the wiring.
- Cooling system—The fan assemblies should go on when power is applied.
- Network processor modules—Problems with these modules can be the most difficult to troubleshoot. The LEDs on the network processor modules can be used to help identify a failure. Refer to the section “Reading Front Panel LEDs” on page 16 for a thorough reference.
- System cables—This subsystem includes all the external cables that connect the router to the network.

Troubleshooting the Power and Cooling Systems

Check the following items to help isolate the problem:

- With the power switch on and system LEDs on, do the fans operate?
    - If no, check the fan to confirm that it is faulty.
- Does the system shut down after being on a short time?
    - Check for an environmentally induced shutdown.
    - Check the environmental site requirements in the section “Safety Recommendations” on page 5 and ensure that the chassis intake and exhaust vents are clear.
    - Check for a power supply failure.
- LEDs do not turn on.
    - Make sure that the system is plugged in.
    - Check for a 5V power supply failure.

Troubleshooting the Network Processor Modules and Cables

Check for the following symptoms to help isolate the problem:

- Network processor module is not recognized by the system.
  - Check the network processor module connection to the motherboard connector to see if it is loose.
  - Check that the daughter card connectors on the module are correctly seated. (See Figure 9.)
  - Check the LEDs on the network processor module to see if they are off.
  - Check that the correct software version is installed.
- Network processor module is recognized, but interface port(s) will not initialize.
  - Check the motherboard connection to see if it is secure.
  - Check the external cables for connection.
  - Check the jumper settings for 75/120 ohm impedance.
  - Verify the linecode, framing, clock source, and timeslots.
- System will not boot properly or constantly or intermittently reboots.
  - Check the network processor module connection to the motherboard.
  - Check the processor or software to see if they are functioning properly.
  - Check that the correct software version is installed.
- System boots, but console screen is frozen.
  - Check that the external console connection is secure.
  - Verify the console baud rate in the documentation for the terminal.
- System powers on and boots with a particular network processor module disconnected from the motherboard.
  - The problem might be the network processor module.
- System powers on and boots with a particular network processor module or cable disconnected.
  - The problem could be the network processor module or cable.

Cisco Connection Online

Cisco Connection Online (CCO), formerly Cisco Information Online (CIO), is Cisco Systems' primary, real-time support channel. Maintenance customers and partners can self-register on CCO to obtain additional content and services.

Available 24 hours a day, 7 days a week, CCO provides a wealth of standard and value-added services to Cisco's customers and business partners. CCO services include product information, software updates, release notes, technical tips, the Bug Navigator, configuration notes, brochures, descriptions of service offerings, and download access to public and authorized files.

CCO serves a wide variety of users through two interfaces that are updated and enhanced simultaneously—a character-based version and a multimedia version that resides on the World Wide Web (WWW). The character-based CCO supports Zmodem, Kermit, Xmodem, FTP, Internet e-mail, and fax download options, and is excellent for quick access to information over lower bandwidths. The WWW version of CCO provides richly formatted documents with photographs, figures, graphics, and video, as well as hyperlinks to related information.

You can access CCO in the following ways:

- WWW: `http://www.cisco.com`.
- Telnet: `cco.cisco.com`.
- Modem: From North America, 408 526-8070; from Europe, 33 1 64 46 40 82. Use the following terminal settings: VT100 emulation; databits: 8; parity: none; stop bits: 1; and baud rates up to 14.4 kbps.

For a copy of Cisco Connection Online's Frequently Asked Questions (FAQ), contact `cco-help@cisco.com`. For additional information, contact `cco-team@cisco.com`.

If you are a network administrator and need personal technical assistance with a Cisco product that is under warranty or covered by a maintenance contract, contact Cisco's Technical Assistance Center (TAC) at 800 553-2447, 408 526-7209, or `tac@cisco.com`. To obtain general information about Cisco Systems, Cisco products, or upgrades, contact 800 553-6387, 408 526-7208, or `cs-rep@cisco.com`.

This document is to be used in conjunction with the *Cisco 4000 Series Installation Guide*.

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