About This Guide

This section discusses the objectives, audience, organization, and conventions of the *Cisco 4000 Series Installation Guide* publication. Use this publication to install and maintain the Cisco 4000-M, Cisco 4500-M, and the Cisco 4700-M.

Cisco documentation and additional literature are available on a CD-ROM called Cisco Connection Documentation, Enterprise Series. The CD is updated and shipped monthly, so it might be more current than printed documentation. To order the Cisco Connection Documentation, Enterprise Series CD, contact your local sales representative or call Customer Service. The CD is available both as a single CD and as an annual subscription.You can also access Cisco technical documentation on the World Wide Web URL http://www.cisco.com.

Documentation for older modules in the Cisco 4000 series can also be found on the Cisco Documentation CD.

Document Objectives

This publication contains the initial site preparation, installation, troubleshooting, and selected upgrade and maintenance procedures.

Audience

This publication is for the router installer, who should be familiar with electronic circuitry and wiring practices and have experience as an electronic or electromechanical technician.

For software configuration information, refer to the appropriate software publication. (See the section “If You Need More Information“ in the chapter “Configuring Cisco 4000 Series Software.”)

Document Organization

The major sections of this user guide are as follows:

- Chapter 1, "Overview of the Cisco 4000 Series Routers," contains an overview of the Cisco 4000 series features and physical specifications.
- Chapter 2, "Preparing to Install Cisco 4000 Series Routers," includes safety recommendations, site requirements, the Installation Checklist and Site Log, tools and equipment, and instructions for inspecting the new system.
- Chapter 3, "Configuring the Cisco 4000 Series Chassis," describes how to access the internal components of the router, replace network processor modules, and install the component tray.
- Chapter 4, "Making External Connections to Cisco 4000 Series Routers," describes slot numbering and unit numbering, console and auxiliary port connections, and each kind of network connection: Ethernet, Token Ring, serial, G.703/G.704, Fiber Distributed Data Interface (FDDI), Basic Rate Interface (BRI), channelized T1/Integrated Services Digital Network (ISDN) Primary Rate Interface (PRI), channelized E1/ISDN PRI, and Asynchronous Transfer Mode (ATM).
- Chapter 5, "Configuring Cisco 4000 Series Software," includes instructions for booting the router for the first time, using the enable secret and enable password, configuring the router, configuring interfaces, checking the router configuration, and saving the router configuration.
- Appendix A, "Troubleshooting the Initial Hardware Configuration," discusses recovering a lost enable password, troubleshooting, environmental reporting features, and problem solving using the LEDs.
- Appendix B, "Cabling Specifications for Cisco 4000 Series Routers," provides cable illustrations and pinouts for the console and auxiliary ports, and synchronous serial, Ethernet, Token Ring, BRI, channelized T1 and channelized E1 cables.
- Appendix C, "Replacing Memory in Cisco 4000 Series Routers," provides instructions for replacing single in-line memory modules (SIMMs) and boot ROM chips.
- Appendix D, "Cisco 4000 Series Virtual Configuration Register," describes the Cisco 4000-M virtual configuration register and procedures for changing the factory-default settings.

- Appendix E, "Cisco 4000-M ROM Monitor," describes the Cisco 4000-M ROM monitor and to run the ROM monitor diagnostics.
- Appendix F, "Cisco 4500-M and Cisco 4700-M ROM Monitor," describes how to enable the ROM monitor program and its commands and conventions.
- Appendix G, "Translated Safety Warnings," contains translations of the safety warnings that appear in this user guide.

Document Conventions

This manual uses the following conventions to convey instructions and information:

Command descriptions use these conventions:

- Commands and keywords are in **boldface** font.
- Variables for which you supply values are in *italic font*.
- Elements in square brackets ([ ]) are optional.
- Alternative but required keywords are grouped in braces ({ }) and are separated by a vertical bar (|).

Samples use these conventions:

- Terminal sessions are printed in `screen` font.
- Information you enter is in **`boldface screen`** font.
- Nonprinting characters are shown in angle brackets (< >).
- Information the system displays is in `screen` font, with default responses in square brackets ([ ]).

Note *Means reader take note*. Notes contain helpful suggestions or references to materials not contained in this manual.

Timesaver Means *the described actions saves time*. You can save time by performing the action described in the paragraph.

Caution *Means reader be careful*. You are capable of doing something that might result in equipment damage or loss of data.

Warning *Means danger.* You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and standard practices for preventing accidents. (To see translated versions of this warning, refer to the appendix “Translated Safety Warnings.”)

CHAPTER 1

Overview of the Cisco 4000 Series Routers

The Cisco 4000 series consists of the Cisco 4000-M, the Cisco 4500-M, and the Cisco 4700-M. All models provide a configurable modular router platform using network processor modules—individual modules that when installed in the router are ready for external network connections. Performance is the key distinction between the Cisco 4000-M, Cisco 4500-M, and Cisco 4700-M.

For maximum performance in the Cisco 4000 series, the Cisco 4700-M contains a 133-MHz RISC microprocessor, 16 to 64 MB main memory, and a 512-KB secondary cache. The faster speed of the Cisco 4700-M allows higher throughput for high-speed interfaces. The 512-KB secondary cache is useful for process switching applications such as compression and encryption.

The Cisco 4500-M contains a 100-MHz RISC microprocessor and 8 to 32 MB of main memory. The Cisco 4000-M contains a 40-MHz CISC microprocessor and 4 to 32 MB of main memory.

All Cisco 4000 series routers provide flexibility, allowing network managers to easily reconfigure the router when needs change.

The Cisco 4000 series routers support up to three network processor modules at a time. The following network processor modules are available at the publication date of this guide:

- Single-port Fast Ethernet with 100BaseT and MII connectors provided for the port
- Single-port and dual-port Ethernet with 10BaseT and AUI connectors provided for each port
- Six-port Ethernet with 10BaseT connectors provided for each port
- Dual-port and four-port synchronous serial supporting EIA/TIA-232, EIA/TIA-449, V.35, X.21, NRZ/NRZI, DTE/DCE, or EIA-530 DTE interfaces on each port

- Dual-port high-speed synchronous serial and 16-port low-speed synchronous/asynchronous serial. The high-speed ports supports EIA/TIA-232, EIA/TIA-449, V.35, X.21, NRZ/NRZI, DTE/DCE, or EIA-530 DTE interfaces. The low-speed ports support EIA/TIA-232, V.35, or X.21 interfaces in DTE or DCE mode. Each low-speed port can be individually configured for synchronous or asynchronous.
- Single-port HSSI
- Single-port and dual-port Token Ring
- Dual attachment single-mode FDDI
- Single attachment or dual attachment multimode FDDI
- Four-port or eight-port ISDN BRI
- Four-port balanced or unbalanced G.703/G.704
- Single-port channelized T1/ISDN PRI
- Single-port balanced or unbalanced channelized E1/ISDN PRI
- Single-port ATM with single-mode OC-3 and long-reach capability, multimode OC-3, DS-3, or E3 interfaces

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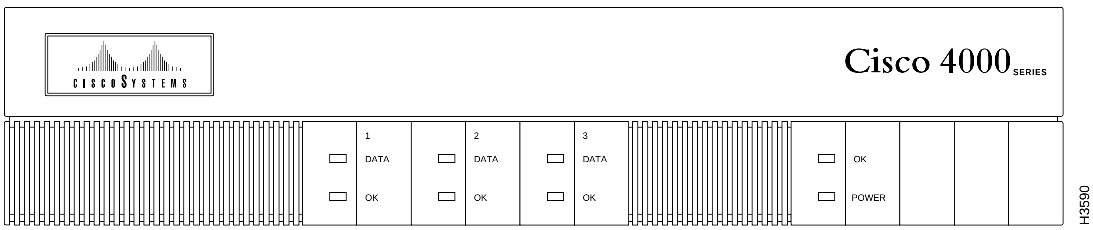
Note For information about modules released after publication of this guide, see the configuration note packet shipped with your router.

Note EIA/TIA-232 and EIA-TIA-449 were known as recommended standards RS-232 and RS-449 before their acceptance as standards by the Electronics Industries Association (EIA) and Telecommunications Industry Association (TIA)

Figure 1-1 shows the front panel of a Cisco 4000 series router.

Figure 1-1 Cisco 4000 Series Chassis—Front Panel


Cisco 4000 SERIES
CISCO SYSTEMS
1
DATA
OK
2
DATA
OK
3
DATA
OK
OK
POWER
H3590

Series Specifications

Design specifications for the Cisco 4000 series are as follows:

- Modular router platform.
- Flash memory capability.
- User-upgradable network processor modules, shared memory, and processor local memory.
- Hardware thermal alarm to warn of excessively high operating temperature.
- Can be rack-mounted in either a standard 19-inch rack or a telco rack.
- Can be mounted on a wall or placed on a desk or table.
- Support for up to three network processor modules at a time. Network processor modules can be placed in any of the three available positions in almost any desired combination. See the *Cisco Product Catalog* for complete configuration details.

The BRI four-port and eight-port network interface modules can not be used in the same chassis with the channelized T1/ISDN PRI network interface module or the channelized E1/ISDN PRI network interface module.

The Cisco 4000-M does not support Fast Ethernet, HSSI, 2T16S, ATM, or six-port Ethernet network processor modules.The Cisco 4000-M can support only one FDDI network processor module in combination with any two other types of network processor modules.

The Cisco 4500-M and Cisco 4700-M can support two FDDI network processor modules. If you are only using one FDDI module, install it in the center slot for optimum heat dissipation.

The Cisco 4500-M and Cisco 4700-M can support one ATM network processor module or up to three six-port Ethernet network processor modules. The single-port Ethernet module is not supported on the Cisco 4500-M or the Cisco 4700-M.

Note The Cisco 4500-M and Cisco 4700-M support all network processor modules except the single-port Ethernet network processor module.

For complete configuration information, refer to the Cisco Product Catalog, which is available on the Web at http://www.cisco.com.

Table 1-1 lists the network processor module interface options available for the Cisco 4000 series when this guide was printed. For current modules, see the configuration note packet that shipped with your router.

Interface Options	Port Options	Part Numbers
Ethernet	Single port, dual port, or six port	NP-1E=, NP-2E=, NP-6E=
Fast Ethernet	Single port	NP-1FE=
Synchronous serial	Dual port or four port	NP-2T=, NP-4T=
Synchronous/asynchronous serial[1]	Dual high-speed ports and 16 low-speed ports	NP-2T16S=
HSSI	Single HSSI port	NP-1HSSI=
Token Ring	Dual port or single port	NP-1RV2=, NP-2R=
Multimode FDDI	Single attachment or dual attachment	NP-1F-D-MM=, NP-1F-S-M=
Single-mode FDDI	Dual attachment	NP-1F-D-SS=
BRI	Four port or eight port	NP-4B=, NP-8B=
G.703	Four port (balanced or unbalanced)[2]	NP-4GB=, NP-4GU=
Channelized T1/ISDN PRI	Single channelized T1/PRI port	NP-CT1=
Channelized E1/ISDN PRI	Single channelized E1/PRI port	NP-CE1=
ATM	Single ATM port	NP-1A-SM=,NP-1A-MM= , NP-1A-DS3=, NP-1A-E3=

1. Each low-speed port can be individually configured for synchronous or asynchronous.
2. For G.703 and G.704 connections, balanced or unbalanced ports must be matched with the corresponding balanced or unbalanced cable.

Table 1-1 lists the specifications of the Cisco 4000 series routers.

Table 1-1 System Specifications

Description	Specification
Dimensions (H x W x D)	3.4 x 17.6 x 17.7" (8.6 x 44.7 x 45 cm)
Weight	24 lb (10.9 kg) (including the chassis and network processor modules)
Power	100–240 VAC, 50–60 Hz, 3.0–1.5A or 40–72 VDC, 5–2.8A
Wire gauge for DC-input power connections	14 AWG[1]
Network interface options	Ethernet, serial, Token Ring, FDDI, BRI, G.703, channelized T1/PRI, channelized E1/PRI, ATM
Serial interfaces	EIA/TIA-232, EIA/TIA-449, V.35, X.21, NRZ/NRZI, DTE/DCE, EIA-530 DTE
Console port	EIA/TIA-232 DB-25 female connector
Auxiliary port	EIA/TIA-232 DB-25 male connector
Nonoperating temperature	– 40–185°F (– 40–85°C)
Operating humidity	5–95%, noncondensing
Operating temperature	32–104°F (0–40°C)
Regulatory compliance	FCC Class A, FCC Part 68, Canadian DOC Class A, CS-03, UL 1950 2nd edition, CAN/CSA 950-M93, EN60950 with Amendments 1 and 2, AN/NZS 3260, NOM 019 Additional regulatory compliance is in the *Cisco 4000 Series Public Network Certification* document that shipped with your router.)

1. AWG = American Wire Gauge

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 was Software Release 9.1; for the Cisco 4000-M, Software Release 9.14; for the Cisco 4500, and

Cisco 4500-M, Cisco Internetwork Operating System (Cisco IOS) Release 10.2; for the Cisco 4700-M, Cisco IOS Release 10.3(10). Table 1-2 lists the minimum system software versions for network processor modules.

Table 1-2 Minimum Software Release Version

Network Processor Module Type	Minimum Software Release Version
Multimode FDDI	Software Release 9.14(1)
Fast Ethernet	Cisco IOS Release 11.1(5) or 11.2(2)P
Dual Ethernet	Software Release 9.14(2)
Six-port Ethernet	Cisco IOS 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)
2T16S-RS232 and 2T16S-V.35	Cisco IOS Release 11.2(3)P for synchronous operation Cisco IOS Release 11.2(4)P for asynchronous operation
2T16S-X.21	Cisco IOS Release 11.2(5)P
HSSI	Cisco IOS Release 11.2(5)P
ISDN BRI	Cisco IOS Release 10.2
G.703	Cisco IOS Release 10.2(7)
Channelized T1/ISDN PRI	Cisco IOS Release 10.3(4)
Channelized E1/ISDN PRI	Cisco IOS Release 10.3(4)
ATM OC-3C	Cisco IOS Release 10.3(4)
ATM DS-3 and E3	Cisco IOS Release 11.0(5)

Note The Cisco 4000 can no longer be ordered, but Cisco IOS Releases 10.0, 10.2, and 10.3 are supported on installed Cisco 4000 routers. The Cisco 4500 can no longer be ordered, but Cisco IOS Releases 10.1, 10.2, and 10.3 are supported on installed Cisco 4500 routers. The Cisco 4700 can no longer be ordered, but Cisco IOS Release 10.3 is supported on installed Cisco 4700 routers.

Table 1-3 lists the processor and memory specifications of the Cisco 4000 series routers.

Table 1-3 Cisco 4000 Series Processor and Memory Specifications

Description	Cisco 4000-M	Cisco 4500-M	Cisco 4700-M
Processor	40-MHz Motorola 68EC030	100-MHz IDT Orion RISC[1]	133-MHz IDT Orion RISC
Main memory (DRAM)[2]	4, 8, 16, or 32 MB	8, 16, or 32 MB	16, 32, or 64 MB
Secondary cache memory	None	None	512 KB
Shared memory (DRAM)	4 or 16 MB	4, 8, or 16 MB	4, 8, or 16 MB
Flash memory	4 or 8 MB	4, 8, 16, 32, or 64 MB	4, 8, 16, 32, or 64 MB
NVRAM[3]	128 KB	128 KB	128 KB
Boot ROM	128 KB–8 MB	128–512 KB	128–512 KB
Boot Flash	Not available	4–16 MB	4–16 MB

1. The Orion microprocessor is based on the MIPS R4400 and is pin-compatible.
2. DRAM = dynamic random-access memory.
3. NVRAM = nonvolatile random-access memory.

Memory Systems

The Cisco 4000 series memory systems (see Figure 1-2) have the following functions:

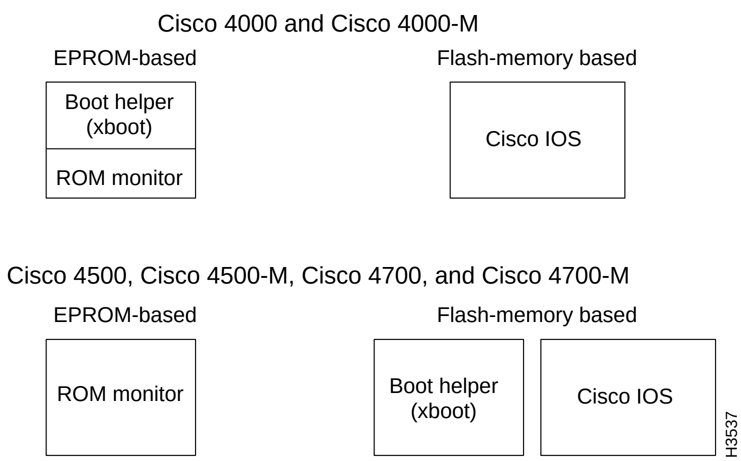
- Main memory—Stores the running configuration and routing tables. The Cisco IOS software executes from main memory.
- Shared memory—Used for packet buffering by the router's network interfaces.
- Flash memory—Stores the operating system software image. In the Cisco 4500-M and 4700-M, the Flash memory also stores the boot helper software.
- NVRAM—Stores the system configuration file and the virtual configuration register.
- Boot EPROM—In the Cisco 4000-M, erasable programmable read-only memory (EPROM)-based memory stores the boot helper—a subset of the Cisco IOS software—and the ROM monitor. In the Cisco 4500-M and Cisco 4700-M, only the ROM monitor is EPROM based. The boot helper image allows you to boot the router

when Flash memory does not contain a valid system image. In the Cisco 4500-M and 4700-M, the ROM monitor allows you to boot a system image from Flash memory if a boot helper image is not present in boot Flash memory.

The differences between the memory systems in the Cisco 4000 series allows enhanced software upgradability in the Cisco 4500-M and Cisco 4700-M.

Note See the appendixes "Cisco 4000 Series Virtual Configuration Register," "Cisco 4000-M ROM Monitor," and "Cisco 4500-M and Cisco 4700-M ROM Monitor" for more information on the ROM Monitor.

Figure 1-2 Cisco 4000 Series Memory Systems and Software Images



Memory Requirements in the Cisco 4000 Series

Each module in the Cisco 4000 series can change memory configurations to accommodate internetworking demands. The memory requirements are affected by the following factors:

- The number of Cisco IOS software images a system stores can be increase by adding Flash memory.
- Network expansion, the use of additional protocols or Cisco IOS services, or newer Cisco IOS releases may require additional main memory
- I/O performance or more physical or virtual interfaces may require additional shared memory.

Shared Memory Requirements

The standard configuration for shared memory is 4 MB for the Cisco 4000 series. 4 MB of memory is enough for most configurations with fewer than 24 physical or virtual interfaces. Routers with multiple ISDN BRI network processor modules or with 24 or more physical and virtual interfaces require 8 to 16 MB of shared memory.

Note The types and numbers of network processor modules installed in a system does not affect main or flash memory requirements.

Table 1-4 Cisco 4000-M Shared Memory Requirements

Network Processor Module	Per-Module Shared Memory Requirements
Single-port Ethernet	0.1 MB
Dual-port Ethernet and dual-port serial	0.2 MB
Dual-port Token Ring, four-port serial, and G.703/G.704 serial	0.4 MB
Eight-port BRI, CT1/PRI, and CE1/PRI	1.0 MB
FDDI	2.0 MB

Table 1-5 Cisco 4500-M and Cisco 4700-M Shared Memory Requirements

Network Processor Module	Per-Module Shared Memory Requirements
Dual-port Ethernet and dual-port serial	0.4 MB
Single-port Fast Ethernet	1.7 MB
Dual-port Token Ring, four-port serial, and G.703/G.704 serial	0.6 MB
Six-port Ethernet, Eight-port BRI, CT1/PRI, and CE1/PRI	1.2 MB
ATM and one FDDI[1]	2.0 MB
Two FDDI[2]	3.0 MB
Dual-port high-speed synchronous serial and 16-port low-speed synchronous serial	0.6 MB
HSSI	1.0 MB

1. FDDI modules are an exception in that two FDDI modules do not require double the shared memory of one FDDI module.
2. FDDI modules are an exception in that two FDDI modules do not require double the shared memory of one FDDI module.

Note For more information, see product bulletin number 419, “Memory Options for Cisco 4000 Series,” on the Web at http://www.cisco.com. This bulletin contains information such as minimum memory requirements for each Cisco IOS image, current shared memory requirements, and sample configurations.

Main Memory Requirements

The amount of main memory required by a Cisco 4000 series router is affected by the size of the network and by the access list configurations. However, it is difficult to quantify the exact main memory requirements based only on network size. Use the following guidelines to determine approximate main memory requirements.

Note If your memory requirements fall near the upper end of one of the available main memory options, consider installing the next larger memory option to allow for network growth.

Main memory requirement guidelines for Cisco 4000 series routers are as follows:

- The 4 MB of main memory standard in the Cisco 4000-M will only suffice on routers with knowledge of very small networks and which run very few protocols.
- The 8 MB of main memory standard in the Cisco 4500-M and the 16 MB of main memory standard in the Cisco 4700-M generally suffices on routers running Cisco IOS Release 10.2.
- 16 MB of main memory, optional in the Cisco 4500-M and standard in the Cisco 4700-M, generally suffices on routers using Cisco IOS Release 10.3 or later.
- The 64 MB main memory option for the Cisco 4700-M is recommended for routers using Border Gateway Protocol (BGP).

Cisco RPS Support

The Cisco 4000-M, 4500-M, or 4700-M router now supports connection to the Cisco Redundant Power System (RPS). The router supports an RPS in two ways:

- The chassis ships with an RPS adapter plate installed by the factory
- The user installs an RPS adapter plate at the site

For more information, refer to the *Cisco RPS Hardware Installation Guide* and *Installing the Cisco RPS Adapter Plate in Cisco 4000 Routers*. This section provides an overview of the Cisco RPS and describes basic features.

Figure 1-3 shows the front panel of the Cisco RPS, and Figure 1-4 shows the rear panel.

Figure 1-3 Cisco RPS Front Panel

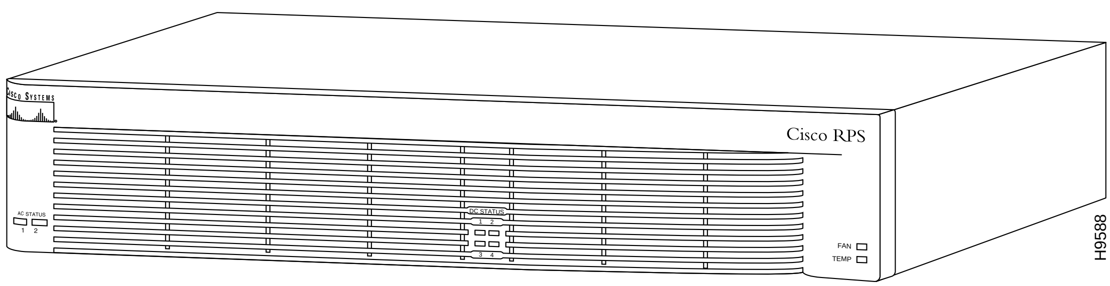
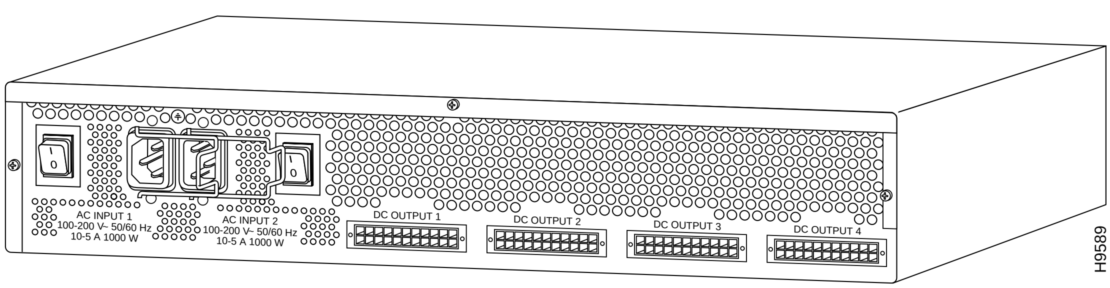


Figure 1-4 Cisco RPS Rear Panel



Caution Use the Cisco RPS (model PWR600-AC-RPS) only to power the external device.

Seul le système d’alimentation redondant Cisco (RPS modèle PWR600-AC-RPS) doit servir à alimenter le dispositif externe.

Das externe Gerät darf nur mit einer redundanten Stromversorgung von Cisco, Modell PWR600-AC-RPS, betrieben werden.

外付部品の電源には、必ず Cisco RPS（モデル番号 PWR600-AC-RPS-CAB/PWR600-AC-RPS-NCAB）をご使用ください。

Para alimentar el dispositivo externo, usar exclusivamente el sistema de alimentación redundante (redundant power system = RPS) Cisco, modelo PWR600-AC-RPS.

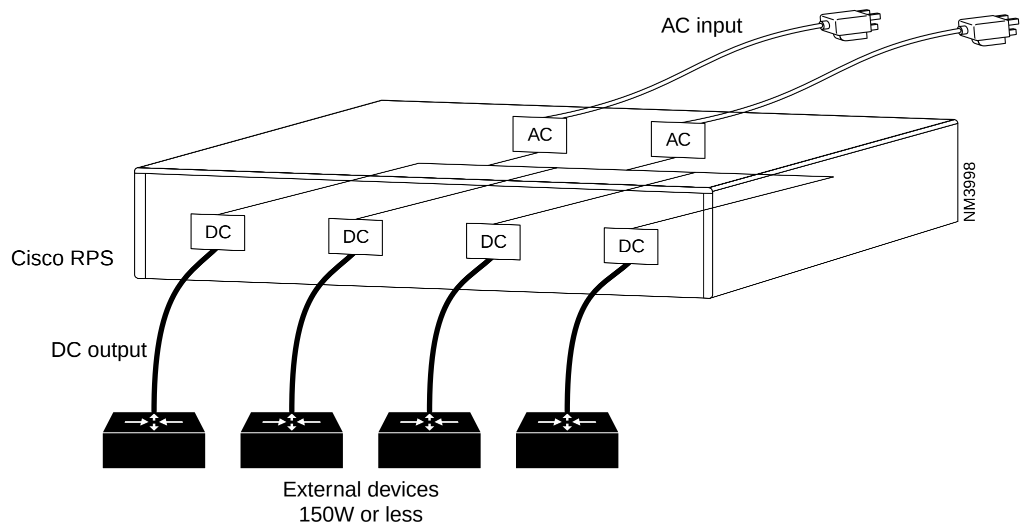
Overview

The Cisco RPS provides power system redundancy to external devices (such as routers, switches, or hubs). The system includes two fully redundant AC input power modules and four DC output power modules for connection to external devices. The Cisco RPS supports the following power source configurations: quasi-redundant and fully redundant.

Quasi-Redundant Power

The Cisco RPS can provide a quasi-redundant power source for up to four external devices that use 150W or less each. You can use a one-to-one cable (one connector at each end of the cable) to connect up to four external devices to the four DC output power modules, as shown in Figure 1-5. When using one-to-one cables, the power source is quasi-redundant because there are two AC input power modules for the Cisco RPS and one DC power output module for each external device. The AC input to the Cisco RPS is fully redundant, but the DC output to the external devices is not.

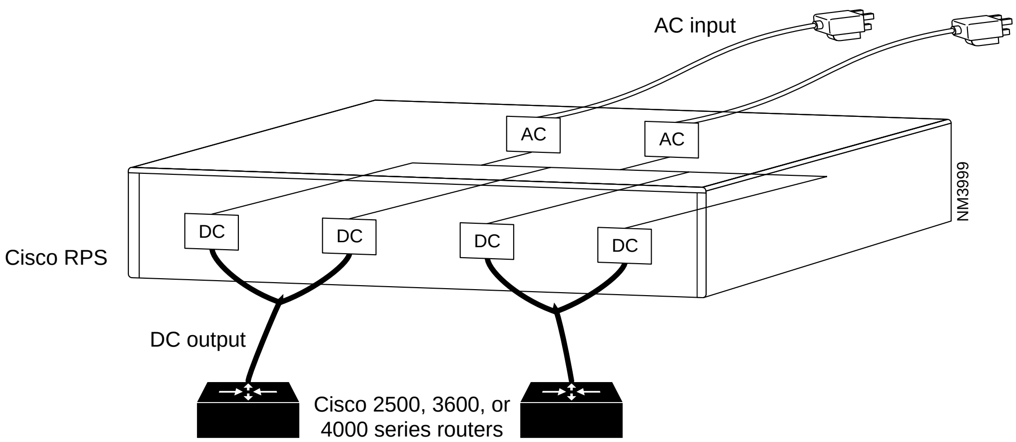
Figure 1-5 Quasi-Redundant Configuration



Fully Redundant Power

The Cisco RPS can provide a fully redundant power source for up to two Cisco 4000 series routers. You can use a two-to-one cable to connect up to two external devices to the four DC output power modules on the rear panel of the Cisco RPS, as shown in Figure 1-6. The two-to-one cable is a Y-shaped cable with two connectors at one end of the cable and one connector at the other end. Two connectors at one end of the Y-shaped cable connect to two DC output power modules. The other end of the cable connects to one external device. When using two-to-one cables, the power source is fully redundant because there are two AC input modules and two DC output power modules connected to each external device. If any power module fails, there is a full backup.

Figure 1-6 Fully Redundant Configuration



RPS Features

The following features are standard:

- Two AC input power cords
- Two fully redundant AC input power modules
- Four 150W DC output power modules
- Four one-to-one cables (PWR600-AC-RPS-CAB)
- Rack-mountable chassis (two rack units in height, 19-inch rack-mount brackets included)
- Redundant cooling
- LEDs for the AC and DC status, fans, and temperature

CHAPTER 2

Preparing to Install Cisco 4000 Series Routers

This chapter includes information you need before you install your Cisco 4000 series router. It includes the following sections:

- Safety Recommendations
- General Site Requirements
- Installation Checklist
- Site Log
- Required Tools and Equipment
- Inspecting the System

Safety Recommendations

The following guidelines will help to ensure your safety and protect the equipment.

- Keep the chassis area clear and dust-free during and after installation.
- Turn the power supply off and unplug the power cord before opening the chassis.

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. (To see translated versions of this warning, refer to the appendix “Translated Safety Warnings.”)

- Keep tools and chassis components away from walk areas.

- Do not wear loose clothing that could get caught in the chassis. Fasten your tie or scarf and roll up your sleeves.

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 weld the metal object to the terminals. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

- 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.

Warning This equipment is intended to be grounded. Ensure that the host is connected to earth ground during normal use. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

Safety with Electricity

Follow these guidelines when working on equipment powered by electricity:

- Locate the emergency power-off switch in the room in which you are working. Then, if an electrical accident occurs, you can act quickly to 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 chassis
  - Working near power supplies
- 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, assess the victim's condition and then call for help.
  - — Determine if the person needs rescue breathing or external cardiac compressions; then take appropriate action.

In addition, use the guidelines that follow when working with any equipment that is disconnected from a power source, but still connected to telephone wiring or other network cabling.

- Never install telephone wiring during a lightning storm.

Warning Do not work on the system or connect or disconnect cables during periods of lightning activity. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

- Never install telephone jacks in wet locations unless the jack is specifically designed for wet locations.
- Never touch uninsulated telephone wires or terminals unless the telephone line is disconnected at the network interface.
- Use caution when installing or modifying telephone lines.

Preventing Electrostatic Discharge Damage

Electrostatic discharge (ESD) can damage equipment and impair electrical circuitry. It occurs when electronic printed circuit cards are improperly handled and can result in complete or intermittent failures. Always follow ESD prevention procedures when removing and replacing cards. Ensure that the router chassis is electrically connected to earth ground. Wear an ESD-preventive wrist strap, ensuring that it makes good skin contact. Connect the clip to an unpainted surface of the chassis frame to safely channel unwanted ESD voltages to ground. To properly guard against ESD damage and shocks, the wrist strap and cord must operate effectively. If no wrist strap is available, ground yourself by touching the metal part of the chassis.

Caution For the safety of your equipment, periodically check the resistance value of the antistatic strap, which should be between 750 kilohm and 10 megohm.

General Site Requirements

This section describes the requirements your site must meet for safe installation and operation of your system. Ensure that your site is properly prepared before beginning installation.

The router can be placed on a desktop or rack-mounted in a data processing or lab environment. The system can be mounted in either a standard or telco rack. Optional rack-mount kits are available.

Site Environment

The location of individual chassis and the layout of your equipment rack or wiring room are extremely important for proper system operation. Equipment placed too close together, inadequate ventilation, and inaccessible panels can cause system malfunctions and shutdowns, and can make system maintenance difficult.

When planning your site layout and equipment locations, use the precautions described in the next section, "Site Configuration Precautions," to help avoid equipment failures and reduce the possibility of environmentally caused shutdowns. If you are currently experiencing shutdowns or unusually high errors with your existing equipment, these precautions will help you isolate the cause of failures and prevent future problems.

Site Configuration Precautions

The following precautions will help you plan an acceptable operating environment for your router and will help you avoid environmentally caused equipment failures:

- Remember that electrical equipment generates heat. Ambient air temperature might not be adequate to cool equipment to acceptable operating temperatures without adequate circulation. Ensure that the room in which your system operates has adequate circulation.
- Never place chassis side by side because the heated exhaust air from one chassis can be drawn into the intake port of the next.
- Always follow the ESD-prevention procedures in the section "Preventing Electrostatic Discharge Damage" earlier in this chapter to avoid damage to equipment. Damage from static discharge can cause immediate or intermittent equipment failure.
- Ensure that the chassis cover and network processor module rear panels are secure. The chassis is designed to allow cooling air to flow within it. An open chassis allows air leaks, which may in turn interrupt and redirect the flow of cooling air across internal components.
- Check the power at your site to ensure that you are receiving "clean" power (free of spikes and noise). Install a power conditioner if necessary.

Warning The device is designed to work with TN power systems. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

- Install proper grounding to avoid damage from lightning and power surges.

Equipment Racks

The following tips will help you plan an acceptable equipment rack configuration:

- Enclosed racks must have adequate ventilation. Ensure that the rack is not overly congested because each unit generates heat. An enclosed rack should have louvered sides and a fan to provide cooling air.
- When mounting a chassis in an open rack, ensure that the rack frame does not block the intake or the exhaust ports. If the chassis is installed on slides, check the position of the chassis when it is seated all the way into the rack.
- In an enclosed rack with a ventilation fan in the top, excessive heat generated by equipment near the bottom of the rack can be drawn upward and into the intake ports of the equipment above.
- Baffles can help to isolate exhaust air from intake air, which also helps to draw cooling air through the chassis. The best placement of the baffles depends on the airflow patterns in the rack, which can be found by experimenting with different configurations.
- When equipment installed in a rack, particularly in an enclosed rack, fails, try operating the equipment by itself, if possible. Turn off other equipment in the rack (and in adjacent racks) to allow the unit under test a maximum of cooling air and clean power.

Power Supply Features

Following are features of the router power supply:

- Autoranging power supply (200W, 100 to 240 VAC, 50 to 60 Hz, 40 to 72 VDC)
- 6-foot electrical power cord

Warning Do not touch the power supply when the power cord is connected. For systems with a power switch, line voltages are present within the power supply even when the power switch is off and the power cord is connected. For systems without a power switch, line voltages are present within the power supply when the power cord is connected. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

Installation Checklist

The Installation Checklist lists the procedures for initial hardware installation of a new router. Make a copy of this checklist and mark the entries as you complete each procedure. Include a copy of the checklist for each system in your Site Log. (See the next section “Site Log.”)

Installation checklist for site____

Task	Verified by	Date
Installation checklist copied		
Background information placed in Site Log		
Site power voltages verified		
Installation site prepower check completed		
Required tools available		
Additional equipment available		
Cisco 4000 series router received		
Cisco 4000 Series Installation Guide (this manual) received		
Cisco Information Packet received		
Optional ordered CD or printed documentation received		
Chassis components verified		
Initial electrical connections established		
ASCII terminal attached to console port, or modem attached to console port (for remote configuration)		
Signal distance limits verified		
Startup sequence steps completed		
Initial system operation verified		
Software image verified		

Site Log

The Site Log provides a historical record of all actions relevant to the router. Keep it in an accessible place near the chassis where anyone who performs tasks has access to it. Use the Installation Checklist to verify steps in the installation and maintenance of your router. Site Log entries might include the following:

- Installation progress—Make a copy of the Installation Checklist and insert it into the Site Log. Make entries as each procedure is completed.
- Upgrades and removal or replacement procedures—Use the Site Log as a record of ongoing router maintenance and expansion history. Each time a procedure is performed on the router, update the Site Log to reflect the following:
  - — Additional network processor modules installed
  - — Removal or replacement of network processor modules
  - — Configuration changes
  - — Maintenance schedules and requirements
  - — Maintenance procedures performed
  - — Intermittent problems
  - — Related comments

Warning Ultimate disposal of this product should be handled according to all national laws and regulations. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

Required Tools and Equipment

You need the following tools and equipment to install the router:

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

In addition, you might need the following additional external equipment:

- Data service unit (DSU) to connect each serial port to an external network.
- To connect a serial port to a T1 network, you need a T1 channel service unit/data service unit (CSU/DSU) that converts the High-Level Data Link Control (HDLC) synchronous serial data stream into a T1 data stream with the correct framing and ones density. (Some telephone systems require a minimum number of one bit per time unit in a data stream, called ones density.) Several T1 CSU/DSU devices are available as additional equipment, and most provide either a V.35, EIA/TIA-449, or EIA-530 electrical interface.
- Ethernet transceiver.
- Network Terminator 1 (NT1) for BRI connections in North America.
- Before installing a G.703/G.704 network processor module, ensure that you have one of the following adapter cables:
    - 75-ohm, unbalanced adapter cable (CAB-E1-BNC-3M)
    - 120-ohm, balanced adapter cable (CAB-E1-TWINAX-3M)

Inspecting the System

Before unpacking the system, make certain that you are ready to install it. If the final installation site is not ready, keep the chassis in its shipping container to prevent accidental damage. After determining where you want the system installed, proceed with the unpacking.

The router, cables, publications, CD, and any optional equipment you ordered might be shipped in more than one container. When you unpack each shipping container, check the packing list to ensure that you received all of the following items:

- Router
- 6-foot (1.8-meter) power cord
- Bag of rubber feet for desktop mounting
- Optional equipment (which might include network connection cables)

- This publication
- *Cisco Information Packet*
- Optional companion publications, or the Cisco Connection Documentation, Enterprise Series CD, as specified on your order

Inspect all items for shipping damage. If anything appears damaged, or if you encounter problems when installing or configuring your system, contact a customer service representative. Also, please complete and mail your product registration (see the publication *Cisco Information Packet*).

CHAPTER 3

Configuring the Cisco 4000 Series Chassis

This chapter describes the tasks that should be completed before you connect a Cisco 4000 series router to your network. It contains the following sections:

- Accessing the Internal Components of the Router
- Replacing Network Processor Modules
- Replacing the Component Tray
- Rack-Mount and Wall-Mount Installation

Accessing the Internal Components of the Router

You must open the chassis to gain access to the router's internal components—the network processor modules, boot ROMs, and jumpers.

Refer to the section "Required Tools and Equipment" in the chapter "Preparing to Install Cisco 4000 Series Routers" for the tools needed to complete the procedures in this chapter.

Warning Before opening the chassis, disconnect the telephone-network cables to avoid contact with telephone-network voltages. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

Warning Do not work on the system or connect or disconnect cables during periods of lightning activity. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

Warning Do not touch the power supply when the power cord is connected. For systems with a power switch, line voltages are present within the power supply even when the power switch is off and the power cord is connected. For systems without a power switch, line voltages are present within the power supply when the power cord is connected. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

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. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

Removing the Component Tray

Some Cisco 4000 series routers have a safety latch tab on the chassis that affects removing the component tray. (See Figure 3-1 and Figure 3-2.)

If you have a chassis with a safety latch tab, follow the procedure in the next 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 Put on 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 3-1.)

Step 5 Pull on the handle located on the upper right corner of the chassis to slide the component tray out of the chassis shell until the safety latch catches. (See Figure 3-1.)

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 3-1.)

Figure 3-1 Component Tray Removal for Chassis With a Safety Latch

Step 6 Support the component tray with one hand, push down on the safety latch tab, and pull the component tray out the rest of the way.

Step 7 Set the component tray on your work surface.

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 Put on 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 3-2.)

Figure 3-2 Component Tray Removal for Chassis Without a Safety Latch

Caution Support the component tray from underneath, either on your work surface or with your hands, to prevent it from falling. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

Step 5 Pull on the handle located on the upper right corner of the chassis to slide the component tray out of the chassis shell while you support the component tray with one hand.

Step 6 Set the component tray on your work surface.

Replacing Network Processor Modules

When you have removed the component tray from the router, you can remove or add network processor modules. If you are replacing shared memory single in-line memory modules (SIMMs), you must first remove the network processor modules.

Removing Network Processor Modules

Caution Some network processor modules are secured to the rear of the chassis with two external screws. On modules with external rear mounting screws, including multimode Fiber-Distributed Data Interface (FDDI) modules, 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 3-3, then remove the module mounting screw from the top of the network processor module. Remove the two external rear mounting screws if the module has them. Set the screws aside.

Step 2 Grasp the network processor module handle and pull it straight up to lift the module out of its connector. (See Figure 3-4.)

Step 3 Place the removed module on an ESD mat.

Figure 3-3 Cisco 4000-M Component Tray—Typical of Cisco 4000 Series

Caution Do not wiggle the handle when handling the network processor module, and do not exert any side-to-side pressure because the handle might work loose and damage the network processor module.

Figure 3-4 Network Processor Module Components

Caution If any of the network processor module cards have daughter cards projecting at right angles to the module (see Figure 3-5), be careful not to cause the module to bow during installation; otherwise the daughter cards can become disconnected. If this happens, carefully reseat the daughter card connectors by handling the card by its edges without touching any of the components on the card.

Figure 3-5 Network Processor Module Daughter Card Installation

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Note See the appendix "Cabling Specifications for Cisco 4000 Series Routers" for network connection pinout information.

Installing Network Processor Modules

Take the following steps to install a network processor module:

Step 1 Hold the network processor 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 3-4.)

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

Step 3 Replace the module mounting screw in its place on the end of the network processor module. (See Figure 3-4.)

Caution Do not overtighten the module mounting screw. The network processor module or the underlying motherboard could be damaged. The maximum screw torque is 7 inch-lb.

Step 4 Replace the external rear mounting screws, if used, to attach the module to the rear of the chassis.

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 chassis shell, pushing on the back of the tray while at the same time pressing on the chassis release screw with the thumb of your right hand. (See Figure 3-2.)

Step 2 Retighten the chassis release screw.

Rack-Mount and Wall-Mount Installation

You can use optional rack-mount and wall-mount kits to install a Cisco 4000 series router in a standard 19-inch rack, a 19-inch telco rack, or on a wall. The procedures for the different installation options involve removing the front panel and component tray from the chassis, fastening mounting brackets to the chassis, and then installing the empty chassis in position. You then reinsert the component tray and replace the front panel.

The optional rack-mount and wall-mount kits ship with their own set of installation instructions. If you are planning to rack-mount or wall-mount the router, do so before making the network and power connections.

CHAPTER 4

Making External Connections to Cisco 4000 Series Routers

This chapter describes how to connect your Cisco 4000 series router to networks and external devices, and contains the following sections:

- Preparing to Make Connections
- Console Port and Auxiliary Port Connection Considerations
- Network Connection Considerations
- Connecting Routers with a DC-Input Power Supply
- Powering Up the Router

Preparing to Make Connections

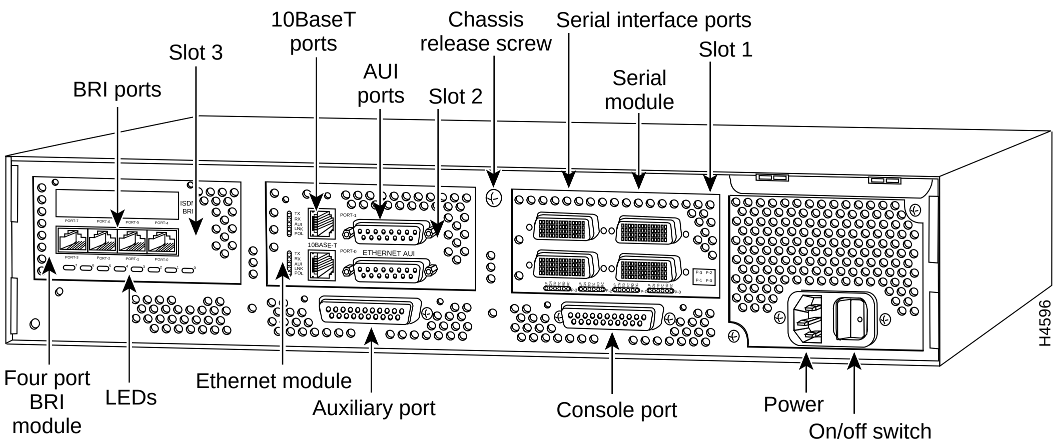
When viewed from the rear, the power cable and power switch appear on the right side of the router chassis. The system console port, auxiliary port, and network processor module ports appear to the left of the power cable and switch. (See Figure 4-1.)

Slot Numbering

The chassis contains slots for three network processor modules. These slots correspond to the three slot numbers printed on the front panel of the chassis. (See Figure 4-1.) Slot numbers represent the order in which the system scans the network processor modules. Network processor module location is not slot dependent. Any module can be moved to any other available slot location. For optimum heat dissipation, use the center slot position, slot 2, for the FDDI module if one is present.

For information on how to remove and replace network processor modules, see the section "Replacing Network Processor Modules" in the chapter "Configuring the Cisco 4000 Series Chassis."

Figure 4-1 Router—Rear View Showing Slot Numbering and Interface Ports



Unit Numbering

Unit numbering allows the system to distinguish between two interfaces of the same type. As viewed from the rear of the chassis, the unit numbering of the network processor modules increments from zero counting from the right to left. The system assigns unit number addresses to these network 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 of that interface type is the module closest to the power supply. For example, the unit number addresses for the modules in Figure 4-1 are listed in Table 4-1.

Table 4-1 Unit Numbering for Serial, Ethernet, and ISDN BRI Modules

Slot Number	Interface and Ports	Unit Address Number
1	Serial port (labeled port 3)	3
	Serial port (labeled port 2)	2
	Serial port (labeled port 1)	1
	Serial port (labeled port 0)	0
2	Ethernet port (top)	1
	Ethernet port (bottom)	0
3	BRI port (labeled port 3)	3
	BRI port (labeled port 2)	2
	BRI port (labeled port 1)	1
	BRI port (labeled port 0)	0

If the BRI module in Figure 4-1 were replaced by a second Ethernet module, the unit addresses would be as listed in Table 4-2.

Table 4-2 Unit Numbering for Serial and Two Ethernet Modules

Slot Number	Interface and Ports	Unit Address Number
1	Serial port (labeled port 3)	3
	Serial port (labeled port 2)	2
	Serial port (labeled port 1)	1
	Serial port (labeled port 0)	0
2	Ethernet port (top)	1
	Ethernet port (bottom)	0
3	Ethernet port (top)	3
	Ethernet port (bottom)	2

Figure 4-2 shows a chassis configured with three Ethernet modules.The unit numbering of these modules would be as listed in Table 4-3.

Figure 4-2 Router—Rear View Showing Ethernet Modules

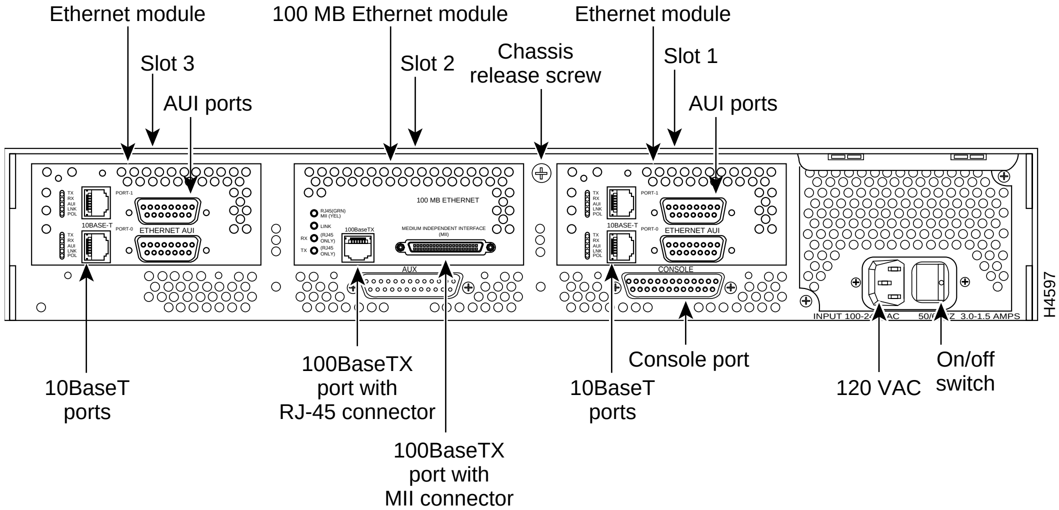


Table 4-3 Unit Numbering for Three Ethernet Modules

Slot Number	Interface and Port	Unit Address Number
1	Ethernet port (top) Ethernet port (bottom)	1 0
2	Fast Ethernet port	2
3	Ethernet port (top) Ethernet port (bottom)	4 3

One final example involves two serial modules (NP-2T16S, each with dual high-speed ports and 16 low-speed ports) and a dual Ethernet module.Figure 4-3 shows the router rear view and Table 4-4 describes the slot numbers and unit number assignments.

Figure 4-3 Router—Rear View Showing Ethernet and Serial Modules

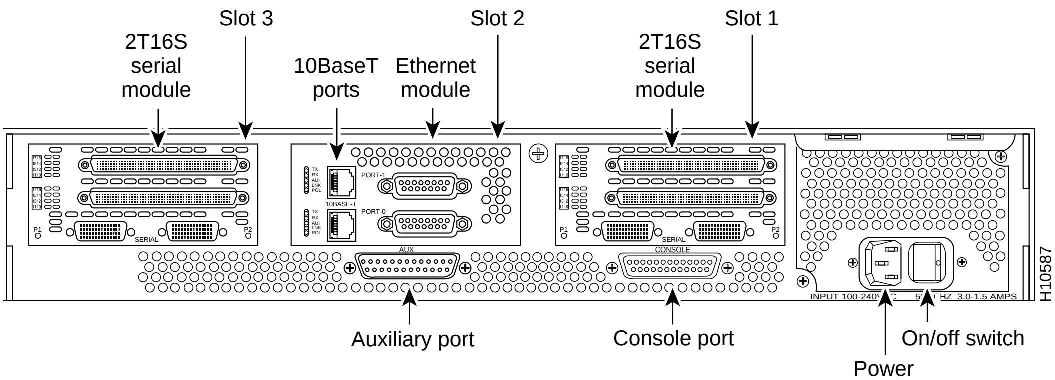


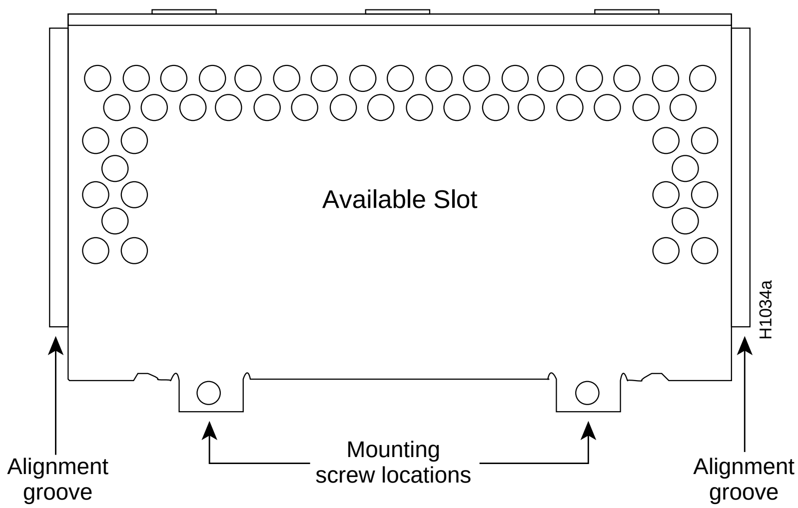
Table 4-4 Unit Numbering for Ethernet and Serial Modules

Slot Number	Interface and Connector	Unit Address Number
1	Serial high-speed connector (right) Serial high-speed connector (left) Low-speed connector (middle) Low-speed connector (top)	0 1 2–9 10-17
2	Ethernet connector (top) Ethernet connector (bottom)	1 0
3	Serial high-speed connector (right) Serial high-speed connector (left) Low-speed connector (middle) Low-speed connector (top)	18 19 20–27 28-35

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. Figure 4-4 shows a slot filler panel.

Figure 4-4 Slot Filler Panel



Console Port and Auxiliary Port Connection Considerations

This section describes the console and auxiliary ports found on all Cisco 4000 series routers.

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. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

Console Port Connections

Each router includes an asynchronous router console port (female DB-25 connector) wired as a data communications equipment (DCE) device. The default parameters for this port are as follows:

- 9600 baud
- 8 data bits
- No parity generated or checked
- 2 stop bits

Table B-1 in the appendix “Cabling Specifications for Cisco 4000 Series Routers,” lists the pinouts for the Cisco 4000-M console port and Table B-2 lists the pinouts for the Cisco 4500-M and Cisco 4700-M console port.

Auxiliary Port Connections

A male DB-25 connector auxiliary port (labeled AUX on the chassis rear) is included on all router units. The auxiliary port is a shared-memory data terminal equipment (DTE) port to which you can attach an EIA/TIA-232 connector from a channel service unit/data service unit (CSU/DSU), a modem, or protocol analyzer for network access. Table B-1 in the appendix “Cabling Specifications for Cisco 4000 Series Routers,” lists the pinouts for the Cisco 4000-M auxiliary port and Table B-3 lists the pinouts for the Cisco 4500-M and Cisco 4700-M asynchronous serial auxiliary port.

Network Connection Considerations

This section describes the considerations for each type of network connection available for Cisco 4000 series routers.

For network processor modules released after publication of this document, see the configuration notes that ship with the chassis and the spare modules, for example

- *Installing Fast Ethernet Network Processor Modules in the Cisco 4000 Series*
- *Installing 2T16S Network Processor Modules in the Cisco 4000 Series*

- *Installing and Configuring HSSI Network Processor Modules in Cisco 4000 Series Routers*

Ethernet Connections

This section describes the single-port, dual-port, and six-port Ethernet network processor modules.

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. (To see translated versions of this warning, refer to the appendix “Translated Safety Warnings.”)

Note The single-port Ethernet network processor module is not supported on the Cisco 4500-M and Cisco 4700-M. The six-port Ethernet network processor module is not supported on the Cisco 4000-M.

Single-Port Ethernet Module Connections

Each single-port Ethernet network processor module has an Ethernet attachment unit interface (AUI) connector and a 10BaseT connector. (See Figure 4-5.) (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.

Selecting the Media Type

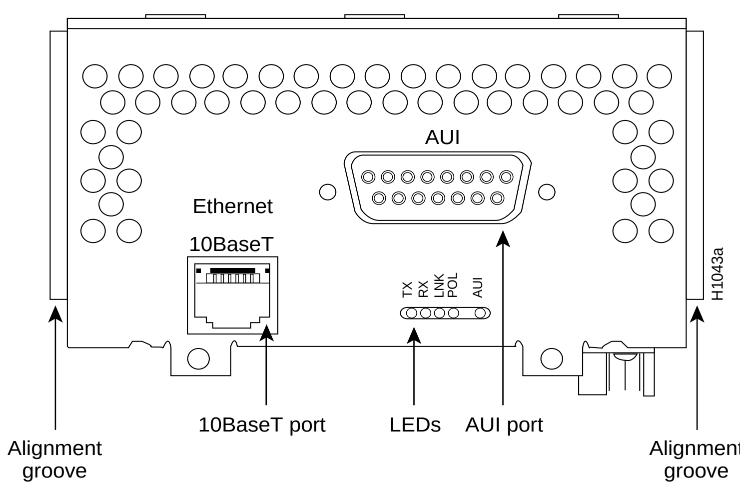
The media type connection, AUI or 10BaseT, is selected by the **media-type** command. Enter the **media-type** command in the router’s configuration file to configure your selection of AUI or 10BaseT on the desired interface. The syntax of the **media-type** command is as follows:

media-type aui
media-type 10baset

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

```
router> enable
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
```

Figure 4-5 Ethernet Network Processor Module with AUI and 10BaseT Connectors



Refer to the Cisco IOS configuration guides and command references for more information on the **media-type** command.

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). A 10BaseT transition cable can connect directly from the router to your network. (See Figure 4-6.)

Figure 4-6 Single-Port Ethernet Network Processor Module 10BaseT Port Connection

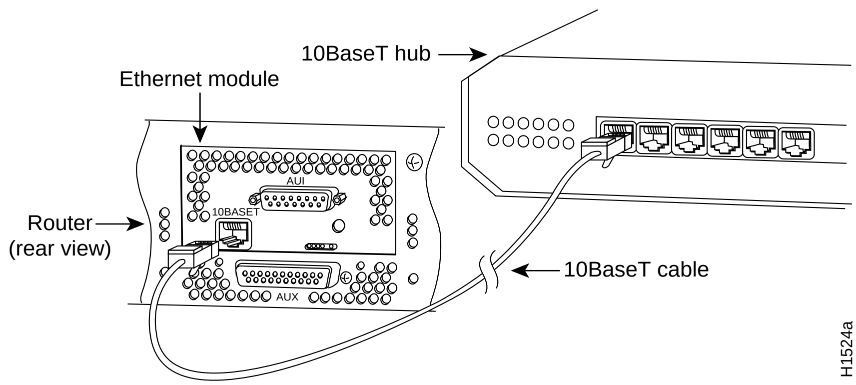


Figure 4-7 shows a single-port Ethernet network processor module with an Ethernet (AUI) connection to a transceiver.

Figure 4-7 Single-Port Ethernet Network Processor Module AUI Port Connection

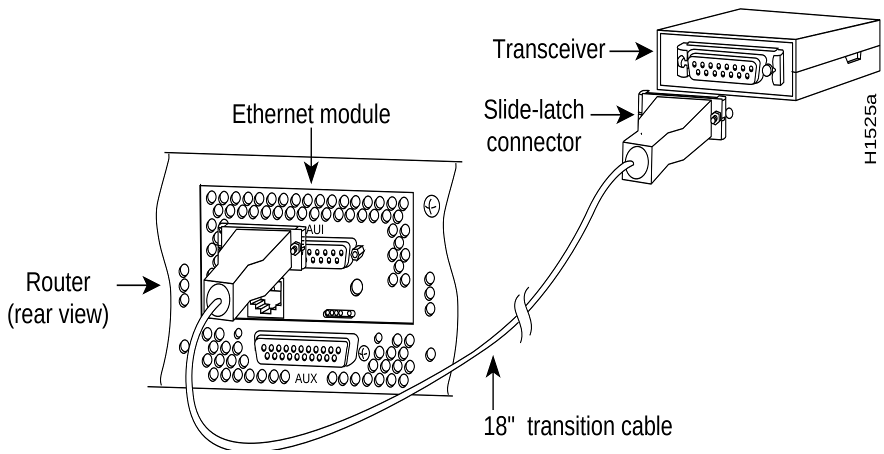
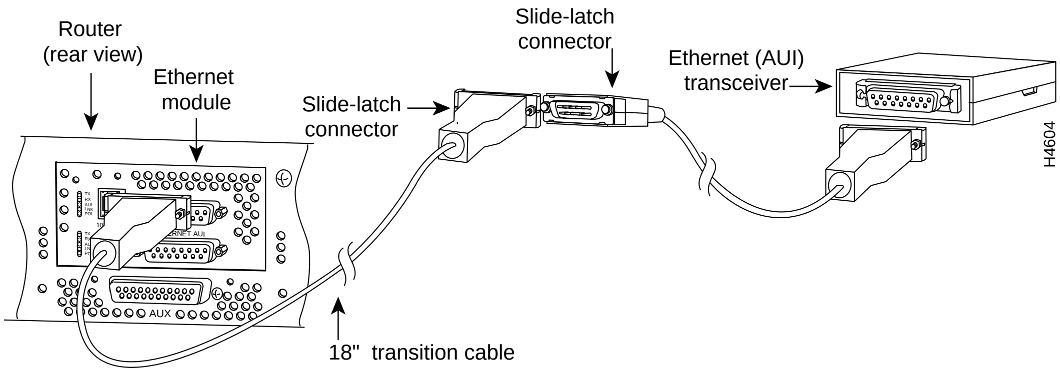


Figure 4-8 shows the transition cable used as a flexible extension of the Ethernet port allowing an Ethernet transceiver cable with a slide-latch connector to mate with the female end of the 18-inch transition cable.

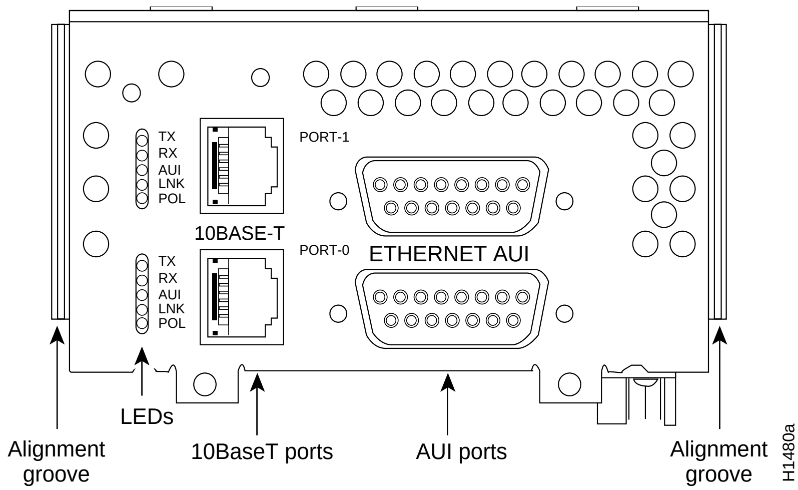
Figure 4-8 Extending the Transition Cable from the Ethernet Port



Dual-Port Ethernet Module Connections

The dual-port Ethernet network processor module has ports for two network connections. (See Figure 4-9.) The top port is labeled PORT-1, and the lower port is labeled PORT-0. On the dual-port Ethernet network processor module, either the Ethernet connector or the 10BaseT connector can be used, but not both. For example, Ethernet port 0 could be attached to either a 10BaseT connector or to an AUI connector, and similarly, Ethernet port 1 could be attached to either a 10BaseT connector or to an AUI connector.

Figure 4-9 Dual-Port Ethernet Network Processor Module with AUI and 10BaseT Connectors

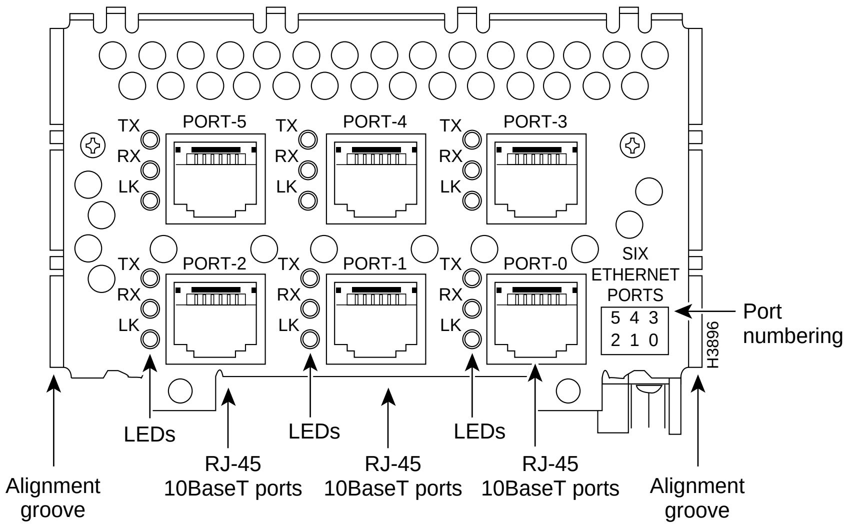


Six-Port Ethernet Module

The six-port Ethernet network processor module has ports for six network connections. (See Figure 4-10.) 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 Ethernet network processor module.

Note The six-port Ethernet module is not supported on the Cisco 4000 and Cisco 4000-M.

Figure 4-10 Six-Port Ethernet Network Processor Module



Token Ring Connections

The dual-port Token Ring network processor module has two standard 9-pin connectors. (See Figure 4-11.) The single-port Token Ring network processor module has one standard 9-pin connector. (See Figure 4-12.)

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. (To see translated versions of this warning, refer to the appendix “Translated Safety Warnings.”)

Figure 4-11 Dual-Port Token Ring Module Network Connector

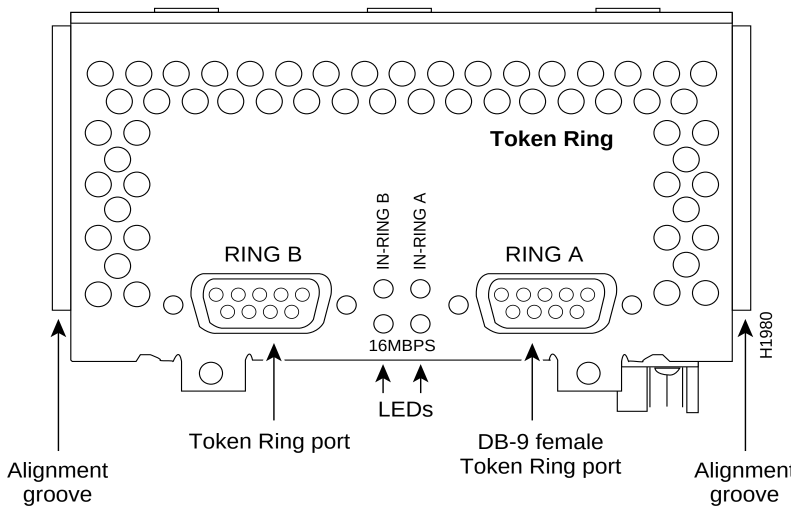
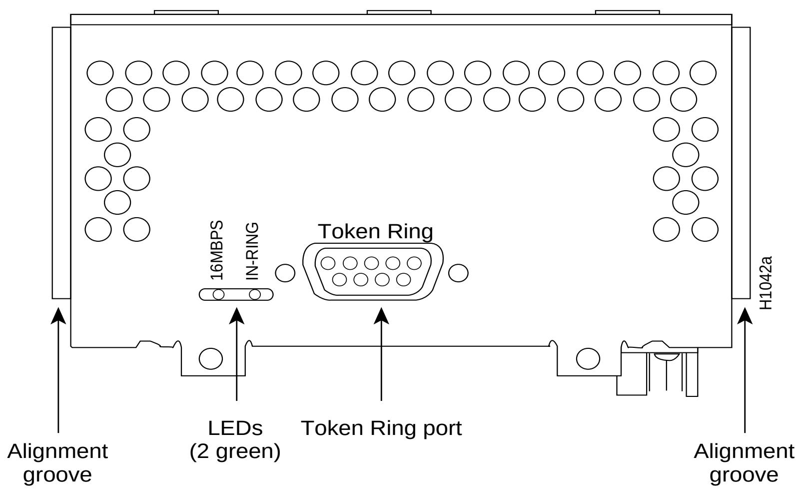
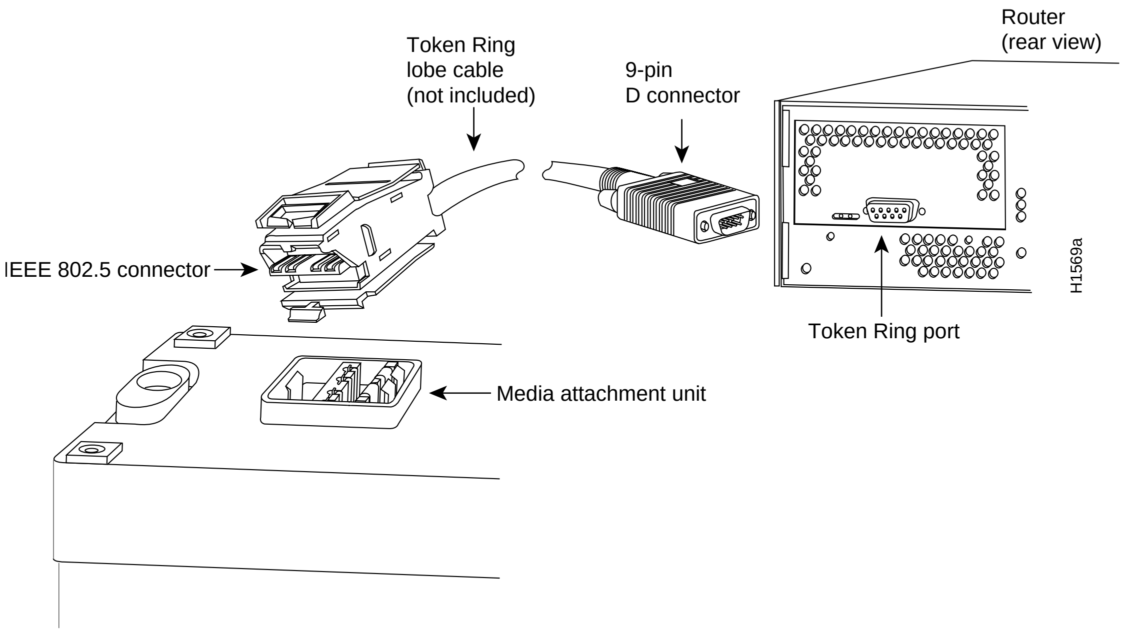


Figure 4-12 Token Ring Module Network Connector



Use a standard 9-pin Token Ring lobe cable to connect the router directly to a media attachment unit (MAU). (See Figure 4-13.)

Figure 4-13 Token Ring Cable Connections



Serial Connections

When setting up your router, consider distance limitations and potential electromagnetic interference (EMI) as defined in the Electronic Industries Association's (EIA) and Telecommunications Industry Association (TIA) standards, such as EIA/TIA-232.

Serial Line 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 4-5 lists the IEEE-recommended maximum speeds and distances for each serial interface type; however, you may get good results at speeds and distances greater than those listed. For instance, the recommended maximum rate for V.35 is 2 Mbps, but 4 Mbps is commonly used. If you understand the electrical problems that might arise and can compensate for them, you can get good results with rates and distances greater than those shown. However, do so at your own risk.

Table 4-5 IEEE Standard Transmission Speeds and Distances

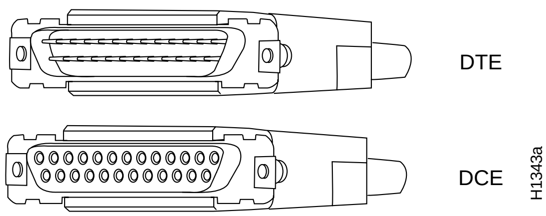
EIA/TIA-232 Distance			EIA/TIA-449, X.21, V.35, EIA-530 Distance	
Rate (bps)	**Feet**	**Meters**	**Feet**	**Meters**
2400	200	60	4100	1250
4800	100	30	2050	625
9600	50	15	1025	312
19200	25	7.6	513	156
38400	12	3.7	256	78
56000	8.6	2.6	102	31
1544000 (T1)	N/A	N/A	50	15

Balanced drivers allow EIA/TIA-449 signals to travel greater distances than EIA/TIA-232. The recommended distance limits for EIA/TIA-449 shown in Table 4-5 are also valid for V.35, X.21, and EIA-530. However, you can get good results at distances and rates greater than those shown in Table 4-5. 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 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 4-14.) The router console and auxiliary ports also use EIA/TIA-232 connections; however, the serial module ports support synchronous connections, and the console and auxiliary ports support asynchronous connections.

Figure 4-14 EIA/TIA-232 Adapter Cable Connectors, Network End



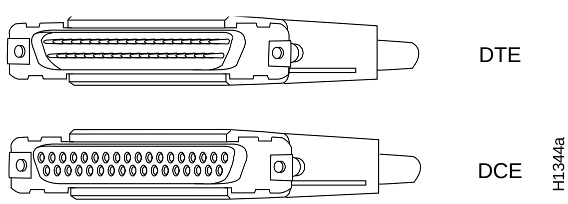
EIA/TIA-449 Connections

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.

The EIA/TIA-449 standard was intended to replace the EIA/TIA-232 standard, but it was not widely adopted primarily because of the large installed base of DB-25 hardware and because of the larger size of the 37-pin EIA/TIA-449 connectors, which limited the number of connections possible (fewer than possible with the smaller, 25-pin EIA/TIA-232 connector).

The network end of the EIA/TIA-449 adapter cable provides a standard 37-pin D-shell connector. (See Figure 4-15.) EIA/TIA-449 cables are available as either DTE (DB-37 plug) or DCE (DB-37 receptacle).

Figure 4-15 EIA/TIA-449 Adapter Cable Connectors, Network End

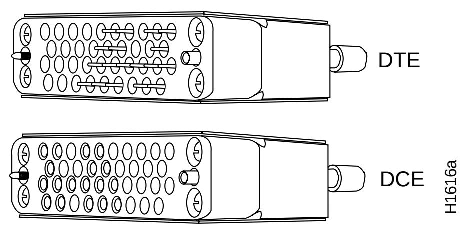


V.35 Connections

The V.35 interface is recommended for speeds up to 48 kbps, although in practice it is used successfully at 4 Mbps.

The network end of the V.35 adapter cable provides a standard 34-pin Winchester-type connector. (See Figure 4-16.) V.35 cables are available with a standard V.35 plug or receptacle in either DTE or DCE mode.

Figure 4-16 V.35 Adapter Cable Connectors, Network End

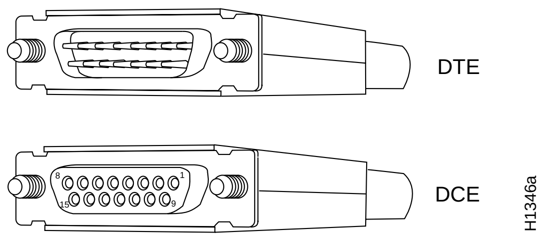


X.21 Connections

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, as a result, 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 4-17.) X.21 cables are available as either DTE (DB-15 plug) or DCE (DB-15 receptacle).

Figure 4-17 X.21 Adapter Cable Connectors, Network End

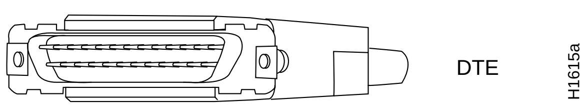


EIA-530 Connections

EIA-530, which supports balanced transmission, provides the increased functionality, speed, and distance of EIA/TIA-449 on the smaller, DB-25 connector used for EIA/TIA-232, instead of the 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 specification recommends a maximum speed of 2 Mbps, EIA-530 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 4-18 shows the DB-25 connector at the network end of the adapter cable.

Figure 4-18 EIA-530 Adapter Cable Connector, Network End



Interference Considerations

When wires are run for any significant distance in an electromagnetic field, interference can occur between the field and the signals on the wires. This fact has two implications for the construction of terminal plant wiring:

- Plant cabling can emit radio frequency interference (RFI) if it is unshielded for a distance exceeding those recommended by the standard.
- Strong electromagnetic interference, especially as caused by lightning or radio transmitters, can destroy the EIA/TIA-232 drivers and receivers in a router.

If you use twisted-pair cables in your plant wiring with a good distribution of grounding conductors, the plant wiring is unlikely to emit radio interference. Ground the conductor for each data signal when exceeding the distances listed in Table 4-5.

If you have cables exceeding the distances in Table 4-5, or if you have cables that pass between buildings, then give special consideration to the effect of lightning strikes and ground loops. The electromagnetic pulse caused by lightning and other high-energy phenomena can couple enough energy into unshielded conductors to destroy electronic devices; the potential existence of ground loops are also a threat to electrical components and to safety. If your site has experienced these problems, then consult experts in lightning suppression and shielding.

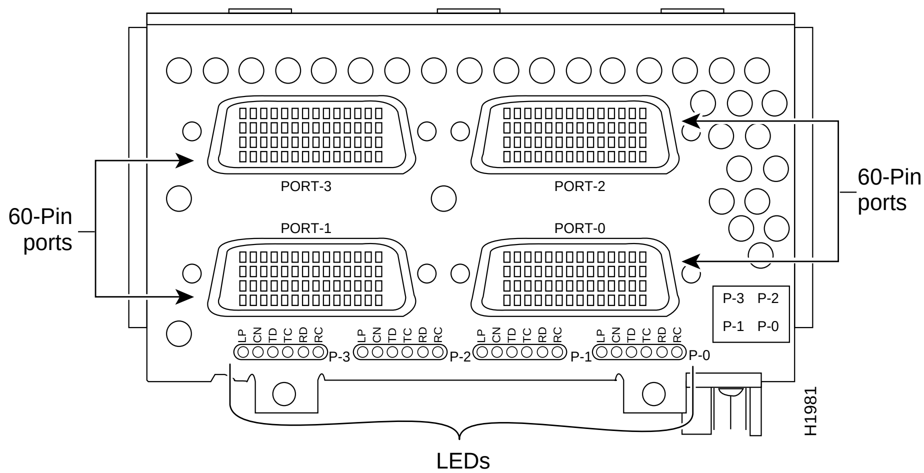
Most data centers cannot resolve the infrequent but potentially catastrophic problems just described without pulse meters and other special equipment. Take precautions to avoid these problems by providing a properly grounded and shielded environment, with special attention to issues of electrical surge suppression. To predict and remedy strong electromagnetic interference, consult experts in RFI.

Configuring Serial Connections

The four-port serial network processor module ports are DB-60 connectors; the dual serial network processor module ports are DB-50 connectors. (See Figure 4-19 and Figure 4-21.) These serial ports can be configured as DTE or DCE, depending on the special serial cable used.

Figure 4-19 shows port numbering on the four-port serial module.

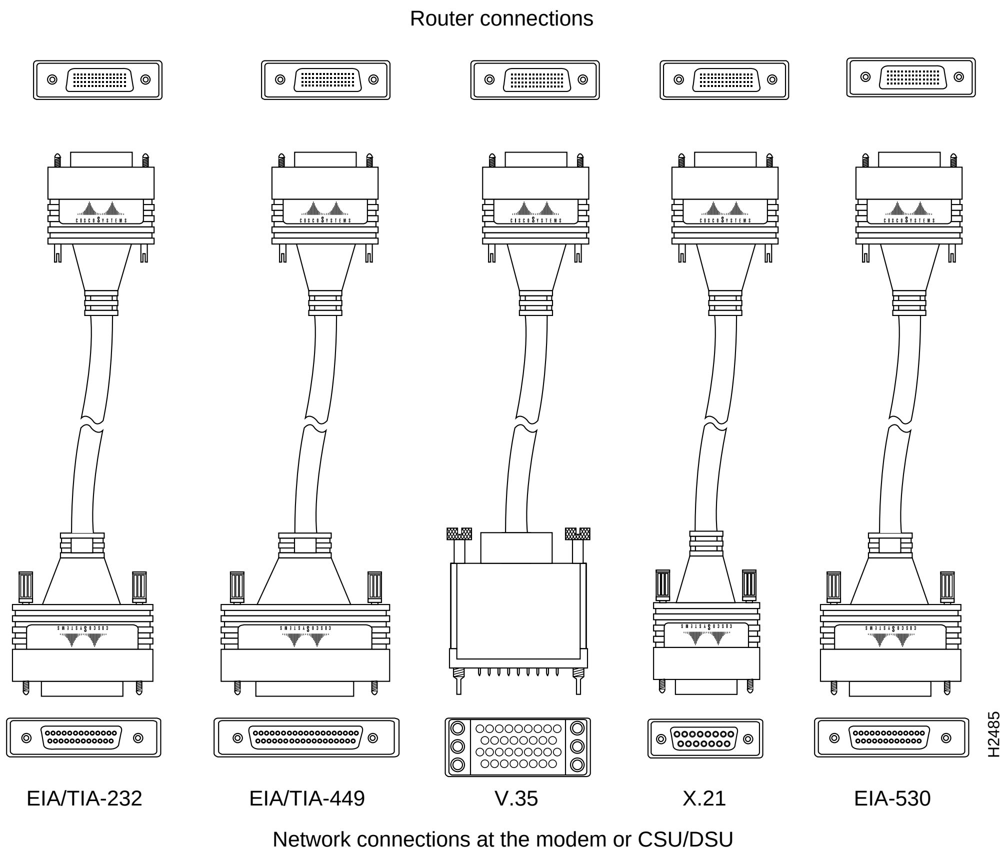
Figure 4-19 Four-Port Serial Network Processor Module Ports



Caution The connector on the four-port serial network processor module is upside down. The cable should match that orientation. Ensure that the 60-pin connectors on the cable and on the module match. Do not force the cable into the connector upside down. (See Figure 4-19.)

Figure 4-20 shows the network connections of the four-port serial network processor module adapter cables.

Figure 4-20 Four-Port Serial Network Processor Module Adapter Cables



The dual serial ports are DB-50 connectors. (See Figure 4-21.) These serial ports can be configured as DTE or DCE, depending on the type of serial cable being used.

Two LED daughter cards are attached to the front of the dual serial module. (See Figure 4-22.)

Note If the dual serial port module is labeled with V2, as shown in Figure 4-21, then for optimum performance, use the version of the cable with the part number ending in -02: for example, 72-0740-02 (DCE) or 72-0671-02 (DTE).

Figure 4-21 Dual Serial Network Processor Module Ports

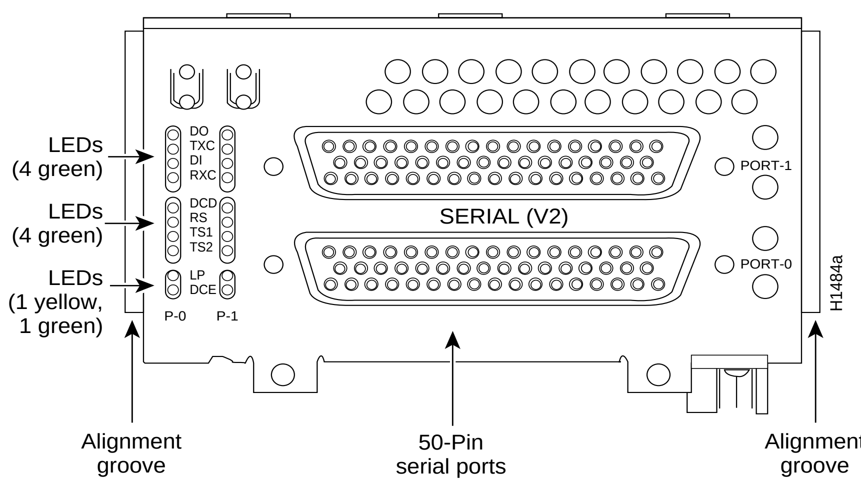
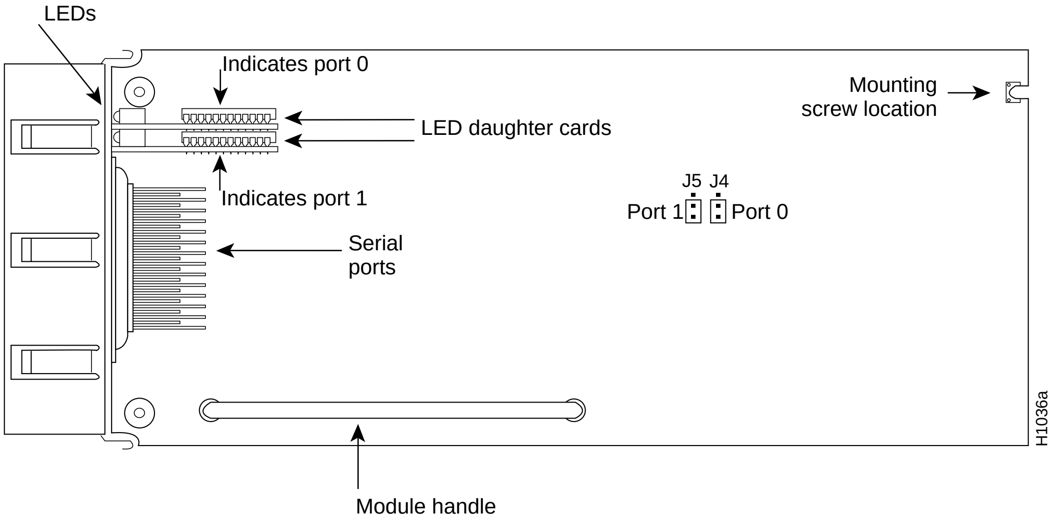


Figure 4-22 Dual Serial Network Processor Module—Top View



Caution Hold the dual serial network processor module carefully by its handle or by the module's edge. To prevent damage from stress or from ESD, do not exert force against the two LED daughter cards, and do not touch the components on the cards.

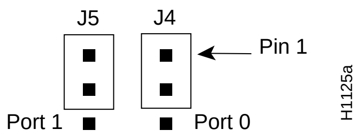
Configuring the Dual Serial Module Interfaces

The dual serial network processor module contains two jumpers, J4 and J5 (see Figure 4-22), which determine whether the ports are configured for nonreturn to zero (NRZ) or nonreturn to zero inverted (NRZI). J4 configures serial port 0, and J5 configures serial port 1. The factory-configured (default) jumper setting is 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 4-23.) For NRZ (not NRZI), the jumpers that connect pins 2 and 3 can be removed.

If the network processor module is operating as DTE in NRZI mode, the sense of the **dte-invert-timing** command must be manually changed. For instance, 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.

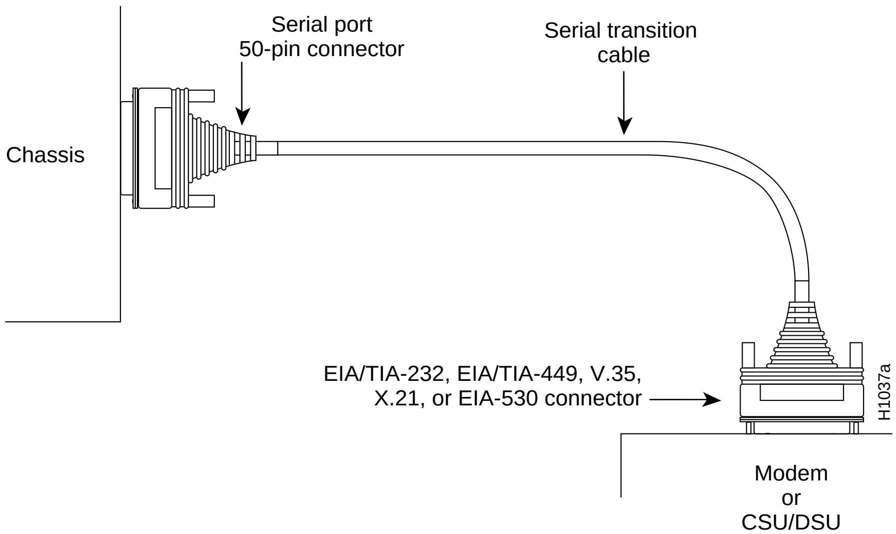
To set the jumpers for NRZI, move the jumpers to the position shown in Figure 4-23 using the orientation shown in Figure 4-22.

Figure 4-23 Dual Serial Network Processor Module Jumpers, J4 and J5—NRZI Setting



You must use a special serial cable to connect the router to a modem, CSU/DSU, or other device as shown in Figure 4-24. This cable, available from your customer service representative, is normally ordered with the system. See the appendix, “Cabling Specifications for Cisco 4000 Series Routers,” for more information. Nine different serial cables are available for the two versions of serial modules: both DTE and DCE versions of V.35, EIA/TIA-232, EIA/TIA-449, and X.21; and EIA-530 DTE. Note that the cables for the two versions are not interchangeable.

Figure 4-24 Router Serial Cable Connections

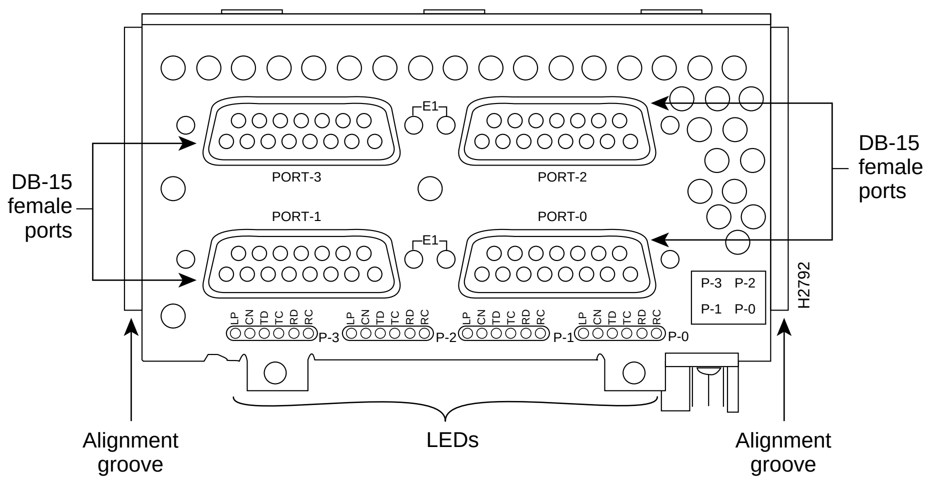


Note Serial ports configured as DCE must also be configured with the **clockrate** command. An error message will be generated if there is a mismatch between the cable and the software configuration of the port—for example, if the cable is DTE and the clock rate is set, or if the cable is DCE and the clock rate is not configured. For more information on software commands, refer to the Cisco IOS configuration guides and command references.

G.703/G.704 Interface Connections

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 4-25.)

Figure 4-25 G.703/G.704 Serial Network Processor Module Ports (DB-15)



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; otherwise the port will not 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 modes 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 4-26.
- Balanced (120-ohm) with a DB-15 connector at the network end, see Figure 4-27.
- Balanced (120-ohm) twinaxial split cable at the network end, with separate transmit and receive cables, each with a twinax connector, see Figure 4-28.

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

Following are the available E1-G.703/G.704 module options:

- Four port E1-G.703/G.704, 120-ohm, balanced
- Four port E1-G.703/G.704, 75-ohm, unbalanced
- E1 cable, TWINAX, 120-ohm, balanced, 5 meters
- E1 cable, DB-15, 120-ohm, balanced, 5 meters
- E1 cable, BNC, 75-ohm, unbalanced, 5 meters

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 4-6 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 4-6 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 4-26, Figure 4-27, and Figure 4-28 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 4-26 E1-G.703/G.704 Interface Cable for Unbalanced Connections (with BNC Connectors and Coaxial Cables)

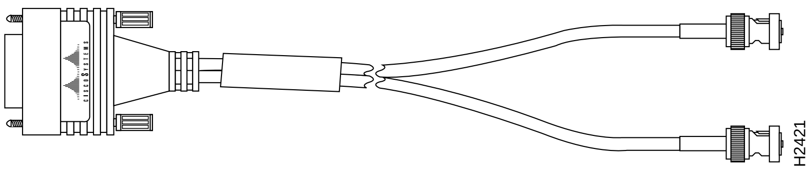


Figure 4-27 E1-G.703/G.704 Interface Cable for Balanced Connections (with DB-15 Connectors on Both Ends)

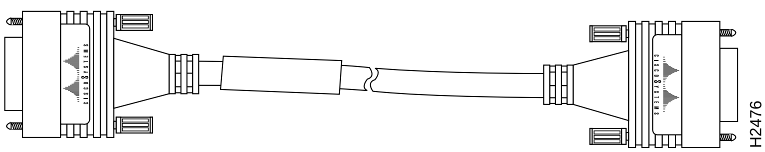
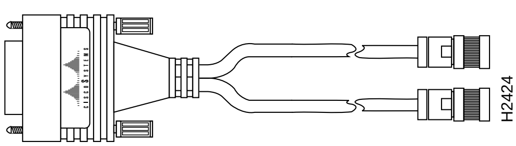


Figure 4-28 E1-G.703/G.704 Interface Cable for Balanced Connections (with Twinax Connectors and Cables)



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.

FDDI Connections

Multimode FDDI network processor modules provide either a dual-attachment station (DAS) or a single-attachment station (SAS). Single-mode FDDI network processor modules provide a DAS. Following are the available FDDI module options:

- 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. The bottom card is the SAS and contains the physical sublayer (PHY)-A port. If the DAS option is included, the PHY-B port is located on the module's top card.

Distance Limitations for FDDI Connections

The distance limitations for single-mode and multimode FDDI stations are shown in Table 4-7. If the distance between two connected stations is greater than the maximum distance shown, significant signal loss can result. The single-mode transmitter and the multimode transceiver each provide 11 decibels of optical power.

Table 4-7 FDDI Maximum Transmission Distances

Transceiver Type	Maximum Distance Between Stations
Single-mode	Up to 6 miles (10 kilometers)
Multimode	Up to 1.2 miles (1.9 kilometers)

FDDI Cable Connections

Older versions of the single-mode network processor module (version 2 or earlier as shown using the **show controller** Cisco IOS command) use simplex FC-type connectors (see Figure 4-29 and Figure 4-33) for the transmit and receive ports. Newer versions of the single-mode network processor module use simplex SC-type connectors. (See Figure 4-30 and Figure 4-34.) 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 six miles (10 kilometers).

Figure 4-29 Older Version, Single-Mode FDDI Network Interface Connector, FC Type

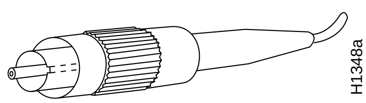
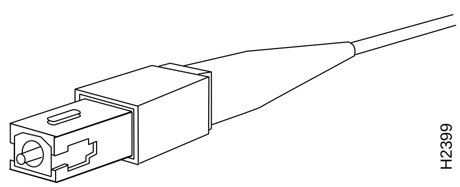


Figure 4-30 Newer Version, Single-Mode FDDI Network Interface Connector, SC Type



Newer versions of the single-mode network processor module are shipped with an FC-to-SC adapter that allows the newer version of the single-mode network processor module to be used with existing cables installed for the earlier version of the module. (See Figure 4-31 and Figure 4-32.)

Figure 4-31 Single-Mode FDDI Network Interface FC-to-SC Adapter, FC End

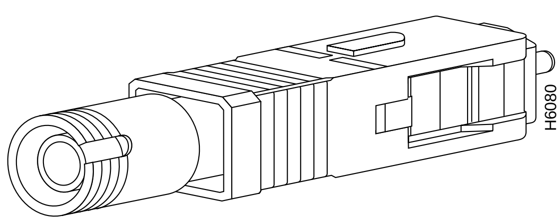


Figure 4-32 Single-Mode FDDI Network Interface FC-to-SC Adapter, SC End

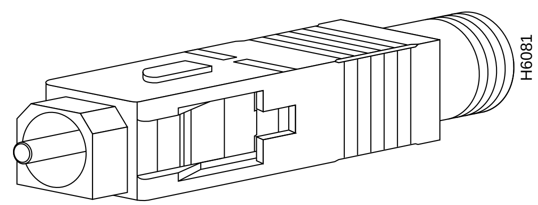


Figure 4-33 Dual-Attachment Single-Mode FDDI Module with FC-type Connectors—End View

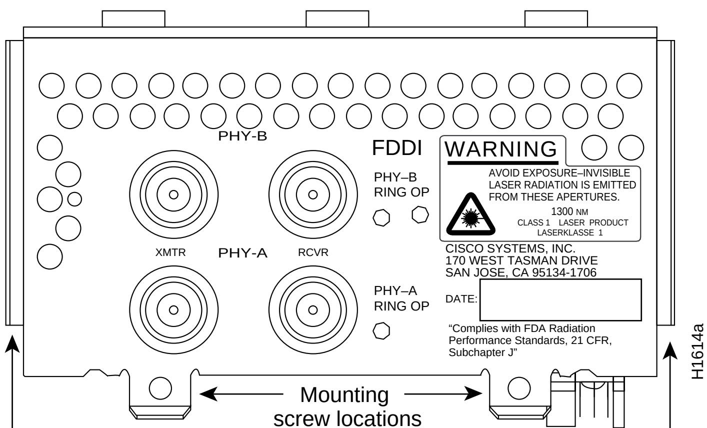
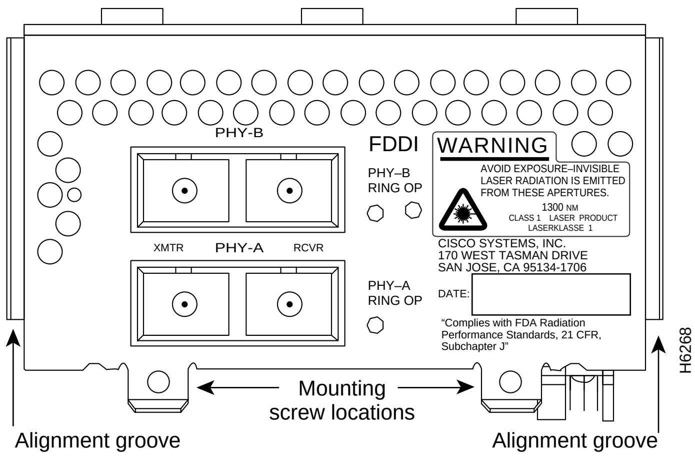


Figure 4-34 Dual-Attachment Single-Mode FDDI Module with SC-type Connectors—End View



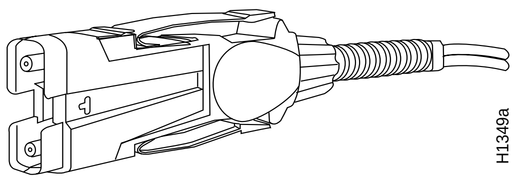
The single-mode transmitter uses a small laser to transmit the light signal to the ring. Keep the transmit port covered whenever a cable is not connected to it. Although multimode transceivers typically use LEDs (not lasers) for transmission, keep open ports covered and avoid staring into open ports or apertures.

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 Center for Devices and Radiological Health (CDRH) FDDI. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

The multimode network processor module connectors are FDDI-standard PHY connectors. The media interface connector (MIC) connects to FDDI standard 62.5/125-micron multimode fiber-optic cable.

Figure 4-35 shows the MIC typically used for network and chassis connections in multimode FDDI applications.

Figure 4-35 Multimode FDDI Network Interface Connector, MIC Type



The port labeled PHY-A is the bottom port (see Figure 4-33 and Figure 4-36), and port labeled PHY-B is the top port on both the multimode and single-mode modules. To connect to another dual-attachment station, connect PHY-A on the module to PHY-B on the other DAS and PHY-B on the module to PHY-A on the other DAS.

The standard connection scheme for a dual-attachment station dictates that the primary ring signal enters the router on the PHY-A receive port and returns to the primary ring from the PHY-B transmit port. (See Figure 4-37.) The secondary ring signal comes into the router on the PHY-B receive port and returns to the primary ring from the PHY-A transmit port. Failure to observe this relationship in making your network connections will prevent the FDDI interface from initializing.

The PHY-S port of the single-attachment module can be connected through a concentrator to a single-attachment ring or directly to another device. (See Figure 4-38.)

Figure 4-36 Dual-Attachment Multimode FDDI Module—End View

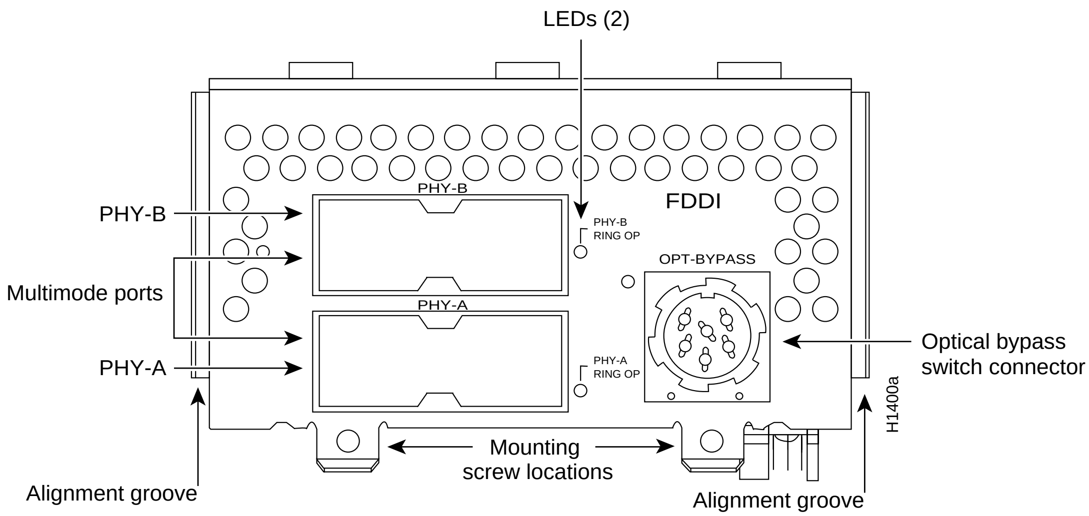


Figure 4-37 Dual-Attachment FDDI Optical Bypass Switch and PHY Connections

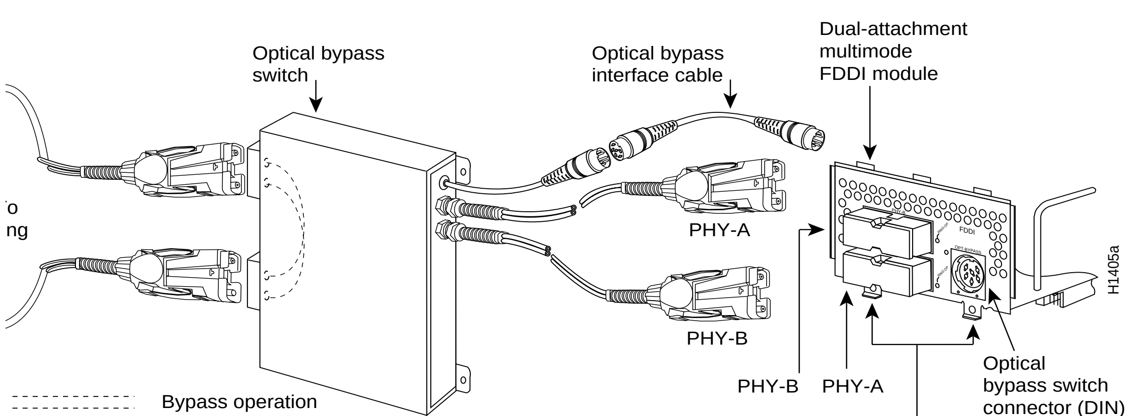
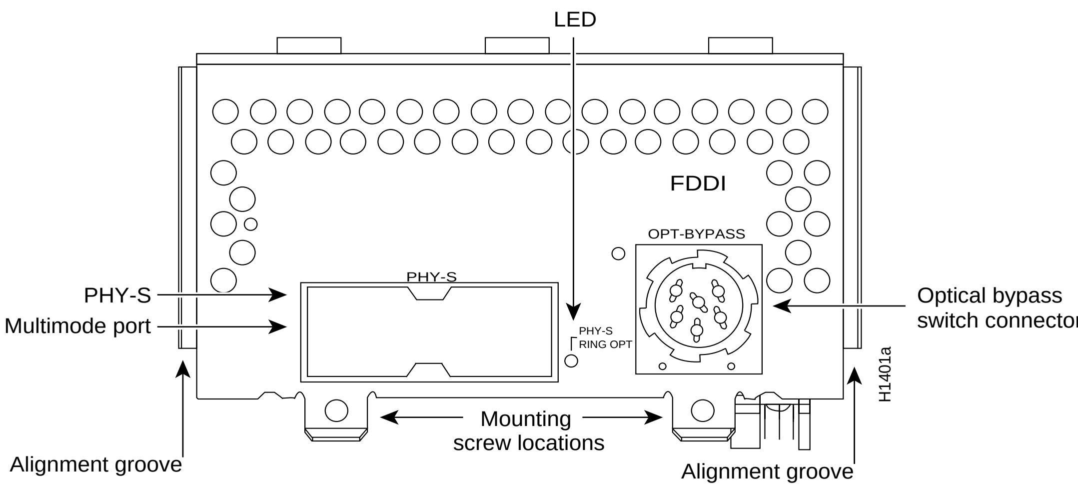


Figure 4-38 Single-Attachment Multimode FDDI Module—End View



Optical Bypass Switch Connections

Both the dual-attachment and single-attachment FDDI modules have an optical bypass switch connector. 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 optical bypass switch is enabled, and the ring will be unaffected. The optical bypass switch is automatically enabled if power is lost. In addition, the system software can enable the optical bypass switch if a problem is detected or if the operator chooses to take the router out of the ring.

BRI Connections

The Basic Rate Interface (BRI) network processor modules (see Figure 4-40 and Figure 4-39) 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 an Integrated Services Digital Network (ISDN) through an ISDN channel service unit/digital service unit (CSU/DSU) called the NT1. The common carrier will provide the NT1 connection, except in North America, where the NT1 is customer owned.

Figure 4-39 Four-Port BRI Network Processor Module

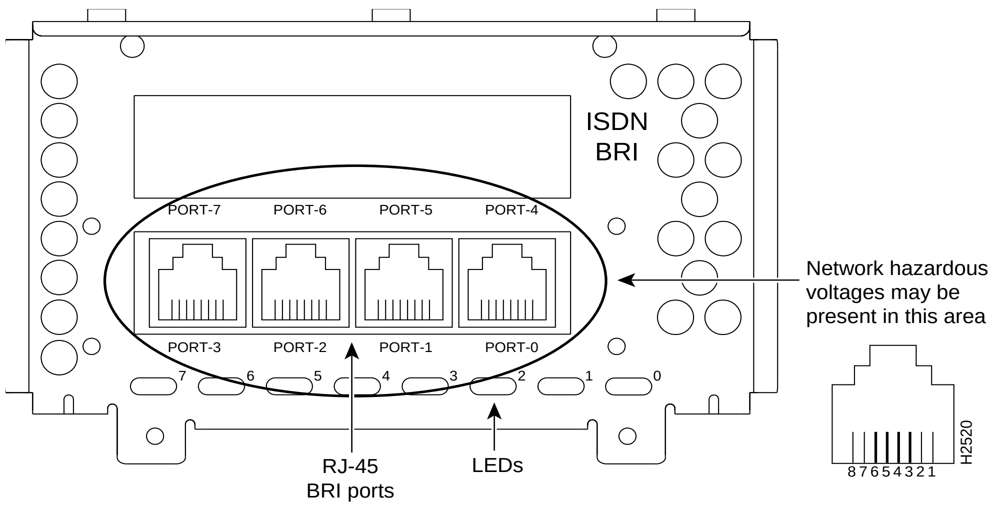
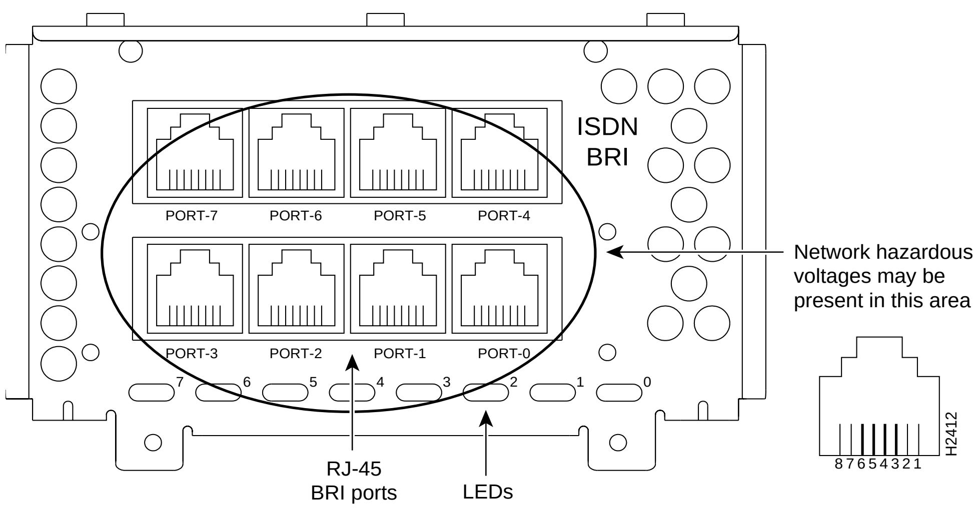


Figure 4-40 Eight-Port BRI Network Processor Module



Warning Network hazardous voltages are accessible in the BRI cable. If you detach the BRI cable, *detach the end away from the router first to avoid possible electric shock.* Network hazardous voltages are also accessible on the BRI module in the area of the BRI port (RJ-45 connector), even when power is turned OFF. (To see translated versions of this warning, refer to the appendix “Translated Safety Warnings.”)

The specifications for the BRI cable are given in Table 4-8.

Table 4-8 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 The multiport BRI network processor module requires that all its interfaces connect to the same carrier or from carriers with synchronized master clocks. If the BRI module connects to ISDN interfaces which have an unsynchronized master clock, the module’s interfaces will occasionally lose some packets.

Channelized T1/ISDN PRI Connections

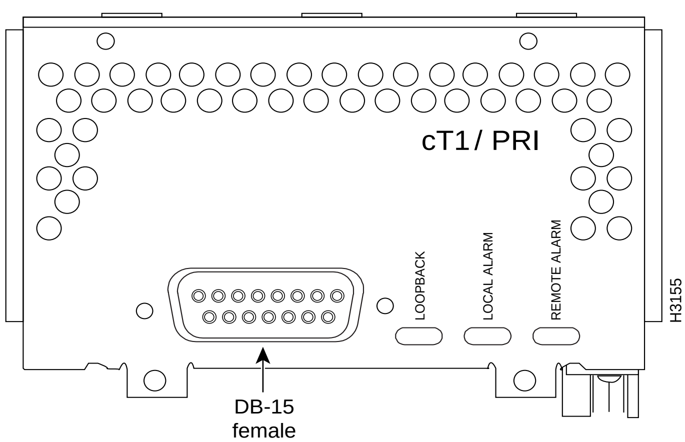
The Cisco 4000 series routers support a channelized T1/ISDN PRI (CT1/PRI) network processor module with one T1 interface.The CT1/PRI module provides one channelized T1 connection via a serial cable to a channel service unit (CSU). On the CT1/PRI module, the controller provides up to 24 virtual channels.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

The CT1/PRI network processor module, shown in Figure 4-41, provides a controller for transmitting and receiving data bidirectionally at the T1 rate of 1.544 Mbps. For wide-area networking, the CT1/PRI module can function as a concentrator for a remote site.

Following are the T1 specifications:

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

Figure 4-41 CT1/PRI Network Processor Module



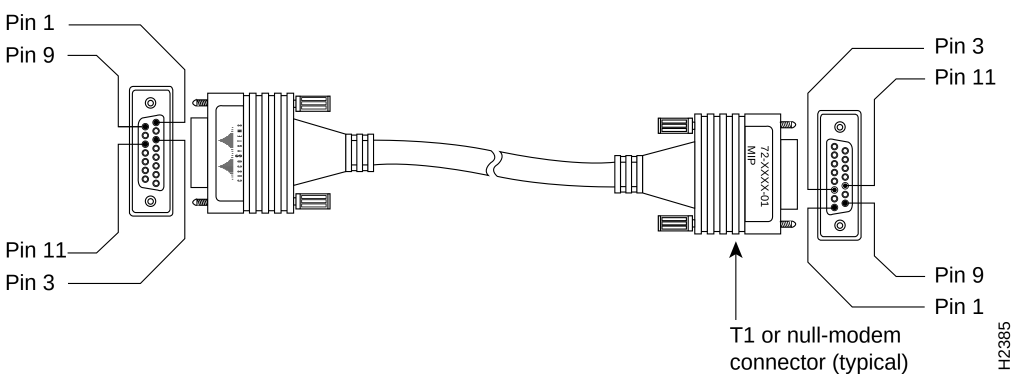
T1 Cabling

For the CT1/PRI network processor module, two standard T1 serial cables are available from Cisco Systems: null-modem and straight-through. A straight-through cable connects your router to an external CSU. Null-modem cables are used for back-to-back operation and testing.

The cables have male 15-pin DB connectors at each end to connect the CT1/PRI module to the external CSU.

The T1 interface cable has two 15-pin DB connectors at each end to connect the CT1/PRI module to the external T1 CSU. Figure 4-42 shows the T1 interface cable, connectors and pinouts.

Figure 4-42 T1 Interface Cable



Channelized E1/ISDN PRI Connections

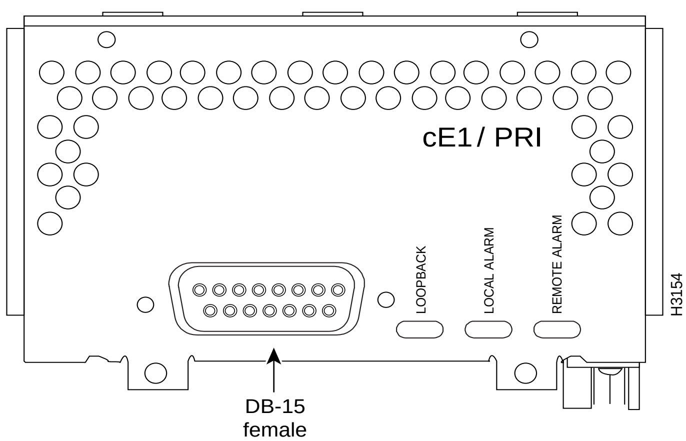
The Cisco 4000 series routers support a channelized E1/ISDN PRI (CE1/PRI) network processor module with one E1 interface.The CE1/PRI network processor module provides one channelized E1 connection using a serial cable to a CSU. On the CE1/PRI module, the controller provides up to 24 virtual channels. Each virtual channel is presented to the system as a serial interface that can be configured individually. This interface is the physical media that supports ISDN PRI.

The CE1/PRI network processor module, shown in Figure 4-43, provides a controller for transmitting and receiving data bidirectionally at the E1 rate of 2.048 Mbps. For wide-area networking, the CE1/PRI module can function as a concentrator for a remote site.

Following are the E1 specifications:

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

Figure 4-43 CE1/PRI Network Processor Module



CE1/PRI Network Processor Module Jumper Settings

The jumpers on the CE1/PRI network processor module set capacitive coupling between the transmit or receive shield and chassis ground, and the cable resistance (120 ohm or 75 ohm).

By default, the CE1/PRI network processor module is set with capacitive coupling between the receive (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 4-44) controls this function. To set capacitive coupling between the transmit (TX) shield and chassis ground, set jumper J2 as described in Table 4-9.

Figure 4-44 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 figure shows the cable impedance set to 120 ohm.

Figure 4-44 Location of Jumpers on the CE1/PRI Network Processor Module

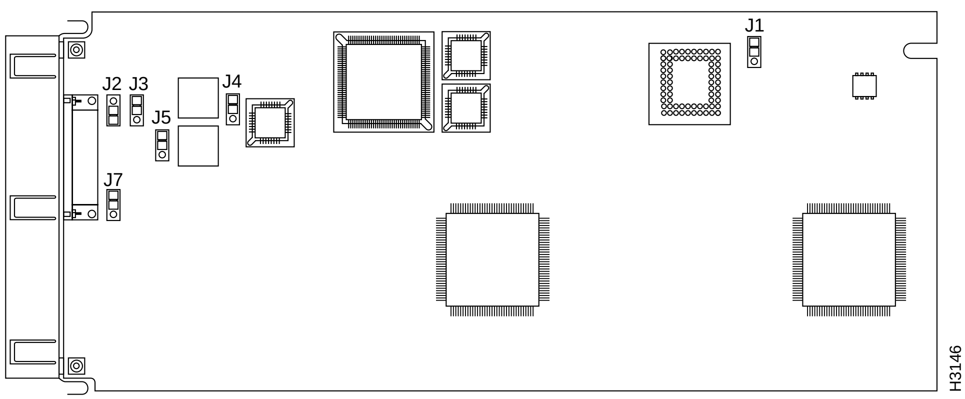


Table 4-9 Jumper Settings and Functions

Jumper	Position	Function
J2	1 and 2 2 and 3	Connects the RX shield to chassis ground. Connects the RX shield through capacitive coupling to chassis ground.
J1, J3, J4, J5, J7[1]	1 and 2 2 and 3	Sets cable impedance to 120 ohms. Sets cable impedance to 75 ohms.

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

Warning To prevent problems with the E1 interface and to reduce the potential for injury, jumper J2 should be configured by trained service personnel *only*. For either impedance option, a jumper installed at J2 bypasses the alternating current (AC)-decoupling capacitor to ground, thereby coupling the interface directly to AC. This is a setting that could pose a risk of severe injury. By default and for safety, J2 has been configured with no ground. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

E1 Cabling

Four serial cables are available from Cisco Systems for the CE1/PRI network processor module. All four cables have DB-15 connectors on the router end and either BNC, DB-15, Twinax, or RJ-45 connectors on the network end. Figure 4-45, Figure 4-46, Figure 4-47, and Figure 4-48 show the E1 interface cables.

Figure 4-45 E1 Interface Cable for 75-Ohm, Unbalanced Connections (with BNC Connectors)

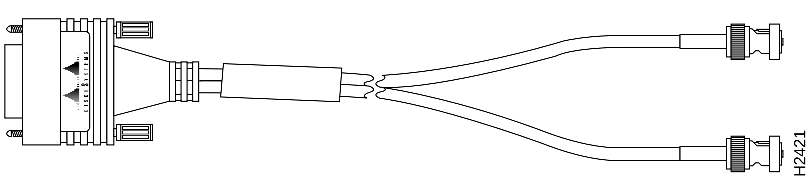


Figure 4-46 E1 Interface Cable for 120-Ohm, Balanced Connections (with DB-15 Connector)

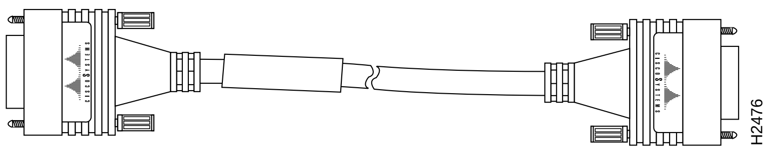


Figure 4-47 E1 Interface Cable for 120-Ohm, Balanced Connections (with Twinax Connectors)

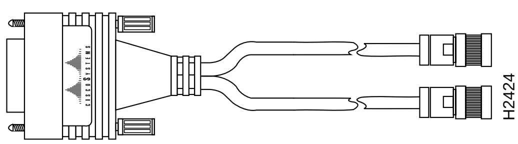
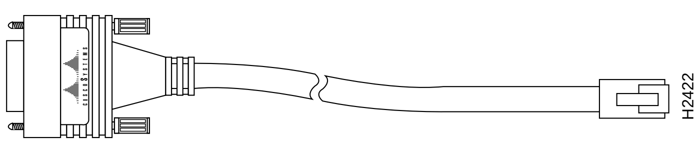


Figure 4-48 E1 Interface Cable for 120-Ohm, Balanced Connections (with RJ-45 Connector)



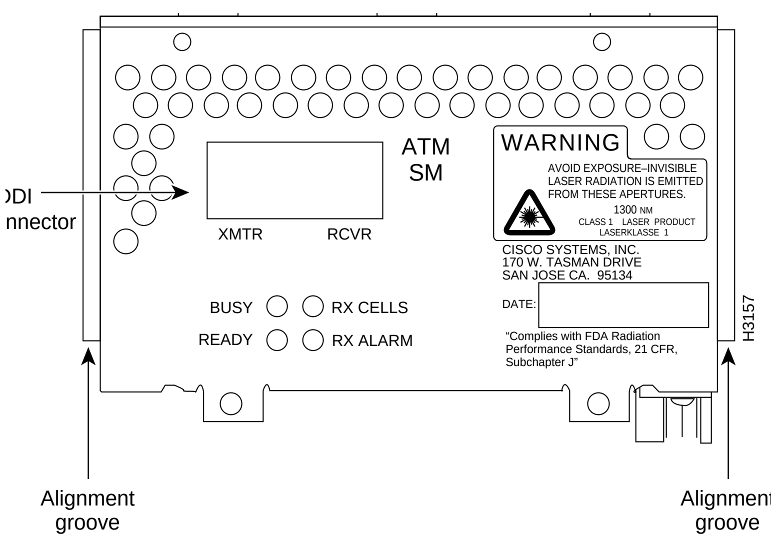
ATM Connections

The ATM network processor module for Cisco 4500, Cisco 4500-M, and Cisco 4700-M routers provides a User-Network Interface (UNI) between the router and an ATM network.

The ATM modules provide an interface to ATM switching fabrics for 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 ATM network technology (by the specific physical layer). Four ATM network processor modules are available that support PLIMs connecting to the following physical layers:

- Synchronous Optical Network (SONET)/Synchronous Digital Hierarchy (SDH) 155-Mbps single-mode fiber-optical—Synchronous Transport Signal level 3, concatenated (STS-3c) or Synchronous Transport Module, level 1 (STM-1) (See Figure 4-49)

Figure 4-49 ATM Network Processor Module with STS-3c/STM-1 Single Mode PLIM



- SONET/SDH 155-Mbps multimode fiber-optical—STS-3c or STM-1 (See Figure 4-50)
- E3 34-Mbps coaxial cable (See Figure 4-51)
- Digital signal (DS)-3 45-Mbps coaxial cable (See Figure 4-51)

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

All ATM interfaces are full-duplex. You must use the appropriate ATM interface cable and accessories to connect the ATM network processor module with an external ATM network. The ATM interface cable is used to connect your router to an ATM switch, or to connect two router ATM interfaces back to back.

An ATM network processor module can be installed in any available network processor module slot. If the middle slot is not occupied by an FDDI network processor module, use this slot for the ATM module.

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

Figure 4-50 ATM Network Processor Module with STS-3c/STM-1 Multimode PLIM

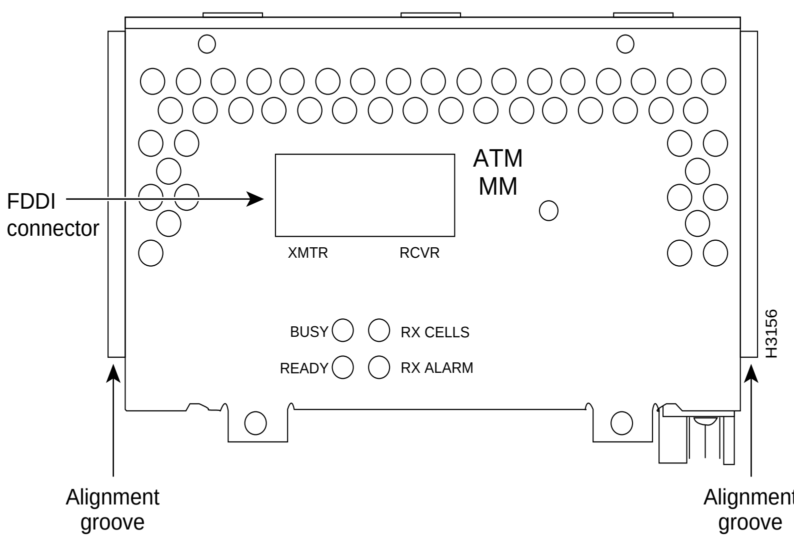
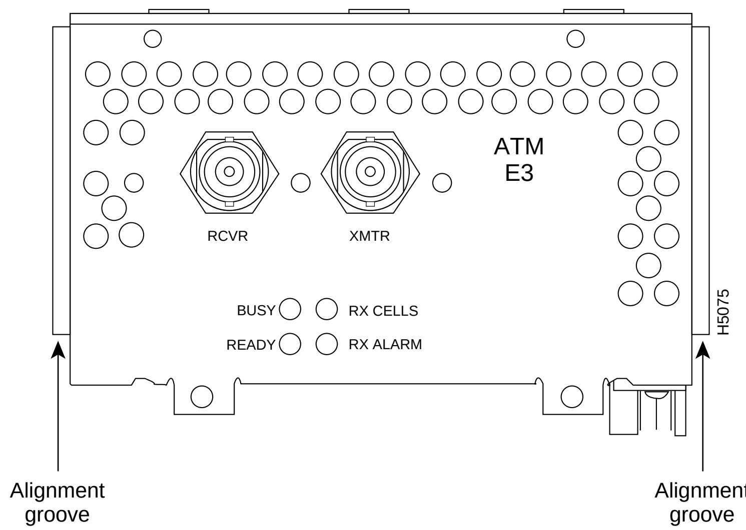


Figure 4-51 ATM Network Processor Module with DS-3/E3 PLIM



ATM Cabling

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

For SONET/SDH multimode connections, use one multimode duplex SC connector (see Figure 4-52) or two single SC connectors. (See Figure 4-53.)

Figure 4-52 Duplex SC Connector

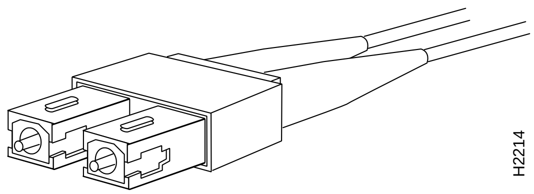
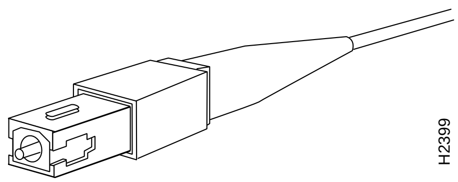
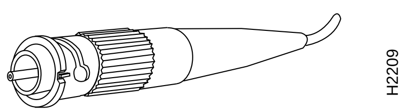


Figure 4-53 Simplex SC Connector



For SONET/SDH single-mode connections, use the single-mode (ST2) connector (bayonet-style twist-lock). (See Figure 4-54.)

Figure 4-54 ST2 Connector

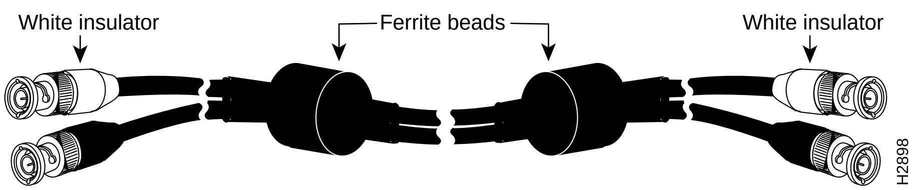


Note The ATM network processor module for the Cisco 4000 series router uses identical duplex SC connectors for single-mode and multimode SONET connections. The front panels are similar in appearance. The best way to tell the difference is by the yellow laser warning label on the front panel of the single-mode module, or by 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. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

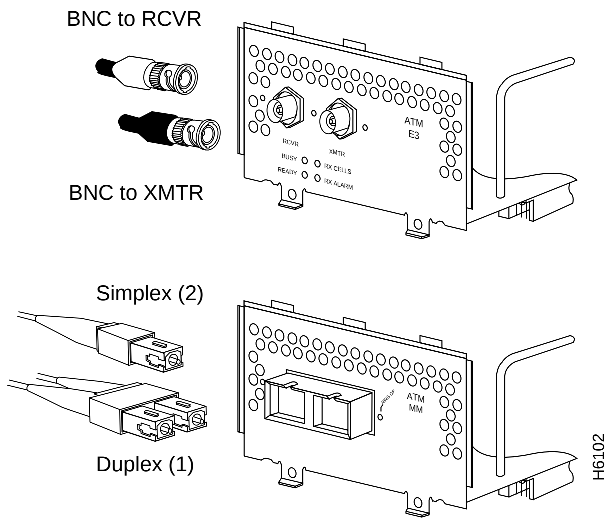
For E3 and DS-3 connections, use the 75-ohm, RG-59, coaxial cable with bayonet-style, twist-lock (BNC) connectors and ferrite beads. (See Figure 4-55.) The E3 and DS-3 PLIMs both use the same cable. Ensure that the transmit and receive portions of the cable are connected to the appropriate module connector.

Figure 4-55 DS3/E3 Cable—RG-59 Coaxial Cable with BNC Connectors



Connect the ATM network processor module interface cables as shown in Figure 4-56.

Figure 4-56 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 the receive port (labeled RCVR); the DS-3 PLIM connection does not require this clip. Figure 4-57 shows the EMI filter clip assembly that is required for the E3 PLIM. Do not operate the E3 PLIM without this assembly.

If you have an E3 PLIM, you must take the following steps to install the cable and EMI filter assembly.

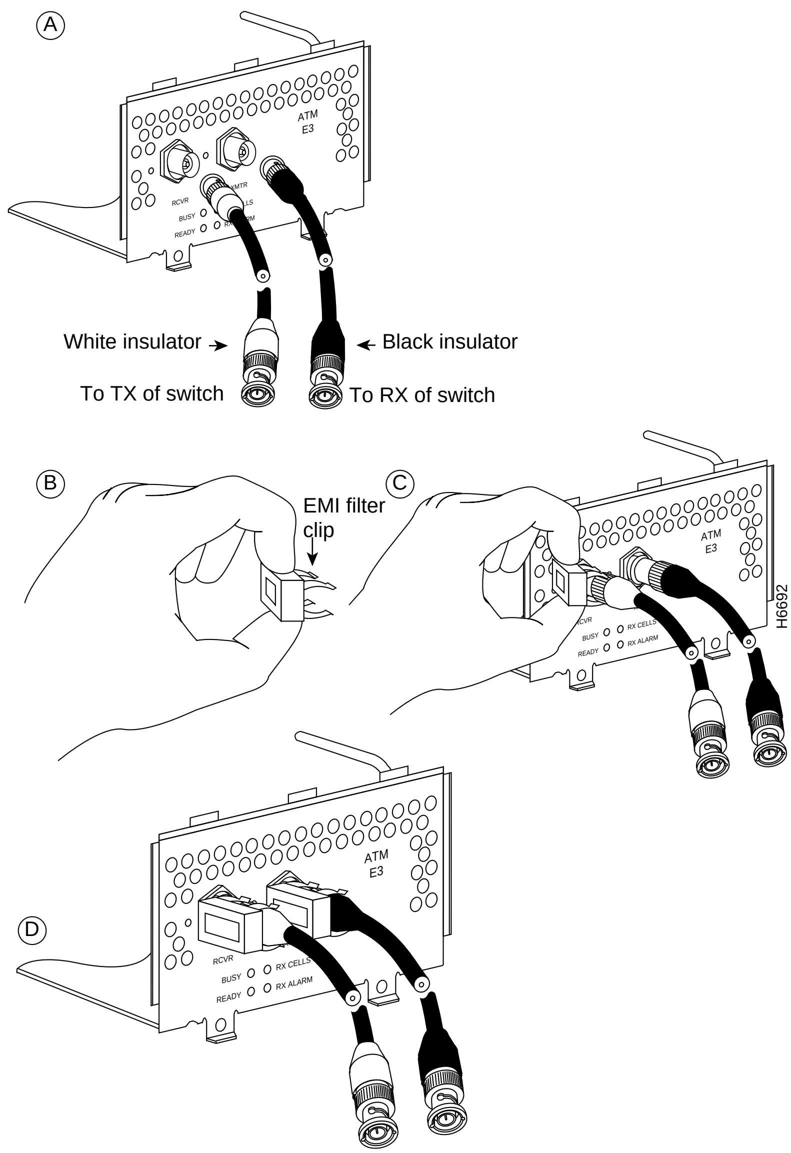
Step 1 Attach the cable to the transmit (XMTR) and receive (RCVR) ports on the E3 PLIM. (See Figure 4-57, part A.)

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

Step 2 Hold the EMI filter clip as shown in Figure 4-57, part B and attach it to the receive cable. (See Figure 4-57, 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. (See Figure 4-57, part D.)

Figure 4-57 E3 EMI Filter Clip Assembly



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 4-10. If the distance between two connected stations is greater than these maximum distances, significant signal loss can result, making transmission unreliable.

Table 4-10 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.

Power Budget

To design an efficient optical data link, you must evaluate the power budget. The power budget is the amount of light available to overcome attenuation in the optical link and to exceed the minimum power that the receiver requires to operate within its specifications. Proper operation of an optical data link depends on modulated light reaching the receiver with enough power to be correctly demodulated.

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

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 power of the system 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 4-11 lists the factors of attenuation and dispersion limit for typical fiber-optic cable.

Table 4-11 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 results from light from the LED entering the fiber and being radiated into the fiber cladding. A worst-case estimate of power margin (M) for multimode transmissions assumes minimum transmitter power (T), maximum link loss (LL), and minimum receiver sensitivity (PR). The worst-case analysis provides a margin of error, although not all of the 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 = T – PR

PB = –18.5 decibels per milliwatt (dBm) – (–30 dBm)

PB = 11.5 dB

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

M = PB – LL

If the power margin is positive, as a rule, the link will work.

Table 4-12 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.

For SONET versions of the ATM module, the signal must meet the worst-case parameters listed in Table 4-13.

Table 4-12 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 4-13 SONET Signal Requirements

Signal	Single-Mode	Multimode
T	–18.5	–15
PR	–30	–28
PB	–11.5	–13

Multimode Power Budget Example

The following is an example multimode power budget, based on the following variables, and calculated to ensure sufficient power for transmission:

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. But, due to the dispersion limit on the link (4 km x 155.52 MHz > 500 MHz/km), this link would 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 there is a single transmission path within the fiber and smear does not occur. In addition, chromatic dispersion is also reduced because laser light is essentially monochromatic.

The maximum overload specification on the single-mode receiver is –14 decibels (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. Statistical power budget analysis is beyond the scope of this document. For further information, refer to User-Network Interface (UNI) Forum specifications, International Telecommunication Union Telecommunication Standardization Sector (ITU-T) standards, and your equipment specifications.

For Further Reference

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

- T1E1.2/92-020R2 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

Connecting Routers with a DC-Input Power Supply

Follow the directions in this section to wire a Cisco 4000 series router with a DC-input power supply.

Warning Before performing any of the following procedures, ensure that power is removed from the DC circuit. To ensure that all power is OFF, locate the circuit breaker on the panel board that services the DC circuit, switch the circuit breaker to the OFF position, and tape the switch handle of the circuit breaker in the OFF position. (To see translated versions of this warning, refer to the appendix “Translated Safety Warnings.”)

Warning When stranded wiring is required, use approved wiring terminations, such as closed-loop or spade-type with upturned lugs. These terminations should be the appropriate size for the wires and should clamp both the insulation and conductor. (To see translated versions of this warning, refer to the appendix “Translated Safety Warnings.”)

Warning This unit is intended for installation in restricted access areas. (To see translated versions of this warning, refer to the appendix “Translated Safety Warnings.”)

Warning Only trained and qualified personnel should be allowed to install or replace this equipment. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

Note The installation must comply with the 1993 National Electric Code (NEC) and other applicable codes.

For identification purposes, the following drawings show the rear view of a Cisco 4000 series router with an AC power supply followed by a Cisco 4000 series router with a DC-input power supply. (See Figure 4-58 and Figure 4-59.)

Figure 4-58 Rear View of a Cisco 4000 Series Router with an AC-Input Power Supply

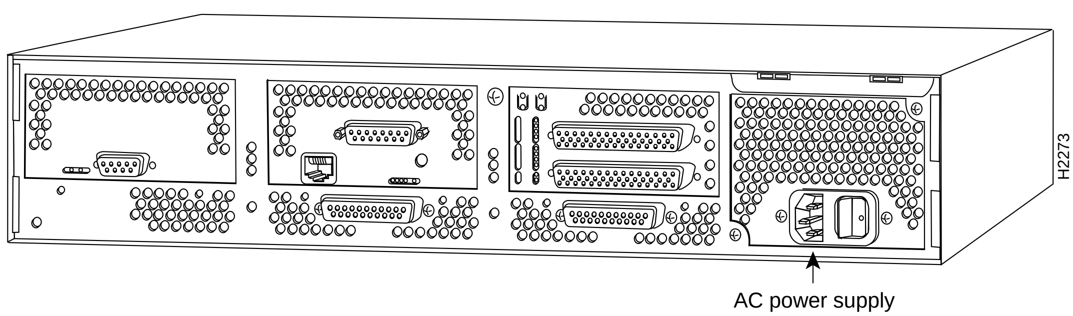
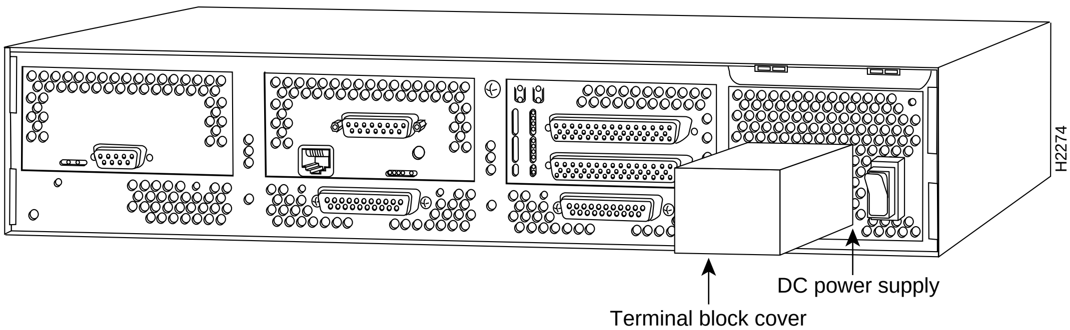


Figure 4-59 Rear View of a Cisco 4000 Series Router with a DC-Input Power Supply



Wiring the DC-Input Power Supply

Warning Read the installation instructions before you connect the system to its power source. (To see translated versions of this warning, refer to the appendix “Translated Safety Warnings.”)

Take the following steps to wire the DC-input power supply terminal block:

Step 1 Feed the wires through the rubber grommet in the terminal block cover.

Step 2 Attach the appropriate lugs at the wire end of the power supply cord.

Warning When installing the unit, the ground connection must always be made first and disconnected last. (To see translated versions of this warning, refer to the appendix “Translated Safety Warnings.”)

Step 3 Wire the DC-input power supply to the terminal block as shown in Figure 4-60. The proper wiring sequence is ground to ground, positive to positive, and negative to negative.

Caution Do not overtorque the terminal block captive thumbscrew or terminal block contact screws. The recommended torque is 8.2 ± 0.4 inch-lb.

Warning The illustration shows the DC power supply terminal block. Wire the DC power supply using the appropriate lugs at the wiring end, as illustrated. The proper wiring sequence is ground to ground, positive to positive (line to L), and negative to negative (neutral to N). Note that the ground wire should always be connected first and disconnected last. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

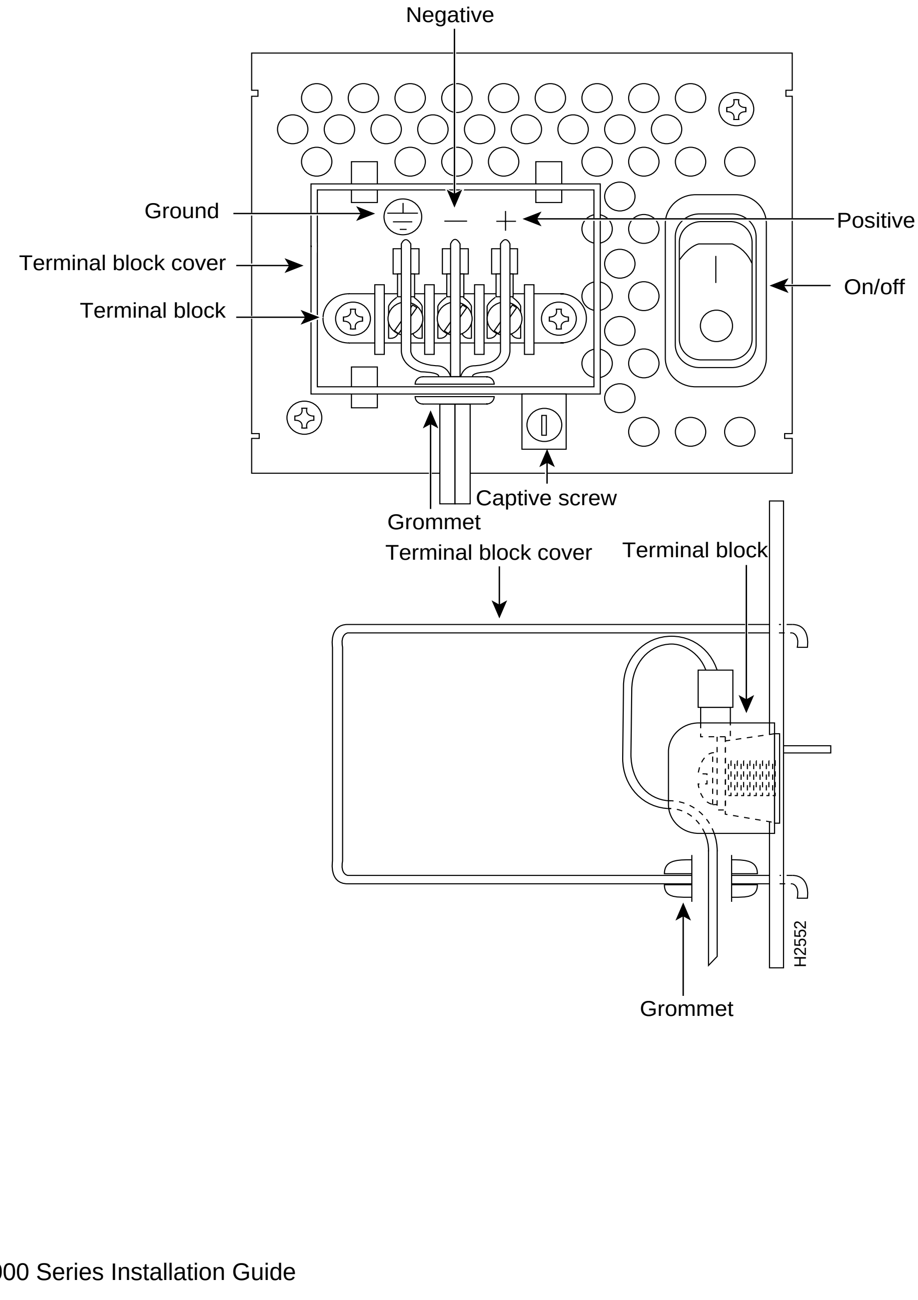
Warning After wiring the DC-input power supply, replace the terminal block cover and screw to ensure user safety. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

Warning After wiring the DC power supply, remove the tape from the circuit breaker switch handle and reinstate power by moving the handle of the circuit breaker to the ON position. (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

Step 4 Remove the tape from the circuit breaker switch handle and restore power by moving the circuit breaker handle to the ON position.

Caution To avoid damaging the power supply when returning the chassis to the manufacturer (for example, if a failure occurs), remove the power supply terminal block cover so that it will fit in the shipping container.

Figure 4-60 DC-Input Power Supply Terminal Block



Powering Up the Router

Caution Never operate the router unless the chassis is completely closed to ensure adequate cooling.

Take the following steps to power up the router:

Step 1 If you have an AC-powered system, plug the system power cord into a 3-terminal, single-phase power source that provides power within the acceptable range (100–240 VAC, 50–60 Hz, 3.0–1.5A).

Step 2 If you have a DC-powered system, refer to the preceding section "Connecting Routers with a DC-Input Power Supply" to connect the input power supply.

Warning This product relies on the building's installation for short-circuit (overcurrent) protection. Ensure that a fuse or circuit breaker no larger than 120 VAC, 15A U.S. (240 VAC, 10A international) is used on the phase conductors (all current-carrying conductors). (To see translated versions of this warning, refer to the appendix "Translated Safety Warnings.")

Step 3 Turn ON the system power switch. The LED labeled POWER on the front panel should go on.

Step 4 Verify that the OK LED on the right side of the front panel goes ON after a few seconds delay.

For more information on configuring the router software, refer to the chapter "Software Configuration."

CHAPTER 5

Software Configuration

This chapter describes the procedures for configuring Cisco IOS software for Cisco 4000 series routers, and it contains the following sections:

- Powering Up the Router
- Booting the Router for the First Time
- Using the Enable Secret and the Enable Passwords
- Configuring the Router
- Additional Configuration Tasks
- Checking the Router Configuration
- Saving the Router Configuration
- If You Need More Information

To configure your router, you need to connect a terminal or PC running terminal emulation software to the router. Configuration requires access to the console port.

Powering Up the Router

Caution Never operate the router unless the chassis is completely closed to ensure adequate cooling.

Take the following steps to power up the router:

Step 1 If you have an AC-powered system, plug the system power cord into a 3-terminal, single-phase power source that provides power within the acceptable range (100–240 VAC, 50–60 Hz, 3.0–1.5A).

Step 2 If you have a DC-powered system, make sure to connect the input power supply as described in the section "DC-Input Power Supply Connection" in the chapter "Router Installation."

Warning This product relies on the building's installation for short-circuit (overcurrent) protection. Ensure that a fuse or circuit breaker no larger than 120 VAC, 15A U.S. (240 VAC, 10A international) is used on the phase conductors (all current-carrying conductors).

Step 3 Turn ON the system power switch. The LED labeled POWER on the front panel should go on.

Step 4 Verify that the OK LED on the right side of the front panel goes ON after a few seconds delay.

Booting the Router for the First Time

You configure Cisco 4000 series routers using the Cisco command interpreter, which is called the EXEC. You must log in to the router before you can enter an EXEC command. For security purposes, the EXEC has two levels of access to commands, user EXEC mode and privileged EXEC mode.

To enter the privileged mode you must enter the enable secret password.

Using the Enable Secret and the Enable Passwords

The commands available in user EXEC mode are a subset of those available in privileged EXEC mode. Because many privileged-level EXEC commands are used to set operating parameters, you should password-protect these commands to prevent unauthorized use.

You use two commands to do this:

- **enable secret** *password* (which is a very secure, encrypted password)
- **enable** *password* (which is a less secure, or nonencrypted password)

You must enter an enable secret password to gain access to privileged-level commands.

For maximum security, the passwords should be different. If you enter the same password for both during the setup script, the system will accept it, but you will receive a warning message indicating that you should enter a different password.

An enable secret password can contain from 1 to 25 uppercase and lowercase alphanumeric characters; an enable password can contain any number of uppercase and lowercase alphanumeric characters. In both cases, a number cannot be the first character. Spaces are also valid password characters; for example, "two words" is a valid password. Leading spaces are ignored; trailing spaces are recognized.

If you lose or forget your enable password, see the section "Recovering Lost Passwords" in the chapter "Maintenance."

Configuring the Router

You can configure the router following the procedures described in one of the following sections:

- Configuring the Router Using Configuration Mode
- Configuring the Router Using AutoInstall
- Configuring the Router Manually Using the Setup Facility

Follow the procedure that best fits the needs of your network configuration.

Note You will need to obtain the correct network addresses from your system administrator or consult your network plan to determine correct addresses before you can complete the router configuration.

Before continuing the configuration process, check the current state of the router by entering the **show version** command. The show version command will display the release of Cisco IOS software that is available on the router.

Configuring the Router Using Configuration Mode

You can configure the router manually if you prefer not to use the setup facility or AutoInstall. Take the following steps to configure the router manually:

Step 1 Connect a console terminal by following the instructions in the section "Console Port and Auxiliary Port Connection Considerations" in the chapter "Cable Connection" and then power up the router to the EXEC prompt (Router>).

Step 2 When you are asked if you would like to enter the initial dialog, answer **no** to go into the normal operating mode of the router:

```
Would you like to enter the initial dialog? [yes]: no
```

Step 3 After a few seconds you will see the user EXEC prompt (Router>). Enter the **enable** command to enter enable mode. You can only make configuration changes in enable mode:

```
Router> enable
```

The prompt will change to the enable prompt, indicated by the "#" sign:

```
Router#
```

Step 4 Enter the command **config terminal** at the enable prompt to enter configuration mode:

```
Router# config terminal
```

You can now enter any changes to the configuration that you want to make. Press **Ctrl-Z** to exit configuration mode.

To see the currently operating configuration, enter the command **show running-config** at the enable prompt:

```
Router# show running-config
```

To see the configuration in nonvolatile random-access memory (NVRAM), enter the command **show config** at the enable prompt.

```
Router# show config
```

To make your changes permanent, enter the command **copy running-config startup-config** at the enable prompt:

```
Router# copy running-config startup-config
********
```

The results of the **show running-config** and **show startup-config** commands will differ if you have made changes to the configuration but have not yet written them to NVRAM.

The router is now configured and will boot with the configuration you have entered.

Configuring the Router Using AutoInstall

The AutoInstall process is designed to configure the router automatically after connection to your WAN. This process is useful when you must configure the router over serial 0.

In order for AutoInstall to work properly, a Transmission Control Protocol/Internet Protocol (TCP/IP) host on your network must be preconfigured to provide the required configuration files. The TCP/IP host may exist anywhere on the network as long as the following conditions are maintained:

- The host must be on the remote side of the router's synchronous serial connection to the WAN.

- User Datagram Protocol (UDP) broadcasts to and from the router and the TCP/IP host must be enabled.

This functionality is coordinated by your system administrator at the site where the TCP/IP host is located. You should not attempt to use AutoInstall unless the required files have been installed on the TCP/IP host.

Take the following steps to prepare your router for the AutoInstall process:

Step 1 Attach the synchronous serial cable to the router.

Step 2 Turn ON power to the router.

The router will load the operating system image from Flash memory. If the remote end of the WAN connection is connected and properly configured, the AutoInstall process will begin.

If the AutoInstall completes successfully, you might want to write the configuration data to the router's NVRAM. Perform the next step to complete this task.

Step 3 At the enable prompt, enter the **copy running-config startup-config** command:

```
Hostname# copy running-config startup-config
```

Taking this step will save the configuration settings that the AutoInstall process created in the router. If you fail to do this, your configuration will be lost the next time you reload the router.

Configuring the Router Manually Using the Setup Facility

If you do not plan to use AutoInstall, do not connect the router's serial (WAN) cable to the channel service unit/data service unit (CSU/DSU). The router will attempt to run AutoInstall whenever you start it if the serial (WAN) connection is connected on both ends and the router does not have a configuration stored in NVRAM. It can take several minutes for the router to determine that AutoInstall is not set up to a remote TCP/IP host.

Once the router has determined that AutoInstall is not configured, it will default to the setup facility. If the serial (WAN) cable is not connected, the router will boot from Flash memory and go into the setup facility.

Note You can run the setup facility any time you are at the enable prompt by entering the **setup** command.

Configuring the Global Parameters

When you first start the setup program you must configure the global parameters, which are used for controlling system-wide settings.

Note The screen displays shown in this section may vary from those displayed on your console terminal, depending on the configuration of your router.

Take the following steps to enter the global parameters:

Step 1 Connect a console terminal by following the instructions in the section "Console Port Connections" in the chapter "Cable Connection," and then power up the router to the EXEC prompt (Router>).

Step 2 When you have booted from Flash memory, copyright and router hardware information will be displayed on the console screen after about 30 seconds. After the router hardware information is displayed, you will see a message similar to the following. When you see this information displayed, you have successfully booted your router.

```
Notice: NVRAM invalid, possibly due to write erase.

         --- System Configuration Dialog ---


At any point you may enter a question mark '?' for help.
Refer to the 'Getting Started' Guide for additional help.
Use ctrl-c to abort configuration dialog at any prompt.
Default settings are in square brackets '[]'.
```

Step 3 Enter **yes** (the default) or press **Return** when you are asked if you would like to enter the configuration dialog and if you would like to see the current interface summary.

```
Would you like to enter the initial configuration dialog? [yes]:

First, would you like to see the current interface summary? [yes]:

Any interface listed with OK? value "NO" does not have a valid
configuration

Interface    IP-Address      OK?  Method     Status  Protocol
Ethernet0    unassigned      NO   not set    up      down
Ethernet1    unassigned      NO   not set    down    down
Serial0      unassigned      NO   not set    down    down
Serial1      unassigned      NO   not set    down    down
Serial2      unassigned      NO   not set    down    down
Serial3      unassigned      NO   not set    down    down
```

Step 4 Choose which protocols to support on your first Ethernet interface. For IP-only installations, you can accept the default values for most of the questions. A typical configuration using IP, Internetwork Packet Exchange (IPX), and AppleTalk follows:

```
Configuring global parameters:

  Enter host name [Router]: router
```

Step 5 Enter the enable secret password, the enable password, and the virtual terminal password:

```
The enable secret is a one-way cryptographic secret used
instead of the enable password when it exists.

  Enter enable secret : shovel

The enable password is used when there is no enable secret
and when using older software and some boot images.

  Enter enable password : trowel
    Enter virtual terminal password: pail
```

Enter **yes** or **no** to accept or refuse Simple Network Management Protocol (SNMP) management:

```
Configure SNMP Network Management? [no]:
```

SNMP is the most widely supported open standard for network management. It provides a means to access and set configuration and run-time parameters of routers and communication servers. SNMP defines a set of functions that can be used to monitor and control network elements.

Step 6 If you are using IP routing, you must also select an interior routing protocol. You can specify only one of two interior routing protocols to operate on your system using the setup facility, Interior Gateway Routing Protocol (IGRP) or Routing Information Protocol (RIP).

Enter **yes** (the default) or press **Return** to configure IP, and then select an interior routing protocol for IP:

```
Configure IP? [yes]:
  Configure IGRP routing? [yes]:
    Your IGRP autonomous system number [1]: 15
```

Step 7 Respond to the prompts as follows to enable routing on IPX and AppleTalk; IP has already been selected:

```
Configure IPX? [no]: yes

Configure AppleTalk? [no]: yes
    Multizone networks? [no]: yes

Configure LAT? [yes]: no
```

Step 8 If your router has an ISDN network processor module installed, you will be prompted to select the switch type for your router. The ISDN switch type appropriate for your router depends on the ISDN provider’s equipment. Table 5-1 lists the ISDN switch types.

Enter the ISDN switch type:

```
Enter ISDN BRI Switch Type [none]: basic-ni1
```

Table 5-1 ISDN BRI Switch Types

ISDN Switch Type	Description
basic-1tr6	German 1TR6 ISDN switches
basic-5ess	AT&T basic rate switches
basic-dms100	NT DMS-100 basic rate switches
basic-net3	NET3 ISDN switches (U. K. and others)
basic-ni1	National ISDN-1 switches
basic-nwnet3	Norwegian NET3 ISDN switches (phase 1)
basic-nznet3	New Zealand NET3 ISDN switches
basic-ts013	Australian TS013 switches
none	Switch type not defined
ntt	Japanese NTT ISDN switches
vn2	French VN2 ISDN switches
vn3	French VN3 ISDN switches

This completes the procedure to configure the global parameters.

Additional Configuration Tasks

When you have completed the setup facility, you might need to complete some additional configuration tasks. See the following sections:

- Configuring the Ethernet Interface
- Configuring the T1 Interface
- Configuring the E1 Interface
- Configuring the ISDN BRI Interface
- Configuring the ATM Network Processor Module Interface
- Configuring the Synchronous Serial Interfaces

- Configuring the Asynchronous/Synchronous Serial Interfaces
- Configuring G.703/G.704 Interfaces

Configuring the Ethernet Interface

If your router has an Ethernet network processor module installed, you need to configure the Ethernet ports.

Take the following steps to configure the Ethernet interfaces:

Step 1 Respond as follows to the prompts, substituting the correct IP address and number of subnet bits for your site. In the following example, the system is being configured for an Ethernet LAN using IP.

```
Configuring interface parameters:

Configuring interface Ethernet0:
  Is this interface in use? [yes]:
 Configure IP on this interface? [yes]:
    IP address for this interface: 172.16.72.1
    Number of bits in subnet field [0]: 8

    Class B network is 172.16.0.0, 8 subnet bits; mask is
255.255.255.0
```

Step 2 Enter **yes** if you will be using AppleTalk on the interface, enter **yes** to configure for extended AppleTalk networks, and then enter the cable range number, the zone name, and any other additional zones that will be associated with your local zone:

```
Configure AppleTalk on this interface? [no]: yes
    Extended AppleTalk network? [no]: yes
    AppleTalk starting cable range [0]: 1
    AppleTalk ending cable range [1]: 2

    AppleTalk zone name [myzone]:
    AppleTalk additional zone name: otherzone
    AppleTalk additional zone name:
```

Step 3 If you are going to enable IPX on this interface, enter the unique IPX network number:

```
Configure IPX on this interface? [no]: yes
    IPX network number [1]: B001
Configure XNS on this interface? [no]
```

Step 4 Repeat Step 1 through Step 3 to configure each Ethernet interface in your router.

You must also select the type of media connection to the module by entering media-type commands in the router's configuration file. For NP-1E, NP-2E, or NP-6E modules, enter one of the following for each Ethernet interface on the router:

media-type aui

or

media-type 10baset

For NP-FE modules, select one of the following for each Fast Ethernet interface on the router

media-type 100baset

or

media-type mii

The following is an example of configuring the Ethernet 0 interface for an 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
```

For more information about the **media-type** command, refer to the Cisco IOS configuration guides and command references.

Configuring the T1 Interface

If you installed a new channelized T1/ ISDN PRI (CT1/PRI) network processor module, or if you want to change the configuration of an existing network processor module, you must enter configuration mode to configure or reconfigure the interface. If you replaced a CT1/PRI module that was previously configured, the system will recognize the new CT1/PRI module and bring it up with the existing configuration.

When you have verified that the new CT1/PRI module is recognized by the router, use the **configure** command to configure the new CT1/PRI module. Have the following information ready when you begin your configuration:

- T1 information—for example, clock source, line code, and framing type
- Channel group and time-slot mapping
- Protocols and encapsulations you plan to use on the new interfaces
- Internet protocol (IP) addresses if you will configure the interfaces for IP routing
- Whether the new interface will use bridging

Take the following steps to complete a basic T1 configuration:

Step 1 At the privileged-level prompt, enter the **configuration terminal** command to enter configuration mode and specify that the console terminal will be the source of the configuration commands:

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

Step 2 Enter the **controller t1** command to specify the unit number of the network processor module you are configuring. For more information on unit numbers, refer to the section “Unit Numbering” in the chapter “Cable Connection.” For example, if you are configuring unit number 1, enter the following command:

```
Router(config)# cont t1 1
```

Step 3 Specify the clock source for the module. The **clock source** command determines which end of the circuit provides the clocking:

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

Note The clock source should only be set to use the internal clocking for testing the network or if the full T1 line is used as the channel group. Only one end of the T1 line should be set to internal.

Step 4 Specify the framing type:

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

Step 5 Specify the line code format:

```
Router(config-controller)# linecode b8zs
Router(config-controller)#
%CONTROLLER-3-UPDOWN: Controller T1 1, changed state to up
Router(config-controller)#
```

Step 6 Specify the channel group and time slots to be mapped. The command shown sets the channel group to 0 and time slots 1, 3 through 5, and 7 are 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 serial interface, unit number, and channel group you want 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 follows, substituting the appropriate IP address and subnet mask for your site:

```
Router(config-if)# ip address 10.1.15.1 255.255.255.0
Router(config-if)#
```

Step 9 Add any additional configuration commands required to enable routing protocols and adjust the interface characteristics. Refer to the Cisco IOS configuration guides and command references for more information on configuration subcommands.

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

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

```
Router# write memory
```

The system displays a confirmation message when the configuration is saved.

Step 12 Enter the **disable** command to return to the user level:

```
Router# disable

Router>
```

Step 13 Enter the **show** commands to check the configuration of the interface.

This completes the procedure to configure a channelized T1 interface.

Configuring the E1 Interface

If you installed a new channelized E1/ISDN PRI (CE1/PRI) network processor module or if you want to change the configuration of an existing network processor module, you must enter configuration mode to configure or reconfigure the interface. If you replaced a CE1/PRI module that was previously configured, the system will recognize the new CE1/PRI module and bring it up with the existing configuration.

When you have verified that the new CE1/PRI module is recognized by the router, use the **configure** command to configure the new CE1/PRI module. Have the following information ready when you begin your configuration:

- E1 information—for example, line code and framing type
- Channel group and time-slot mapping
- Protocols and encapsulations you plan to use on the new interfaces

- IP addresses if you will configure the interfaces for IP routing
- Whether the new interface will use bridging

Take the following steps to complete a basic E1 configuration.

Step 1 At the privileged-level prompt, enter the **configuration terminal** command to enter configuration mode and specify that the console terminal will be the source of the configuration commands:

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

Step 2 Enter the **controller e1** command to specify the unit number of the network processor module you are configuring. For more information on unit numbers, refer to the section “Unit Numbering” in the chapter “Cable Connection.” For example, if you are configuring unit number 1, enter the following command:

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

Step 3 Specify the framing type:

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

Step 4 Specify the channel group and time slots to be mapped. The command shown below sets the channel group to 0 and time slots 1, 3 through 5, and 7 are 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 you want to modify:

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

Step 6 Assign an IP address and subnet mask to the interface using the **ip address** command as follows, substituting the appropriate IP address and subnet mask for your site:

```
Router(config-if)# ip address 10.1.15.1 255.255.255.0
Router(config-if)#
```

Step 7 Add any additional configuration subcommands required to enable routing protocols and adjust the interface characteristics. Refer to the Cisco IOS configuration guides and command references for more information on configuration subcommands.

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

Step 9 Write the new configuration to memory, as follows:

```
Router# write memory
```

The system displays a confirmation message when the configuration is saved.

Step 10 Enter the **disable** command to return to the user level:

```
Router# disable

Router>
```

Step 11 Enter the **show** commands to check the configuration of the interface.

This completes the procedure to configure a channelized E1 interface.

Configuring the ISDN BRI Interface

If your router has a ISDN BRI network processor module installed, you need to configure the ISDN BRI ports.

The BRI interface is configured to allow connection to ISDN WANs through an NT1 device.

Take the following steps to configure the BRI interfaces:

Step 1 Respond as follows to the prompts, substituting the correct IP address and number of subnet bits for your site:

```
Configuring interface BRI0:
  Is this interface in use? [yes]:
  Configure IP on this interface? [yes]:
    IP address for this interface: 172.16.21.15
    Number of bits in subnet field [0]:
```

```
    Class B network is 172.16.0.0, 8subnet bits; mask is
255.255.255.0
```

Step 2 Repeat Step 1 for each BRI interface installed in your router.

Configuring the ATM Network Processor Module Interface

If you installed a new ATM network processor module or if you want to change the configuration of an existing module, you must enter the configuration mode. If you replaced an ATM network processor module that was previously configured, 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 available the following information:

- 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 **int atm** command and the unit number of the network processor module you are configuring. For more information on unit numbers, refer to the section “Unit Numbering” in the chapter “Making External Connections to the Cisco 4000 Series.” The following example is for an ATM module with unit number 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 10.1.15.1 255.255.255.0
```

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 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 Virtual channel identifier (VCI) values 0–31 are reserved by ITU-T and the ATM Forum.

Step 6 Assign the appropriate map list to the interface:

```
Router(config-if)# map-group list1
```

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 list1
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 of the network processor module you are configuring. For more information on unit numbers, refer to the section "Unit Numbering" in the chapter "Making External Connections to the Cisco 4000 Series." The following example is for an ATM module with unit number 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 10.1.15.1 255.255.255.0
```

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. In the following example, signaling virtual channel 1 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 10.1.15.1 nsap-addr nsap-addr broadcast
Router(config-map-list)# ip 10.1.15.1 nsap-addr nsap-addr broadcast
```

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
```

Configuring the Synchronous Serial Interfaces

If you have a serial network processor module installed, you need to configure the synchronous serial interfaces to allow connection to WANs through a CSU/DSU. Take the following steps to configure the serial ports:

Step 1 Determine which protocols you will allow on the synchronous serial interface and enter the appropriate responses:

```
Configure IP unnumbered on this interface? [no]: no
    IP address for this interface: 172.16.73.1
    Number of bits in subnet field [8]:
Class B network is 172.16.0.0, 8 subnet bits; mask is 255.255.255.0

Configure AppleTalk on this interface? [no]: yes
    Extended AppleTalk network? [yes]:

    AppleTalk starting cable range [2]: 3
    AppleTalk ending cable range [3]: 3

    AppleTalk zone name [myzone]: ZZ Serial
    AppleTalk additional zone name:

Configure IPX on this interface? [no]: yes
    IPX network number [2]: B000
```

Step 2 Repeat Step 1 for the remaining serial interfaces.

The following sections describe the commands for configuring an external clock signal for a data communications equipment (DCE) interface and for configuring a port for NRZI encoding or 32-bit cyclic redundancy check (CRC). Configuration commands are executed from the privileged level of the EXEC command interpreter. (For G.703/G.704 interface configuration, see the section “Configuring G.703/G.704 Interfaces” later in this chapter.)

Configuring Timing (Clock) Signals for Serial Interfaces

All interfaces support both data terminal equipment (DTE) and DCE modes, depending on the mode of the interface cable attached to the port. 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** command. This section describes how to set the clock rate on a DCE port and, if necessary, how to invert the clock to correct a phase shift between the data and clock signals.

Note 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 the clock rate is set, or if the cable is DCE and the clock rate is not configured.

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 transmit clock signal (TXC) and send it to the remote DTE. The remote DTE 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 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, the problem might be caused by a phase shift. 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 serial clock transmit external (SCTE) to the DCE port. The DCE sends serial clock transmit (SCT) and serial clock receive (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, you must use the **dce-terminal-timing-enable** command to configure the DCE port to use its own clock signal instead of the SCTE signal that would normally be returned from the DTE device.

To configure an interface to accept the internal clock generated by the serial module instead of the SCTE clock that is normally returned by the DTE device, specify the interface followed by the **dce-terminal-timing-enable** command. In the example that follows, the serial 0 port is 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.

If the network processor module is operating as DTE in NRZI mode, the sense of the **dte-invert-timing** command must be manually changed. For instance, 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.

Configuring NRZI Format on Serial Interfaces

All interfaces support both nonreturn to zero (NRZ) and NRZI formats. Both formats 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
```

To disable NRZI encoding on a port, specify the port and use the **no nrzi-encoding** command. Refer to the Cisco IOS configuration guides and command references for complete command descriptions and instructions.

Calculating CRCs on Cisco 4000 Series Serial Interfaces

On Cisco 4000 series routers, all serial interfaces support CRC-ITU-T, a 16-bit cyclic redundancy check (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 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 same predetermined number. If the result is not 0, the receiver assumes that a transmission error occurred and sends 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 the Asynchronous/Synchronous Serial Interfaces

If you have a NP-2T16S serial network processor module installed, the ports you plan to use for asynchronous operation must be reconfigured after the initial setup. The following steps provide an example of how to configure a synchronous serial port to be an asynchronous serial port.

Step 1 Enter the command **config terminal** to enter configuration mode:

```
Router# config terminal
Router(config)#
```

The router enters global configuration mode, indicated by the Router(config)# prompt.

Step 2 Select the serial interface to configure:

```
Router(config)# interface serial 2
Router(config-if)#
```

The prompt changes again to show that you are in interface configuration mode.

Step 3 Because all serial ports are initially configured as synchronous, you must change the port to asynchronous operation by entering the **physical-layer** command:

```
Router(config-if)# physical-layer async
```

Configure other asynchronous parameters according to your needs, for example:

```
Router(config-if)# async mode dedicated
Router(config-if)# async default routing
```

Step 4 To configure asynchronous line settings, use the **line async** command. A serial port's line number is related to its slot number and unit number in the following way:

line-number = (16 x *slot-number*) + *unit-number* + 1

For example, serial port 1/2 corresponds to line number (16 x 1) + 2 + 1 = 19. To set this port to a speed of 115200 bps, you would enter the following commands:

```
Router(config-if)# line async 2
Router(config-if)# speed 115200
```

Note Future releases of Cisco IOS will support automatic line configuration. Existing asynchronous ports will be renumbered according to a different line numbering convention.

To return an asynchronous port to synchronous operation, use the configuration mode **physical-layer sync** command.

Step 5 If you have completed the configuration, press **Ctrl-Z** to exit configuration mode.

Step 6 Write the new configuration to memory, as follows:

```
Router# copy running-config startup-config
```

The system displays a confirmation message when the configuration is saved.

Note For older versions of software, use the **write mem** command to write the new configuration to memory.

Step 7 Enter the **disable** command to return to the user level:

```
Router# disable
Router>
```

Step 8 Enter the **show** commands to check the configuration of the interface.

Note On Step 2, the serial interface numbers for the low-speed ports can be 2–17 or 20–35 as previously described in Table 4-4.

Configuring G.703/G.704 Interfaces

This section describes how to configure individual interfaces for framed or unframed mode, four-bit CRC, 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.

Be prepared with the information you will need, such as the following:

- Timing source for each new interface (a line-derived or internal clock signal)
- Whether you will 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:

- 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 altering the configuration of an interface, particularly after changing a time slot or CRC-4 setting.

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. 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 port 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. For complete command descriptions and instructions refer to the Cisco IOS configuration guides and command references.

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 the unit number of the interface. 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
```

The field *underrun* in the output of the **show interface** command may be nonzero in approximately one of 250,000 packets.

To display the current internal status of a network processor module, use the **show controller** command with the *interface type and unit* number options. (Note in the following example that universal serial means the four-port serial module.) The following is 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 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. For complete command descriptions and instructions, refer to the Cisco IOS configuration guides and command references.

Saving the Router Configuration

To store the configuration or changes to your startup configuration, enter the command **copy running-config startup-config** at the enable prompt (#):

```
Hostname# copy running-config startup-config
```

Entering this command will save the configuration settings that the setup process created in the router. If you fail to do this, your configuration will be lost the next time you reload the router.

If You Need More Information

The Cisco IOS software running your router contains extensive features and functionality. The effective use of many of these features is easier if you have more information at hand. The complete Cisco IOS documentation set is included on the Dcoumentation CD-ROM shipped with the router. The same information is also available on the World Wide Web at http://www.cisco.com.

The Documentation CD is updated and shipped monthly, so it might be more current than printed documentation. To order the Documentation CD, contact your local sales representative or call Customer Service. The CD is available both as a single CD and as an annual subscription.

APPENDIX A

Cabling Specifications

This appendix provides cable pinout descriptions for the Cisco 4000 series routers.

Note All pins not listed are not connected.

Following are the signal summaries contained in this appendix:

The cables available from Cisco meet Federal Communications Commission (FCC) part 15J Class A requirements and Verband Deutscher Electrotechniker (VDE) 0871 Limit B levels. When constructing your own cables, refer to the appropriate documentation regarding interference considerations and cable length limitations.

Console and Auxiliary Port Pinouts

Refer to Table A-1 when assembling an EIA/TIA-232 console cable or auxiliary port cable for the Cisco 4000-M and to Table A-2 when assembling an EIA/TIA-232 console cable or auxiliary port cable for the Cisco 4500-M, Cisco 4700-M, or Cisco 4800-M.

Table A-1 Cisco 4000-M Console and Auxiliary Port Signals

Console Port			Auxiliary Port		
DCE DB-25 Connector			DCE DB-25 Connector		
Pin	Signal Name	Input/Output	Pin	Signal Name	Input/Output
1	Frame GND[1]	–	1	Frame GND	–
2	TXD	Input	2	TXD	Output
3	RXD	Output	3	RXD	Input
4	RTS	Shorted to pin 5	4	RTS	Output
5	CTS	Shorted to pin 4	5	CTS	Input
6	Shorted to pin 8	Output	7	GND	–
7	GND	–	8	CD	Input
8	CD[2]	Output	20	DTR	Output
20	DTR	Input	22	Ring Indicator	Input

1. GND = Ground
2. CD = Carrier Detect

Table A-2 Cisco 4500-M, Cisco 4700-M, or Cisco 4800-M Console Port Signals

Console Port		
DCE DB-25 Connector		
Pin	Signal Name	Direction
1	Frame Ground	–
2	Received Data	Input

Table A-2 Cisco 4500-M, Cisco 4700-M, or Cisco 4800-M Console Port Signals

Console Port		
DCE DB-25 Connector		
Pin	**Signal Name**	**Direction**
3	Transmitted Data	Output
4	Request To Send	Looped to Clear To Send
5	Clear To Send	Looped to Request To Send
6	Connected to Pin 8	Output
7	Signal Ground	–
8	Data Carrier Detect	Output
20	Data Terminal Ready	Input

Table A-3 Cisco 4500-M and Cisco 4700-M Auxiliary Port Signals

Auxiliary Port		
DCE DB-25 Connector		
Pin	**Signal Name**	**Direction**
1	Frame Ground	–
2	Transmitted Data	Output
3	Received Data	Input
4	Request To Send	Output
5	Clear To Send	Input
7	Signal Ground	–
8	Data Carrier Detect	Input
20	Data Terminal Ready	Output

Serial Cables

All interface types except EIA-530 are available in DTE or DCE format: DTE with a plug connector at the network end and DCE with a receptacle at the network end. V.35 is available in either mode with either gender at the network end. EIA-530 is available in DTE only.

The tables that follow list the signal pinouts for both the DTE-mode and DCE-mode serial port adapter cables for each serial interface type.

Note All four-port serial network processor modules use a universal high-density, 60-pin receptacle; all of the older dual serial network processor modules use a 50-pin receptacle. Each universal port requires a serial port adapter cable that determines the port's electrical interface type and mode: DTE or DCE. Although all port adapter cables use a universal plug at the quad serial module end, the network end of each cable type uses the physical connectors commonly used for the interface. (For example, the network end of the EIA/TIA-232 port adapter cable is a DB-25 connector, the most widely used EIA/TIA-232 connector.) The dual serial and four-port serial module pinouts are listed separately.

EIA/TIA-232 Dual Serial Module Cable Assembly

Figure A-1 shows the dual serial module EIA/TIA-232 cable assembly. Table A-4 lists the DTE and DCE pinouts.

Figure A-1 Dual Serial EIA/TIA-232 Cable Assembly

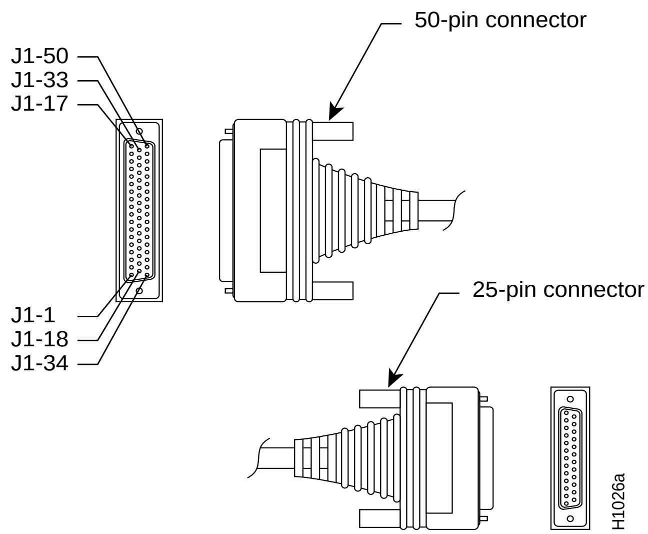


Table A-4 Dual Serial Module EIA/TIA-232 DTE and DCE Serial Cable Pinouts

72-0670-01 DTE Connections			72-0736-01 DCE Connections			
50 Pin	**25 Pin**	**Type**	**50 Pin**	**25 Pin**	**Signal**	**Type**
J1-3	J1-36		J1-3	J1-36	MUX	
J1-39 J1-40	J2-5 J2-4	Twisted pair	J1-47 J1-17	J2-24 J1-38	SCTE DCE	Twisted pair
J1-9 J1-42	J2-8 J2-6	Twisted pair	J1-40 J1-39	J2-5 J2-4	CTS RTS	Twisted pair
J1-11 J1-44	J2-2 J2-7	Twisted pair	J1-14 J1-30	J2-8 J2-6	DCD DSR	Twisted pair

Table A-4 Dual Serial Module EIA/TIA-232 DTE and DCE Serial Cable Pinouts (Continued)

72-0670-01 DTE Connections			72-0736-01 DCE Connections			
50 Pin	**25 Pin**	**Type**	**50 Pin**	**25 Pin**	**Signal**	**Type**
J1-46	J2-3	Twisted pair	J1-46	J2-2	TXD	Twisted pair
J1-30	J2-20		J1-44	J2-7	GND	
J1-14	J2-18	Twisted pair	J1-11	J2-3	RXD	Twisted pair
J1-47	J2-17		J1-42	J2-20	DTR	
J1-31	J2-15	Twisted pair	J1-9	J2-18	LTST	Twisted pair
J1-15	J2-1		J1-23	J2-17	RXC	
J1-16	J2-24	Twisted pair	J1-16	J2-15	TXC	Twisted pair
			J1-15	J2-1	Chassis ground	

EIA/TIA-232 Four-Port Serial Module Cable Assembly

Figure A-2 shows the serial module EIA/TIA-232 cable assembly that is used on the NP-4T and the high-speed serial ports on the NP-2T16S; Table A-5 lists the DTE pinouts; and Table A-6 lists the DCE pinouts. Arrows indicate signal direction: —> indicates DTE to DCE, and <— indicates DCE to DTE.

Figure A-2 EIA/TIA-232 Cable Assembly

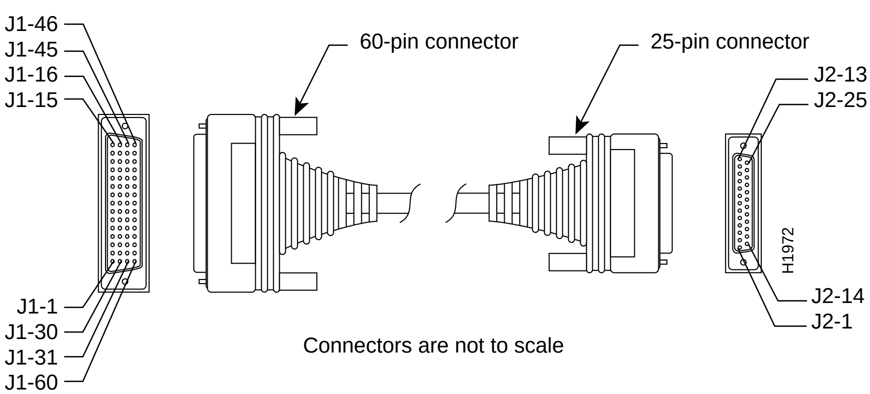


Table A-5 Four-Port Serial EIA/TIA-232 DTE Cable Pinouts (DB-60 to DB-25)

60 Pin	Signal	Note	Direction	25 Pin	Signal
J1-50 J1-51 J1-52	MODE_0 GND MODE_DCE	Shorting group	–	–	–
J1-46	Shield GND	Single	–	J2-1	Shield GND
J1-46	Shield GND	Single	–	J2-1	Shield GND
J1-41 Shield	TXD/RXD –	Twisted pair no. 5	—> –	J2-2 Shield	TXD –
J1-36 Shield	RXD/TXD –	Twisted pair no. 9	<— –	J2-3 Shield	RXD –
J1-42 Shield	RTS/CTS –	Twisted pair no. 4	—> –	J2-4 Shield	RTS –
J1-35 Shield	CTS/RTS –	Twisted pair no. 10	<— –	J2-5 Shield	CTS –
J1-34 Shield	DSR/DTR –	Twisted pair no. 11	<— –	J2-6 Shield	DSR –
J1-45 Shield	Circuit GND –	Twisted pair no. 1	– –	J2-7 Shield	Circuit GND –
J1-33 Shield	DCD/LL –	Twisted pair no. 12	<— –	J2-8 Shield	DCD –
J1-37 Shield	TXC/NIL –	Twisted pair no. 8	<— –	J2-15 Shield	TXC –
J1-38 Shield	RXC/TXCE –	Twisted pair no. 7	<— –	J2-17 Shield	RXC –
J1-44 Shield	LL/DCD –	Twisted pair no. 2	—> –	J2-18 Shield	LTST –
J1-43 Shield	DTR/DSR –	Twisted pair no. 3	—> –	J2-20 Shield	DTR –

Table A-5 Four-Port Serial EIA/TIA-232 DTE Cable Pinouts (DB-60 to DB-25)

60 Pin	Signal	Note	Direction	25 Pin	Signal
J1-39 Shield	TXCE/TXC –	Twisted pair no. 6	—> –	J2-24 Shield	TXCE –

Table A-6 Four-Port Serial EIA/TIA-232 DCE Cable Pinouts (DB-60 to DB-25)

60 Pin	Signal	Note	Direction	25 Pin	Signal
J1-50 J1-51	MODE_0 GND	Shorting group	–	–	–
J1-36 Shield	RXD/TXD –	Twisted pair no. 9	<— –	J2-2 Shield	TXD –
J1-41 Shield	TXD/RXD –	Twisted pair no. 5	—> –	J2-3 Shield	RXD –
J1-35 Shield	CTS/RTS –	Twisted pair no. 10	<— –	J2-4 Shield	RTS –
J1-42 Shield	RTS/CTS –	Twisted pair no. 4	—> –	J2-5 Shield	CTS –
J1-43 Shield	DTR/DSR –	Twisted pair no. 3	—> –	J2-6 Shield	DSR –
J1-45 Shield	Circuit GND –	Twisted pair no. 1	– –	J2-7 Shield	Circuit GND
J1-44 Shield	LL/DCD –	Twisted pair no. 2	—> –	J2-8 Shield	DCD –
J1-39 Shield	TXCE/TXC –	Twisted pair no. 7	—> –	J2-15 Shield	TXC –
J1-40 Shield	NIL/RXC –	Twisted pair no. 6	—> –	J2-17 Shield	RXC –
J1-33 Shield	DCD/LL –	Twisted pair no. 12	<— –	J2-18 Shield	LTST –

60 Pin	Signal	Note	Direction	25 Pin	Signal
J1-34 Shield	DSR/DTR –	Twisted pair no. 11	<— –	J2-20 Shield	DTR –
J1-38 Shield	RXC/TXCE –	Twisted pair no. 8	<— –	J2-24 Shield	TXCE –

EIA/TIA232 Octal Serial Cable Assembly

Figure A-3 shows the compact octal cable used on the NP-2T and NP-2T16S-RS232 module low-speed ports.Table A-7 lists connector pinouts for the DTE serial cable, CAB-OCT-232-MT. Table A-8 lists connector pinouts for the DCE serial cable, CAB-OCT-232-FC.

Figure A-3 Low-Speed EIA/TIA-232 Compact Octal Serial Cable

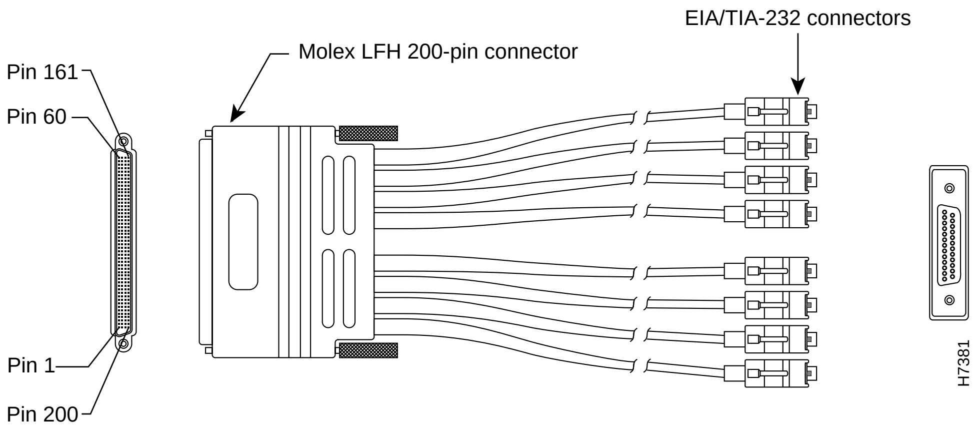


Table A-7 Low-Speed EIA/TIA-232 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-175	MODE_0	Shorting	–		
J8-176	GROUND	Group			
J8-26	MODE_DCE	Shorting	–		
J8-25	GROUND	Group			
	SHIELD_GROUND	Braid		SHIELD GND	J0-1
J8-1	O_TXD/RXD+	Twisted pair # 1	—>	TXD	J0-2
	Not used			Not used	J0-7
J8-5	I_RXD/TXD+	Twisted pair #3	<—	RXD	J0-3
	Not used			Not used	J0-7
J8-16	O_RTS/CTS+	Twisted pair #7	—>	RTS	J0-4
J8-14	O_DTR/DSR+		—>	DTR	J0-20
J8-23	I_CTS/RTS+	Twisted pair #8	<—	CTS	J0-5
J8-21	I_DSR/DTR+		<—	DSR	J0-6
J8-12	IO_DCD/DCD+	Twisted pair #6	<—	DCD	J0-8
J8-11	SIG_GROUND			SIG GND	J0-7
J8-9	IO_TXC/TXC+	Twisted pair #5	<—	TXC	J0-15
	Not used			Not used	J0-7
J8-7	I_RXC/TXCE+	Twisted pair #4	<—	RXC	J0-17
	Not used			Not used	J0-7
J8-19	O_LL/NIL+	Twisted pair #9	—>	LTST	J0-18
J8-18	SIG_GROUND			SIG GND	J0-7
J8-3	O_TXCE/RXC+	Twisted pair #2	—>	TXCE	J0-24
	Not used			Not used	J0-7
	SHIELD_GROUND	Braid		SHIELD GND	J1-1

Table A-7 Low-Speed EIA/TIA-232 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-50	O_TXD/RXD+	Twisted pair # 1	—>	TXD	J1-2
	Not used			Not used	J1-7
J8-46	I_RXD/TXD+	Twisted pair #3	<—	RXD	J1-3
	Not used			Not used	J1-7
J8-35	O_RTS/CTS+	Twisted pair #7	—>	RTS	J1-4
J8-37	O_DTR/DSR+		—>	DTR	J1-20
J8-28	I_CTS/RTS+	Twisted pair #8	<—	CTS	J1-5
J8-30	I_DSR/DTR+		<—	DSR	J1-6
J8-39	IO_DCD/DCD+	Twisted pair #6	<—	DCD	J1-8
J8-40	SIG_GROUND			SIG GND	J1-7
J8-42	IO_TXC/TXC+	Twisted pair #5	<—	TXC	J1-15
	Not used			Not used	J1-7
J8-44	I_RXC/TXCE+	Twisted pair #4	<—	RXC	J1-17
	Not used			Not used	J1-7
J8-32	O_LL/NIL+	Twisted pair #9	—>	LTST	J1-18
J8-33	SIG_GROUND			SIG GND	J1-7
J8-48	O_TXCE/RXC+	Twisted pair #2	—>	TXCE	J1-24
	Not used			Not used	J1-7
	SHIELD_GROUND	Braid		SHIELD GND	J2-1
J8-51	O_TXD/RXD+	Twisted pair # 1	—>	TXD	J2-2
	Not used			Not used	J2-7
J8-55	I_RXD/TXD+	Twisted pair #3	<—	RXD	J2-3
	Not used			Not used	J2-7
J8-66	O_RTS/CTS+	Twisted pair #7	—>	RTS	J2-4
J8-64	O_DTR/DSR+		—>	DTR	J2-20

Table A-7 Low-Speed EIA/TIA-232 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-73	I_CTS/RTS+	Twisted pair #8	<—	CTS	J2-5
J8-71	I_DSR/DTR+		<—	DSR	J2-6
J8-62	IO_DCD/DCD+	Twisted pair #6	<—	DCD	J2-8
J8-61	SIG_GROUND			SIG GND	J2-7
J8-59	IO_TXC/TXC+	Twisted pair #5	<—	TXC	J2-15
	Not used			Not used	J2-7
J8-57	I_RXC/TXCE+	Twisted pair #4	<—	RXC	J2-17
	NOT USED			Not used	J2-7
J8-69	O_LL/NIL+	Twisted pair #9	—>	LTST	J2-18
J8-68	SIG_GROUND			SIG GND	J2-7
J8-53	O_TXCE/RXC+	Twisted pair #2	—>	TXCE	J2-24
	Not used			Not used	J2-7
	SHIELD_GROUND	Braid		SHIELD GND	J3-1
J8-100	O_TXD/RXD+	Twisted pair # 1	—>	TXD	J3-2
	Not used			Not used	J3-7
J8-96	I_RXD/TXD+	Twisted pair #3	<—	RXD	J3-3
	Not used			Not used	J3-7
J8-85	O_RTS/CTS+	Twisted pair #7	—>	RTS	J3-4
J8-87	O_DTR/DSR+		—>	DTR	J3-20
J8-78	I_CTS/RTS+	Twisted pair #8	<—	CTS	J3-5
J8-80	I_DSR/DTR+		<—	DSR	J3-6
J8-89	IO_DCD/DCD+	Twisted pair #6	<—	DCD	J3-8
J8-90	SIG_GROUND			SIG GND	J3-7
J8-92	IO_TXC/TXC+	Twisted pair #5	<—	TXC	J3-15
	Not used			Not used	J3-7

Table A-7 Low-Speed EIA/TIA-232 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-94	I_RXC/TXCE+	Twisted pair #4	<—	RXC	J3-17
	Not used			Not used	J3-7
J8-82	O_LL/NIL+	Twisted pair #9	—>	LTST	J3-18
J8-83	SIG_GROUND			SIG GND	J3-7
J8-98	O_TXCE/RXC+	Twisted pair #2	—>	TXCE	J3-24
	Not used			Not used	J3-7
	SHIELD_GROUND	Braid		SHIELD GND	J4-1
J8-101	O_TXD/RXD+	Twisted pair # 1	—>	TXD	J4-2
	Not used			Not used	J4-7
J8-105	I_RXD/TXD+	Twisted pair #3	<—	RXD	J4-3
	Not used			Not used	J4-7
J8-116	O_RTS/CTS+	Twisted pair #7	—>	RTS	J4-4
J8-114	O_DTR/DSR+		—>	DTR	J4-20
J8-123	I_CTS/RTS+	Twisted pair #8	<—	CTS	J4-5
J8-121	I_DSR/DTR+		<—	DSR	J4-6
J8-112	IO_DCD/DCD+	Twisted pair #6	<—	DCD	J4-8
J8-111	SIG_GROUND			SIG GND	J4-7
J8-109	IO_TXC/TXC+	Twisted pair #5	<—	TXC	J4-15
	Not used			NOT USED	J4-7
J8-107	I_RXC/TXCE+	Twisted pair #4	<—	RXC	J4-17
	Not used			Not used	J4-7
J8-119	O_LL/NIL+	Twisted pair #9	—>	LTST	J4-18
J8-118	SIG_GROUND			SIG GND	J4-7
J8-103	O_TXCE/RXC+	Twisted pair #2	—>	TXCE	J4-24
	Not used			Not used	J4-7

Table A-7 Low-Speed EIA/TIA-232 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
	SHIELD_GROUND	Braid		SHIELD GND	J5-A
J8-135	O_RTS/CTS+	Twisted Pair # 7	—>	RTS	J5-C
J8-137	O_DTR/DSR+			DTR	J5-H
J8-128	I_CTS/RTS+	Twisted Pair # 8	<—	CTS	J5-D
J8-130	I_DSR/DTR+			DSR	J5-E
J8-139	IO_DCD/DCD+	Twisted Pair # 6	—>	RLSD	J5-F
J8-140	SIG_GROUND		—>	SIG GND	J5-B
J8-132	O_LL/NIL+	Twisted Pair # 9	<—	LT	J5-K
J8-133	SIG_GROUND		<—	SIG GND	J5-B
J8-150	O_TXD/RXD+	Twisted Pair # 1	<—	SD+	J5-P
J8-149	O_TXD/RXD-			SD-	J5-S
J8-146	I_RXD/TXD+	Twisted Pair # 3	<—	RD+	J5-R
J8-145	I_RXD/TXD-			RD-	J5-T
J8-148	O_TXCE/RXC+	Twisted Pair # 2	<—	SCTE+	J5-U
J8-147	O_TXCE/RXC-			SCTE-	J5-W
J8-144	I_RXC/TXCE+	Twisted Pair # 4	—>	SCR+	J5-V
J8-143	I_RXC/TXCE-			SCR-	J5-X
J8-142	IO_TXC/TXC+	Twisted Pair # 5	—>	SCT+	J5-Y
J8-141	IO_TXC/TXC-			SCT-	J5-AA
	SHIELD_GROUND	Braid		SHIELD GND	J6-A
J8-166	O_RTS/CTS+	Twisted Pair # 7	—>	RTS	J6-C
J8-164	O_DTR/DSR+			DTR	J6-H
J8-173	I_CTS/RTS+	Twisted Pair # 8	<—	CTS	J6-D
J8-171	I_DSR/DTR+			DSR	J6-E

Table A-7 Low-Speed EIA/TIA-232 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-162	IO_DCD/DCD+	Twisted Pair # 6	—>	RLSD	J6-F
J8-161	SIG_GROUND		—>	SIG GND	J6-B
J8-169	O_LL/NIL+	Twisted Pair # 9	<—	LT	J6-K
J8-168	SIG_GROUND		<—	SIG GND	J6-B
J8-151	O_TXD/RXD+	Twisted Pair # 1	<—	SD+	J6-P
J8-152	O_TXD/RXD-			SD-	J6-S
J8-155	I_RXD/TXD+	Twisted Pair # 3	<—	RD+	J6-R
J8-156	I_RXD/TXD-			RD-	J6-T
J8-153	O_TXCE/RXC+	Twisted Pair # 2	<—	SCTE+	J6-U
J8-154	O_TXCE/RXC-			SCTE-	J6-W
J8-157	I_RXC/TXCE+	Twisted Pair # 4	—>	SCR+	J6-V
J8-158	I_RXC/TXCE-			SCR-	J6-X
J8-159	IO_TXC/TXC+	Twisted Pair # 5	—>	SCT+	J6-Y
J8-160	IO_TXC/TXC-			SCT-	J6-AA
	SHIELD_GROUND	Braid		SHIELD GND	J7-A
J8-185	O_RTS/CTS+	Twisted Pair # 7	—>	RTS	J7-C
J8-187	O_DTR/DSR+			DTR	J7-H
J8-178	I_CTS/RTS+	Twisted Pair # 8	<—	CTS	J7-D
J8-180	I_DSR/DTR+			DSR	J7-E
J8-189	IO_DCD/DCD+	Twisted Pair # 6	—>	RLSD	J7-F
J8-190	SIG_GROUND		—>	SIG GND	J7-B
J8-182	O_LL/NIL+	Twisted Pair # 9	<—	LT	J7-K
J8-183	SIG_GROUND		<—	SIG GND	J7-B
J8-200	O_TXD/RXD+	Twisted Pair # 1	<—	SD+	J7-P
J8-199	O_TXD/RXD-			SD-	J7-S

Table A-7 Low-Speed EIA/TIA-232 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-196	I_RXD/TXD+	Twisted Pair # 3	<—	RD+	J7-R
J8-195	I_RXD/TXD-			RD-	J7-T
J8-198	O_TXCE/RXC+	Twisted Pair # 2	<—	SCTE+	J7-U
J8-197	O_TXCE/RXC-			SCTE-	J7-W
J8-194	I_RXC/TXCE+	Twisted Pair # 4	—>	SCR+	J7-V
J8-193	I_RXC/TXCE-			SCR-	J7-X
J8-192	IO_TXC/TXC+	Twisted Pair # 5	—>	SCT+	J7-Y
J8-191	IO_TXC/TXC-			SCT-	J7-AA

Table A-8 Low-Speed EIA/TIA-232 DCE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-126	MODE_1	Shorting	–		
J8-125	GROUND	Group			
J8-175	MODE_0	Shorting	–		
J8-176	GROUND	Group			
	SHIELD_GROUND	Braid		SHIELD GND	J0-A
J8-23	I_CTS/RTS+	Twisted Pair # 8	<—	RTS	J0-C
J8-21	I_DSR/DTR+		<—	DSR	J0-H
J8-16	O_RTS/CTS+	Twisted Pair # 7	—>	CTS	J0-D
J8-14	O_DTR/DSR+		—>	DTR	J0-E
J8-12	IO_DCD/DCD+	Twisted Pair #6	—>	RLSD	J0-F
J8-11	SIG_GROUND			SIG GND	J0-B

Table A-8 Low-Speed EIA/TIA-232 DCE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-20	I_NIL/LL+	Twisted Pair #9	<—	LT	J0-K
J8-18	SIG_GROUND			SIG GND	J0-B
J8-5	I_RXD/TXD+	Twisted Pair #3	<—	SD+	J0-P
J8-6	I_RXD/TXD-		<—	SD-	J0-S
J8-1	O_TXD/RXD+	Twisted Pair #1	—>	RD+	J0-R
J8-2	O_TXD/RXD-		—>	RD-	J0-T
J8-7	I_RXC/TXCE+	Twisted Pair #4	<—	SCTE+	J0-U
J8-8	I_RXC/TXCE-		<—	SCTE-	J0-W
J8-3	O_TXCE/RXC+	Twisted Pair #2	—>	SCR+	J0-V
J8-4	O_TXCE/RXC-		—>	SCR-	J0-X
J8-9	IO_TXC/TXC+	Twisted Pair #5	—>	SCT+	J0-Y
J8-10	IO_TXC/TXC-		—>	SCT-	J0-AA
	SHIELD_GROUND	Braid		SHIELD GND	J1-A
J8-28	I_CTS/RTS+	Twisted Pair # 8	<—	RTS	J1-C
J8-30	I_DSR/DTR+		<—	DSR	J1-H
J8-35	O_RTS/CTS+	Twisted Pair # 7	—>	CTS	J1-D
J8-37	O_DTR/DSR+		—>	DTR	J1-E
J8-39	IO_DCD/DCD+	Twisted Pair #6	—>	RLSD	J1-F
J8-40	SIG_GROUND			SIG GND	J1-B
J8-31	I_NIL/LL+	Twisted Pair #9	<—	LT	J1-K
J8-33	SIG_GROUND			SIG GND	J1-B
J8-46	I_RXD/TXD+	Twisted Pair #3	<—	SD+	J1-P
J8-45	I_RXD/TXD-		<—	SD-	J1-S
J8-50	O_TXD/RXD+	Twisted Pair #1	—>	RD+	J1-R
J8-49	O_TXD/RXD-		—>	RD-	J1-T

Table A-8 Low-Speed EIA/TIA-232 DCE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-44	I_RXC/TXCE+	Twisted Pair #4	<—	SCTE+	J1-U
J8-43	I_RXC/TXCE-		<—	SCTE-	J1-W
J8-48	O_TXCE/RXC+	Twisted Pair #2	—>	SCR+	J1-V
J8-47	O_TXCE/RXC-		—>	SCR-	J1-X
J8-42	IO_TXC/TXC+	Twisted Pair #5	—>	SCT+	J1-Y
J8-41	IO_TXC/TXC-		—>	SCT-	J1-AA
	SHIELD_GROUND	Braid		SHIELD GND	J2-A
J8-73	I_CTS/RTS+	Twisted Pair # 8	<—	RTS	J2-C
J8-71	I_DSR/DTR+		<—	DSR	J2-H
J8-66	O_RTS/CTS+	Twisted Pair # 7	—>	CTS	J2-D
J8-64	O_DTR/DSR+		—>	DTR	J2-E
J8-62	IO_DCD/DCD+	Twisted Pair #6	—>	RLSD	J2-F
J8-61	SIG_GROUND			SIG GND	J2-B
J8-70	I_NIL/LL+	Twisted Pair #9	<—	LT	J2-K
J8-68	SIG_GROUND			SIG GND	J2-B
J8-55	I_RXD/TXD+	Twisted Pair #3	<—	SD+	J2-P
J8-56	I_RXD/TXD-		<—	SD-	J2-S
J8-51	O_TXD/RXD+	Twisted Pair #1	—>	RD+	J2-R
J8-52	O_TXD/RXD-		—>	RD-	J2-T
J8-57	I_RXC/TXCE+	Twisted Pair #4	<—	SCTE+	J2-U
J8-58	I_RXC/TXCE-		<—	SCTE-	J2-W
J8-53	O_TXCE/RXC+	Twisted Pair #2	—>	SCR+	J2-V
J8-54	O_TXCE/RXC-		—>	SCR-	J2-X
J8-59	IO_TXC/TXC+	Twisted Pair #5	—>	SCT+	J2-Y
J8-60	IO_TXC/TXC-		—>	SCT-	J2-AA

Table A-8 Low-Speed EIA/TIA-232 DCE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
	SHIELD_GROUND	Braid		SHIELD GND	J3-A
J8-78	I_CTS/RTS+	Twisted Pair # 8	<—	RTS	J3-C
J8-80	I_DSR/DTR+		<—	DSR	J3-H
J8-85	O_RTS/CTS+	Twisted Pair # 7	—>	CTS	J3-D
J8-87	O_DTR/DSR+		—>	DTR	J3-E
J8-89	IO_DCD/DCD+	Twisted Pair #6	—>	RLSD	J3-F
J8-90	SIG_GROUND			SIG GND	J3-B
J8-81	I_NIL/LL+	Twisted Pair #9	<—	LT	J3-K
J8-83	SIG_GROUND			SIG GND	J3-B
J8-96	I_RXD/TXD+	Twisted Pair #3	<—	SD+	J3-P
J8-95	I_RXD/TXD-		<—	SD-	J3-S
J8-100	O_TXD/RXD+	Twisted Pair #1	—>	RD+	J3-R
J8-99	O_TXD/RXD-		—>	RD-	J3-T
J8-94	I_RXC/TXCE+	Twisted Pair #4	<—	SCTE+	J3-U
J8-93	I_RXC/TXCE-		<—	SCTE-	J3-W
J8-98	O_TXCE/RXC+	Twisted Pair #2	—>	SCR+	J3-V
J8-97	O_TXCE/RXC-		—>	SCR-	J3-X
J8-92	IO_TXC/TXC+	Twisted Pair #5	—>	SCT+	J3-Y
J8-91	IO_TXC/TXC-		—>	SCT-	J3-AA
	SHIELD_GROUND	Braid		SHIELD GND	J4-A
J8-123	I_CTS/RTS+	Twisted Pair # 8	<—	RTS	J4-C
J8-121	I_DSR/DTR+		<—	DSR	J4-H
J8-116	O_RTS/CTS+	Twisted Pair # 7	—>	CTS	J4-D
J8-114	O_DTR/DSR+		—>	DTR	J4-E

Table A-8 Low-Speed EIA/TIA-232 DCE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-112	IO_DCD/DCD+	Twisted Pair #6	—>	RLSD	J4-F
J8-111	SIG_GROUND			SIG GND	J4-B
J8-120	I_NIL/LL+	Twisted Pair #9	<—	LT	J4-K
J8-118	SIG_GROUND			SIG GND	J4-B
J8-105	I_RXD/TXD+	Twisted Pair #3	<—	SD+	J4-P
J8-106	I_RXD/TXD-		<—	SD-	J4-S
J8-101	O_TXD/RXD+	Twisted Pair #1	—>	RD+	J4-R
J8-102	O_TXD/RXD-		—>	RD-	J4-T
J8-107	I_RXC/TXCE+	Twisted Pair #4	<—	SCTE+	J4-U
J8-108	I_RXC/TXCE-		<—	SCTE-	J4-W
J8-103	O_TXCE/RXC+	Twisted Pair #2	—>	SCR+	J4-V
J8-104	O_TXCE/RXC-		—>	SCR-	J4-X
J8-109	IO_TXC/TXC+	Twisted Pair #5	—>	SCT+	J4-Y
J8-110	IO_TXC/TXC-		—>	SCT-	J4-AA
	SHIELD_GROUND	Braid		SHIELD GND	J5-A
J8-128	I_CTS/RTS+	Twisted Pair # 8	<—	RTS	J5-C
J8-130	I_DSR/DTR+		<—	DSR	J5-H
J8-135	O_RTS/CTS+	Twisted Pair # 7	—>	CTS	J5-D
J8-137	O_DTR/DSR+		—>	DTR	J5-E
J8-139	IO_DCD/DCD+	Twisted Pair #6	—>	RLSD	J5-F
J8-140	SIG_GROUND			SIG GND	J5-B
J8-131	I_NIL/LL+	Twisted Pair #9	<—	LT	J5-K
J8-133	SIG_GROUND			SIG GND	J5-B
J8-146	I_RXD/TXD+	Twisted Pair #3	<—	SD+	J5-P
J8-145	I_RXD/TXD-		<—	SD-	J5-S

Table A-8 Low-Speed EIA/TIA-232 DCE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-150	O_TXD/RXD+	Twisted Pair #1	—>	RD+	J5-R
J8-149	O_TXD/RXD-		—>	RD-	J5-T
J8-144	I_RXC/TXCE+	Twisted Pair #4	<—	SCTE+	J5-U
J8-143	I_RXC/TXCE-		<—	SCTE-	J5-W
J8-148	O_TXCE/RXC+	Twisted Pair #2	—>	SCR+	J5-V
J8-147	O_TXCE/RXC-		—>	SCR-	J5-X
J8-142	IO_TXC/TXC+	Twisted Pair #5	—>	SCT+	J5-Y
J8-141	IO_TXC/TXC-		—>	SCT-	J5-AA
	SHIELD_GROUND	Braid		SHIELD GND	J6-A
J8-173	I_CTS/RTS+	Twisted Pair # 8	<—	RTS	J6-C
J8-171	I_DSR/DTR+		<—	DSR	J6-H
J8-166	O_RTS/CTS+	Twisted Pair # 7	—>	CTS	J6-D
J8-164	O_DTR/DSR+		—>	DTR	J6-E
J8-162	IO_DCD/DCD+	Twisted Pair #6	—>	RLSD	J6-F
J8-161	SIG_GROUND			SIG GND	J6-B
J8-170	I_NIL/LL+	Twisted Pair #9	<—	LT	J6-K
J8-168	SIG_GROUND			SIG GND	J6-B
J8-155	I_RXD/TXD+	Twisted Pair #3	<—	SD+	J6-P
J8-156	I_RXD/TXD-		<—	SD-	J6-S
J8-151	O_TXD/RXD+	Twisted Pair #1	—>	RD+	J6-R
J8-152	O_TXD/RXD-		—>	RD-	J6-T
J8-157	I_RXC/TXCE+	Twisted Pair #4	<—	SCTE+	J6-U
J8-158	I_RXC/TXCE-		<—	SCTE-	J6-W
J8-153	O_TXCE/RXC+	Twisted Pair #2	—>	SCR+	J6-V
J8-154	O_TXCE/RXC-		—>	SCR-	J6-X

Table A-8 Low-Speed EIA/TIA-232 DCE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (25-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-159	IO_TXC/TXC+	Twisted Pair #5	—>	SCT+	J6-Y
J8-160	IO_TXC/TXC-		—>	SCT-	J6-AA
	SHIELD_GROUND	Braid		SHIELD GND	J7-A
J8-178	I_CTS/RTS+	Twisted Pair # 8	<—	RTS	J7-C
J8-180	I_DSR/DTR+		<—	DSR	J7-H
J8-185	O_RTS/CTS+	Twisted Pair # 7	—>	CTS	J7-D
J8-187	O_DTR/DSR+		—>	DTR	J7-E
J8-189	IO_DCD/DCD+	Twisted Pair #6	—>	RLSD	J7-F
J8-190	SIG_GROUND			SIG GND	J7-B
J8-181	I_NIL/LL+	Twisted Pair #9	<—	LT	J7-K
J8-183	SIG_GROUND			SIG GND	J7-B
J8-196	I_RXD/TXD+	Twisted Pair #3	<—	SD+	J7-P
J8-195	I_RXD/TXD-		<—	SD-	J7-S
J8-200	O_TXD/RXD+	Twisted Pair #1	—>	RD+	J7-R
J8-199	O_TXD/RXD-		—>	RD-	J7-T
J8-194	I_RXC/TXCE+	Twisted Pair #4	<—	SCTE+	J7-U
J8-193	I_RXC/TXCE-		<—	SCTE-	J7-W
J8-198	O_TXCE/RXC+	Twisted Pair #2	—>	SCR+	J7-V
J8-197	O_TXCE/RXC-		—>	SCR-	J7-X
J8-192	IO_TXC/TXC+	Twisted Pair #5	—>	SCT+	J7-Y
J8-191	IO_TXC/TXC-		—>	SCT-	J7-AA

EIA/TIA-449 Dual Serial Module Cable Assembly

Figure A-4 shows the dual serial module EIA/TIA-449 cable assembly for cable CAB-NP449T and CAB-NP449T. Table A-9 lists the DTE and DCE pinouts and signal descriptions.

Figure A-4 Dual Serial Module EIA/TIA-449 Cable Assembly

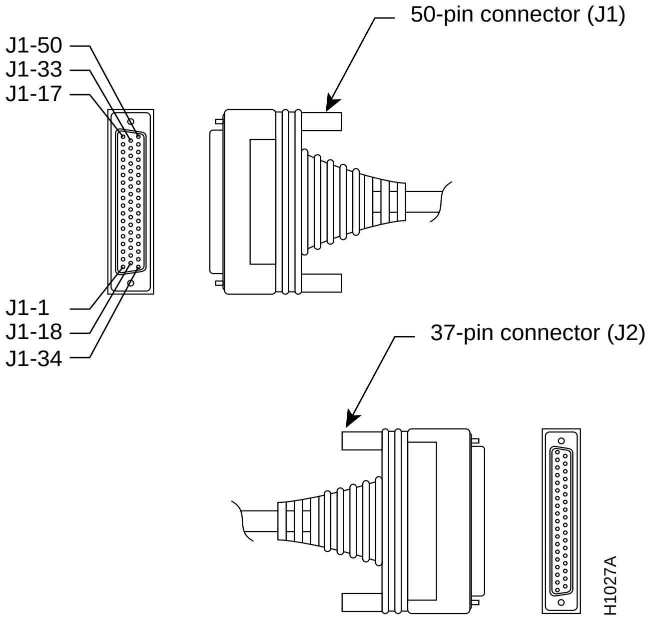


Table A-9 Dual Serial Module EIA/TIA-449 DTE and DCE Cable Pinouts

72-0672-01 DTE Connection Table			**72-0738-01 DCE Connection Table**			
50 Pin	**37 Pin**	**Type**	**50 Pin**	**37 Pin**	**Type**	**Signal Name**
J1-5	J1-38		J1-5	J1-38		MUX
J1-7	J2-10		J1-13	J2-10		LL
J1-1 J1-34	J2-4 J2-22	Twisted pair	J1-35 J1-19	J2-4 J2-22	Twisted pair	TXD+ TXD–
J1-2 J1-18	J2-5 J2-23	Twisted pair	J1-43 J1-27	J2-5 J2-23	Twisted pair	SCT+ SCT–
J1-35 J1-19	J2-6 J2-24	Twisted pair	J1-1 J1-34	J2-6 J2-24	Twisted pair	RXD+ RXD–

Table A-9 Dual Serial Module EIA/TIA-449 DTE and DCE Cable Pinouts

72-0672-01 DTE Connection Table			72-0738-01 DCE Connection Table			
50 Pin	**37 Pin**	**Type**	**50 Pin**	**37 Pin**	**Type**	**Signal Name**
J1-4 J1-20	J2-7 J2-25	Twisted pair	J1-6 J1-22	J2-7 J2-25	Twisted pair	RTS+ RTS–
J1-37 J1-21	J2-8 J2-26	Twisted pair	J1-49 J1-50	J2-8 J2-26	Twisted pair	SCR+ SCR–
			J1-17	J1-44		DCE
J1-22 J1-6	J2-27 J2-9	Twisted pair	J1-20 J1-4	J2-27 J2-9	Twisted pair	CTS– CTS+
J1-8 J1-24	J2-11 J2-29	Twisted pair	J1-41 J1-25	J2-11 J2-29	Twisted pair	DSR+ DSR–
J1-41 J1-25	J2-12 J2-30	Twisted pair	J1-8 J1-24	J2-12 J2-30	Twisted pair	DTR+ DTR–
J1-10 J1-26	J2-13 J2-31	Twisted pair	J1-10 J1-26	J2-13 J2-31	Twisted pair	RLSD+ RLSD–
J1-43 J1-27	J2-17 J2-35	Twisted pair	J1-37 J1-21	J2-17 J2-35	Twisted pair	SCTE+ SCTE–
J1-36 J1-15	J2-19 J2-1	Twisted pair	J1-36 J1-15	J2-19 J2-1	Twisted pair	Ground Chassis ground
J1-44 J1-48	J2-37 J2-20	Twisted pair	J1-44 J1-48	J2-37 J2-20	Twisted pair	Ground Ground

EIA/TIA-449 Four-Port Serial Module Cable Assembly

Figure A-5 shows the four-port EIA/TIA-449 cable assembly that is used on the NP-4T and the high-speed serial ports on the NP-2T16S; Table A-10 lists the DTE pinouts; Table A-11 lists the DCE pinouts. Arrows indicate signal direction: —> indicates DTE to DCE, and <— indicates DCE to DTE.

Figure A-5 EIA/TIA-449 Four-Port Module Cable Assembly

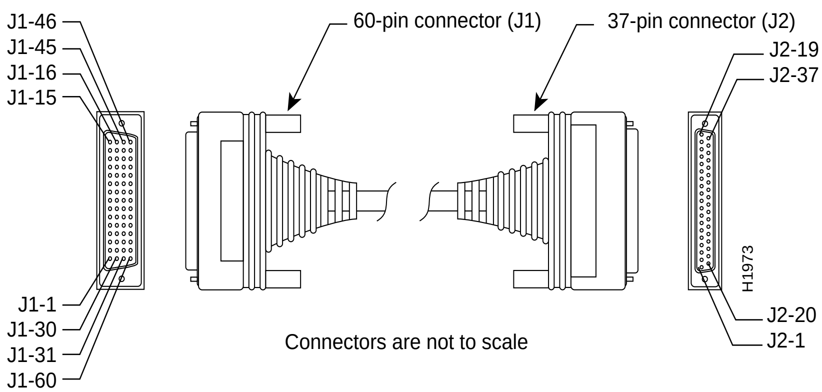


Table A-10 EIA/TIA-449 DTE Cable Pinouts (DB-60 to DB-37)

60 Pin	Signal Name	Note	Direction	37 Pin	Signal Name
J1-49 J1-48	MODE_1 GND	Shorting group	–	–	–
J1-51 J1-52	GND MODE_DCE	Shorting group	–	–	–
J1-46	Shield_GND	Single	_	J2-1	Shield GND
J1-11 J1-12	TXD/RXD+ TXD/RXD–	Twisted pair no. 6	—> —>	J2-4 J2-22	SD+ SD–
J1-24 J1-23	TXC/RXC+ TXC/RXC–	Twisted pair no. 9	<— <—	J2-5 J2-23	ST+ ST–
J1-28 J1-27	RXD/TXD+ RXD/TXD–	Twisted pair no. 11	<— <—	J2-6 J2-24	RD+ RD–
J1-9 J1-10	RTS/CTS+ RTS/CTS–	Twisted pair no. 5	—> —>	J2-7 J2-25	RS+ RS–
J1-26 J1-25	RXC/TXCE+ RXC/TXCE–	Twisted pair no. 10	<— <—	J2-8 J2-26	RT+ RT–

Table A-10 EIA/TIA-449 DTE Cable Pinouts (DB-60 to DB-37) (Continued)

60 Pin	Signal Name	Note	Direction	37 Pin	Signal Name
J1-1	CTS/RTS+	Twisted pair no. 1	<—	J2-9	CS+
J1-2	CTS/RTS–		<—	J2-27	CS–
J1-44	LL/DCD	Twisted pair no. 12	—>	J2-10	LL
J1-45	Circuit_GND		_	J2-37	SC
J1-3	DSR/DTR+	Twisted pair no. 2	<—	J2-11	DM+
J1-4	DSR/DTR–		<—	J2-29	DM–
J1-7	DTR/DSR+	Twisted pair no. 4	—>	J2-12	TR+
J1-8	DTR/DSR–		—>	J2-30	TR–
J1-5	DCD/DCD+	Twisted pair no. 3	<—	J2-13	RR+
J1-6	DCD/DCD–		<—	J2-31	RR–
J1-13	TXCE/TXC+	Twisted pair no. 7	—>	J2-17	TT+
J1-14	TXCE/TXC–		—>	J2-35	TT–
J1-15	Circuit_GND	Twisted pair no. 9	–	J2-19	SG
J1-16	Circuit_GND		–	J2-20	RC

Table A-11 EIA/TIA-449 DCE Four-Port Cable Pinouts (DB-60 to DB-37)

60 Pin	Signal Name	Note	Direction	37 Pin	Signal Name
J1-49	MODE_1	Shorting group	–	–	–
J1-48	GND				
J1-46	Shield_GND	Single	–	J2-1	Shield GND
J1-28	RXD/TXD+	Twisted pair no. 11	<—	J2-4	SD+
J1-27	RXD/TXD–		<—	J2-22	SD–
J1-13	TXCE/TXC+	Twisted pair no. 7	—>	J2-5	ST+
J1-14	TXCE/TXC–		—>	J2-23	ST–
J1-11	TXD/RXD+	Twisted pair no. 6	—>	J2-6	RD+
J1-12	TXD/RXD–		—>	J2-24	RD–

Table A-11 EIA/TIA-449 DCE Four-Port Cable Pinouts (DB-60 to DB-37)

60 Pin	Signal Name	Note	Direction	37 Pin	Signal Name
J1-1	CTS/RTS+	Twisted pair no. 1	<—	J2-7	RS+
J1-2	CTS/RTS–		<—	J2-25	RS–
J1-24	TXC/RXC+	Twisted pair no. 9	—>	J2-8	RT+
J1-23	TXC/RXC–		—>	J2-26	RT–
J1-9	RTS/CTS+	Twisted pair no. 5	—>	J2-9	CS+
J1-10	RTS/CTS–		—>	J2-27	CS–
J1-29	NIL/LL	Twisted pair no. 12	—>	J2-10	LL
J1-30	Circuit_GND		–	J2-37	SC
J1-7	DTR/DSR+	Twisted pair no. 4	—>	J2-11	DM+
J1-8	DTR/DSR–		—>	J2-29	DM–
J1-3	DSR/DTR+	Twisted pair no. 2	<—	J2-12	TR+
J1-4	DSR/DTR–		<—	J2-30	TR–
J1-5	DCD/DCD+	Twisted pair no. 3	—>	J2-13	RR+
J1-6	DCD/DCD–		—>	J2-31	RR–
J1-26	RXC/TXCE+	Twisted pair no. 10	<—	J2-17	TT+
J1-25	RXC/TXCE–		<—	J2-35	TT–
J1-15	Circuit_GND	Twisted pair no. 8	_	J2-19	SG
J1-16	Circuit_GND		_	J2-20	RC

V.35 Dual Serial Module Cable Assembly

Figure A-6 shows the dual serial module V.35 cable assembly with the resistor (1/4 watt, ±1%, 301 ohms). Table A-12 lists the DTE pinouts; Table A-13 lists the DCE pinouts. Arrows indicate signal direction: —> indicates DTE to DCE, and <— indicates DCE to DTE.

Figure A-6 Dual Serial Module V.35 Cable Assembly

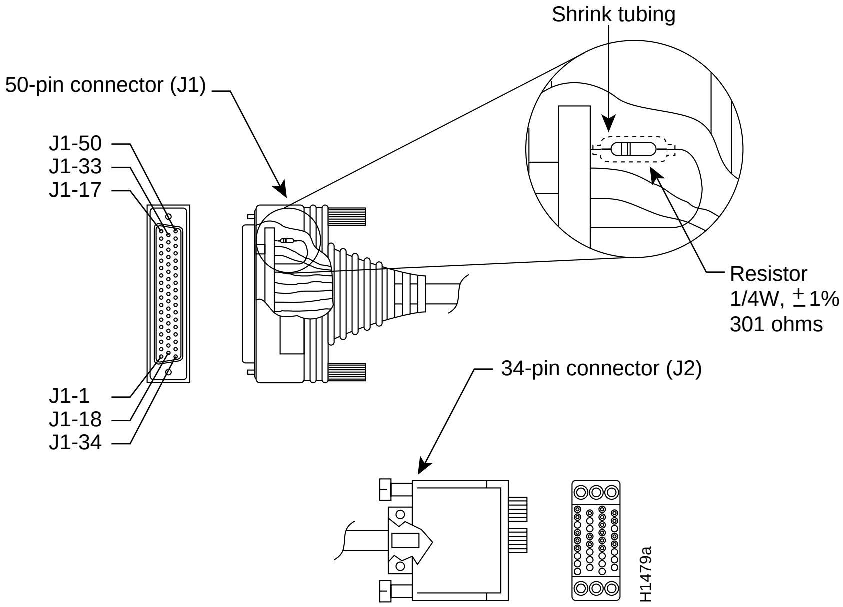


Table A-12 Dual Serial Module V.35 DTE Cable Pinouts

72-0671-02 DTE Connections				
50 Pin	**34 Pin**	**Type**	**Signal Name**	**Direction**
J1-3	J1-36	Jumper	MUX	To ground
J1-5	J1-38	Jumper	MUX	To ground
J1-14 J1-Shiel d	J2-K J2-Shiel d	Twisted pair	LTST Not used	—>

Table A-12 Dual Serial Module V.35 DTE Cable Pinouts (Continued)

72-0671-02 DTE Connections

50 Pin	34 Pin	Type	Signal Name	Direction
J1-2	J2-Y	Twisted pair	SCT+	<—
J1-18	J2-AA		SCT-	<—
J1-12	J2-P	Twisted pair	TXD+	—>
J1-28	J2-S		TXD-	—>
J1-35	J2-R	Twisted pair	RXD+	<—
J1-19	J2-T		RXD–	<—
J1-37	J2-V	Twisted pair	SCR+	<—
J1-21	J2-X		SCR–	<—
J1-45	J2-U	Twisted pair	SCTE+	—>
J1-29	J2-W		SCTE–	—>
J1-42	J2-E	Twisted pair	DSR	<—
J1-Shield	J2-Shield		Not used	
J1-9	J2-F	Twisted pair	RLSD	<—
J1-48	J2-A		Ground	<—
J1-40	J2-C	Twisted pair	RTS	—>
J1-Shield	J2-Shield		Not used	
J1-2	J1-3	Resistor	SCT+	R to
J1-18	J1-5	Resistor	SCT–	Ground
J1-35	J1-36	Resistor	RXD+	R to
J1-19	J1-38	Resistor	RXD–	Ground
J1-37	J1-44	Resistor	SCR+	R to
J1-21	J1-48	Resistor	SCR–	Ground
J1-30	J2-H	Twisted pair	DTR	—>
J1-44	J2-B		Ground	—>
J1-39	J2-D	Twisted pair	CTS	—>
J1-Shield	J2-Shield		Not used	

Table A-12 Dual Serial Module V.35 DTE Cable Pinouts (Continued)

72-0671-02 DTE Connections				
50 Pin	**34 Pin**	**Type**	**Signal Name**	**Direction**
J1-Shield J1-Shield	J2-Shield J2-Shield	Twisted pair	Not used Not used	
J1-Shield	J2-Shield	Single	Not used	

Table A-13 Dual Serial Module V.35 DCE Cable Pinouts

72-0740-02 DCE Connections				
50 Pin	**34 Pin**	**Type**	**Signal Name**	**Direction**
J1-3	J1-36	Jumper	MUX	To ground
J1-5	J1-38	Jumper	MUX	To ground
J1-9 J1-Shield	J2-K J2-Shield	Twisted pair	LTST	<—
J1-45 J1-29	J2-Y J2-AA	Twisted pair	SCT+ SCT–	—> —>
J1-35 J1-19	J2-P J2-S	Twisted pair	TXD+ TXD–	<— <—
J1-12 J1-28	J2-R J2-T	Twisted pair	RXD + RXD–	—> —>
J1-32 J1-33	J2-V J2-X	Twisted pair	SCR+ SCR–	—> —>
J1-37 J1-21	J2-U J2-W	Twisted pair	SCTE+ SCTE–	<— <—
J1-30 J1-Shield	J2-E J2-Shield	Twisted pair	DSR	—>

Table A-13 Dual Serial Module V.35 DCE Cable Pinouts (Continued)

72-0740-02 DCE Connections				
50 Pin	**34 Pin**	**Type**	**Signal Name**	**Direction**
J1-14 J1-48	J2-F J2-A	Twisted pair	RLSD Ground	—> —>
J1-39 J1-Shield	J2-C J2-Shield	Twisted pair	RTS Not used	<—
J1-17	J1-5	Jumper	DCE Mode	To ground
J1-Shield	J2-Shield	Single	Not used	
J1-35[1] J1-19	J1-36 J1-38	Resistor Resistor	TXD+ TXD–	R to ground
J1-37 J1-21	J1-44 J1-48	Resistor Resistor	SCTE+ SCTE–	R to ground
J1-42 J1-44	J2-H J2-B	Twisted pair	DTR Ground	<— <—
J1-40 J1-Shield	J2-D J2-Shield	Twisted pair	CTS Not used	—>
J1-Shield J1-Shield	J2-Shield J2-Shield	Twisted pair		

1. See Figure A-6. Resistor = 1/4W, ±1%, 301 ohms.

V.35 Four-Port Serial Module Cable Assembly

Figure A-7 shows the V.35 cable assembly that is used on the NP-4T and the high-speed serial ports on the NP-2T16S; Table A-13 lists the DTE pinouts; Table A-15 lists the DCE pinouts. Arrows indicate signal direction: —> indicates DTE to DCE, and <— indicates DCE to DTE.

Figure A-7 Four-Port Serial Module V.35 Cable Assembly

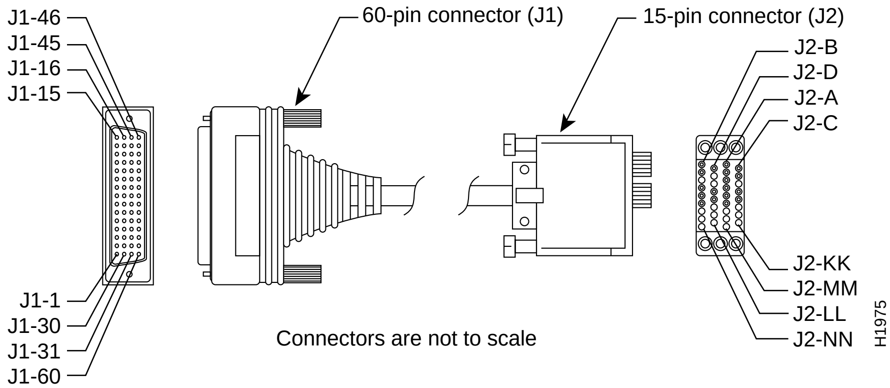


Table A-14 Four-Port Serial Module V.35 DTE Cable Pinouts (DB-60 to Winchester-Type 34 Pin)

60 Pin	Signal Name	Type	Direction	34 Pin	Signal Name
J1-49 J1-48	MODE_1 GND	Shorting group	–	–	–
J1-50 J1-51 J1-52	MODE_0 GND MODE_DCE	Shorting group	–	–	–
J1-53 J1-54 J1-55 J1-56	TXC/NIL RXC_TXCE RXD/TXD GND	Shorting group	–	–	–
J1-46	Shield_GND	Single	–	J2-A	Frame GND
J1-45 Shield	Circuit_GND –	Twisted pair no. 12	– –	J2-B Shield	Circuit GND –
J1-42 Shield	RTS/CTS –	Twisted pair no. 9	—> –	J2-C Shield	RTS –

Table A-14 Four-Port Serial Module V.35 DTE Cable Pinouts (DB-60 to Winchester-Type 34 Pin) (Continued)

60 Pin	Signal Name	Type	Directio n	34 Pin	Signal Name
J1-35	CTS/RTS	Twisted pair no. 8	<—	J2-D	CTS
Shield	–		–	Shield	–
J1-34	DSR/DTR	Twisted pair no. 7	<—	J2-E	DSR
Shield	–		–	Shield	–
J1-33	DCD/LL	Twisted pair no. 6	<—	J2-F	RLSD
Shield	–		–	Shield	–
J1-43	DTR/DSR	Twisted pair no. 10	—>	J2-H	DTR
Shield	–		–	Shield	–
J1-44	LL/DCD	Twisted pair no. 11	—>	J2-K	LT
Shield	–		–	Shield	–

Table A-14 Four-Port Serial Module V.35 DTE Cable Pinouts (DB-60 to Winchester-Type 34 Pin) (Continued)

60 Pin	Signal Name	Type	Directio n	34 Pin	Signal Name
J1-18	TXD/RXD+	Twisted pair no. 1	—>	J2-P	SD+
J1-17	TXD/RXD–		—>	J2-S	SD–
J1-28	RXD/TXD+	Twisted pair no. 5	<—	J2-R	RD+
J1-27	RXD/TXD–		<—	J2-T	RD–
J1-20	TXCE/TXC+	Twisted pair no. 2	—>	J2-U	SCTE+
J1-19	TXCE/TXC–		—>	J2-W	SCTE–
J1-26	RXC/TXCE+	Twisted pair no. 4	<—	J2-V	SCR+
J1-25	RXC/TXCE–		<—	J2-X	SCR–
J1-24	TXC/RXC+	Twisted pair no. 3	<—	J2-Y	SCT+
J1-23	TXC/RXC–		<—	J2-AA	SCT–

Table A-15 Four-Port Serial V.35 DCE Cable Pinouts (DB-60 to Winchester-Type 34 Pin)

60 Pin	Signal Name	Type	Directio n	34 Pin	Signal Name
J1-49	MODE_1	Shorting group	–	–	–
J1-48	GND				
J1-50	MODE_0	Shorting group	–	–	–
J1-51	GND				
J1-53	TXC/NIL	Shorting group	–	–	–
J1-54	RXC_TXCE				
J1-55	RXD/TXD				
J1-56	GND				
J1-46	Shield_GND	Single	–	J2-A	Frame GND
J1-45	Circuit_GND	Twisted pair no. 12	–	J2-B	Circuit GND
Shield	–		–	Shield	–

Table A-15 Four-Port Serial V.35 DCE Cable Pinouts (DB-60 to Winchester-Type 34 Pin) (Continued)

60 Pin	Signal Name	Type	Direction	34 Pin	Signal Name
J1-35 Shield	CTS/RTS –	Twisted pair no. 8	<— –	J2-C Shield	RTS –
J1-42 Shield	RTS/CTS –	Twisted pair no. 9	—> –	J2-D Shield	CTS –
J1-43 Shield	DTR/DSR –	Twisted pair no. 10	—> –	J2-E Shield	DSR –
J1-44 Shield	LL/DCD –	Twisted pair no. 11	—> –	J2-F Shield	RLSD –
J1-34 Shield	DSR/DTR –	Twisted pair no. 7	<— –	J2-H Shield	DTR –
J1-33 Shield	DCD/LL –	Twisted pair no. 6	<— –	J2-K Shield	LT –
J1-28 J1-27	RXD/TXD+ RXD/TXD–	Twisted pair no. 5	<— <—	J2-P J2-S	SD+ SD–
J1-18 J1-17	TXD/RXD+ TXD/RXD–	Twisted pair no. 1	—> —>	J2-R J2-T	RD+ RD–
J1-26 J1-25	RXC/TXCE+ RXC/TXCE–	Twisted pair no. 4	<— <—	J2-U J2-W	SCTE+ SCTE–
J1-22 J1-21	NIL/RXC+ NIL/RXC–	Twisted pair no. 3	—> —>	J2-V J2-X	SCR+ SCR–
J1-20 J1-19	TXCE/TXC+ TXCE/TXC–	Twisted pair no. 2	—> —>	J2-Y J2-AA	SCT+ SCT–

V.35 Octal Serial Cable Assembly

Figure A-8 shows the compact octal cable used on the NP-2T16S-V.35 module low-speed ports. Table A-16 lists pinouts for the DTE cable, and Table A-17 lists pinouts for the DCE cable.

Figure A-8 Low-Speed V.35 Compact Serial Cable

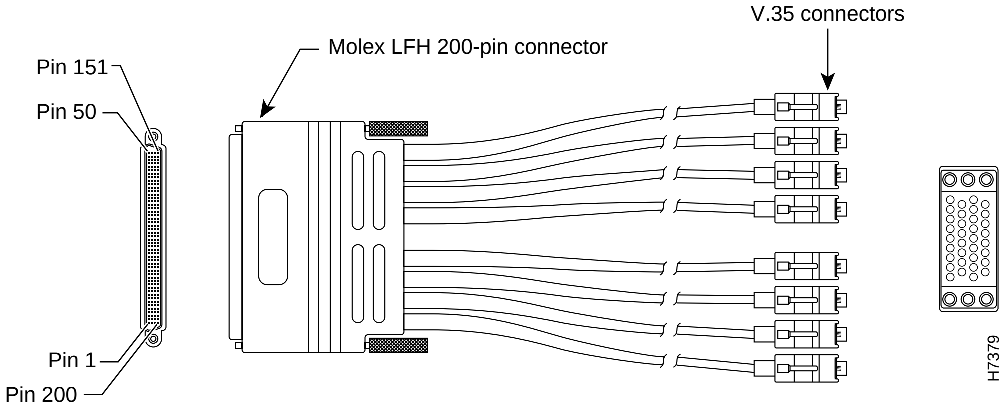


Table A-16 Low-Speed V.35 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-126	MODE_1	Shorting	–		
J8-125	GROUND	Group			
J8-175	MODE_0	Shorting	–		
J8-176	GROUND	Group			
J8-26	MODE_DCE	Shorting	–		
J8-25	GROUND	Group			
	SHIELD_GROUND	Braid		SHIELD GND	J0-A
J8-16	O_RTS/CTS+	Twisted pair # 7	—>	RTS	J0-C
J8-14	O_DTR/DSR+		—>	DTR	J0-H
J8-23	I_CTS/RTS+	Twisted pair # 8	<—	CTS	J0-D
J8-21	I_DSR/DTR+		<—	DSR	J0-E

Table A-16 Low-Speed V.35 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-12	IO_DCD/DCD+	Twisted pair # 6	<—	RLSD	J0-F
J8-11	SIG_GROUND			SIG GND	J0-B
J8-19	O_LL/NIL+	Twisted pair # 9	—>	LT	J0-K
J8-18	SIG_GROUND			SIG GND	J0-B
J8-1	O_TXD/RXD+	Twisted pair # 1	—>	SD+	J0-P
J8-2	O_TXD/RXD-		—>	SD-	J0-S
J8-5	I_RXD/TXD+	Twisted pair # 3	<—	RD+	J0-R
J8-6	I_RXD/TXD-		<—	RD-	J0-T
J8-3	O_TXCE/RXC+	Twisted pair # 2	—>	SCTE+	J0-U
J8-4	O_TXCE/RXC-		—>	SCTE-	J0-W
J8-7	I_RXC/TXCE+	Twisted pair # 4	<—	SCR+	J0-V
J8-8	I_RXC/TXCE-		<—	SCR-	J0-X
J8-9	IO_TXC/TXC+	Twisted pair # 5	<—	SCT+	J0-Y
J8-10	IO_TXC/TXC-		<—	SCT-	J0-AA
	SHIELD_GROUND	Braid		SHIELD GND	J1-A
J8-35	O_RTS/CTS+	Twisted pair # 7	—>	RTS	J1-C
J8-37	O_DTR/DSR+		—>	DTR	J1-H
J8-28	I_CTS/RTS+	Twisted pair # 8	<—	CTS	J1-D
J8-30	I_DSR/DTR+		<—	DSR	J1-E
J8-39	IO_DCD/DCD+	Twisted pair # 6	<—	RLSD	J1-F
J8-40	SIG_GROUND			SIG GND	J1-B
J8-32	O_LL/NIL+	Twisted pair # 9	—>	LT	J1-K
J8-33	SIG_GROUND			SIG GND	J1-B
J8-50	O_TXD/RXD+	Twisted pair # 1	—>	SD+	J1-P
J8-49	O_TXD/RXD-		—>	SD-	J1-S

Table A-16 Low-Speed V.35 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-46	I_RXD/TXD+	Twisted pair # 3	<—	RD+	J1-R
J8-45	I_RXD/TXD-		<—	RD-	J1-T
J8-48	O_TXCE/RXC+	Twisted pair # 2	—>	SCTE+	J1-U
J8-47	O_TXCE/RXC-		—>	SCTE-	J1-W
J8-44	I_RXC/TXCE+	Twisted pair # 4	<—	SCR+	J1-V
J8-43	I_RXC/TXCE-		<—	SCR-	J1-X
J8-42	IO_TXC/TXC+	Twisted pair # 5	<—	SCT+	J1-Y
J8-41	IO_TXC/TXC-		<—	SCT-	J1-AA
	SHIELD_GROUND	Braid		SHIELD GND	J2-A
J8-66	O_RTS/CTS+	Twisted pair # 7	—>	RTS	J2-C
J8-64	O_DTR/DSR+		—>	DTR	J2-H
J8-73	I_CTS/RTS+	Twisted pair # 8	<—	CTS	J2-D
J8-71	I_DSR/DTR+		<—	DSR	J2-E
J8-62	IO_DCD/DCD+	Twisted pair # 6	<—	RLSD	J2-F
J8-61	SIG_GROUND			SIG GND	J2-B
J8-69	O_LL/NIL+	Twisted pair # 9	—>	LT	J2-K
J8-68	SIG_GROUND			SIG GND	J2-B
J8-51	O_TXD/RXD+	Twisted pair # 1	—>	SD+	J2-P
J8-52	O_TXD/RXD-		—>	SD-	J2-S
J8-55	I_RXD/TXD+	Twisted pair # 3	<—	RD+	J2-R
J8-56	I_RXD/TXD-		<—	RD-	J2-T
J8-53	O_TXCE/RXC+	Twisted pair # 2	—>	SCTE+	J2-U
J8-54	O_TXCE/RXC-		—>	SCTE-	J2-W
J8-57	I_RXC/TXCE+	Twisted pair # 4	<—	SCR+	J2-V
J8-58	I_RXC/TXCE-		<—	SCR-	J2-X

Table A-16 Low-Speed V.35 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-59	IO_TXC/TXC+	Twisted pair # 5	<—	SCT+	J2-Y
J8-60	IO_TXC/TXC-		<—	SCT-	J2-AA
	SHIELD_GROUND	Braid		SHIELD GND	J3-A
J8-85	O_RTS/CTS+	Twisted pair # 7	—>	RTS	J3-C
J8-87	O_DTR/DSR+		—>	DTR	J3-H
J8-78	I_CTS/RTS+	Twisted pair # 8	<—	CTS	J3-D
J8-80	I_DSR/DTR+		<—	DSR	J3-E
J8-89	IO_DCD/DCD+	Twisted pair # 6	<—	RLSD	J3-F
J8-90	SIG_GROUND			SIG GND	J3-B
J8-82	O_LL/NIL+	Twisted pair # 9	—>	LT	J3-K
J8-83	SIG_GROUND			SIG GND	J3-B
J8-100	O_TXD/RXD+	Twisted pair # 1	—>	SD+	J3-P
J8-99	O_TXD/RXD-		—>	SD-	J3-S
J8-96	I_RXD/TXD+	Twisted pair # 3	<—	RD+	J3-R
J8-95	I_RXD/TXD-		<—	RD-	J3-T
J8-98	O_TXCE/RXC+	Twisted pair # 2	—>	SCTE+	J3-U
J8-97	O_TXCE/RXC-		—>	SCTE-	J3-W
J8-94	I_RXC/TXCE+	Twisted pair # 4	<—	SCR+	J3-V
J8-93	I_RXC/TXCE-		<—	SCR-	J3-X
J8-92	IO_TXC/TXC+	Twisted pair # 5	<—	SCT+	J3-Y
J8-91	IO_TXC/TXC-		<—	SCT-	J3-AA
	SHIELD_GROUND	Braid		SHIELD GND	J4-A
J8-116	O_RTS/CTS+	Twisted pair # 7	—>	RTS	J4-C
J8-114	O_DTR/DSR+		—>	DTR	J4-H

Table A-16 Low-Speed V.35 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-123	I_CTS/RTS+	Twisted pair # 8	<—	CTS	J4-D
J8-121	I_DSR/DTR+		<—	DSR	J4-E
J8-112	IO_DCD/DCD+	Twisted pair # 6	<—	RLSD	J4-F
J8-111	SIG_GROUND			SIG GND	J4-B
J8-119	O_LL/NIL+	Twisted pair # 9	—>	LT	J4-K
J8-118	SIG_GROUND			SIG GND	J4-B
J8-101	O_TXD/RXD+	Twisted pair # 1	—>	SD+	J4-P
J8-102	O_TXD/RXD-		—>	SD-	J4-S
J8-105	I_RXD/TXD+	Twisted pair # 3	<—	RD+	J4-R
J8-106	I_RXD/TXD-		<—	RD-	J4-T
J8-103	O_TXCE/RXC+	Twisted pair # 2	—>	SCTE+	J4-U
J8-104	O_TXCE/RXC-		—>	SCTE-	J4-W
J8-107	I_RXC/TXCE+	Twisted pair # 4	<—	SCR+	J4-V
J8-108	I_RXC/TXCE-		<—	SCR-	J4-X
J8-109	IO_TXC/TXC+	Twisted pair # 5	<—	SCT+	J4-Y
J8-110	IO_TXC/TXC-		<—	SCT-	J4-AA
	SHIELD_GROUND	Braid		SHIELD GND	J5-A
J8-135	O_RTS/CTS+	Twisted pair # 7	—>	RTS	J5-C
J8-137	O_DTR/DSR+		—>	DTR	J5-H
J8-128	I_CTS/RTS+	Twisted pair # 8	<—	CTS	J5-D
J8-130	I_DSR/DTR+		<—	DSR	J5-E
J8-139	IO_DCD/DCD+	Twisted pair # 6	<—	RLSD	J5-F
J8-140	SIG_GROUND			SIG GND	J5-B
J8-132	O_LL/NIL+	Twisted pair # 9	—>	LT	J5-K
J8-133	SIG_GROUND			SIG GND	J5-B

Table A-16 Low-Speed V.35 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-150	O_TXD/RXD+	Twisted pair # 1	—>	SD+	J5-P
J8-149	O_TXD/RXD-		—>	SD-	J5-S
J8-146	I_RXD/TXD+	Twisted pair # 3	<—	RD+	J5-R
J8-145	I_RXD/TXD-		<—	RD-	J5-T
J8-148	O_TXCE/RXC+	Twisted pair # 2	—>	SCTE+	J5-U
J8-147	O_TXCE/RXC-		—>	SCTE-	J5-W
J8-144	I_RXC/TXCE+	Twisted pair # 4	<—	SCR+	J5-V
J8-143	I_RXC/TXCE-		<—	SCR-	J5-X
J8-142	IO_TXC/TXC+	Twisted pair # 5	<—	SCT+	J5-Y
J8-141	IO_TXC/TXC-		<—	SCT-	J5-AA
	SHIELD_GROUND	Braid		SHIELD GND	J6-A
J8-166	O_RTS/CTS+	Twisted pair # 7	—>	RTS	J6-C
J8-164	O_DTR/DSR+		—>	DTR	J6-H
J8-173	I_CTS/RTS+	Twisted pair # 8	<—	CTS	J6-D
J8-171	I_DSR/DTR+		<—	DSR	J6-E
J8-162	IO_DCD/DCD+	Twisted pair # 6	<—	RLSD	J6-F
J8-161	SIG_GROUND			SIG GND	J6-B
J8-169	O_LL/NIL+	Twisted pair # 9	—>	LT	J6-K
J8-168	SIG_GROUND			SIG GND	J6-B
J8-151	O_TXD/RXD+	Twisted pair # 1	—>	SD+	J6-P
J8-152	O_TXD/RXD-		—>	SD-	J6-S
J8-155	I_RXD/TXD+	Twisted pair # 3	<—	RD+	J6-R
J8-156	I_RXD/TXD-		<—	RD-	J6-T
J8-153	O_TXCE/RXC+	Twisted pair # 2	—>	SCTE+	J6-U
J8-154	O_TXCE/RXC-		—>	SCTE-	J6-W

Table A-16 Low-Speed V.35 DTE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-157	I_RXC/TXCE+	Twisted pair # 4	<—	SCR+	J6-V
J8-158	I_RXC/TXCE-		<—	SCR-	J6-X
J8-159	IO_TXC/TXC+	Twisted pair # 5	<—	SCT+	J6-Y
J8-160	IO_TXC/TXC-		<—	SCT-	J6-AA
	SHIELD_GROUND	Braid		SHIELD GND	J7-A
J8-185	O_RTS/CTS+	Twisted pair # 7	—>	RTS	J7-C
J8-187	O_DTR/DSR+		—>	DTR	J7-H
J8-178	I_CTS/RTS+	Twisted pair # 8	<—	CTS	J7-D
J8-180	I_DSR/DTR+		<—	DSR	J7-E
J8-189	IO_DCD/DCD+	Twisted pair # 6	<—	RLSD	J7-F
J8-190	SIG_GROUND			SIG GND	J7-B
J8-182	O_LL/NIL+	Twisted pair # 9	—>	LT	J7-K
J8-183	SIG_GROUND			SIG GND	J7-B
J8-200	O_TXD/RXD+	Twisted pair # 1	—>	SD+	J7-P
J8-199	O_TXD/RXD-		—>	SD-	J7-S
J8-196	I_RXD/TXD+	Twisted pair # 3	<—	RD+	J7-R
J8-195	I_RXD/TXD-		<—	RD-	J7-T
J8-198	O_TXCE/RXC+	Twisted pair # 2	—>	SCTE+	J7-U
J8-197	O_TXCE/RXC-		—>	SCTE-	J7-W
J8-194	I_RXC/TXCE+	Twisted pair # 4	<—	SCR+	J7-V
J8-193	I_RXC/TXCE-		<—	SCR-	J7-X
J8-192	IO_TXC/TXC+	Twisted pair # 5	<—	SCT+	J7-Y
J8-191	IO_TXC/TXC-		<—	SCT-	J7-AA

Table A-17 Low-Speed V.35 DCE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-126	MODE_1	Shorting	–		
J8-125	GROUND	Group			
J8-175	MODE_0	Shorting	–		
J8-176	GROUND	Group			
	SHIELD_GROUND	Braid		SHIELD GND	J0-A
J8-23	I_CTS/RTS+	Twisted pair # 8	<—	RTS	J0-C
J8-21	I_DSR/DTR+		<—	DSR	J0-H
J8-16	O_RTS/CTS+	Twisted pair # 7	—>	CTS	J0-D
J8-14	O_DTR/DSR+		—>	DTR	J0-E
J8-12	IO_DCD/DCD+	Twisted pair #6	—>	RLSD	J0-F
J8-11	SIG_GROUND			SIG GND	J0-B
J8-20	I_NIL/LL+	Twisted pair #9	<—	LT	J0-K
J8-18	SIG_GROUND			SIG GND	J0-B
J8-5	I_RXD/TXD+	Twisted pair #3	<—	SD+	J0-P
J8-6	I_RXD/TXD-		<—	SD-	J0-S
J8-1	O_TXD/RXD+	Twisted pair #1	—>	RD+	J0-R
J8-2	O_TXD/RXD-		—>	RD-	J0-T
J8-7	I_RXC/TXCE+	Twisted pair #4	<—	SCTE+	J0-U
J8-8	I_RXC/TXCE-		<—	SCTE-	J0-W
J8-3	O_TXCE/RXC+	Twisted pair #2	—>	SCR+	J0-V
J8-4	O_TXCE/RXC-		—>	SCR-	J0-X
J8-9	IO_TXC/TXC+	Twisted pair #5	—>	SCT+	J0-Y
J8-10	IO_TXC/TXC-		—>	SCT-	J0-AA
	SHIELD_GROUND	Braid		SHIELD GND	J1-A

Table A-17 Low-Speed V.35 DCE Compact Octal Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-28	I_CTS/RTS+	Twisted pair # 8	<—	RTS	J1-C
J8-30	I_DSR/DTR+		<—	DSR	J1-H
J8-35	O_RTS/CTS+	Twisted pair # 7	—>	CTS	J1-D
J8-37	O_DTR/DSR+		—>	DTR	J1-E
J8-39	IO_DCD/DCD+	Twisted pair #6	—>	RLSD	J1-F
J8-40	SIG_GROUND			SIG GND	J1-B
J8-31	I_NIL/LL+	Twisted pair #9	<—	LT	J1-K
J8-33	SIG_GROUND			SIG GND	J1-B
J8-46	I_RXD/TXD+	Twisted pair #3	<—	SD+	J1-P
J8-45	I_RXD/TXD-		<—	SD-	J1-S
J8-50	O_TXD/RXD+	Twisted pair #1	—>	RD+	J1-R
J8-49	O_TXD/RXD-		—>	RD-	J1-T
J8-44	I_RXC/TXCE+	Twisted pair #4	<—	SCTE+	J1-U
J8-43	I_RXC/TXCE-		<—	SCTE-	J1-W
J8-48	O_TXCE/RXC+	Twisted pair #2	—>	SCR+	J1-V
J8-47	O_TXCE/RXC-		—>	SCR-	J1-X
J8-42	IO_TXC/TXC+	Twisted pair #5	—>	SCT+	J1-Y
J8-41	IO_TXC/TXC-		—>	SCT-	J1-AA
	SHIELD_GROUND	Braid		SHIELD GND	J2-A
J8-73	I_CTS/RTS+	Twisted pair # 8	<—	RTS	J2-C
J8-71	I_DSR/DTR+		<—	DSR	J2-H
J8-66	O_RTS/CTS+	Twisted pair # 7	—>	CTS	J2-D
J8-64	O_DTR/DSR+		—>	DTR	J2-E
J8-62	IO_DCD/DCD+	Twisted pair #6	—>	RLSD	J2-F
J8-61	SIG_GROUND			SIG GND	J2-B

Table A-17 Low-Speed V.35 DCE Compact Octal Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-70	I_NIL/LL+	Twisted pair #9	<—	LT	J2-K
J8-68	SIG_GROUND			SIG GND	J2-B
J8-55	I_RXD/TXD+	Twisted pair #3	<—	SD+	J2-P
J8-56	I_RXD/TXD-		<—	SD-	J2-S
J8-51	O_TXD/RXD+	Twisted pair #1	—>	RD+	J2-R
J8-52	O_TXD/RXD-		—>	RD-	J2-T
J8-57	I_RXC/TXCE+	Twisted pair #4	<—	SCTE+	J2-U
J8-58	I_RXC/TXCE-		<—	SCTE-	J2-W
J8-53	O_TXCE/RXC+	Twisted pair #2	—>	SCR+	J2-V
J8-54	O_TXCE/RXC-		—>	SCR-	J2-X
J8-59	IO_TXC/TXC+	Twisted pair #5	—>	SCT+	J2-Y
J8-60	IO_TXC/TXC-		—>	SCT-	J2-AA
	SHIELD_GROUND	Braid		SHIELD GND	J3-A
J8-78	I_CTS/RTS+	Twisted pair # 8	<—	RTS	J3-C
J8-80	I_DSR/DTR+		<—	DSR	J3-H
J8-85	O_RTS/CTS+	Twisted pair # 7	—>	CTS	J3-D
J8-87	O_DTR/DSR+		—>	DTR	J3-E
J8-89	IO_DCD/DCD+	Twisted pair #6	—>	RLSD	J3-F
J8-90	SIG_GROUND			SIG GND	J3-B
J8-81	I_NIL/LL+	Twisted pair #9	<—	LT	J3-K
J8-83	SIG_GROUND			SIG GND	J3-B
J8-96	I_RXD/TXD+	Twisted pair #3	<—	SD+	J3-P
J8-95	I_RXD/TXD-		<—	SD-	J3-S
J8-100	O_TXD/RXD+	Twisted pair #1	—>	RD+	J3-R
J8-99	O_TXD/RXD-		—>	RD-	J3-T

Table A-17 Low-Speed V.35 DCE Compact Octal Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-94	I_RXC/TXCE+	Twisted pair #4	<—	SCTE+	J3-U
J8-93	I_RXC/TXCE-		<—	SCTE-	J3-W
J8-98	O_TXCE/RXC+	Twisted pair #2	—>	SCR+	J3-V
J8-97	O_TXCE/RXC-		—>	SCR-	J3-X
J8-92	IO_TXC/TXC+	Twisted pair #5	—>	SCT+	J3-Y
J8-91	IO_TXC/TXC-		—>	SCT-	J3-AA
	SHIELD_GROUND	Braid		SHIELD GND	J4-A
J8-123	I_CTS/RTS+	Twisted pair # 8	<—	RTS	J4-C
J8-121	I_DSR/DTR+		<—	DSR	J4-H
J8-116	O_RTS/CTS+	Twisted pair # 7	—>	CTS	J4-D
J8-114	O_DTR/DSR+		—>	DTR	J4-E
J8-112	IO_DCD/DCD+	Twisted pair #6	—>	RLSD	J4-F
J8-111	SIG_GROUND			SIG GND	J4-B
J8-120	I_NIL/LL+	Twisted pair #9	<—	LT	J4-K
J8-118	SIG_GROUND			SIG GND	J4-B
J8-105	I_RXD/TXD+	Twisted pair #3	<—	SD+	J4-P
J8-106	I_RXD/TXD-		<—	SD-	J4-S
J8-101	O_TXD/RXD+	Twisted pair #1	—>	RD+	J4-R
J8-102	O_TXD/RXD-		—>	RD-	J4-T
J8-107	I_RXC/TXCE+	Twisted pair #4	<—	SCTE+	J4-U
J8-108	I_RXC/TXCE-		<—	SCTE-	J4-W
J8-103	O_TXCE/RXC+	Twisted pair #2	—>	SCR+	J4-V
J8-104	O_TXCE/RXC-		—>	SCR-	J4-X
J8-109	IO_TXC/TXC+	Twisted pair #5	—>	SCT+	J4-Y
J8-110	IO_TXC/TXC-		—>	SCT-	J4-AA

Table A-17 Low-Speed V.35 DCE Compact Octal Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
	SHIELD_GROUND	Braid		SHIELD GND	J5-A
J8-128	I_CTS/RTS+	Twisted pair # 8	<—	RTS	J5-C
J8-130	I_DSR/DTR+		<—	DSR	J5-H
J8-135	O_RTS/CTS+	Twisted pair # 7	—>	CTS	J5-D
J8-137	O_DTR/DSR+		—>	DTR	J5-E
J8-139	IO_DCD/DCD+	Twisted pair #6	—>	RLSD	J5-F
J8-140	SIG_GROUND			SIG GND	J5-B
J8-131	I_NIL/LL+	Twisted pair #9	<—	LT	J5-K
J8-133	SIG_GROUND			SIG GND	J5-B
J8-146	I_RXD/TXD+	Twisted pair #3	<—	SD+	J5-P
J8-145	I_RXD/TXD-		<—	SD-	J5-S
J8-150	O_TXD/RXD+	Twisted pair #1	—>	RD+	J5-R
J8-149	O_TXD/RXD-		—>	RD-	J5-T
J8-144	I_RXC/TXCE+	Twisted pair #4	<—	SCTE+	J5-U
J8-143	I_RXC/TXCE-		<—	SCTE-	J5-W
J8-148	O_TXCE/RXC+	Twisted pair #2	—>	SCR+	J5-V
J8-147	O_TXCE/RXC-		—>	SCR-	J5-X
J8-142	IO_TXC/TXC+	Twisted pair #5	—>	SCT+	J5-Y
J8-141	IO_TXC/TXC-		—>	SCT-	J5-AA
	SHIELD_GROUND	Braid		SHIELD GND	J6-A
J8-173	I_CTS/RTS+	Twisted pair # 8	<—	RTS	J6-C
J8-171	I_DSR/DTR+		<—	DSR	J6-H
J8-166	O_RTS/CTS+	Twisted pair # 7	—>	CTS	J6-D
J8-164	O_DTR/DSR+		—>	DTR	J6-E

Table A-17 Low-Speed V.35 DCE Compact Octal Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-162	IO_DCD/DCD+	Twisted pair #6	—>	RLSD	J6-F
J8-161	SIG_GROUND			SIG GND	J6-B
J8-170	I_NIL/LL+	Twisted pair #9	<—	LT	J6-K
J8-168	SIG_GROUND			SIG GND	J6-B
J8-155	I_RXD/TXD+	Twisted pair #3	<—	SD+	J6-P
J8-156	I_RXD/TXD-		<—	SD-	J6-S
J8-151	O_TXD/RXD+	Twisted pair #1	—>	RD+	J6-R
J8-152	O_TXD/RXD-		—>	RD-	J6-T
J8-157	I_RXC/TXCE+	Twisted pair #4	<—	SCTE+	J6-U
J8-158	I_RXC/TXCE-		<—	SCTE-	J6-W
J8-153	O_TXCE/RXC+	Twisted pair #2	—>	SCR+	J6-V
J8-154	O_TXCE/RXC-		—>	SCR-	J6-X
J8-159	IO_TXC/TXC+	Twisted pair #5	—>	SCT+	J6-Y
J8-160	IO_TXC/TXC-		—>	SCT-	J6-AA
	SHIELD_GROUND	Braid		SHIELD GND	J7-A
J8-178	I_CTS/RTS+	Twisted pair # 8	<—	RTS	J7-C
J8-180	I_DSR/DTR+		<—	DSR	J7-H
J8-185	O_RTS/CTS+	Twisted pair # 7	—>	CTS	J7-D
J8-187	O_DTR/DSR+		—>	DTR	J7-E
J8-189	IO_DCD/DCD+	Twisted pair #6	—>	RLSD	J7-F
J8-190	SIG_GROUND			SIG GND	J7-B
J8-181	I_NIL/LL+	Twisted pair #9	<—	LT	J7-K
J8-183	SIG_GROUND			SIG GND	J7-B
J8-196	I_RXD/TXD+	Twisted pair #3	<—	SD+	J7-P
J8-195	I_RXD/TXD-		<—	SD-	J7-S

Table A-17 Low-Speed V.35 DCE Compact Octal Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (34-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-200	O_TXD/RXD+	Twisted pair #1	—>	RD+	J7-R
J8-199	O_TXD/RXD-		—>	RD-	J7-T
J8-194	I_RXC/TXCE+	Twisted pair #4	<—	SCTE+	J7-U
J8-193	I_RXC/TXCE-		<—	SCTE-	J7-W
J8-198	O_TXCE/RXC+	Twisted pair #2	—>	SCR+	J7-V
J8-197	O_TXCE/RXC-		—>	SCR-	J7-X
J8-192	IO_TXC/TXC+	Twisted pair #5	—>	SCT+	J7-Y
J8-191	IO_TXC/TXC-		—>	SCT-	J7-AA

X.21 Dual Serial Module Cable Assembly

Figure A-9 shows the dual serial module X.21 cable assembly. Table A-18 lists the DTE pinouts; Table A-18 lists the DCE pinouts. Arrows indicate signal direction: —> indicates DTE to DCE, and <— indicates DCE to DTE.

Figure A-9 Dual Serial Module X.21 Cable Assembly

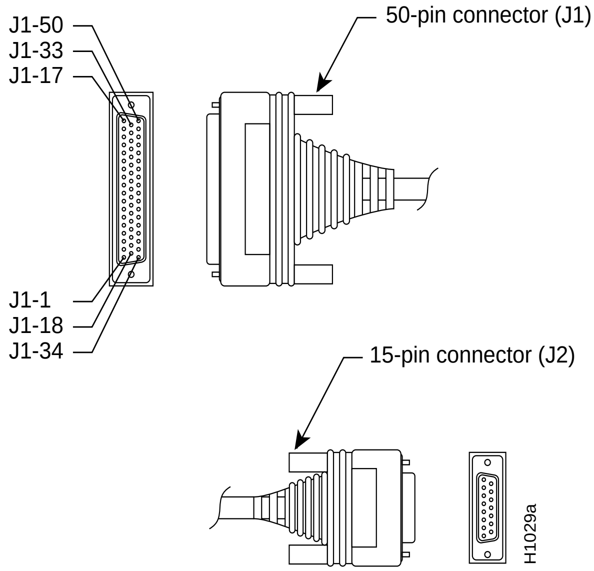


Table A-18 Dual Serial Module X.21 DTE Cable Pinouts

72-0683-02 DTE Connections				
From	**Signal Name**	**Type**	**To**	**Signal Name**
J1-5	MUX SEL		J1-38	GND
J1-36	449 GND		J2-8	X.21 GND
J1-41 J1-25	449 DTR	Jumper	J1-6 J1-22	449 CTS
J1-41 J1-25	449 DTR	Jumper	J1-8 J1-24	449 DSR
J1-43 J1-27	449 SCTE	Jumper	J1-37 J1-21	449 SCR

Table A-18 Dual Serial Module X.21 DTE Cable Pinouts (Continued)

72-0683-02 DTE Connections				
From	**Signal Name**	**Type**	**To**	**Signal Name**
J1-1 J1-34	449 TXD	Twisted pair	J2-2 J2-9	X.21 TXD
J1-4 J1-20	449 RTS	Twisted pair	J2-3 J2-10	X.21 CTL
J1-35 J1-19	449 RXD	Twisted pair	J2-4 J2-11	X.21 RXD
J1-10 J1-26	449 RLSD	Twisted pair	J2-5 J2-12	X.21 IND
J1-2 J1-18	449 SCT	Twisted pair	J2-6 J2-13	X.21 CLK

Table A-19 Dual Serial Module X.21 DCE Cable Pinouts

72-0737-01 DCE Connections				
From	**Signal Name**	**Type**	**To**	**Signal Name**
J1-5	MUX SEL		J1-38	GND
J1-36	449 GND		J2-8	X.21 GND
J1-41 J1-25	449 DSR	Jumper	J1-8 J1-24	449 DTR
J1-35 J1-19	449 TXD	Twisted pair	J2-2 J2-9	X.21 TXD
J1-6 J1-22	449-RTS	Twisted pair	J2-3 J2-10	X.21 CTL
J1-1 J1-34	449 RXD	Twisted pair	J2-4 J2-11	X.21 RXD

Table A-19 Dual Serial Module X.21 DCE Cable Pinouts (Continued)

72-0737-01 DCE Connections				
From	**Signal Name**	**Type**	**To**	**Signal Name**
J1-10 J1-26	449 RLSD	Twisted pair	J2-5 J2-12	X.21 IND
J1-43 J1-27	449 SCT	Twisted pair	J2-6 J2-13	X.21 CLK
J1-17	DCE SEL		J1-44	
J1-15	Chassis GND		J2-1	

X.21 Four-Port Serial Module Cable Assembly

Figure A-10 shows the four-port serial X.21 cable assembly that is used on the NP-4T and the high-speed serial ports on the NP-2T16S; Table A-20 lists the DTE pinouts; Table A-21 lists the DCE pinouts. Arrows indicate signal direction: —> indicates DTE to DCE, and <— indicates DCE to DTE.

Figure A-10 Four-Port Serial Module X.21 Cable Assembly

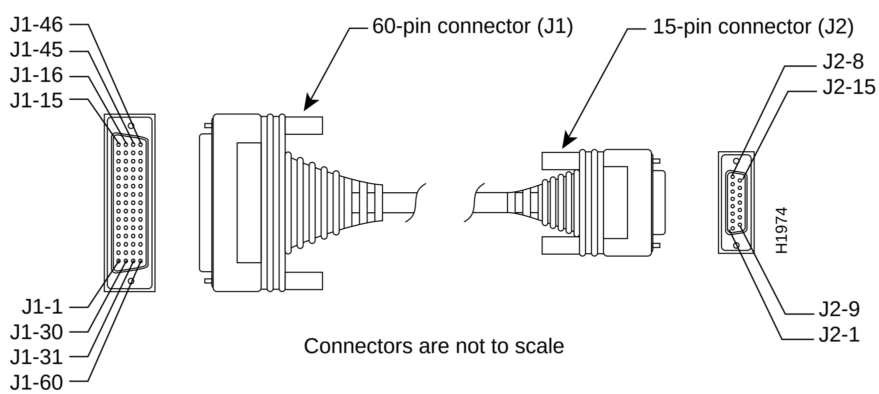


Table A-20 Four-Port Serial X.21 DTE Cable Pinouts (DB-60 to DB-15)

60 Pin	Signal Name	Type	Direction	15 Pin	Signal Name
J1-48 J1-47	GND MODE_2	Shorting group	-	–	–
J1-51 J1-52	GND MODE_DCE	Shorting group	–	–	–
J1-46	Shield_GND	Single	–	J2-1	Shield GND
J1-11 J1-12	TXD/RXD+ TXD/RXD–	Twisted pair no. 3	—> —>	J2-2 J2-9	Transmit+ Transmit–
J1-9 J1-10	RTS/CTS+ RTS/CTS–	Twisted pair no. 2	—> —>	J2-3 J2-10	Control+ Control–
J1-28 J1-27	RXD/TXD+ RXD/TXD–	Twisted pair no. 6	<— <—	J2-4 J2-11	Receive+ Receive–
J1-1 J1-2	CTS/RTS+ CTS/RTS–	Twisted pair no. 1	<— <—	J2-5 J2-12	Indication+ Indication–
J1-26 J1-25	RXC/TXCE+ RXC/TXCE–	Twisted pair no. 5	<— <—	J2-6 J2-13	Timing+ Timing–
J1-15 Shield	Control_GND –	Twisted pair no. 4	– –	J2-8 Shield	Control GND –

Table A-21 Four-Port Serial X.21 DCE Cable Pinouts (DB-60 to DB-15)

60 Pin	Signal Name	Type	Direction	15 Pin	Signal Name
J1-48 J1-47	GND MODE_2	Shorting group	–	–	–
J1-46	Shield_GND	Single	–	J2-1	Shield GND
J1-28 J1-27	RXD/TXD+ RXD/TXD–	Twisted pair no. 6	<— <—	J2-2 J2-9	Transmit+ Transmit–

Table A-21 Four-Port Serial X.21 DCE Cable Pinouts (DB-60 to DB-15) (Continued)

60 Pin	Signal Name	Type	Direction	15 Pin	Signal Name
J1-1	CTS/RTS+	Twisted pair no. 1	<—	J2-3	Control+
J1-2	CTS/RTS–		<—	J2-10	Control–
J1-11	TXD/RXD+	Twisted pair no. 3	—>	J2-4	Receive+
J1-12	TXD/RXD–		—>	J2-11	Receive–
J1-9	RTS/CTS+	Twisted pair no. 2	—>	J2-5	Indication+
J1-10	RTS/CTS–		—>	J2-12	Indication–
J1-24	TXC/RXC+	Twisted pair no. 4	—>	J2-6	Timing+
J1-23	TXC/RXC–		—>	J2-13	Timing–
J1-15	Control_GND	Twisted pair no. 5	–	J2-8	Control GND
Shield	–		–	Shield	–

X.21 Octal Serial Cable Assembly

Figure A-11 shows the compact octal cable used on the NP-2T16S-X21 module. Table A-22 lists pinouts for the DTE cable, and Table A-23 lists pinouts for the DCE cable.

Figure A-11 Low-Speed X.21 Compact Serial Cable

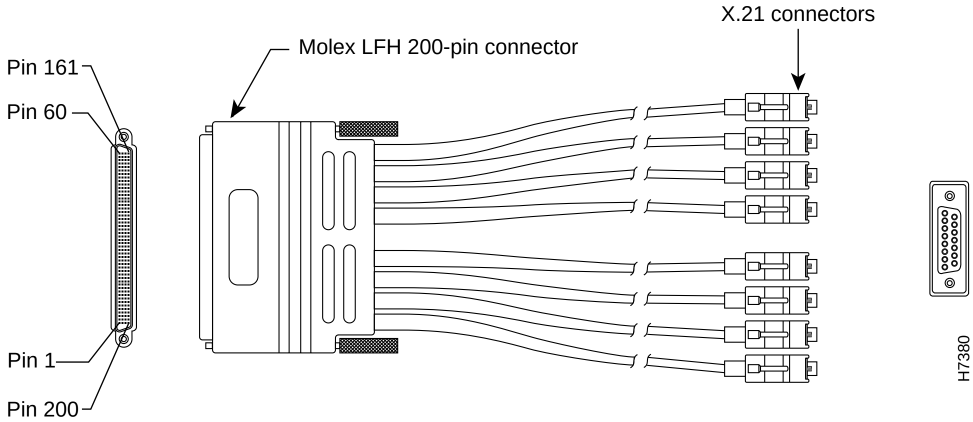


Table A-22 Low-Speed X.21 DTE Compact Serial Cable Pinouts

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-75	MODE_2	Shorting	–		
J8-76	GROUND	Group			
J8-26	MODE_DCE	Shorting	–		
J8-25	GROUND	Group			
	SHIELD_GROUND	Braid		SHIELD GND	J0-1
J8-1	O_TXD/RXD+	Twisted pair #1	—>	TRANSMIT+	J0-2
J8-2	O_TXD/RXD-		—>	TRANSMIT-	J0-9
J8-16	O_RTS/CTS+	Twisted pair #4	—>	CONTROL+	J0-3
J8-17	O_RTS/CTS-		—>	CONTROL-	J0-10
J8-5	I_RXD/TXD+	Twisted pair #2	<—	RECEIVE+	J0-4
J8-6	I_RXD/TXD-		<—	RECEIVE-	J0-11

Table A-22 Low-Speed X.21 DTE Compact Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-23	I_CTS/RTS+	Twisted pair #5	<—	INDICATION+	J0-5
J8-24	I_CTS/RTS-		<—	INDICATION-	J0-12
J8-7	I_RXC/TXCE+	Twisted pair #3	<—	TIMING+	J0-6
J8-8	I_RXC/TXCE-		<—	TIMING-	J0-13
J8-11	SIG_GROUND	Twisted pair #6	–	SIG GND	J0-8
J8-18	SIG_GROUND			SIG GND	J0-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	
	SHIELD_GROUND	Braid		SHIELD GND	J1-1
J8-50	O_TXD/RXD+	Twisted pair #1	—>	TRANSMIT+	J1-2
J8-49	O_TXD/RXD-		—>	TRANSMIT-	J1-9
J8-35	O_RTS/CTS+	Twisted pair #4	—>	CONTROL+	J1-3
J8-34	O_RTS/CTS-		—>	CONTROL-	J1-10
J8-46	I_RXD/TXD+	Twisted pair #2	<—	RECEIVE+	J1-4
J8-45	I_RXD/TXD-		<—	RECEIVE-	J1-11
J8-28	I_CTS/RTS+	Twisted pair #5	<—	INDICATION+	J1-5
J8-27	I_CTS/RTS-		<—	INDICATION-	J1-12
J8-44	I_RXC/TXCE+	Twisted pair #3	<—	TIMING+	J1-6
J8-43	I_RXC/TXCE-		<—	TIMING-	J1-13
J8-40	SIG_GROUND	Twisted pair #6	–	SIG GND	J1-8
J8-33	SIG_GROUND			SIG GND	J1-8

Table A-22 Low-Speed X.21 DTE Compact Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	
	SHIELD_GROUND	Braid		SHIELD GND	J2-1
J8-51	O_TXD/RXD+	Twisted pair #1	—>	TRANSMIT+	J2-2
J8-52	O_TXD/RXD-		—>	TRANSMIT-	J2-9
J8-66	O_RTS/CTS+	Twisted pair #4	—>	CONTROL+	J2-3
J8-67	O_RTS/CTS-		—>	CONTROL-	J2-10
J8-55	I_RXD/TXD+	Twisted pair #2	<—	RECEIVE+	J2-4
J8-56	I_RXD/TXD-		<—	RECEIVE-	J2-11
J8-73	I_CTS/RTS+	Twisted pair #5	<—	INDICATION+	J2-5
J8-74	I_CTS/RTS-		<—	INDICATION-	J2-12
J8-57	I_RXC/TXCE+	Twisted pair #3	<—	TIMING+	J2-6
J8-58	I_RXC/TXCE-		<—	TIMING-	J2-13
J8-61	SIG_GROUND	Twisted pair #6	–	SIG GND	J2-8
J8-68	SIG_GROUND			SIG GND	J2-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	

Table A-22 Low-Speed X.21 DTE Compact Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
	SHIELD_GROUND	Braid		SHIELD GND	J3-1
J8-100	O_TXD/RXD+	Twisted pair #1	—>	TRANSMIT+	J3-2
J8-99	O_TXD/RXD-		—>	TRANSMIT-	J3-9
J8-85	O_RTS/CTS+	Twisted pair #4	—>	CONTROL+	J3-3
J8-84	O_RTS/CTS-		—>	CONTROL-	J3-10
J8-96	I_RXD/TXD+	Twisted pair #2	<—	RECEIVE+	J3-4
J8-95	I_RXD/TXD-		<—	RECEIVE-	J3-11
J8-78	I_CTS/RTS+	Twisted pair #5	<—	INDICATION+	J3-5
J8-77	I_CTS/RTS-		<—	INDICATION-	J3-12
J8-94	I_RXC/TXCE+	Twisted pair #3	<—	TIMING+	J3-6
J8-93	I_RXC/TXCE-		<—	TIMING-	J3-13
J8-90	SIG_GROUND	Twisted pair #6	–	SIG GND	J3-8
J8-83	SIG_GROUND			SIG GND	J3-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	
	SHIELD_GROUND	Braid		SHIELD GND	J4-1
J8-101	O_TXD/RXD+	Twisted pair #1	—>	TRANSMIT+	J4-2
J8-102	O_TXD/RXD-		—>	TRANSMIT-	J4-9
J8-116	O_RTS/CTS+	Twisted pair #4	—>	CONTROL+	J4-3
J8-117	O_RTS/CTS-		—>	CONTROL-	J4-10

Table A-22 Low-Speed X.21 DTE Compact Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-105	I_RXD/TXD+	Twisted pair #2	<—	RECEIVE+	J4-4
J8-106	I_RXD/TXD-		<—	RECEIVE-	J4-11
J8-123	I_CTS/RTS+	Twisted pair #5	<—	INDICATION+	J4-5
J8-124	I_CTS/RTS-		<—	INDICATION-	J4-12
J8-107	I_RXC/TXCE+	Twisted pair #3	<—	TIMING+	J4-6
J8-108	I_RXC/TXCE-		<—	TIMING-	J4-13
J8-111	SIG_GROUND	Twisted pair #6	–	SIG GND	J4-8
J8-118	SIG_GROUND			SIG GND	J4-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	
	SHIELD_GROUND	Braid		SHIELD GND	J5-1
J8-150	O_TXD/RXD+	Twisted pair #1	—>	TRANSMIT+	J5-2
J8-149	O_TXD/RXD-		—>	TRANSMIT-	J5-9
J8-135	O_RTS/CTS+	Twisted pair #4	—>	CONTROL+	J5-3
J8-134	O_RTS/CTS-		—>	CONTROL-	J5-10
J8-146	I_RXD/TXD+	Twisted pair #2	<—	RECEIVE+	J5-4
J8-145	I_RXD/TXD-		<—	RECEIVE-	J5-11
J8-128	I_CTS/RTS+	Twisted pair #5	<—	INDICATION+	J5-5
J8-127	I_CTS/RTS-		<—	INDICATION-	J5-12
J8-144	I_RXC/TXCE+	Twisted pair #3	<—	TIMING+	J5-6
J8-143	I_RXC/TXCE-		<—	TIMING-	J5-13

Table A-22 Low-Speed X.21 DTE Compact Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-140	SIG_GROUND	Twisted pair #6	–	SIG GND	J5-8
J8-133	SIG_GROUND			SIG GND	J5-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	
	SHIELD_GROUND	Braid		SHIELD GND	J6-1
J8-151	O_TXD/RXD+	Twisted pair #1	—>	TRANSMIT+	J6-2
J8-152	O_TXD/RXD-		—>	TRANSMIT-	J6-9
J8-166	O_RTS/CTS+	Twisted pair #4	—>	CONTROL+	J6-3
J8-167	O_RTS/CTS-		—>	CONTROL-	J6-10
J8-155	I_RXD/TXD+	Twisted pair #2	<—	RECEIVE+	J6-4
J8-156	I_RXD/TXD-		<—	RECEIVE-	J6-11
J8-173	I_CTS/RTS+	Twisted pair #5	<—	INDICATION+	J6-5
J8-174	I_CTS/RTS-		<—	INDICATION-	J6-12
J8-157	I_RXC/TXCE+	Twisted pair #3	<—	TIMING+	J6-6
J8-158	I_RXC/TXCE-		<—	TIMING-	J6-13
J8-161	SIG_GROUND	Twisted pair #6	–	SIG GND	J6-8
J8-168	SIG_GROUND			SIG GND	J6-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	

Table A-22 Low-Speed X.21 DTE Compact Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	
	SHIELD_GROUND	Braid		SHIELD GND	J7-1
J8-200	O_TXD/RXD+	Twisted pair #1	—>	TRANSMIT+	J7-2
J8-199	O_TXD/RXD-		—>	TRANSMIT-	J7-9
J8-185	O_RTS/CTS+	Twisted pair #4	—>	CONTROL+	J7-3
J8-184	O_RTS/CTS-		—>	CONTROL-	J7-10
J8-196	I_RXD/TXD+	Twisted pair #2	<—	RECEIVE+	J7-4
J8-195	I_RXD/TXD-		<—	RECEIVE-	J7-11
J8-178	I_CTS/RTS+	Twisted pair #5	<—	INDICATION+	J7-5
J8-177	I_CTS/RTS-		<—	INDICATION-	J7-12
J8-194	I_RXC/TXCE+	Twisted pair #3	<—	TIMING+	J7-6
J8-193	I_RXC/TXCE-		<—	TIMING-	J7-13
J8-190	SIG_GROUND	Twisted pair #6	–	SIG GND	J7-8
J8-183	SIG_GROUND			SIG GND	J7-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	

Table A-23 Low-Speed X.21 DCE Compact Octal Serial Cable Pinouts

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-75	MODE_2	Shorting	–		
J8-76	GROUND	Group			
	SHIELD_GROUND	Braid		SHIELD GND	J0-1
J8-5	I_RXD/TXD+	Twisted pair #1	<—	TRANSMIT+	J0-2
J8-6	I_RXD/TXD-		<—	TRANSMIT-	J0-9
J8-23	I_CTS/RTS+	Twisted pair #4	<—	CONTROL+	J0-3
J8-24	I_CTS/RTS-		<—	CONTROL-	J0-10
J8-1	O_TXD/RXD+	Twisted pair #2	—>	RECEIVE+	J0-4
J8-2	O_TXD/RXD-		—>	RECEIVE-	J0-11
J8-16	O_RTS/CTS+	Twisted pair #5	—>	INDICATION+	J0-5
J8-17	O_RTS/CTS-		—>	INDICATION-	J0-12
J8-3	O_TXCE/RXC+	Twisted pair #3	—>	TIMING+	J0-6
J8-4	O_TXCE/RXC-		—>	TIMING-	J0-13
J8-11	SIG_GROUND	Twisted pair #6	–	SIG GND	J0-8
J8-18	SIG_GROUND			SIG GND	J0-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	
	SHIELD_GROUND	Braid		SHIELD GND	J1-1
J8-46	I_RXD/TXD+	Twisted pair #1	<—	TRANSMIT+	J1-2
J8-45	I_RXD/TXD-		<—	TRANSMIT-	J1-9

Table A-23 Low-Speed X.21 DCE Compact Octal Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-28	I_CTS/RTS+	Twisted pair #4	<—	CONTROL+	J1-3
J8-27	I_CTS/RTS-		<—	CONTROL-	J1-10
J8-50	O_TXD/RXD+	Twisted pair #2	—>	RECEIVE+	J1-4
J8-49	O_TXD/RXD-		—>	RECEIVE-	J1-11
J8-35	O_RTS/CTS+	Twisted pair #5	—>	INDICATION+	J1-5
J8-34	O_RTS/CTS-		—>	INDICATION-	J1-12
J8-48	O_TXCE/RXC+	Twisted pair #3	—>	TIMING+	J1-6
J8-47	O_TXCE/RXC-		—>	TIMING-	J1-13
J8-40	SIG_GROUND	Twisted pair #6	–	SIG GND	J1-8
J8-33	SIG_GROUND			SIG GND	J1-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	
	SHIELD_GROUND	Braid		SHIELD GND	J2-1
J8-55	I_RXD/TXD+	Twisted pair #1	<—	TRANSMIT+	J2-2
J8-56	I_RXD/TXD-		<—	TRANSMIT-	J2-9
J8-73	I_CTS/RTS+	Twisted pair #4	<—	CONTROL+	J2-3
J8-74	I_CTS/RTS-		<—	CONTROL-	J2-10
J8-51	O_TXD/RXD+	Twisted pair #2	—>	RECEIVE+	J2-4
J8-52	O_TXD/RXD-		—>	RECEIVE-	J2-11
J8-66	O_RTS/CTS+	Twisted pair #5	—>	INDICATION+	J2-5
J8-67	O_RTS/CTS-		—>	INDICATION-	J2-12

Table A-23 Low-Speed X.21 DCE Compact Octal Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-53	O_TXCE/RXC+	Twisted pair #3	—>	TIMING+	J2-6
J8-54	O_TXCE/RXC-		—>	TIMING-	J2-13
J8-61	SIG_GROUND	Twisted pair #6	–	SIG GND	J2-8
J8-68	SIG_GROUND			SIG GND	J2-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	
	SHIELD_GROUND	Braid		SHIELD GND	J3-1
J8-96	I_RXD/TXD+	Twisted pair #1	<—	TRANSMIT+	J3-2
J8-95	I_RXD/TXD-		<—	TRANSMIT-	J3-9
J8-78	I_CTS/RTS+	Twisted pair #4	<—	CONTROL+	J3-3
J8-77	I_CTS/RTS-		<—	CONTROL-	J3-10
J8-100	O_TXD/RXD+	Twisted pair #2	—>	RECEIVE+	J3-4
J8-99	O_TXD/RXD-		—>	RECEIVE-	J3-11
J8-85	O_RTS/CTS+	Twisted pair #5	—>	INDICATION+	J3-5
J8-84	O_RTS/CTS-		—>	INDICATION-	J3-12
J8-98	O_TXCE/RXC+	Twisted pair #3	—>	TIMING+	J3-6
J8-97	O_TXCE/RXC-		—>	TIMING-	J3-13
J8-90	SIG_GROUND	Twisted pair #6	–	SIG GND	J3-8
J8-83	SIG_GROUND			SIG GND	J3-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	

Table A-23 Low-Speed X.21 DCE Compact Octal Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	
	SHIELD_GROUND	Braid		SHIELD GND	J4-1
J8-105	I_RXD/TXD+	Twisted pair #1	<—	TRANSMIT+	J4-2
J8-106	I_RXD/TXD-		<—	TRANSMIT-	J4-9
J8-123	I_CTS/RTS+	Twisted pair #4	<—	CONTROL+	J4-3
J8-124	I_CTS/RTS-		<—	CONTROL-	J4-10
J8-101	O_TXD/RXD+	Twisted pair #2	—>	RECEIVE+	J4-4
J8-102	O_TXD/RXD-		—>	RECEIVE-	J4-11
J8-116	O_RTS/CTS+	Twisted pair #5	—>	INDICATION+	J4-5
J8-117	O_RTS/CTS-		—>	INDICATION-	J4-12
J8-103	O_TXCE/RXC+	Twisted pair #3	—>	TIMING+	J4-6
J8-104	O_TXCE/RXC-		—>	TIMING-	J4-13
J8-111	SIG_GROUND	Twisted pair #6	–	SIG GND	J4-8
J8-118	SIG_GROUND			SIG GND	J4-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	
	SHIELD_GROUND	Braid		SHIELD GND	J5-1

Table A-23 Low-Speed X.21 DCE Compact Octal Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-146	I_RXD/TXD+	Twisted pair #1	<—	TRANSMIT+	J5-2
J8-145	I_RXD/TXD-		<—	TRANSMIT-	J5-9
J8-128	I_CTS/RTS+	Twisted pair #4	<—	CONTROL+	J5-3
J8-127	I_CTS/RTS-		<—	CONTROL-	J5-10
J8-150	O_TXD/RXD+	Twisted pair #2	—>	RECEIVE+	J5-4
J8-149	O_TXD/RXD-		—>	RECEIVE-	J5-11
J8-135	O_RTS/CTS+	Twisted pair #5	—>	INDICATION+	J5-5
J8-134	O_RTS/CTS-		—>	INDICATION-	J5-12
J8-148	O_TXCE/RXC+	Twisted pair #3	—>	TIMING+	J5-6
J8-147	O_TXCE/RXC-		—>	TIMING-	J5-13
J8-140	SIG_GROUND	Twisted pair #6	–	SIG GND	J5-8
J8-133	SIG_GROUND			SIG GND	J5-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	
	SHIELD_GROUND	Braid		SHIELD GND	J6-1
J8-155	I_RXD/TXD+	Twisted pair #1	<—	TRANSMIT+	J6-2
J8-156	I_RXD/TXD-		<—	TRANSMIT-	J6-9
J8-173	I_CTS/RTS+	Twisted pair #4	<—	CONTROL+	J6-3
J8-174	I_CTS/RTS-		<—	CONTROL-	J6-10
J8-151	O_TXD/RXD+	Twisted pair #2	—>	RECEIVE+	J6-4
J8-152	O_TXD/RXD-		—>	RECEIVE-	J6-11

Table A-23 Low-Speed X.21 DCE Compact Octal Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
J8-166	O_RTS/CTS+	Twisted pair #5	—>	INDICATION+	J6-5
J8-167	O_RTS/CTS-		—>	INDICATION-	J6-12
J8-153	O_TXCE/RXC+	Twisted pair #3	—>	TIMING+	J6-6
J8-154	O_TXCE/RXC-		—>	TIMING-	J6-13
J8-161	SIG_GROUND	Twisted pair #6	–	SIG GND	J6-8
J8-168	SIG_GROUND			SIG GND	J6-8
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	
	SHIELD_GROUND	Braid		SHIELD GND	J7-1
J8-196	I_RXD/TXD+	Twisted pair #1	<—	TRANSMIT+	J7-2
J8-195	I_RXD/TXD-		<—	TRANSMIT-	J7-9
J8-178	I_CTS/RTS+	Twisted pair #4	<—	CONTROL+	J7-3
J8-177	I_CTS/RTS-		<—	CONTROL-	J7-10
J8-200	O_TXD/RXD+	Twisted pair #2	—>	RECEIVE+	J7-4
J8-199	O_TXD/RXD-		—>	RECEIVE-	J7-11
J8-185	O_RTS/CTS+	Twisted pair #5	—>	INDICATION+	J7-5
J8-184	O_RTS/CTS-		—>	INDICATION-	J7-12
J8-198	O_TXCE/RXC+	Twisted pair #3	—>	TIMING+	J7-6
J8-197	O_TXCE/RXC-		—>	TIMING-	J7-13
J8-190	SIG_GROUND	Twisted pair #6	–	SIG GND	J7-8
J8-183	SIG_GROUND			SIG GND	J7-8

Table A-23 Low-Speed X.21 DCE Compact Octal Serial Cable Pinouts (Continued)

Router End (200-Position Plug)				Network End (15-Pin Connectors)	
Pin	**Signal**	**Note**	**Direction**	**Signal**	**Pin**
–	Not used	Twisted pair #7	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #8	–	Not used	–
	Not used			Not used	
–	Not used	Twisted pair #9	–	Not used	–
	Not used			Not used	

EIA-530 Dual Serial Module Cable Assembly

Figure A-12 shows the dual serial module EIA-530 cable assembly and Table A-24 lists the EIA-530 DTE serial cable pinouts. Arrows indicate signal direction: —> indicates DTE to DCE, and <— indicates DCE to DTE.

Figure A-12 Dual Serial Module EIA-530 Cable Assembly

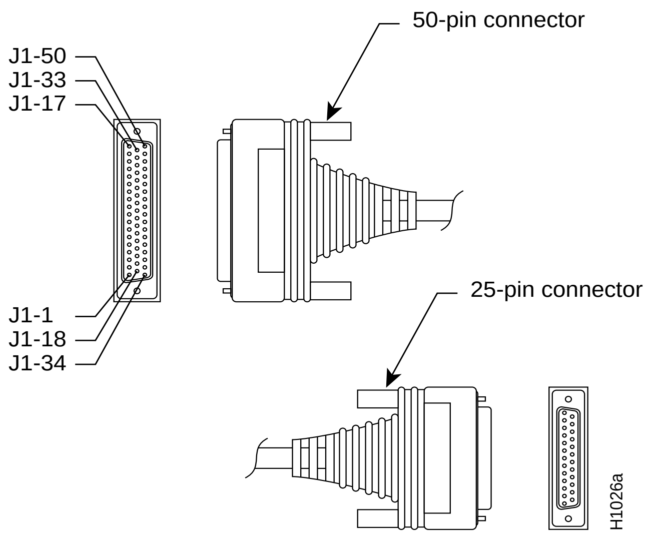


Table A-24 Dual Serial Module EIA-530 DTE Serial Cable Pinouts

72-0732-01 Connections				
50 Pin	**Signal Name**	**Direction**	**25 Pin**	**Type**
J1-5 J1–38	Looped		NC	Jumper
J1-1 J1-34	TXD+ TXD–	—> —>	J2-2 J2-14	Twisted pair
J1-35 J1-19	RXD+ RXD–	<— <—	J2-3 J2-16	Twisted pair
J1-4 J1-20	RTS+ RTS–	—> —>	J2-4 J2-19	Twisted pair
J1-6 J1-22	CTS+ CTS–	<— <—	J2-5 J2-13	Twisted pair

Table A-24 Dual Serial Module EIA-530 DTE Serial Cable Pinouts (Continued)

72-0732-01 Connections				
50 Pin	**Signal Name**	**Direction**	**25 Pin**	**Type**
J1-10 J1-26	RLSD+ (RR+) RLSD– (RR–)	<— <—	J2-8 J2-10	Twisted pair
J1-2 J1-18	SCT+ SCT–	<— <—	J2-15 J2-12	Twisted pair
J1-37 J1-21	SCR+ SCR–	<— <—	J2-17 J2-9	Twisted pair
J1-43 J1-27	SCTE+ (TT+) SCTE– (TT–)	<— <—	J2-24 J2-11	Twisted pair
J1-7	LL	—>	J2-18	Twisted pair
J1-48 J1-36	Ground		J2-23 J2-7	Twisted pair
J1-15	Shield		J2-1	Single wire
J1-8 J1-24	DCE Ready Ground	<—	J2-6 J2-23	Twisted pair
J1-41	DTE Ready	—>	J2-20	Twisted pair

EIA-530 Four-Port Serial Module Cable Assembly

Figure A-13 shows the four-port serial module EIA-530 cable assembly that is used on the NP-4T and the high-speed serial ports on the NP-2T16S, Table A-25 lists the pinouts. Arrows indicate signal direction: —> indicates DTE to DCE, and <— indicates DCE to DTE.

Figure A-13 Four-Port Serial Module EIA-530 Cable Assembly

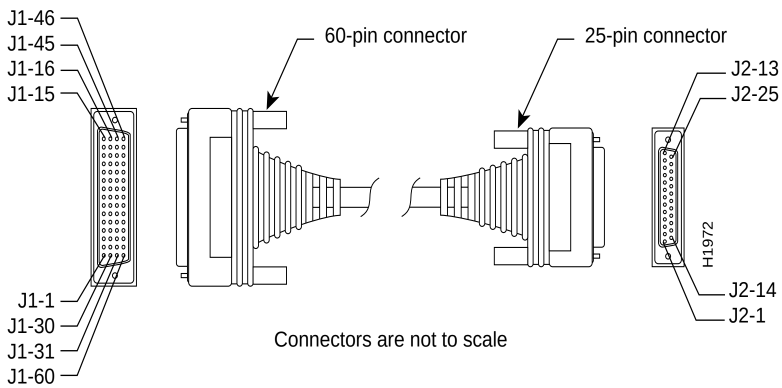


Table A-25 Four-Port Serial EIA-530 DTE Cable Pinouts (DB-60 to DB-25)

60 Pin	Signal Name	25 Pin	Signal Name	Direction DTE DCE[1]
J1-11	TXD/RXD+	J2-2	BA(A), TXD+	—>
J1-12	TXD/RXD–	J2-14	BA(B), TXD–	—>
J1-28	RXD/TXD+	J2-3	BB(A), RXD+	<—
J1-27	RXD/TXD–	J2-16	BB(B), RXD–	<—
J1-9	RTS/CTS+	J2-4	CA(A), RTS+	—>
J1-10	RTS/CTS–	J2-19	CA(B), RTS–	—>
J1-1	CTS/RTS+	J2-5	CB(A), CTS+	<—
J1-2	CTS/RTS–	J2-13	CB(B), CTS–	<—
J1-3	DSR/DTR+	J2-6	CC(A), DSR+	<—
J1-4	DSR/DTR–	J2-22	CC(B), DSR–	<—
J1-46	Shield_GND	J2-1	Shield	Shorted
J1-47	MODE_2	–	–	
J1-48	GND	–	–	Shorted
J1-49	MODE_1	–	–	

Table A-25 Four-Port Serial EIA-530 DTE Cable Pinouts (DB-60 to DB-25) (Continued)

60 Pin	Signal Name	25 Pin	Signal Name	Direction DTE DCE[1]
J1-5	DCD/DCD+	J2-8	CF(A), DCD+	<—
J1-6	DCD/DCD–	J2-10	CF(B), DCD–	<—
J1-24	TXC/RXC+	J2-15	DB(A), TXC+	<—
J1-23	TXC/RXC–	J2-12	DB(B), TXC–	<—
J1-26	RXC/TXCE+	J2-17	DD(A), RXC+	<—
J1-25	RXC/TXCE–	J2-9	DD(B), RXC–	<—
J1-44	LL/DCD	J2-18	LL	—>
J1-45	Circuit_GND	J2-7	Circuit_ GND	–
J1-7	DTR/DSR+	J2-20	CD(A), DTR+	—>
J1-8	DTR/DSR–	J2-23	CD(B), DTR–	—>
J1-13	TXCE/TXC+	J2-24	DA(A), TXCE+	—>
J1-14	TXCE/TXC–	J2-11	DA(B), TXCE–	—>
J1-51	GND	–	–	Shorted
J1-52	MODE_DCE	–	–	

1. The EIA-530 interface cannot be operated in DCE mode. A DCE cable is not available for the EIA-530 interface.

E1-G.703/G.704 Cable Pinouts

Table A-26 shows 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 A-26 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 described in this table are not connected.
2. TX = transmit; RX = receive.

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 modes 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).
- Balanced (120-ohm) with a DB-15 connector at the network end.
- Balanced (120-ohm) twinaxial split cable at the network end, with separate transmit and receive cables, each with a twinax connector.

In addition to these cables, some connections require bare-wire connections (directly to terminal posts). See the E1-G.703/G.704 network processor module configuration note for complete information.

HSSI Cable Pinouts

Two types of cables are available for use with an HSSI network processor module:

- CAB-HSI1=, an HSSI cable used to connect your router to an external DSU (and the HSSI network)
- CAB-HNUL=, a null-modem HSSI cable used to connect two routers back-to-back. The Cisco 4000 series router can connect a Cisco 7000 family HIP, PA-H, or PA-2H.

HSSI Interface Cable

Figure A-14 shows the HSSI cable (product number CAB-HSI1= and part number 72-0710-xx). Table A-27 provides pinouts. The cable has a male DB-50 (SCSI) connector on each end.

Figure A-14 HSSI Interface Cable Connectors

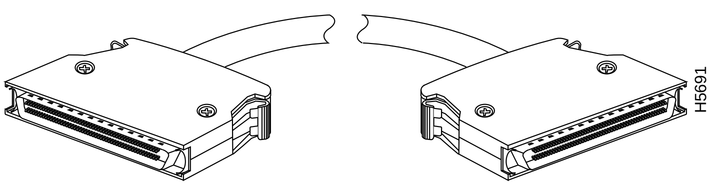


Table A-27 HSSI Interface Cable Pinouts

Signal Name	Pin No. + Side (Router End)	Direction [1]	Pin No. – Side (DSU End)
SG (Signal Ground)	1	—	26
RT (Receive Timing)	2	<—	27

Table A-27 HSSI Interface Cable Pinouts (Continued)

Signal Name	Pin No. + Side (Router End)	Direction [1]	Pin No. – Side (DSU End)
CA (DCE Available)	3	<—	28
RD (Receive Data Reserved)	4	<—	29
LC (Loopback circuit C)	5	<—	30
ST (Send Timing)	6	<—	31
SG (Signal Ground)	7	—	32
TA (DTE Available)	8	—>	33
TT (Terminal Timing)	9	—>	34
LA (Loopback Circuit A)	10	—>	35
SD (Send Data)	11	—>	36
LB (Loopback Circuit B)	12	—>	37
SG (Signal Ground)	13	—	38
5 (Ancillary to DCE)	14–18	—>	39–43
SG (Signal Ground)	19	—	44
5 (Ancillary from DCE)	20–24	<—	45–49
SG (Signal Ground)	25	—	50

1. Router is + side (DTE). DSU is – side (DCE).

HSSI Null- Modem Cable

Figure A-14 shows the HSSI null-modem cable (product number CAB-HNUL= and part number 72-0727-xx). Table A-28 provides pinouts. The cable has a male DB-50 (SCSI) connector on each end.Null Modem Cable Connectors

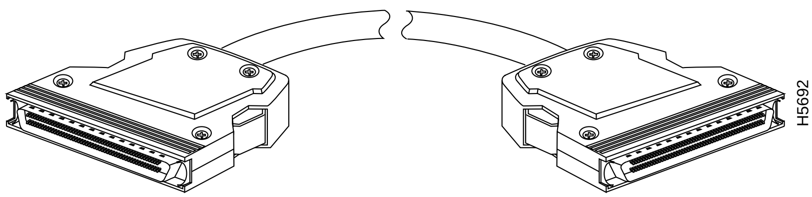


Table A-28 Null Modem Cable Pinouts

Signal Name	From Pins	Direction	To Pins	Signal Name
RT (Receive Timing)	2, 27	—>	9, 34	TT (Terminal Timing)
CA (DCE Available)	3, 28	—>	8, 33	TA (DTE Available)
RD (Receive Data)	4, 29	—>	11, 36	SD (Send Data)
LC (Loopback C)	5, 30	—>	10, 35	LA (Loopback A)
ST (Send Timing)	6, 31	—>	6, 31	ST (Send Timing)
TA (DTE Available)	8, 33	—>	3, 28	CA (DCE Available)
TT (Terminal Timing)	9, 34	—>	2, 27	RT (Receive Timing)
LA (Loopback A)	10, 35	—>	5, 30	LC (Loopback C)
SD (Send Data)	11, 36	—>	4, 29	RD (Receive Data)
GND (Ground)	1, 26, 7, 32, 13, 38, 19, 44, 25, 50		1, 26, 7, 32, 13, 38, 19, 44, 25, 50	GND (Ground)
Loopback (not connected)	12, 37			
			12, 37	Loopback (not connected)

Table A-28 Null Modem Cable Pinouts (Continued)

Signal Name	From Pins	Directio n	To Pins	Signal Name
Not used	14–18, 20–24, 39–43, 45–49		14–18, 20–24, 39–43, 45–49	Not used

Ethernet Cable Pinouts

The following figures and tables provide the pinouts and signal descriptions for the Ethernet (AUI) cable and RJ-45 connector.

Ethernet (AUI) Cable Pinouts

Figure A-15 shows the Ethernet (AUI) cable assembly, and Table A-29 lists the pinouts.

Figure A-15 Ethernet (AUI) Cable Assembly

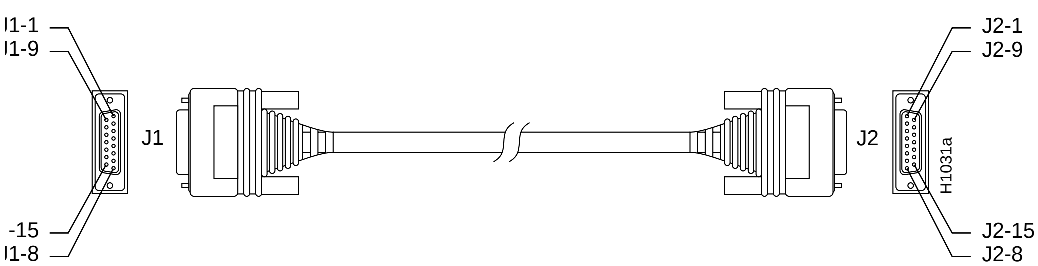


Table A-29 Ethernet (AUI) Pinouts

Pin[1]	Ethernet Circuit	Signal Name
3	DO-A	Data Out Circuit A
10	DO-B	Data Out Circuit B

Table A-29 Ethernet (AUI) Pinouts (Continued)

Pin[1]	Ethernet Circuit	Signal Name
11	DO-S	Data Out Circuit Shield
5	DI-A	Data In Circuit A
12	DI-B	Data In Circuit B
4	DI-S	Data In Circuit Shield
7	CO-A	Control Out Circuit A (not connected)
15	CO-B	Control Out Circuit B (not connected)
8	CO-S	Control Out Circuit Shield (not connected)
2	CI-A	Control In Circuit A
9	CI-B	Control In Circuit B
1	CI-S	Control In Circuit Shield
6	VC	Voltage Common
13	VP	Voltage Plus
14	VS	Voltage Shield (L25 and M25)
Shell	PG	Protective Ground

1. Any pin not referenced on a connector is not connected.

10BaseT Connector Pinouts

Figure A-16 shows the RJ-45 10BaseT connector, and Table A-30 lists the pinouts.

Figure A-16 RJ-45 10BaseT Connector

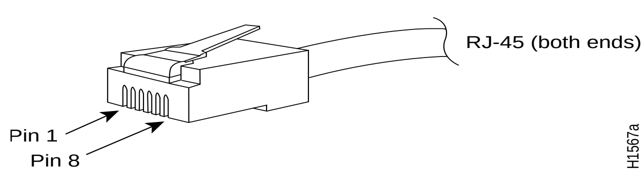


Table A-30 RJ-45 10BaseT Connector Pinouts

Pin[1]	Description
1	TX+
2	TX–
3	RX+
4	–
5	–
6	RX–
7	–
8	–

1. Any pin not shown is not connected.

100BaseT Connector Pinouts

The two interface receptacles on the Fast Ethernet network processor module are a single MII, 40-pin, D-shell type, and a single RJ-45. Each connection supports IEEE 802.3u interfaces that are compliant with the 100BaseX and 100BaseT standards. Only one can be used at a time.

The RJ-45 connection does not require an external transceiver. The MII connection requires an external physical sublayer (PHY) and an external transceiver. Figure A-17 shows the RJ-45 connectors.

Figure A-17 RJ-45 Connector and Plug

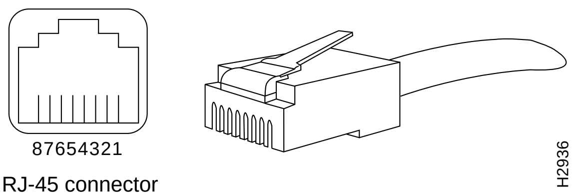


Table A-31 lists the pinouts and signals for the RJ-45 connectors. Refer to the RJ-45 pinout in Table 5 when selecting proper common-mode line terminations for the unused Category 5, UTP cable pairs 4/5 and 7/8. Wire pairs 4/5 and 7/8 are actively terminated in the RJ-45, 100BaseTX port circuitry in the 100E module. Common-mode termination reduces electromagnetic interference (EMI) and susceptibility to common-mode sources.

Table A-31 RJ-45 Connector Pinout

Pin	Description
1	Receive Data + (RxD+)
2	RxD–
3	Transmit Data + (TxD+)
6	TxD–

Depending on your RJ-45 interface cabling requirements, use the pinouts in Figure A-18 and Figure A-19.

Figure A-18 Straight-Through Cable Pinout (Connecting 100E RJ-45 Interface to a Hub or Repeater)

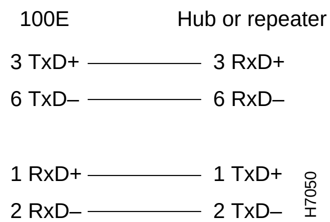
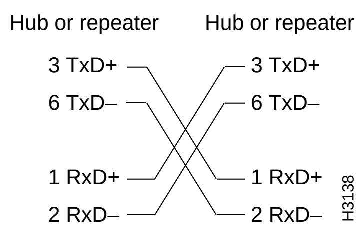


Figure A-19 Crossover Cable Pinout (RJ-45 Connections Between Hubs and Repeaters)



The module transceiver must be equipped with the appropriate connector, depending on the media type used for the MII connection. Connectors can be ST-type for optical fiber, RJ-45 for 100BaseT4, and so on. Figure A-20 shows the pin orientation of the female MII connector on the 100E module.

The MII receptacle uses 2-56 screw-type locks, called *jackscrews* (shown in Figure A-20), to secure the cable or transceiver to the MII port and provide strain relief. MII cables and transceivers have knurled thumbscrews (tightened with the fingers) that fasten to the jackscrews on the module's MII connector (shown in Figure A-20). In contrast, the RJ-45 modular plug has strain relief functionality incorporated into the design of its standard plastic connector.

Figure A-20 MII Connection (Female)

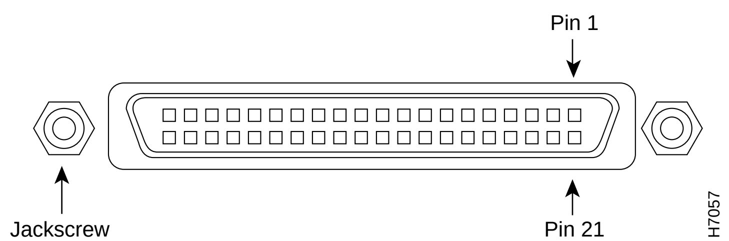


Table A-32 lists the MII connector pinouts and signals. MII cables are available commercially.

Table A-32 MII Connector Pinouts and Signals

Pin[1]	In	Out	In/Out	Description
14–17	–	Yes	–	Transmit Data (TxD)
12	Yes	–	–	Transmit Clock (Tx_CLK)[2]
11	–	Yes	–	Transmit Error (Tx_ER)
13	–	Yes	–	Transmit Enable (Tx_EN)
3	–	Yes	–	MII Data Clock (MDC)
4–7	Yes	–	–	Receive Data (RxD)
9	Yes	–	–	Receive Clock (Rx_CLK)
10	Yes	–	–	Receive Error (Rx_ER)
8	Yes	–	–	Receive Data Valid (Rx_DV)
18	Yes	–	–	Collision (COL)
19	Yes	–	–	Carrier Sense (CRS)
2	–	–	Yes	MII Data Input/Output (MDIO)
22–39	–	–	–	Common (ground)
1, 20, 21, 40	–	–	–	+5.0 volts (V)

1. Any pins not indicated are not used.
2. Tx_CLK and Rx_CLK are generated by the external transceiver.

See the NP-FE module configuration note for additional cabling information such as specifications for 100-Mbps 100BaseT transmission over UTP and STP cables and IEEE 802.3u 100BaseT physical characteristics.

Token Ring Port Pinouts

Table A-33 shows the original single-port Token Ring network processor module (Cisco product number NP-1R) port pinouts.

Table A-33 Token Ring Port Pinouts (DB-9 Connector)

9-Pin	Signal Name
1	RX–
2	NC[1]
3	NC
4	NC
5	TX–
6	RX+
7	NC
8	NC
9	TX+

1. NC = not connected.

Table A-34 shows the dual-port and newer single-port (Cisco product numbers NP-2R and NP-1RV2) Token Ring network processor module port pinouts:

Table A-34 Dual-Port Token Ring Pinouts (DB-9 Connector)

9-Pin	Signal Name
1	RX–
2	Ground
3	+5 Volt, fused
4	Ground

Table A-34 Dual-Port Token Ring Pinouts (DB-9 Connector) (Continued)

9-Pin	Signal Name
5	TX–
6	+RX
7	Ground
8	Ground
9	+TX

BRI Pinouts

The BRI interface port pinouts are shown in Table A-35.

Table A-35 BRI Port Pinouts (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 NT1 and NT2 functional groups.

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

Channelized T1 Pinouts

For the CT1, two standard T1 serial cables are available from Cisco Systems: null-modem and straight-through. A straight-through cable connects your router to an external CSU. Null-modem cables are used for back-to-back operation and testing.

The cables have male 15-pin DB connectors at each end to connect the CT1with the external CSU.

The T1 interface cable has two 15-pin DB connectors at each end to connect the CT1with the external T1 CSU. Figure A-21 shows the T1 interface cable, connectors and pinouts.

The T1 interface cables have two, male, 15-pin DB connectors (one at each end) to connect the CT1 with the external CSU. Table A-36 lists the pinouts for the null-modem T1 cable and Table A-37 lists the pinouts for the straight-through T1 cable.

Figure A-21 T1 Interface Cable

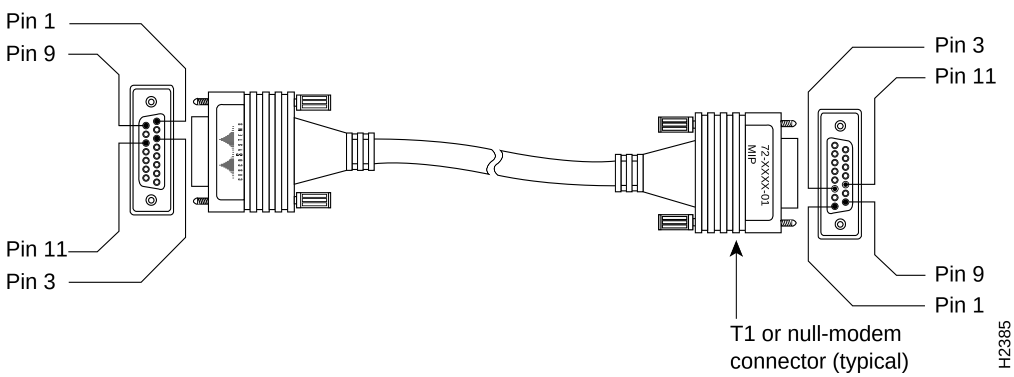


Table A-36 T1 Null-Modem Cable Pinouts

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

Table A-36 T1 Null-Modem Cable Pinouts (Continued)

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

Table A-37 T1 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

Channelized E1 Pinouts

For the CE1 module, four serial cables are available from Cisco Systems. All three have DB-15 connectors on the CE1 end and either BNC, DB-15, twinax, or RJ-45 connectors on the network end. Figure A-22, Figure A-23, Figure A-24, and Figure A-25 show the E1 interface cables.

Figure A-22 E1 Interface Cable for 75-Ohm, Unbalanced Connections (with BNC Connectors)

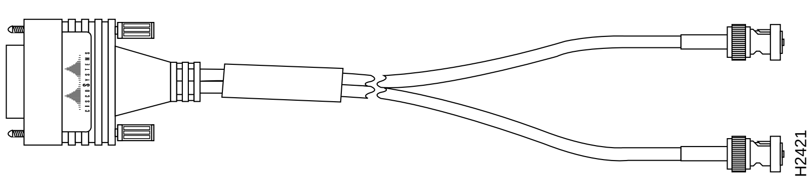


Figure A-23 E1 Interface Cable for 120-Ohm, Balanced Connections (with DB-15 Connector)

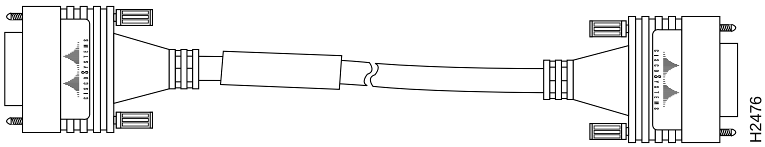


Figure A-24 E1 Interface Cable for 120-Ohm, Balanced Connections (with Twinax Connectors)

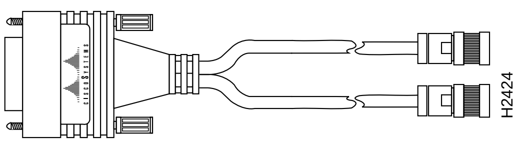
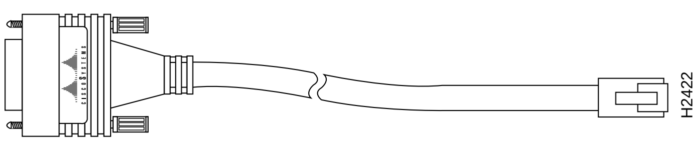


Figure A-25 E1 Interface Cable for 120-Ohm, Balanced Connections (with RJ-45 Connector)



The E1 interface cables have two, male, 15-pin DB connectors (one at each end) to connect the CE1with the external CSU. Table A-39 lists the pinouts for the E1 interface cables available from Cisco Systems.

Table A-38 E1 Interface Cable Pinouts

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

1. Any pins not described in this table are not connected.
2. Connected as a network interface.
3. Connected as a network terminal.
4. TX = transmit; RX = receive.

Table A-39 E1 Interface Cable Pinouts

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

1. Any pins not described in this table are not connected.
2. Connected as a network interface.
3. Connected as a network terminal.
4. TX = transmit; RX = receive.

APPENDIX C

Replacing Memory in Cisco 4000 Series Routers

This appendix describes how to replace or upgrade memory in a Cisco 4000 series router and contains the following sections:

- Replacing Main Memory SIMMs
- Replacing Shared-Memory SIMMs
- Replacing the Cisco 4500-M and Cisco 4700-M Boot Helper Flash Memory SIMM
- Replacing Boot ROMs in the Cisco 4000-M

There are two dynamic random-access memory (DRAM) systems in Cisco 4000 series routers. One is the shared memory, which is the interface that the network processor modules send data to or transmit data from, and the other is the primary or main memory, which is reserved for the CPU. In addition, the Cisco 4000-M has Flash memory for storing the system software image; the Cisco 4500-M and Cisco 4700-M have Flash memory for the system software image and for the boot helper image.

Caution To avoid damaging ESD-sensitive components, observe all ESD precautions. To avoid damaging the underlying system card, avoid using excessive force when you remove or replace SIMMs.

The Cisco 4000-M main memory upgrade requires replacing the main memory configuration of 4 MB (one 4-MB SIMM) with one 8, 16, or 32-MB SIMM. The Cisco 4500-M main memory upgrade requires replacing the main memory configuration of 8 MB (two 4-MB SIMMs) with two 8-MB SIMMs or two 16-MB SIMMs.

The Cisco 4700-M main memory upgrade requires replacing the main memory configuration of two 8-MB SIMMs(16 MB) with two 16-MB SIMMs (32 MB) or with two 32-MB SIMMs (64 MB).

For the Cisco 4000-M shared-memory upgrade, replace the 4-MB shared-memory SIMM with a 16-MB shared-memory SIMM. The Cisco 4500-M and Cisco 4700-M shared-memory upgrade permits you to replace the 4-MB shared-memory SIMM with an 8-MB SIMM or a 16-MB SIMM.

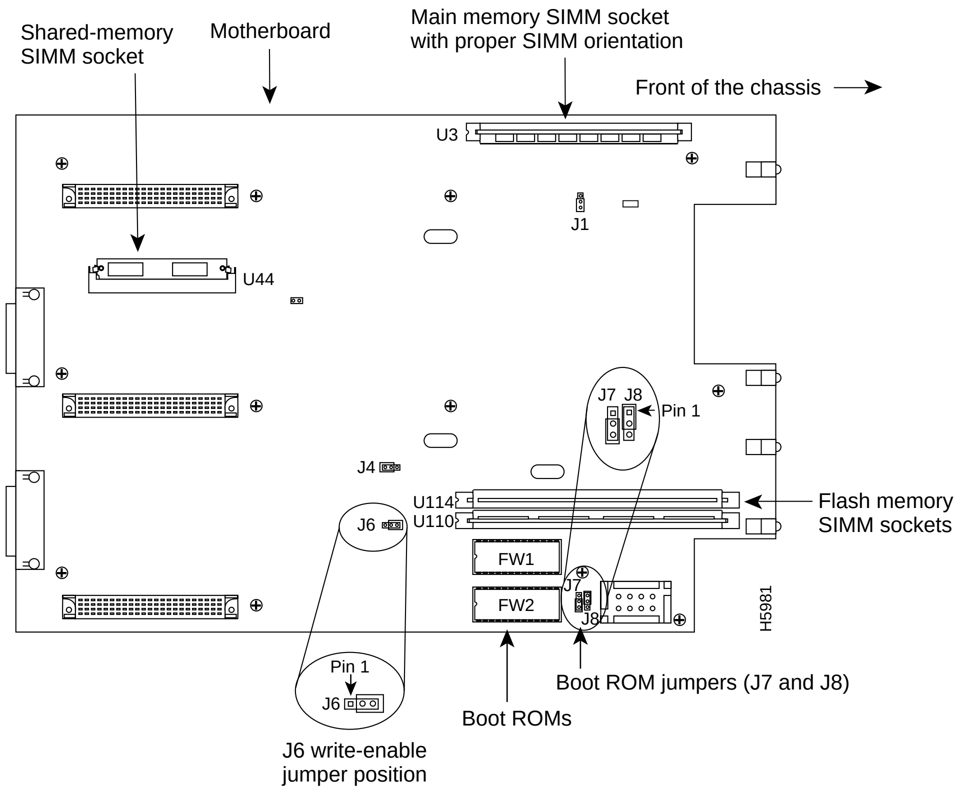
To upgrade the Cisco 4000-M Flash memory, replace the standard Flash memory configuration of 2 MB with 4 MB of Flash memory. The Cisco 4500-M and Cisco 4700-M Flash memory upgrade requires replacing or adding to the standard Flash memory configuration of 4 MB with 8, 16, 32, or 64 MB of Flash memory. Figure C-1 shows the SIMM locations in the Cisco 4000-M.

The Cisco 4000 and the Cisco 4000-M use boot ROMs to store the boot helper Cisco IOS image. To upgrade the boot ROM software to a new software image in the Cisco 4000 or Cisco 4000-M, the existing boot ROMs must be replaced.

NVRAM in the Cisco 4000 series uses an internal lithium battery to maintain data. Although this is not a field-serviceable component, we are required to provide the following safety warning:

Warning There is the danger of explosion if the battery is replaced incorrectly. Replace the battery only with the same or equivalent type recommended by the manufacturer. Dispose of used batteries according to the manufacturer’s instructions. (To see translated versions of this warning, refer to the appendix “Translated Safety Warnings.”)

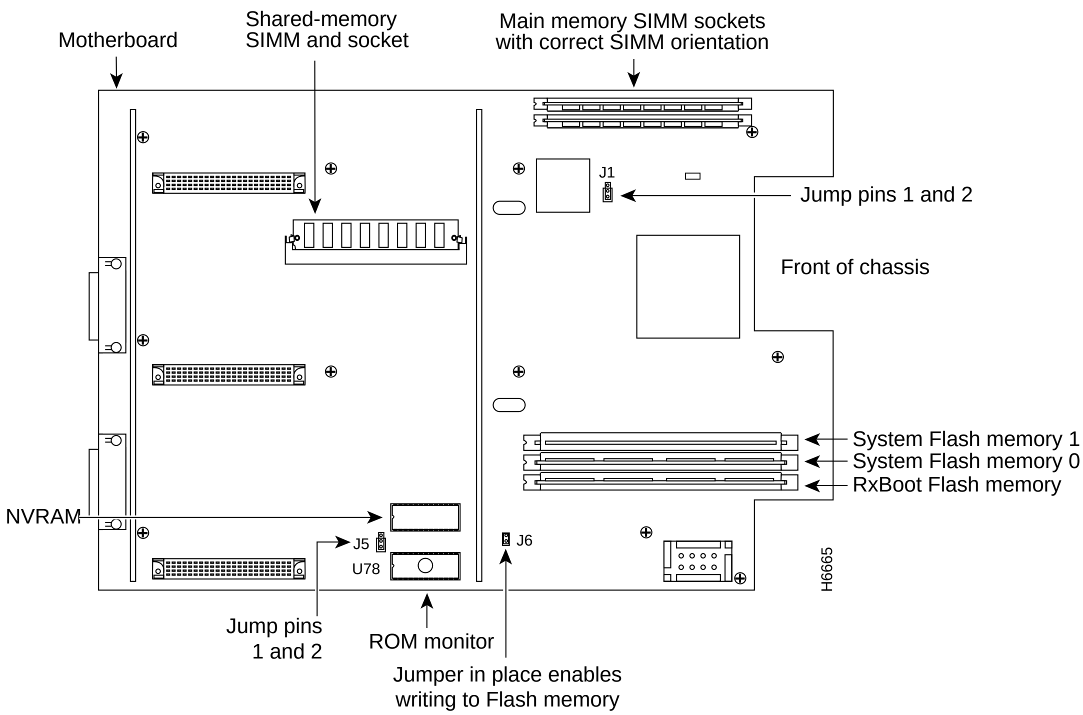
Figure C-1 Cisco 4000-M SIMM Locations



Note Configure the J5 jumper as shown in Figure C-1 to permit writing to Flash memory.

Figure C-2 shows the Cisco 4500-M and Cisco 4700-M SIMM and jumper locations.

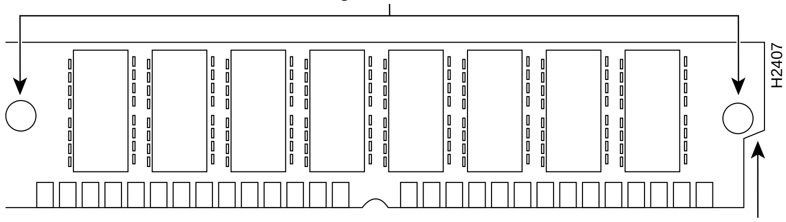
Figure C-2 Cisco 4500-M and Cisco 4700-M SIMM Locations



Replacing Main Memory SIMMs

SIMMs are manufactured with a polarization notch to prevent them from being installed backward. Figure C-3 shows the polarization notch and locations of the alignment holes on a main memory SIMM card. The main memory SIMM cards are installed with the connector edge down and the component side facing in, as shown in the upper right of Figure C-1 and Figure C-2.

Figure C-3 Cisco 4000 Series Main Memory SIMM



Removing Main Memory SIMMS

Take the following steps to remove main memory SIMMs:

Step 1 Put on an ESD-preventive wrist strap and ensure that it makes good contact with your skin. Connect the equipment end of the wrist strap to the metal back plate of the chassis, avoiding contact with the connectors.

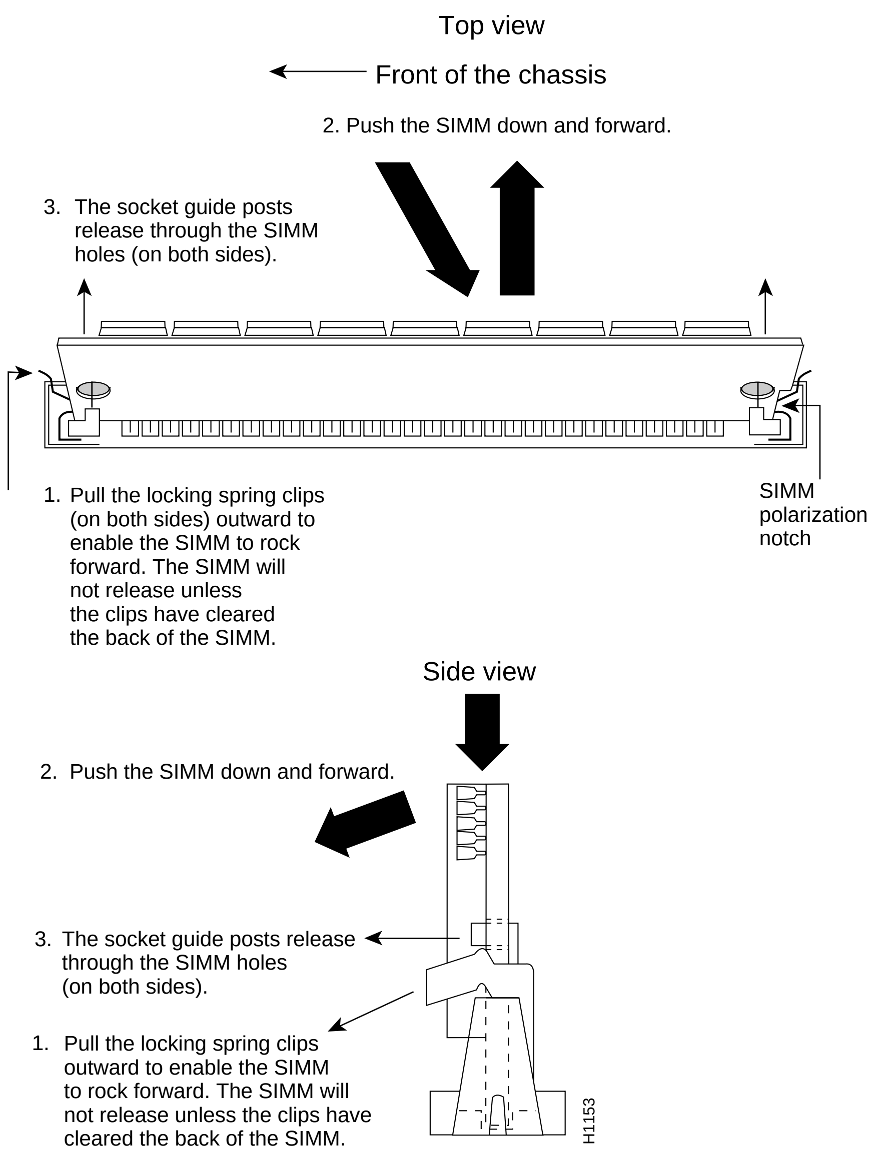
Step 2 On the motherboard, locate the main memory SIMM card sockets shown in the upper right corner of Figure C-1 (for the Cisco 4000-M) and Figure C-2 (for the Cisco 4500-M and Cisco 4700-M).

Caution Handle SIMMs by the card edges only. SIMMs are ESD-sensitive components and can be damaged by mishandling.

Step 3 Remove one SIMM at a time, beginning with the SIMM farthest from the edge of the motherboard. (The Cisco 4000-M has only one main memory SIMM.)

Step 4 Pull the locking spring clips on both sides outward and tilt the SIMM free of the clips to lift the SIMM out of its socket. (See Figure C-4.)

Figure C-4 Removing Main Memory SIMMs



Step 5 Hold the SIMM by the edges with your thumb and index finger and lift it out of the socket. Place the removed SIMM in an antistatic bag to protect it from ESD damage.

Step 6 Repeat Step 2 through Step 5 for each main memory SIMM card.

Proceed to the next section, "Installing Main Memory SIMMs."

Installing Main Memory SIMMs

Take the following steps to install main memory SIMMs:

Step 1 Put on an ESD-preventive wrist strap and ensure that it makes good contact with your skin. Connect the equipment end of the wrist strap to the metal back plate of the chassis, avoiding contact with the connectors.

Step 2 On the motherboard, locate the main memory SIMM card sockets shown in the upper right corner of Figure C-1 for the Cisco 4000-M and Figure C-2 for the Cisco 4500-M and Cisco 4700-M. All of the sockets should be empty. If not, follow the steps in the section "Removing Main Memory SIMMS" earlier in this chapter.

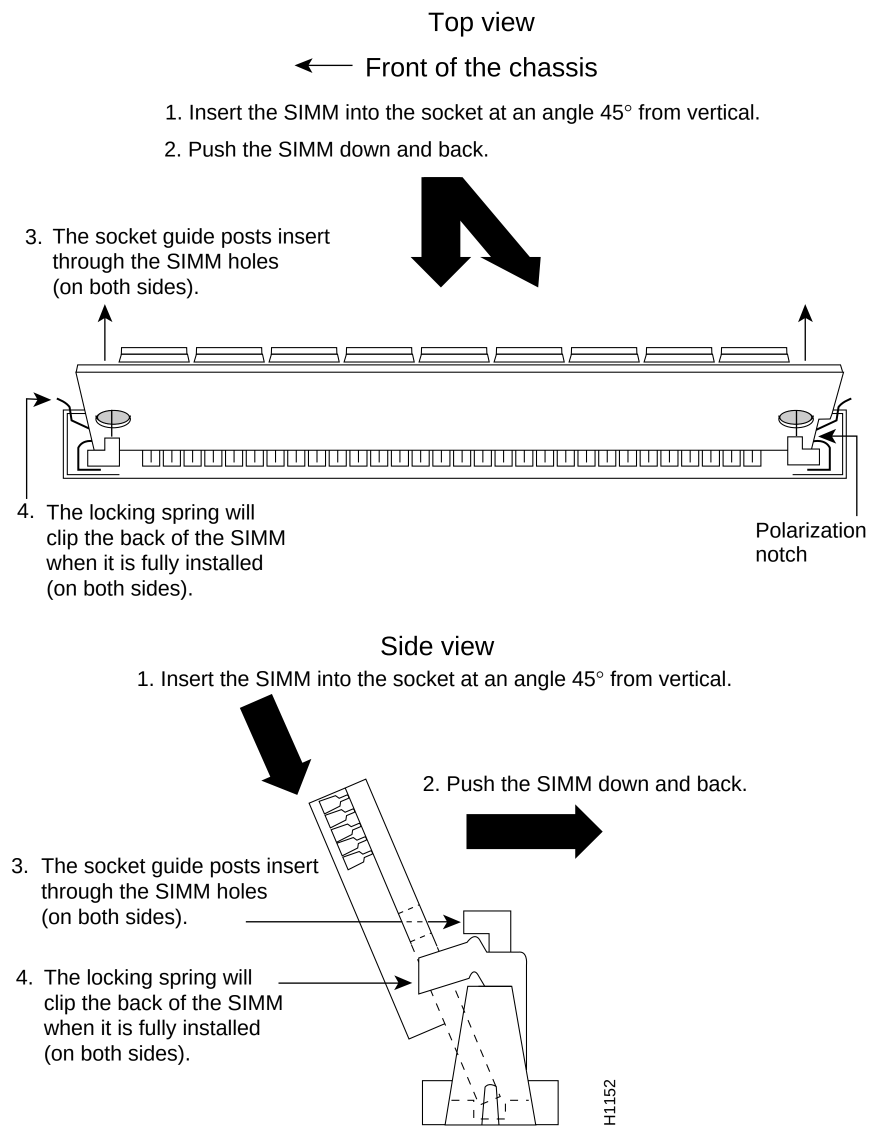
Caution Handle SIMMs by the card edges only. SIMMs are ESD-sensitive components and can be damaged by mishandling.

Step 3 Hold the SIMM with the polarization notch on the right and the component side away from you with the connector edge at the bottom. (See Figure C-3.)

Step 4 Beginning with the SIMM nearest the edge of the motherboard, insert the main memory SIMM card at a 45-degree angle and rock it into its vertical position (see Figure C-5), using the minimum amount of force required. When the SIMM is properly seated, the socket guide posts will insert through the alignment holes, and the connector springs will click into place.

Step 5 Ensure that each SIMM is straight and that the alignment holes (as shown in Figure C-5) line up with the plastic socket guides on the socket.

Figure C-5 Installing Main Memory SIMMs



Caution You will feel some resistance, but *do not use excessive force on the SIMM and do not touch the surface components to avoid damaging them.*

Step 6 Repeat Step 2 through Step 5 for each main memory SIMM.

If you are done with all SIMM replacement procedures, proceed to the section "Replacing Network Processor Modules" in the chapter "Configuring the Cisco 4000 Series Chassis."

Replacing Shared-Memory SIMMs

Use the following procedures to replace shared-memory SIMMs in a Cisco 4000-M, Cisco 4500-M, or Cisco 4700-M.

Removing Shared-Memory SIMMs

Take the following steps to remove the shared-memory SIMMs:

Step 1 Unplug the chassis power cord and network connections.

Step 2 Put on an ESD-preventive wrist strap and ensure that it makes good contact with your skin. Connect the equipment end of the wrist strap to the metal back plate of the chassis, avoiding contact with the connectors.

Step 3 Remove the chassis cover as described in the section "Accessing the Internal Components of the Router" in the chapter "Configuring the Cisco 4000 Series Chassis."

Step 4 Remove and safely store all the network processor modules present as described in the "Replacing Network Processor Modules" section in the chapter "Configuring the Cisco 4000 Series Chassis."

Step 5 Locate the shared-memory SIMM card socket shown on the left of the motherboard as shown in Figure C-1 (for the Cisco 4000-M) and Figure C-2 (for the Cisco 4500-M and Cisco 4700-M).

Step 6 Turn the chassis so that the rear of the chassis is closest to you.

Step 7 The SIMMs are held in place at each end by small metal spring clasps. To remove a shared memory SIMM, push the two metal clasps apart. Angle the SIMM upward and pull it out. (See Figure C-5.)

Caution Do not exert pressure on the components on the SIMM surface because it might damage them. The sides of the SIMM must clear the metal clasps before the SIMM can be safely removed.

Step 8 Place the removed SIMM in an antistatic bag to protect it from ESD damage.

Step 9 Repeat Step 7 and Step 8 for each SIMM.

Step 10 Proceed to the next section, "Installing Shared-Memory SIMMs."

Installing Shared-Memory SIMMs

Take the following steps to install shared-memory SIMMs:

Step 1 Unplug the chassis power cord and network connections.

Step 2 Put on an ESD-preventive wrist strap and ensure that it makes good contact with your skin. Connect the equipment end of the wrist strap to the metal back plate of the chassis, avoiding contact with the connectors.

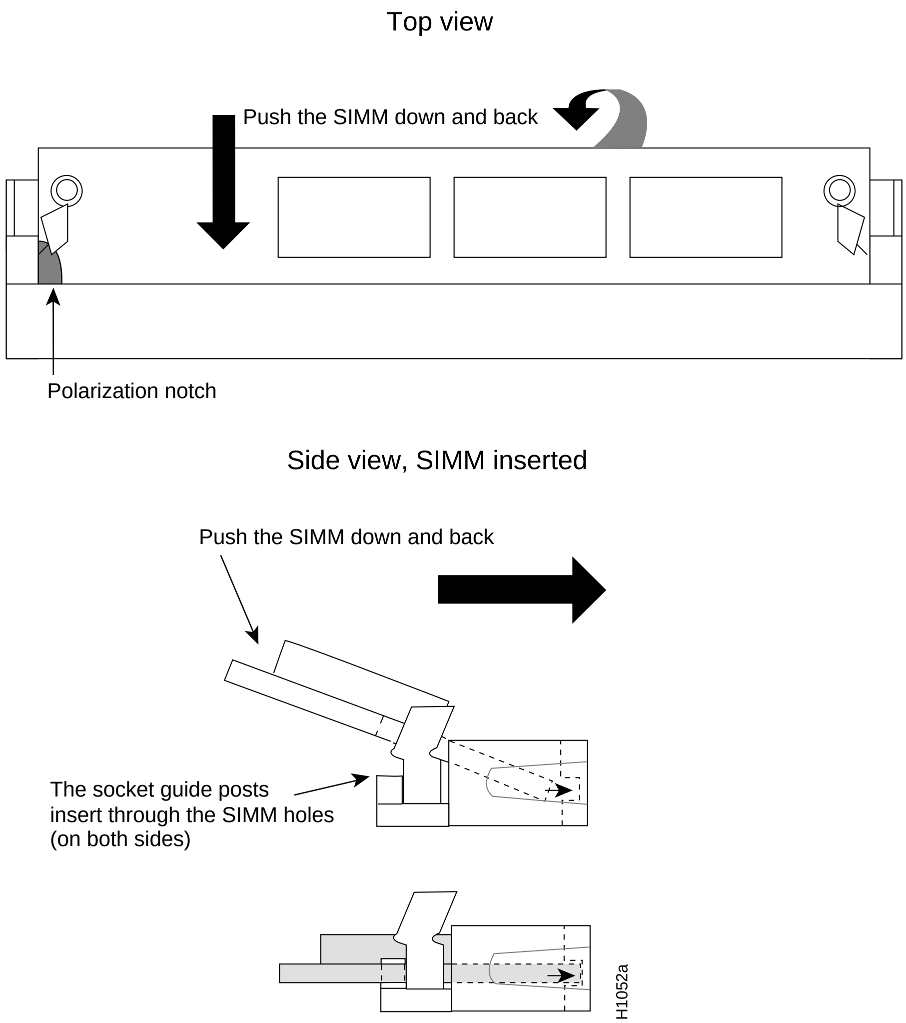
Step 3 Remove the chassis cover as described in the section "Accessing the Internal Components of the Router" in the chapter "Configuring the Cisco 4000 Series Chassis."

Step 4 Find the shared-memory SIMM card socket locations on the left of the motherboard (as aligned in Figure C-1 and Figure C-2). All the sockets should be empty. If not, remove the shared-memory SIMMs following the procedures in the previous section "Removing Shared-Memory SIMMs."

Step 5 Turn the chassis so that the side with the shared-memory SIMM cards is closest to you.

Step 6 Hold the SIMM with the connector edge at the bottom, with the component side facing you, and the polarization notch on the left. (See Figure C-6.)

Figure C-6 Inserting Shared-Memory SIMMs



Caution Handle SIMMs by the card edges only. SIMMs are sensitive components and can be shorted by mishandling.

Step 7 To insert a SIMM, angle it into position, then carefully push down and back on the edges, holding each edge so that it securely snaps into place. (See Figure C-6.) When it snaps into place, the two metal holders clip over the edge of the SIMM, and it sits horizontally.

Caution Avoid damage to the SIMMs and SIMM socket by handling them gently. The SIMMs are also sensitive to ESD damage.

Step 8 Check that the SIMM is straight and that the holes are aligned with the socket guide posts on the socket. (See Figure C-6.)

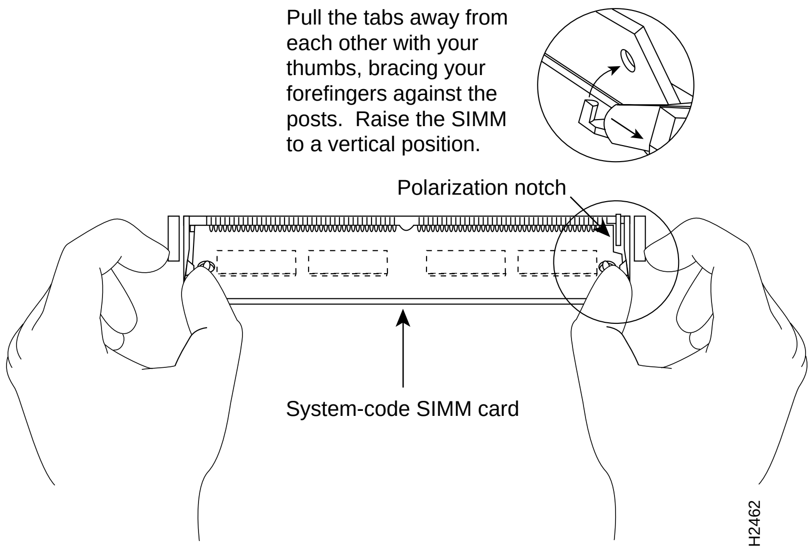
If you are done with all SIMM replacement procedures, proceed to the section "Replacing Network Processor Modules" in the chapter "Configuring the Cisco 4000 Series Chassis."

Replacing the Cisco 4500-M and Cisco 4700-M Boot Helper Flash Memory SIMM

The boot helper image (Rxboot image) is stored in Flash memory on the Cisco 4500-M and Cisco 4700-M. (See Figure C-7.)

You upgrade boot helper Flash memory by replacing the existing SIMM (labeled SYSTEM FLASH MEMORY 0), or by adding a second SIMM to the empty socket (labeled SYSTEM FLASH MEMORY 1).

Figure C-7 Removing the Boot Helper Flash Memory SIMM



Removing the Cisco 4500-M and Cisco 4700-M Boot Helper Flash Memory SIMM

Take the following steps to remove the boot helper Flash memory SIMM in a Cisco 4500-M or Cisco 4700-M:

Step 1 Put on an ESD-preventive wrist strap and ensure that it makes good contact with your skin. Connect the equipment end of the wrist strap to the metal back plate of the chassis, avoiding contact with the connectors.

Step 2 Locate the SIMM card socket labeled RxBoot Flash memory on the lower right corner of the Cisco 4500-M and Cisco 4700-M motherboard. (See Figure C-2.)

Caution Handle SIMMs by the card edges only. SIMMs are ESD-sensitive components and can be damaged by mishandling.

Step 3 Pull the locking spring clips on both sides outward and tilt the SIMM free of the clips to lift the SIMM out of its socket. (See Figure C-7.)

Proceed to the next section, "Installing Flash-Memory SIMMs."

Installing Flash-Memory SIMMs

Take the following steps to add Flash memory SIMMs:

Step 1 On the motherboard, locate the Flash-memory SIMM sockets shown in Figure C-1 and Figure C-2.

Caution Handle SIMMs by the edges only. SIMMs are ESD-sensitive components and can be damaged by mishandling.

Step 2 Hold the SIMM with the polarization notch on the right and the component side away from you with the connector edge at the bottom.

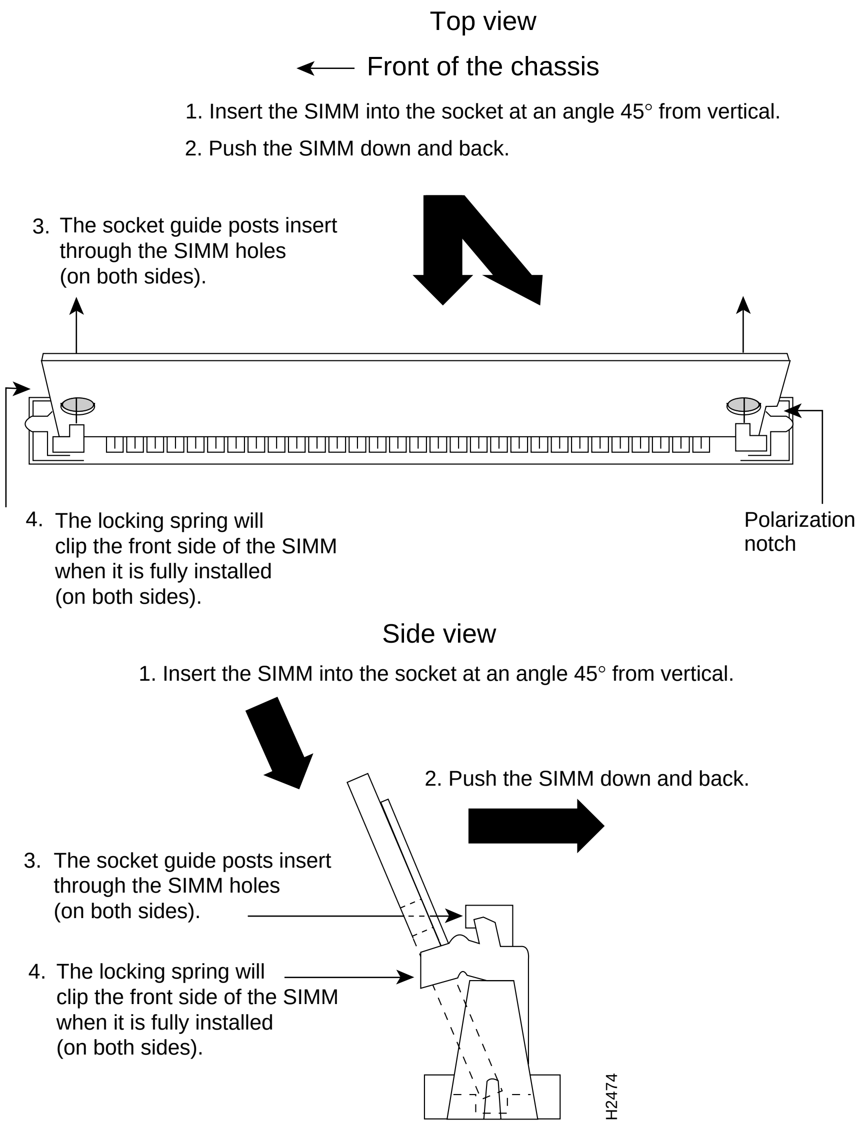
Step 3 Referring to Figure C-8, insert the Flash-memory SIMM at a 45-degree angle and rock it into its vertical position. (See Figure C-1 and Figure C-2.) When the SIMM is properly seated, the socket guide posts will insert through the alignment holes, and the locking springs will click into place. Use the minimum amount of force required.

Caution You will feel some resistance, *but do not use excessive force on the SIMM and do not touch the surface components to avoid damaging them.*

Step 4 Check the alignment of each SIMM to make sure that it is straight and that the alignment holes are lined up with the plastic socket guides.

If you have completed all memory upgrade procedures, proceed to the section "Replacing Network Processor Modules" in the chapter "Configuring the Cisco 4000 Series Chassis."

Figure C-8 Inserting Flash-Memory SIMMs



Replacing Boot ROMs in the Cisco 4000-M

To upgrade the boot read-only memory (ROM) software to a new software image, the existing boot ROMs must be replaced.

Take the following steps to replace boot ROMs in a Cisco 4000-M.

Step 1 Remove the chassis cover and expose the boot ROMs following the procedures in the section “Accessing the Internal Components of the Router” in the chapter “Configuring the Cisco 4000 Series Chassis.”

Step 2 After the boot ROMs labeled FW1 and FW2 on the system card are exposed (see Figure C-1), follow the procedures in this section to replace the boot ROMs.

Note It is not necessary to remove the Flash EPROM card for this upgrade procedure.

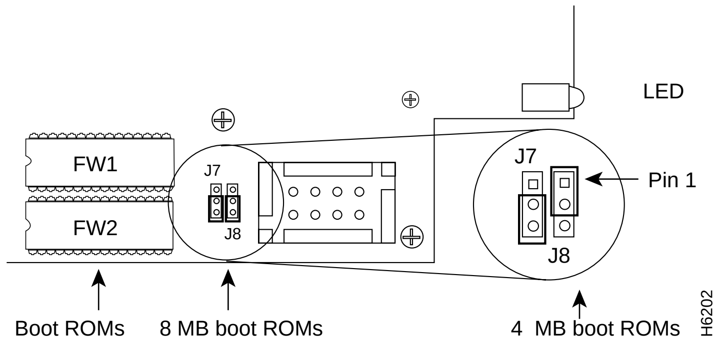
Caution The correct placement of the boot ROMs is crucial. If improperly positioned, the new components could be damaged when the system is powered on. Read all of the instructions before proceeding. To prevent damage to the ROMs from ESD (when handling the system and its components), follow the ESD procedures described earlier. Also, be careful not to damage or scratch the printed circuit card under the ROMs.

Step 3 Locate the boot ROMs, FW1 and FW2, on the motherboard. (See Figure C-9.)

Step 4 Gently extract the old ROMs with an ROM extraction tool or a small flat-blade screwdriver, and set the old boot ROMs aside.

Step 5 Insert the new boot ROMs in their respective sockets in the orientation shown in Figure C-9, 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.

Figure C-9 Boot ROM Locations



Step 6 Jumpers J7 and J8 must be set to designate the capacity of the Boot ROMs. For the 8 MB boot ROMs used in Cisco IOS Release 10.2(8) and higher, short pins 2 and 3 on jumper J7 and on jumper J8. (See Figure C-9.) For the 4 MB boot ROMs used in Cisco IOS releases prior to version 10.2(8), short pins 2 and 3 on jumper J7 and pins 1 and 2 on jumper J8. (See Figure C-9.)

If you have completed all memory upgrade procedures, proceed to the section “Replacing Network Processor Modules” in the chapter “Configuring the Cisco 4000 Series Chassis.”

Testing Your Boot ROM Installation

Test your installing by rebooting the system. When you power up a system in which one or more of the boot ROMs was incorrectly inserted, the system will not boot into the ROM monitor or the operating system mode.

If you suspect that your boot ROMs were inserted incorrectly, reopen the chassis, locate the affected boot ROM and remove it, straighten its pins, reinsert the boot ROM, and try booting the system again.

Caution The notch on the ROM must match the notch on the socket on the card. Installing the components backward will damage them.

APPENDIX D

Cisco 4000 Series Virtual Configuration Register

This appendix describes the Cisco 4000 series virtual configuration register, the factory-default settings, and the procedures for changing those settings.

Virtual Configuration Register Settings

The Cisco 4000 series has a 16-bit virtual register, which is written into the nonvolatile random access memory (NVRAM). Use the processor configuration register information contained in this appendix to do the following:

- Set and display the configuration register value
- Force the system into the bootstrap program
- Select a boot source and default boot filename
- Enable or disable the Break function
- Control broadcast addresses
- Set the console terminal baud rate
- Load operating software from ROM
- Enable booting from a Trivial File Transfer Protocol (TFTP) server

Table D-1 lists the meaning of each of the virtual configuration memory bits.

Table D-1 Virtual Configuration Bit Meanings

Bit No.	Hex	Meaning
00–03	0x0000–0x000F	Boot field (see Table D-2)
06	0x0040	Causes system software to ignore nonvolatile memory contents
07	0x0080	OEM bit enabled
08	0x0100	Break disabled
10	0x0400	IP broadcast with all zeros
11–12	0x0800–0x1000	Console line speed
13	0x2000	Boots default ROM software if network boot fails
14	0x4000	IP broadcasts do not have net numbers
15	0x8000	Enables diagnostic messages and ignores NVRAM contents

Changing Configuration Register Settings

Some common reasons to modify the value of the virtual configuration register follow:

- Recover a lost password
- Change the console baud rate
- Enable or disable the Break function
- Manually boot the operating system using the **b** command at the ROM monitor prompt
- Force the router to boot automatically its system image in Flash memory, or boot as per any **boot system** commands that are stored in its configuration file in NVRAM

Note If the router finds no **boot system** commands, it uses the configuration register value to form a filename from which to boot a default system image stored on a network server. (See Table D-3.)

Take the following steps to change the configuration register while running the Cisco IOS software:

Step 1 Enter the **enable** command and your password to enter the privileged level, as follows:

```
router> enable
Password:
router#
```

Step 2 At the privileged-level system prompt (router #), enter the command **configure terminal.** You will be prompted as shown in the following example:

```
router# configure term
Enter configuration commands, one per line.
Edit with DELETE, CTRL/W, and CTRL/U; end with CTRL/Z
```

Step 3 To set the contents of the configuration register, enter the **config-register** *value* configuration command where *value* is a hexadecimal number preceded by 0x (see Table D-3), as in the following:

```
config-register 0xvalue
```

(The virtual configuration register is stored in nonvolatile memory.)

Step 4 Press **CTRL-Z** to exit the configuration mode. The new value settings will be saved to memory; however, the new settings do not take effect until the system software is reloaded by rebooting the router.

Step 5 Enter the **show version** EXEC command to display the configuration register value currently in effect and the value that will be used at the next reload. The value will be displayed on the last line of the screen display as in the following example:

```
Configuration register is 0x142 (will be 0x102 at next reload)
```

Step 6 Reboot the router. The new value takes effect. Configuration register changes take effect only when the server restarts, for example, when you switch the power OFF and ON or when you issue a **reload** command from the console.

Configuring the Boot Field

The lowest four bits of the processor configuration register (bits 3, 2, 1, and 0) form the boot field. (See Table D-2.)

Table D-2 Explanation of Boot Field (Configuration Register Bits 00–03)

Boot Field	Meaning
00	Stays at the system bootstrap prompt (ROM monitor) on a reload or power cycle
01	Boots the boot helper image as a system image
02-F	Specifies a default netboot filename Enables default booting from system Flash memory Enables boot system commands that override the default netboot filename[1]

1. Values of the boot field are 2–15 in the form cisco<*n*>*-processor_name*, where $2 \leq n \leq 15$.

The boot field specifies a number in binary. If you set the boot field value to 0, you must have console port access to boot the operating system manually. Boot the operating system manually by entering the **b** command at the bootstrap prompt as follows:

> b [tftp] flash *filename*

Definitions of the various command options follow:

b—Boots the default system software from ROM

b flash—Boots the first file in Flash memory

b *filename [host]*—Boots over the network using TFTP

b flash *[filename]*—Boots the file (*filename*) from Flash memory

For more information about the **b** [**tftp**] **flash** *filename* command, see the appropriate Cisco IOS software publications.

If you set the boot field value to a value of 2 through F, and there is a valid system boot command stored in the configuration file, the router boots the system software as directed by that value. (See Table D-3.) If you set the boot field to any other bit pattern, the router uses the resulting number to form a default boot filename for booting from a network (TFTP) server.

If there are no boot commands in the configuration file, the router attempts to boot the first file in system Flash memory. If no file is found in system Flash memory, the router attempts to netboot a default file whose name is derived from the value of the boot field (for example: cisco2-4500). If the attempt to boot from a network (TFTP) server fails, the boot helper image in boot Flash will boot up.

If boot commands are in the configuration file, the router software processes each boot command in sequence until the process is successful or the end of the list is reached. If the end of the list is reached without a file being successfully booted, the router will retry the netboot commands up to six times unless the boot default ROM software if netboot fails bit (bit 13 of the virtual configuration register) is set. If bit 13 is set, the system boots the boot helper image found in boot Flash memory without any retries.

In the following example, the virtual configuration register is set to boot the router automatically from Flash memory and to ignore Break at the next reboot of the router:

```
router# configure terminal
Enter configuration commands, one per line.
Edit with DELETE, CTRL/W, and CTRL/U; end with CTRL/Z
config-register 0x102
Ctrl-Z
router#
```

The server creates a default boot filename as part of the automatic configuration processes. To form the boot filename, the server starts with *cisco* and links the octal equivalent of the boot field number, a dash, and the processor-type name. Table D-3 lists the default boot filenames or actions for the processor.

Note A **boot system** configuration command in the router configuration in NVRAM overrides the default netboot filename.

Table D-3 Default Boot Filenames

Action/File Name	Bit 3	Bit 2	Bit 1	Bit 0
bootstrap mode	0	0	0	0
ROM software	0	0	0	1
cisco2-4000 or cisco2-4500	0	0	1	0
cisco3-4000 or cisco3-4500	0	0	1	1
cisco4-4000 or cisco4-4500	0	1	0	0
cisco5-4000 or cisco5-4500	0	1	0	1
cisco6-4000 or cisco6-4500	0	1	1	0
cisco7-4000 or cisco7-4500	0	1	1	1
cisco10-4000 or cisco10-4500	1	0	0	0
cisco11-4000 or cisco11-4500	1	0	0	1
cisco12-4000 or cisco12-4500	1	0	1	0
cisco13-4000 or cisco13-4500	1	0	1	1
cisco14-4000 or cisco14-4500	1	1	0	0
cisco15-4000 or cisco15-4500	1	1	0	1
cisco16-4000 or cisco16-4500	1	1	1	0
cisco17-4000 or cisco17-4500	1	1	1	1

Bit 8 controls the console Break key. Setting bit 8 (the factory default) causes the processor to ignore the console Break key. Clearing bit 8 causes the processor to interpret Break as a command to force the system into the bootstrap monitor, halting normal operation. A Break can be sent in the first 60 seconds while the system reboots, regardless of the configuration settings.

Bit 10 controls the host portion of the Internet broadcast address. Setting bit 10 causes the processor to use all zeros; clearing bit 10 (the factory default) causes the processor to use all ones. Bit 10 interacts with bit 14, which controls the network and subnet portions of the broadcast address. Table D-4 shows the combined effect of bits 10 and 14.

Table D-4 Configuration Register Settings for Broadcast Address Destination

Bit 14	Bit 10	Address (<net> <host>)
Off	Off	<ones> <ones>
Off	On	<zeros> <zeros>
On	On	<net> <zeros>
On	Off	<net> <ones>

Bit 13 determines the server response to a bootload failure. Setting bit 13 causes the server to load operating software from ROM after five unsuccessful attempts to load a boot file from the network. Clearing bit 13 causes the server to continue indefinitely to attempt loading a boot file from the network. By factory default, bit 13 is cleared to 0.

Bits 11 and 12 in the configuration register determine the baud rate of the console terminal. Table D-5 shows the bit settings for the four available baud rates. (The factory-default baud rate is 9600.)

Table D-5 System Console Terminal Baud Rate Settings

Baud	Bit 12	Bit 11
9600	0	0
4800	0	1
1200	1	0
2400	1	1

Enabling Booting from Flash Memory

To enable booting from Flash memory, set bits 3, 2, 1, and 0 to a value between 2 through 15. To specify a filename to boot, enter the system software configuration **boot system flash** *filename* command in the configuration file.

To enter the configuration mode while in the system software image, enter the **configure** command at the enable prompt as follows:

```
Gateway# configure
Configuring from terminal, memory, or network [terminal]? term
Enter configuration commands, one per line.
Edit with DELETE, CTRL/W, and CTRL/U; end with CTRL/Z
boot system flash filename
```

To disable Break and enable the **boot system flash** command, enter the **config-register** command with a value as follows:

```
config-reg 0x102
CTRL/Z
```

If you set the configuration register value to 0x102, as in the example, it is not necessary to enter the **boot system flash** command unless there is more than one image in Flash memory.

APPENDIX E

Cisco 4000-M ROM Monitor

This appendix describes the Cisco 4000-M ROM monitor, which is also known as the bootstrap program. The ROM monitor can help you isolate or rule out hardware problems encountered when installing your router. A summary of the ROM monitor diagnostic tests and command options is provided.

Entering the Cisco 4000-M ROM Monitor Program

The ROM monitor diagnostics help initialize the processor hardware and boot the main operating system software. If you set the software configuration register (bits 3, 2, 1, and 0) to zero, you can start the server in the standalone ROM monitor. The ROM monitor prompt is an angle bracket (>).

Enter the following command at the ROM monitor prompt (>) to enable the Break key and to default to booting in the ROM monitor:

```
o/r 0x0
```

See Table E-1 for an explanation of the **o/r** command.

While running the system software, you can reset the configuration register to 0x0 by entering configuration mode, and then entering the following configuration command:

```
config-register 0x0
```

The new configuration register value, 0x0, takes effect after the router is rebooted. If you set the configuration to 0x0, you must manually boot the system each time you reboot the router.

Timesaver Break (system interrupt) is always enabled for 60 seconds after rebooting the system, regardless of whether Break is configured to be off by setting the configuration register. During the 60-second window, you can use Break to get to the ROM monitor prompt.

Available ROM Monitor Commands

At the ROM monitor prompt, enter a question mark (**?**) at the > prompt to display a list of available commands and options, as follows:

```
?
$       Toggle cache state
B [filename] [TFTP Server IP address | TFTP Server Name]
             Load and execute system image from ROM or from TFTP server
C [address]  Continue [optional address]
D /S M L V   Deposit value V of size S into location L with modifier M
E /S M L     Examine location L with size S with modifier M
G [address]  Begin execution
H            Help for commands
I            Initialize
K            Displays Stack trace
L [filename] [TFTP Server IP address | TFTP Server Name]
             Load system image from ROM or from TFTP server, but do not
             begin execution
O            Show software configuration register option settings
P            Set break point
S            Single step next instruction
T function   Test device (? for help)
Deposit and Examine sizes may be B (byte), L (long) or S (short).
Modifiers may be R (register) or S (byte swap).
Register names are: D0-D7, A0-A7, SS, US, SR, and PC.
```

The following Cisco 4000-M ROM monitor commands are among the most useful:

- Boot—The **b** command with no argument reboots the system and boots the default software from ROM as defined by the lower four bits of the configuration register, which form the boot field. You can include an argument, filename, to specify a file to be booted over the network using the TFTP. You can also include a second argument, host, which is the Internet address or name of a particular server host. You must enter **i** and press **Return** before entering **b**. The various forms of the **b** command follow:

b—Boots the default system software from ROM.

b *filename [host]*—Boots from a network server (netboots) using TFTP.

b flash—Boots the first file in Flash memory

b flash *[filename]*—Boots the file (*filename*) from Flash memory

To prevent the router from automatically booting over the network, enter the **o/r 0x0** command as follows:

```
> o/r 0x0
```

- Continue—The **c** command allows you to exit the ROM monitor without rebooting the router after you press the **Break** key while running the system software image.
- Help—The **h** command prints a summary of the ROM monitor commands to the console screen.This is the same output as entering **?**.
- Initialize—The **i** command causes the ROM monitor to reinitialize the hardware, clear the contents of memory, and boot the system if so directed by the boot field in the virtual configuration register. (It is best to use the **i** command before running any tests or booting software.)
- Display Stack Trace—The **k** command displays a stack trace of the last running system software. This will be useful as a diagnostic reading if a problem occurs, such as an unexpected system crash.
- Display/Reset Virtual Configuration Register—The **o** command displays the virtual configuration register. The **o** command used with the **/r** option will reset the configuration register to the default and cause the system software image to ignore the configuration register information (sets the ignore NVRAM contents bit, 0x0040). To reset to the default, enter the following at the > prompt:

```
o/r
```

Enter the **i** command after entering the **o/r** command to automatically reboot the router.

Table E-1 lists additional **o** command options.

Table E-1 o Command Options

Monitor Command	Function
o	Displays the virtual configuration register currently in effect, with a description of the bits
o/r	Resets the virtual configuration register to the defaults as follows: 9600-baud console UART[1] speed Break/abort has no effect Ignore the system configuration Boot from ROM
o/r *0xvalue*	Sets the virtual configuration register to the (hex) value, *value*

1. UART= Universal Asynchronous Receiver/Transmitter.

Note To enable the router to read the configuration file in nonvolatile RAM, clear the ignore NVRAM contents bit (0x0040) with the **config-register** command after using the **o/r** command.

- Memory/Bus Diagnostic—The **t m** command runs the memory test. By default, the memory test examines processor main memory.

Caution Save the configuration in a file on a host in your network as a backup before testing because the file could be lost.

To test memory, enter the **t** command with the **m** option at the > prompt, as follows:

```
> t m
```

To use the default addresses and select the default tests, press **Return** after each prompt appears.

The time to run a diagnostic is memory-size dependent. It will take a minimum of ten minutes. If the program encounters memory problems, it will display appropriate error messages on the console terminal. Be sure to reinitialize the processor before booting the system by entering **i** at the ROM monitor prompt.

Running the Diagnostics

Take the following steps to run the ROM monitor diagnostics:

Step 1 Turn OFF the unit.

Step 2 Restart the router.

Step 3 Within 60 seconds, press the **Break** key on the console terminal to force the server into the ROM monitor. Wait for the server to print the two-line banner message and for the (>) prompt to appear.

APPENDIX F

Cisco 4500-M and Cisco 4700-M ROM Monitor

This appendix describes the Cisco 4500-M and Cisco 4700-M ROM monitor, the first software to run when the router is powered up or reset. The Cisco 4500-M and Cisco 4700-M ROM monitor supports more features than the familiar Cisco 4000-M ROM monitor. The ROM Monitor can help you isolate or rule out hardware problems encountered when installing your router. A summary of the ROM monitor diagnostic tests and command options is provided.

Entering the ROM Monitor Program

The ROM monitor diagnostics help initialize the processor hardware and boot the main operating system software. If you set the software configuration register (bits 3, 2, 1, and 0) to zero, you can start the router in the standalone ROM monitor. An example of the Cisco 4500-M and Cisco 4700-M ROM monitor prompt follows:

```
rommon 1 >
```

To enable Break and to default to booting at the ROM monitor while running the system software, reset the configuration register to 0x0 by entering configuration mode, then enter the following configuration command:

```
config-reg 0x0
```

The new configuration register value, 0x0, takes effect after the router is rebooted when you enter the **reload** command. If you set the configuration to 0x0, you will have to manually boot the system from the console each time you reload the router.

Timesaver Break (system interrupt) is always enabled for 60 seconds after rebooting the system, regardless of whether Break is configured to be off by setting the configuration register. During the 60-second window, you can use Break to get to the ROM monitor prompt.

Available ROM Monitor Commands

At the ROM monitor prompt, enter **?** or **help** at the **rommon 1 >** prompt to display a list of available commands and options, as follows:

```
rommon 1 > ?
help                monitor builtin command help
boot                boot up an external process
dir                 list files in file system
dev                 list the device table
confreg             configuration register utility
reset               system reset
stack               produce a stack trace
context             display the context of a loaded image
frame               print out a selected stack frame
sysret              print out info from last system return
meminfo             main memory information
rommon 2 >
```

Note Further information about a command can be displayed by entering the command name with a **-?** option, which will cause the command usage message to be printed.

ROM Monitor Command Conventions

Following are ROM monitor command conventions:

- Brackets [ ] denote an optional field. If a minus option is followed by a colon (for example: [-s:]) the user must provide an argument for the option.
- A word in italics means that the user must fill in the appropriate information.
- All of the built-in commands can be aborted (user interrupt signal) by pressing the Break key at the console.

The following case-sensitive ROM monitor commands are among the most useful:

- **help**—The **help** command prints a summary of the ROM monitor commands to the console screen.This is the same output as entering **?**.
- **boot** or **b**—Boot an image. The **boot** command with no arguments will boot the first image in boot Flash memory. You can include an argument, *filename*, to specify a file to be booted over the network using the Trivial File Transfer Protocol (TFTP). The local device (see the description of the **b** *device* command following) can be specified by entering the device specifier (*devid*). If the specified device name is not recognized by the ROM monitor, the system will attempt to boot the image (*imagename*) from a network TFTP server. Do not insert a space between *devid* and *imagename*. Options to the boot command are **-x**, load image but do not execute, and **-v**, verbose. The form of the **boot** command follows:

  boot [-xv] [*devid*][*imagename*]

  b—Boots the default system software from ROM.

  b *filename [host]*—Boots using a network TFTP server. When a host is specified, either by name or IP address, the **boot** command will boot from that source.

  b flash:—Boots the first file in Flash memory.

  b *device:*—Boots the first file found in the Flash device. The Flash device specified can be either *flash*:, to boot the Cisco Internetwork Operating System (Cisco IOS) software, or *bootflash*:, to boot the boot image in Flash memory.

  b *device:name*—An extension of the above command, allows you to specify a particular filename in the flash memory.
- **reset** or **i**—Resets and initializes the system, similar to power on.
- **dev**—Lists boot device identifications on the router.

  For example:

```
rommon 10 > dev
Devices in device table:
        id  name
    flash:  flash
bootflash:  boot flash
    eprom:  eprom
```

- **dir**—Lists the files on the named device, **dir** *device*, where the device is flash or bootflash; lists the available files on that device.

  For example:

```
rommon 11 > dir flash:
         File size           Checksum   File name
       2229799 bytes (0x220627)   0x469e    C4500-k
```

Debugging Commands

Most of the debugging commands are functional only when the Cisco IOS software has crashed or is aborted. If you enter the debug commands and Cisco IOS crash information is not available, the screen will display the following error message:

```
“xxx: kernel context state is invalid, can not proceed."
```

- **stack** or **k**—Produces a stack trace.
- **context—**Displays the processor context.
- **frame**—Displays an individual stack frame.
- **sysret**—Displays the return information from the last booted system image. This includes the reason for terminating the image, a stack dump of up to eight frames, and if an exception is involved, the address where the exception occurred.

  For example:

```
rommon 8 > sysret
System Return Info:
count: 19,  reason: user break
pc:0x60043754,  error address: 0x0
Stack Trace:
FP: 0x80007e78, PC: 0x60043754
FP: 0x80007ed8, PC: 0x6001540c
FP: 0x80007ef8, PC: 0x600087f0
FP: 0x80007f18, PC: 0x80008734
```

- **meminfo**—Displays the size in bytes, the starting address, the available range of the main memory, the starting point and size of packet memory, and the size of nonvolatile random-access memory (NVRAM).

```
rommon 9 > meminfo

Main memory size: 8 MB. Packet memory size: 4 MB
Available main memory starts at 0xa000e001, size 0x7f1fff
Packet memory starts at 0xa8000000
NVRAM size: 0x20000
```

Configuration Register

The configuration register resides in NVRAM. The configuration register is identical in operation to other Cisco routers. Enter the **confreg** command for the menu-driven system, or enter the new value of the register in hexadecimal.

Note The value is always interpreted as hex. The **confreg** command will print a before and after view of the configuration register when used in menu-driven mode.

- **confreg** [*hexnum*]—Executing the **confreg** command with the argument *hexnum* will change the virtual configuration register to match the hex number specified. Without the argument, **confreg** will dump the contents of the virtual configuration register in English and allow the user to alter the contents. The user is prompted to change or keep the information held in each bit of the virtual configuration register. In either case the new virtual configuration register value is written into NVRAM and does not take effect until the user resets or power cycles the platform.

  For example:

```
rommon 7 > confreg

     Configuration Summary
enabled are:
console baud: 9600
boot: the ROM Monitor
```

```
do you wish to change the configuration? y/n  [n]:  y
enable  “diagnostic mode”? y/n  [n]:  y
enable  “use net in IP bcast address”? y/n  [n]:
enable  “load rom after netboot fails”? y/n  [n]:
enable  “use all zero broadcast”? y/n  [n]:
enable  “break/abort has effect”? y/n  [n]:
enable  “ignore system config info”? y/n  [n]:
change console baud rate? y/n  [n]:  y
enter rate: 0 = 9600, 1 = 4800, 2 = 1200, 3 = 2400  [0]:  0
change the boot characteristics? y/n  [n]:  y
enter to boot:
 0 = ROM Monitor
 1 = the boot helper image
 2-15 = boot system
    [0]:  0


    Configuration Summary
enabled are:
diagnostic mode
console baud: 9600
boot: the ROM Monitor

do you wish to change the configuration? y/n  [n]:


You must reset or power cycle for new config to take effect
```