Cisco IGX 8400 Series Reference

Release 9.1

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Cisco IGX 8400 Series Reference

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About This Manual

This section discusses the objectives, audience, organization, and conventions of the *Cisco IGX 8400 Series Reference* publication.

Cisco documentation and additional literature are available in a CD-ROM package, which ships with the product. The Documentation CD-ROM is updated monthly. Therefore, it might be more up-to-date than printed documentation. To order additional copies of the Documentation CD-ROM, contact your local sales representative or call customer service. The CD-ROM package is available as a single package or as an annual subscription. You can also access Cisco documentation on the World Wide Web at http://www.cisco.com, http://www-china.cisco.com, or http://www-europe.cisco.com.

Objectives

This publication provides descriptions of the following IGX hardware with introductory information on the operation of each component (when appropriate):

- Enclosures
- Power sources (AC and DC)
- Controller cards (the CPU for the node)
- Frame relay interface cards
- Voice interface cards
- Serial data interface cards
- ATM interface cards
- Trunk cards
- Alarm cards

Audience

The *Cisco IGX 8400 Series Reference* provides installers, operators, and network designers and managers with the necessary understanding to plan for IGX usage in a network. This manual applies to the IGX 8410, IGX 8420, and IGX 8430 in both rack-mount and stand-alone versions.

Organization

The major sections of this publication are as follows:

- Chapter 1, “Introduction to the IGX Switches”
- Chapter 2, “Enclosure and Power Description”
- Chapter 3, “Processor and Trunk Cards”
- Chapter 4, “Line Interface Cards”
- Appendix A, “System Specifications”

Conventions

This publication uses the following conventions to convey instructions and information.

Command descriptions use these conventions:

- Commands and keywords are in **boldface**.
- Arguments for which you supply values are in *italics*.
- Required command arguments are inside angle brackets (< >).
- Optional command arguments are in square brackets ([ ]).
- Alternative keywords are separated by vertical bars (|).

Examples use these conventions:

- Terminal sessions and information the system displays are in `screen` font.
- Information you enter is in **`boldface screen`** font.
- Nonprinting characters, such as passwords, are in angle brackets (< >).
- Default responses to system prompts are 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 action saves time*. You can save time by performing the action described in the paragraph.

Caution Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Warning This warning symbol means *danger*. You are in a situation that could cause bodily injury. Before you work on any equipment, you must be aware of the hazards involved with electrical circuitry and familiar with standard practices for preventing accidents. (To see translated versions of this warning, refer to the *Regulatory Compliance and Safety Information* document that accompanied the product.

Introduction to the IGX Switches

This manual describes the IGX hardware that runs Release 9.1 of the System Software. The descriptions cover both common and unique aspects of the IGX 8410, 8420, and 8430 models. The descriptions consist of hardware specifics and operational parameters at the system level. For a description of how to install and start an IGX switch, refer to the *Cisco IGX 8400 Series Installation* manual.

Features of the IGX Switches

Like other Cisco switches, the IGX node operates in public or private Wide Area Networks (WANs). An IGX node can support OC3, T3, E3, T1, E1, Inverse Multiplexing Over ATM (IMA) for T1 or E1, fractional T1 or E1, or subrate digital transmission facilities. The IGX cell relay technology provides maximum throughput with minimum delays. Cell relay performance characteristics are the heart of efficient digital networks and make the IGX node an ideal choice for a high-performance, multimedia platform. Key features of the IGX switch include:

- A 1 gigabit per second (Gbps) Cellbus for high speed switching and a redundant, .2 Gbps bus for backup.
- Full compatibility with IPX/BPX system software includes.
- Up to 64 circuit lines, 32 trunks, and 3500 connections on the IGX 8420 and IGX 8430.
- IGX configuration and management through StrataView Plus or the same standard user interface used with the IPX/BPX systems.
- High performance switching suitable for a variety of protocols/applications, including Channel Associated Signaling (CAS), Asynchronous Transfer Mode (ATM), Frame Relay, voice, FAX, slow-scan and full-bandwidth video, and synchronous or asynchronous data.
- Six cabinet models, which consist of:
    - An 8-slot standalone unit.
    - An 8-slot rack-mount unit.
    - A 16-slot standalone unit.
    - A 16-slot rack-mount unit.
    - A 32-slot standalone unit.
    - A 32-slot rack-mount unit.
- Redundancy of controller cards, service module cards, system buses, and power supplies to provide hardware reliability.

- Hot-swappable modules to facilitate non-stop operation: service cards, NPMs, AC-power supplies, and fan tray assembly.
- 110/220 VAC and -48 DC power options for use in varied network environments.
- Factory upgrade program for IPX 16/32 feature cards. This upgrade *excludes* IPX 8-specific cards. Upgrades are available for the NTC, AIT, CDP, LDP, SDP, FRP, and FTC cards.

CHAPTER 2

Enclosure and Power Description

This chapter describes the hardware and related functions for each model of the IGX switches. For IGX enclosures, this chapter describes:

- Rack-mount and stand-alone enclosures
- AC and DC power sources
- Cooling system
- Backplane and system bus.

A brief description of optional peripherals and third-party equipment appears at the end of the chapter. For system specifications, such as protocols and standards, refer to the appendix.

For all matters relating to installation, troubleshooting, user-commands, and repair and replacement, refer to the *Cisco IGX 8400 Series Installation* manual.

Other manuals that relate to IGX operation are:

- The *Cisco WAN Switching Command Reference* and *Cisco WAN Switching SuperUser Command Reference* describe standard user commands and superuser commands.
- The *Cisco System Overview* contains general Cisco system and network information.
- The *Cisco StrataView Plus Operations* contains information on Cisco network management.

IGX Cabinets and Components

An IGX system is available in the following models:

- IGX 8410 Stand-alone, an eight-slot unit in a free-standing enclosure
- IGX 8410 Rack-mount, an eight-slot, rack-mountable unit
- IGX 8420 Stand-alone, a 16-slot, single-shelf unit in a free-standing enclosure
- IGX 8420 Rack-mount, a 16-slot, single-shelf, rack-mountable unit
- IGX 8430 Stand-alone, a 32-slot, dual-shelf unit in a free-standing enclosure
- IGX 8430 Rack-mount, a 32-slot, dual-shelf, rack-mountable unit

IGX 8410 Rack-Mount Switch

The standard IGX 8410 enclosure is a standalone. By using the rack-mounting parts that come with the IGX 8410 node, you can mount it in a standard 19” rack. The installation uses standard EIA spacing between vertical rails. Also, the vertical spacing between components, such as the card cage and fan tray, must be in the range 0.047”–0.077” (0.119 cm to 0.196 cm). The IGX 8410 rack-mount cabinet contains:

- A backplane with all purchased cards in place
- A fan tray with four fans
- An exhaust plenum
- Power connections
- An optional AC Power Tray that holds up to four power supplies

Figure 2-1 and Figure 2-2 show the rack-mount IGX 8410 in front and back views, respectively.

Figure 2-1 IGX 8410 Rack-Mount Switch, Front View

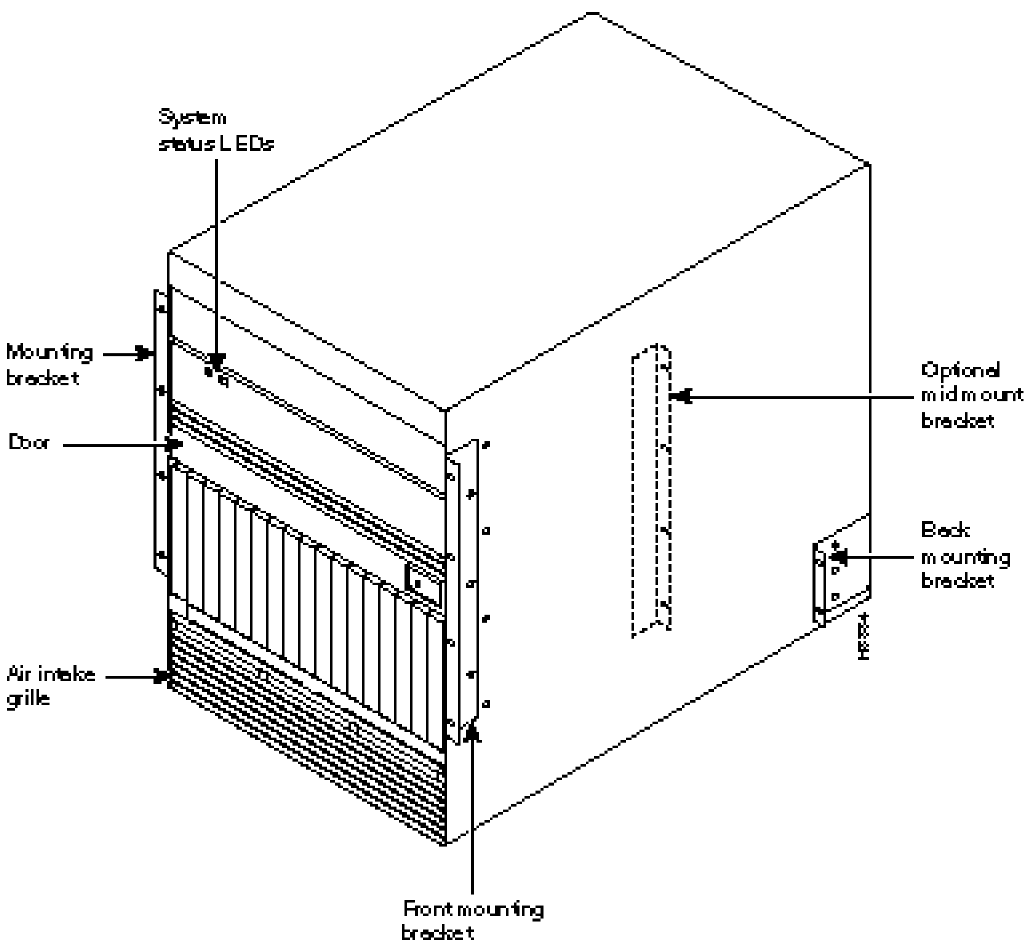
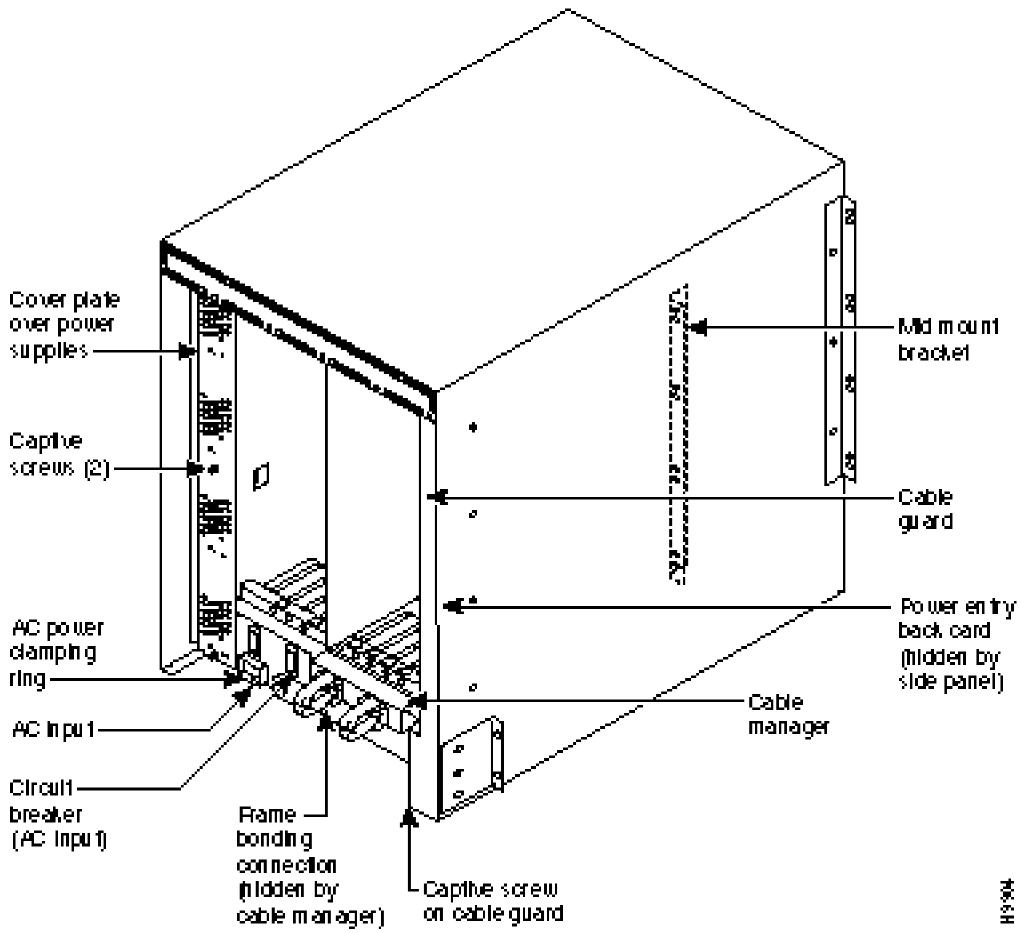


Figure 2-2 AC-Powered IGX 8410 Rack-Mount, Back View

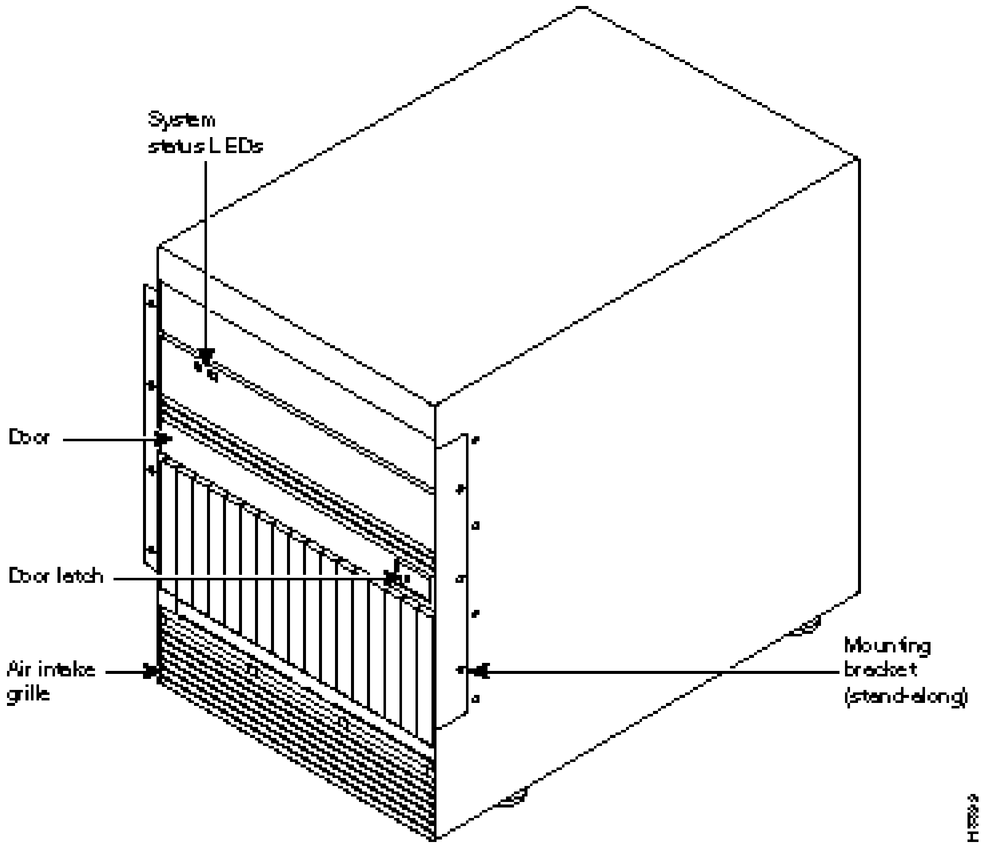


IGX 8410 Standalone Switch

The IGX 8410 standalone system comes in a free-standing enclosure with a tool-operated front door latch. Four plastic feet support the IGX 8410 standalone at its base.

The stand-alone enclosure holds all of the system modules, power modules, power supplies, and cooling fans. The IGX 8410 cabinet contains one eight-slot card cage with a backplane into which front cards plug, three auxiliary slots, a fan tray with four fans, an exhaust plenum, a power entry module, and an optional AC Power Tray that holds up to four power supplies. Figure 2-3 is a front view of the IGX 8410 stand-alone switch.

Figure 2-3 Component Locations in IGX 8410 Standalone Switch



IGX 8420 Standalone Switch

The IGX 8420 stand-alone system comes in a free-standing enclosure with a tool-operated front door latch. Side panels attach to the unit on vertical mounting rails at each corner of the unit. The four wheels at the base of the stand-alone unit allow the unit to roll into position. The unit also includes levelers. With the unit at the appropriate location, you can adjust the height of the levelers to make the unit immobile. The wheels and feet are removable, so you can secure the standalone IGX 8420 node to the floor with four .250-20 fasteners.

The IGX 8420 stand-alone enclosure holds all of the system modules, including:

- A backplane into which front cards, the SCM, and the Power Entry Back Card plug
- A fan tray with six fans
- An exhaust plenum
- An optional AC Power Tray that holds the power supplies

Figure 2-4 shows a front view of the position of the major components of the IGX 8420 stand-alone switch. Figure 2-5 shows a view of an AC-powered IGX 8420 switch from the back.

Figure 2-4 Component Locations IGX 8420 Standalone Switch

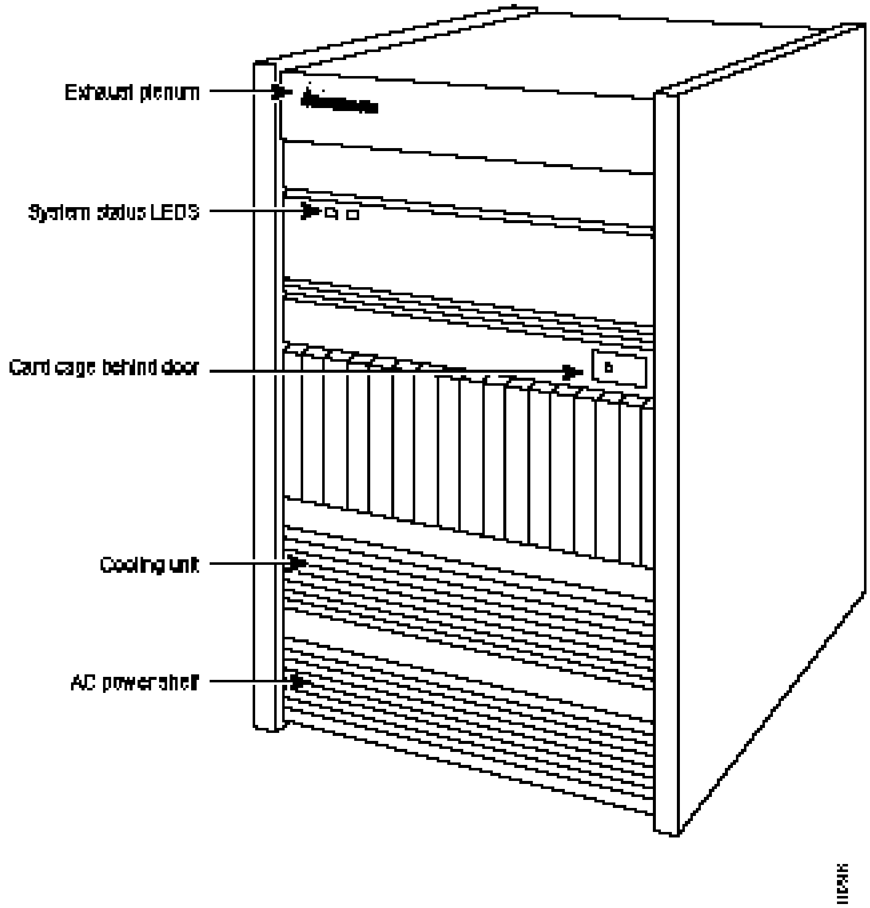
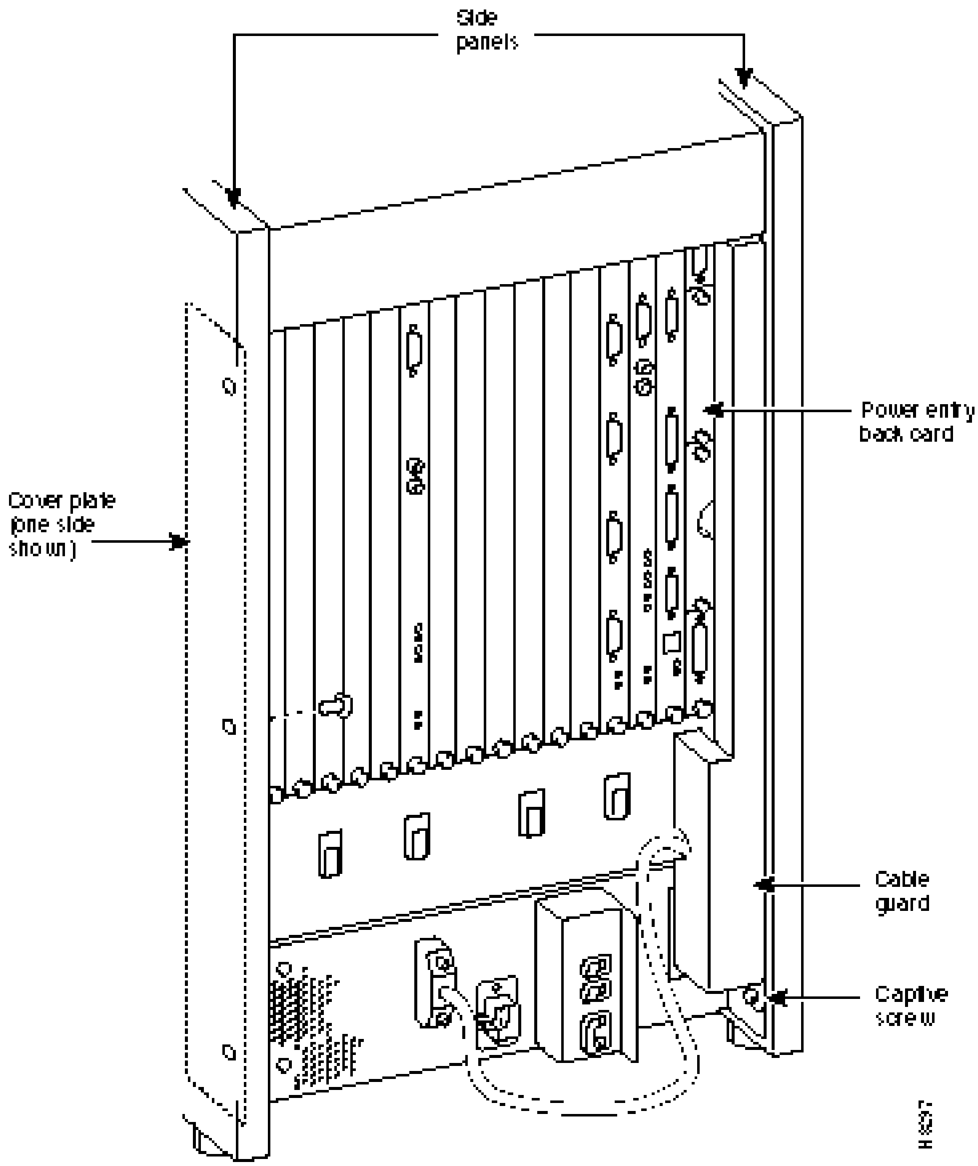


Figure 2-5 AC-Powered IGX 8420 Standalone Switch, Back View



IGX 8430 Standalone Switch

The IGX 8430 stand-alone system has a free-standing enclosure with a tool-operated front door latch. Side panels attach to the unit on vertical mounting rails at each corner of the unit. The four wheels at the base allow the it to roll into position. The unit also includes levelers. With the unit at the appropriate location, you can adjust the height of the levelers to immobilize it. The wheels and feet are removable, so you can secure the standalone node to the floor with four .375-16 fasteners.

The IGX 8430 stand-alone enclosure holds all of the system modules, including:

- Two backplanes, into which plug the front cards, SCM, and Power Entry Back Cards
- A main (lower) fan tray and a booster (upper) fan tray, each with six fans
- An exhaust plenum
- An optional AC Power Tray that holds up to six power supplies

Figure 2-6 shows a front view of the position of the major components of the IGX 8430 standalone node. Figure 2-7 is a view of the back of an AC-powered IGX 8430 switch.

Figure 2-6 IGX 8430 Standalone Switch, Front View

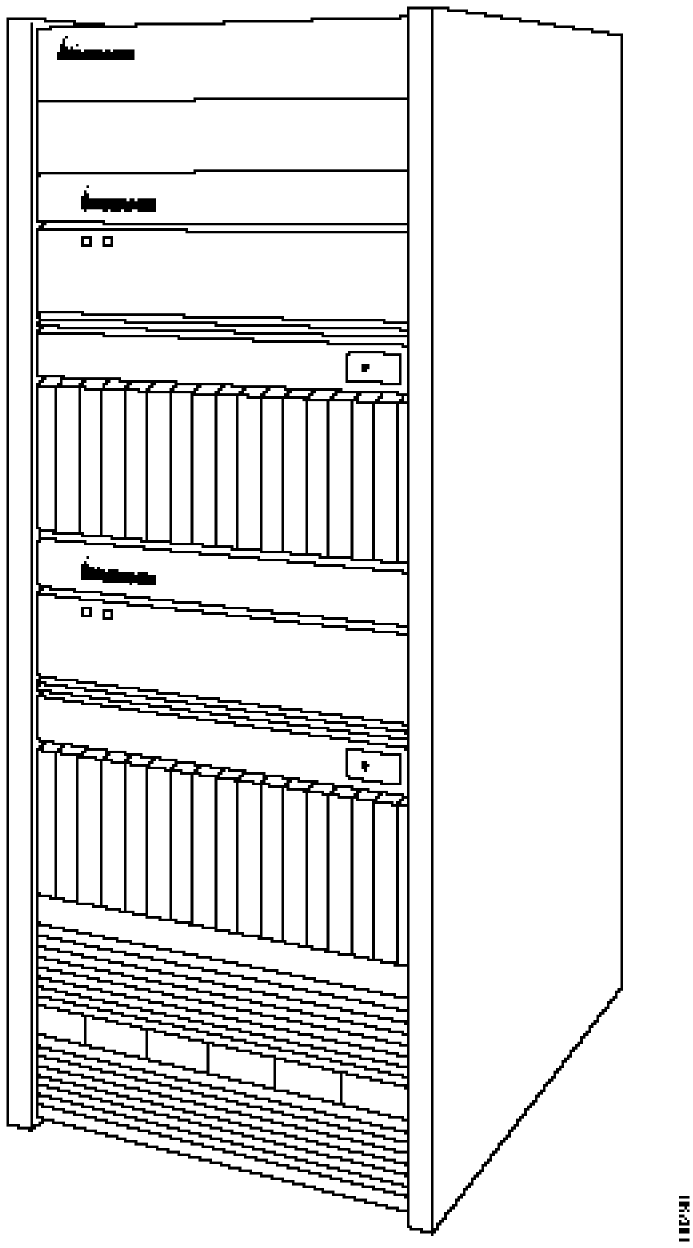
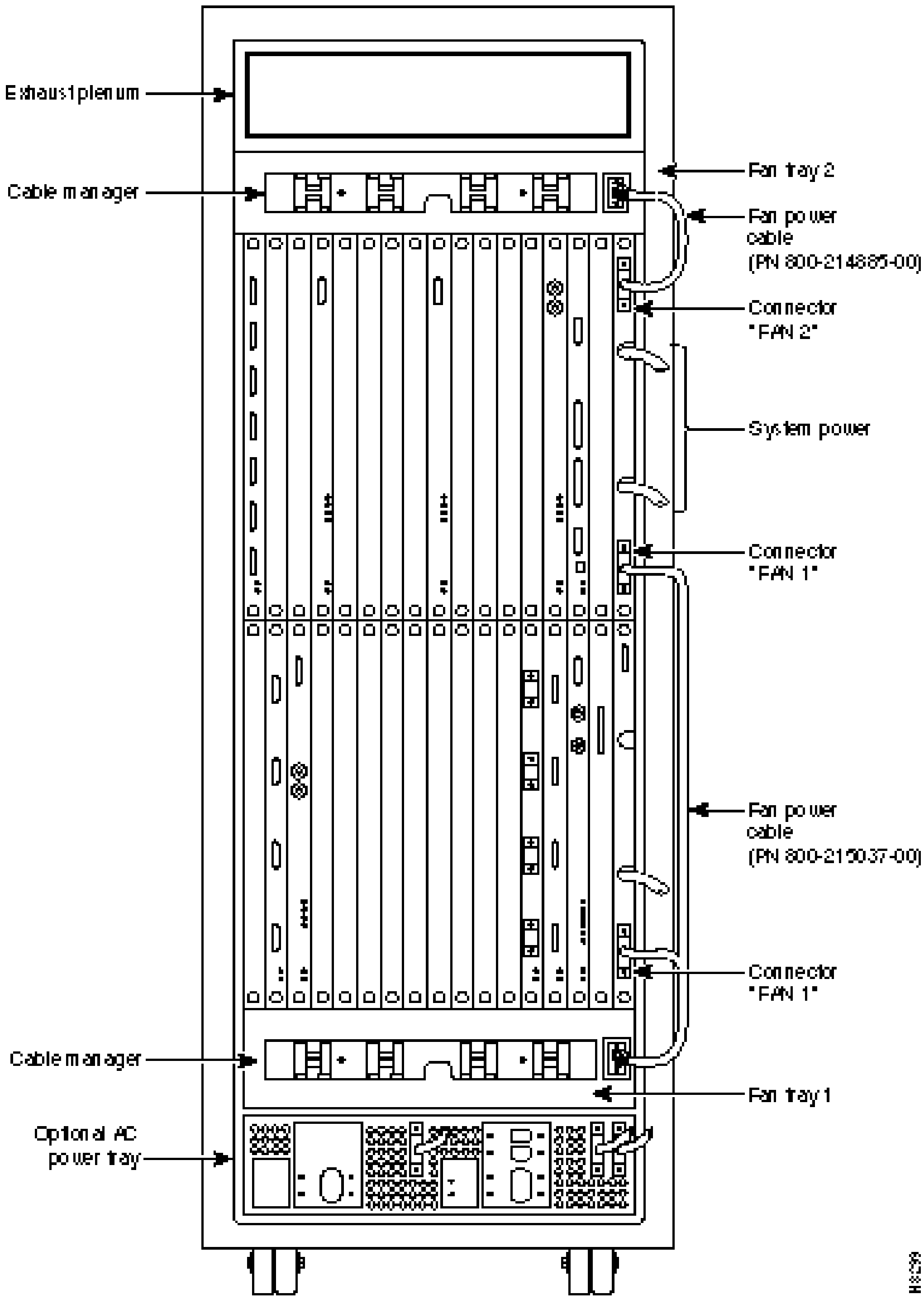


Figure 2-7 IGX 8430 Standalone Switch, Back View



IGX 8420 Rack-Mount Switch

The IGX 8420 rack-mount system components fir in a standard 19-inch rack, such as a Cisco-supplied cabinet. This installation uses standard EIA spacing between vertical rails. Also, the vertical spacing between components, such as the card cage and fan tray, must be in the range .047”–.077” (0.119 cm–0.196 cm).

The IGX 8420 cabinet includes:

- A 16-slot card shelf
- A backplane into which plug the front cards, the SCM, and Power Entry Back Card
- A main (lower) fan tray with six fans
- An exhaust plenum
- Power connections for the shelf
- An optional AC Power Tray

IGX 8430 Rack-Mount Switch

The IGX 8430 rack-mount components can be mounted in a standard 19" rack. This installation uses standard EIA spacing between vertical rails. Also, the vertical spacing between components such as the card cage and fan tray, must be in the range .047”–.077” (0.119 cm–0.196 cm).

The IGX 8430 cabinet includes:

- Two 16-slot card shelves
- Two backplanes, into which plug the front cards, SCM, and Power Entry Back Cards
- A main (lower) fan tray with six fans
- A booster (upper) fan tray
- An exhaust plenum
- Power connections for each shelf
- An optional AC Power Tray that holds up to six power supplies

The two IGX backplanes connect through an interconnect cable. Figure 2-8 and Figure 2-9 show the location of the major components of an IGX 8430 switch.

Figure 2-8 Stacking Order for IGX 8430 Rack-Mount Components, Front

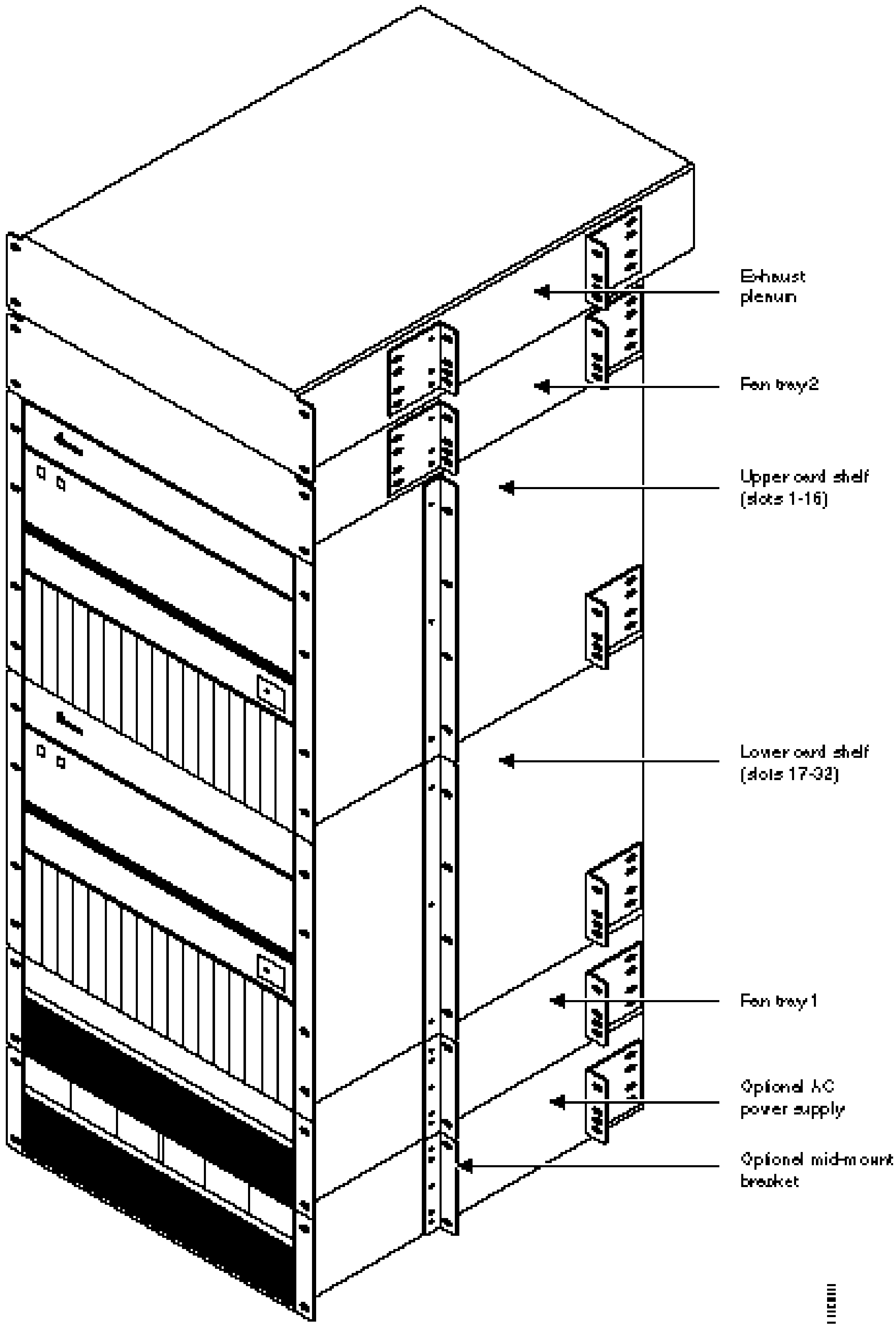
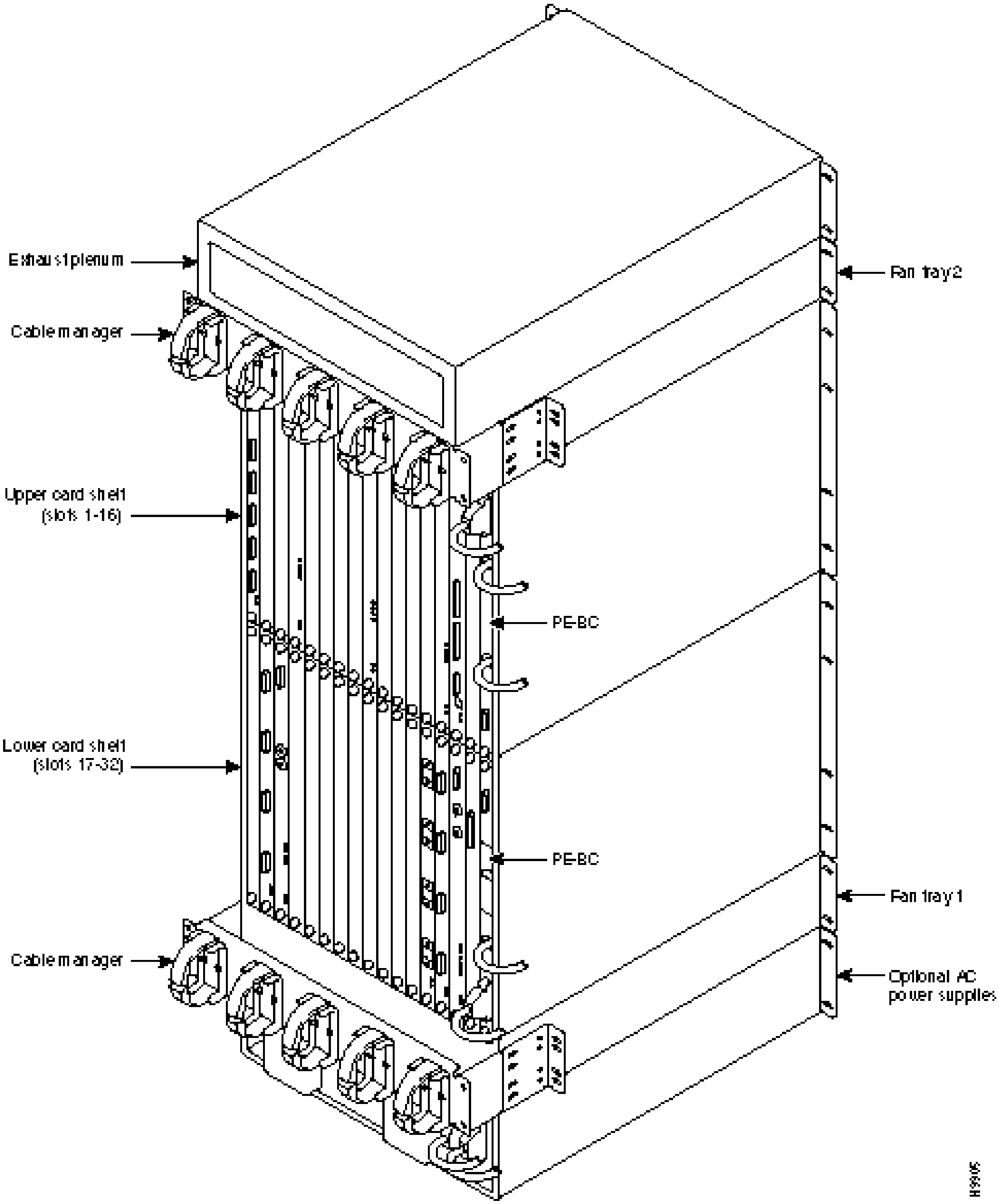


Figure 2-9 Stacking Order for IGX 8430 Rack-Mount Components, Back



Power Entry Back Card and Power Entry Module

This section describes the Power Entry Back Card (PE-BC), the Power Entry Module (PEM), and the fan tray power connections to the PE-BC.

For all IGX models, the type of power supplied at the unit can be either AC or DC. In a unit that uses a DC source, the power cord is attached to a Power Entry Module (PEM). The PEM provides circuit protection for the DC voltage. In a unit that uses an AC source, an AC power supply module is necessary for generating the DC voltages for the backplane and cooling fans.

Power Entry Back Card (PE-BC)

Each shelf of an IGX node requires a PE-BC. For the IGX 8410 node and standalone versions of the IGX 8420 and IGX 8430 nodes, the card cage ships with the PE-BC already in place. For rack-mount versions of the IGX 8420 and IGX 8430 nodes, you must install the PE-BC. Because of its shape, the PE-BC is also called the “E card.”

In both AC-powered and DC-powered systems, the PE-BC connects the -48 VDC primary power for the system to the backplane. It also routes power to the fan tray. In an AC-powered system, a cable from the supply module plugs into the PE-BC. In a DC-powered system, the PE-BC must have at least one PEM. Figure 2-10 shows a PE-BC for an AC-powered system.

The slot for the PE-BC has no number. It plugs into the slot on the right of back-slot 1. If the enclosure is an IGX 8430 node, a PE-BC also goes in the slot to the right of back-slot 32. Figure 2-11 shows the location of a PE-BC in an IGX 8410 node as an example.

Figure 2-10 Power Entry Back Card, AC-Powered System

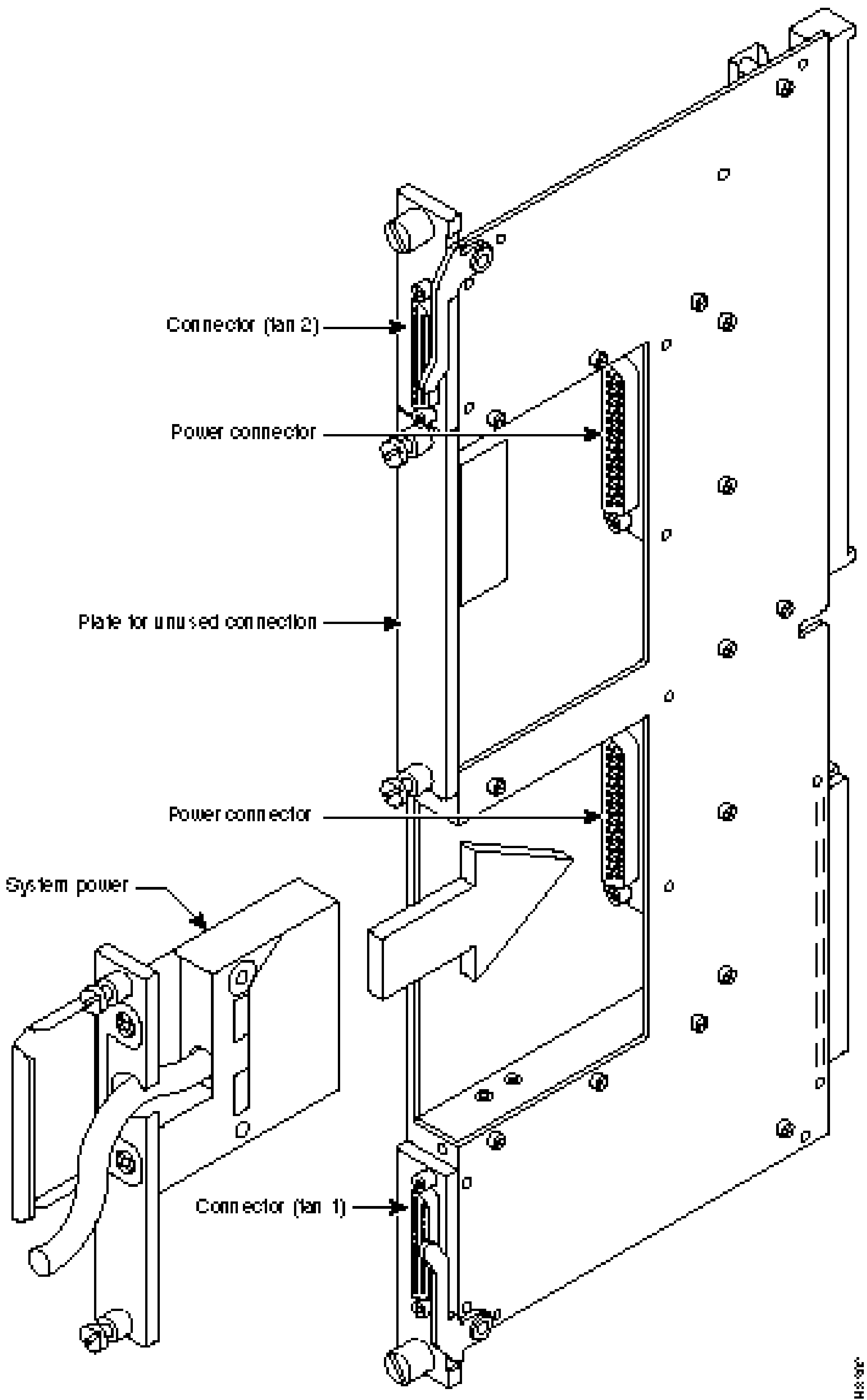
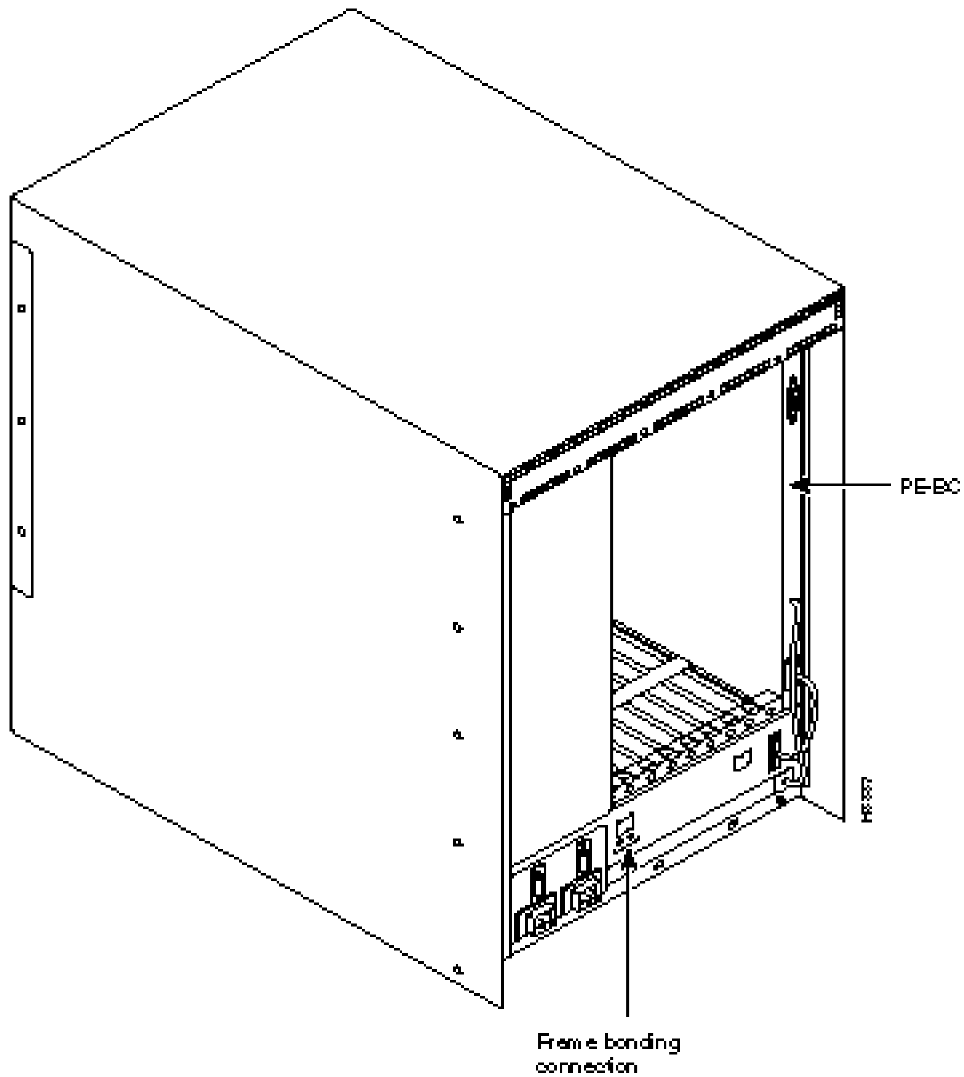


Figure 2-11 Location of the PE-BC



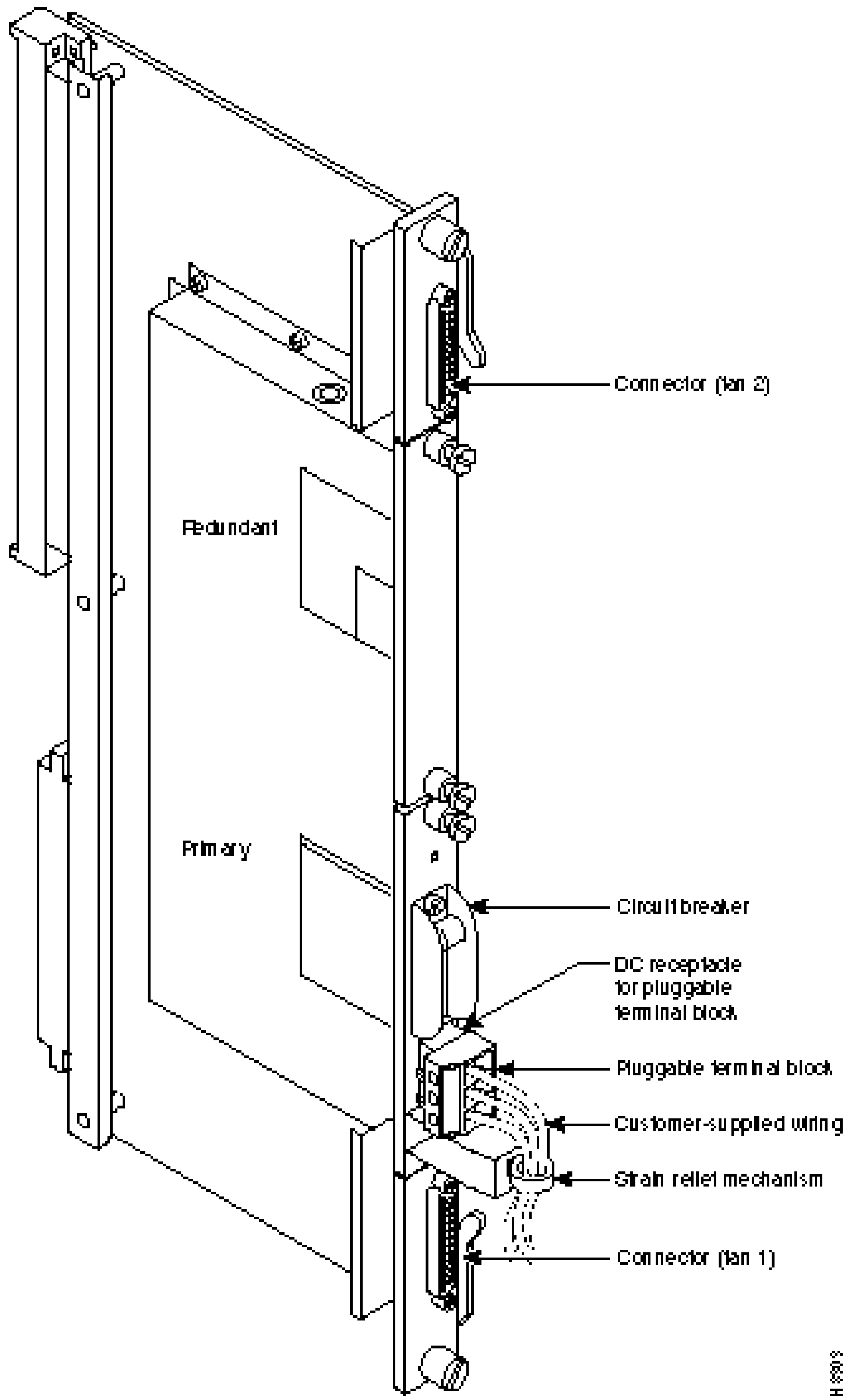
Power Entry Module (PEM)

A PEM is a small card that plugs into a connector on the PE-BC. (The PEM plugs into the same connector as a cable from the power supply module in an AC-powered system.) A PEM takes the DC power directly from the DC power source in the building, filters it, and passes it to the PE-BC. A PEM also has a circuit breaker and a strain-relief clamp for the DC power cable. Figure 2-12 shows a PEM plugged into a PE-BC in a non-redundant system. It also shows the blank plate that covers an unused connection in a non-redundant system. Redundancy of DC sources and PEMs lets the system continue to operate in case one of the two independent DC branch circuits fails. The *Cisco IGX 8400 Series Installation* publication describes the DC power setup.

Fan Power Connections

In an IGX 8410 or IGX 8420 switch, power to the fan tray comes from the “Fan 1” connector on the PE-BC (refer to Figure 2-12). In an IGX 8430 switch, the booster fan at the top receives power at the Fan 2 connector. The lower tray uses the two Fan 1 connectors. The *Cisco IGX 8400 Series Installation* publication describes fan installation.

Figure 2-12 PE-BC and DC PEM With Plug



AC Power Modules

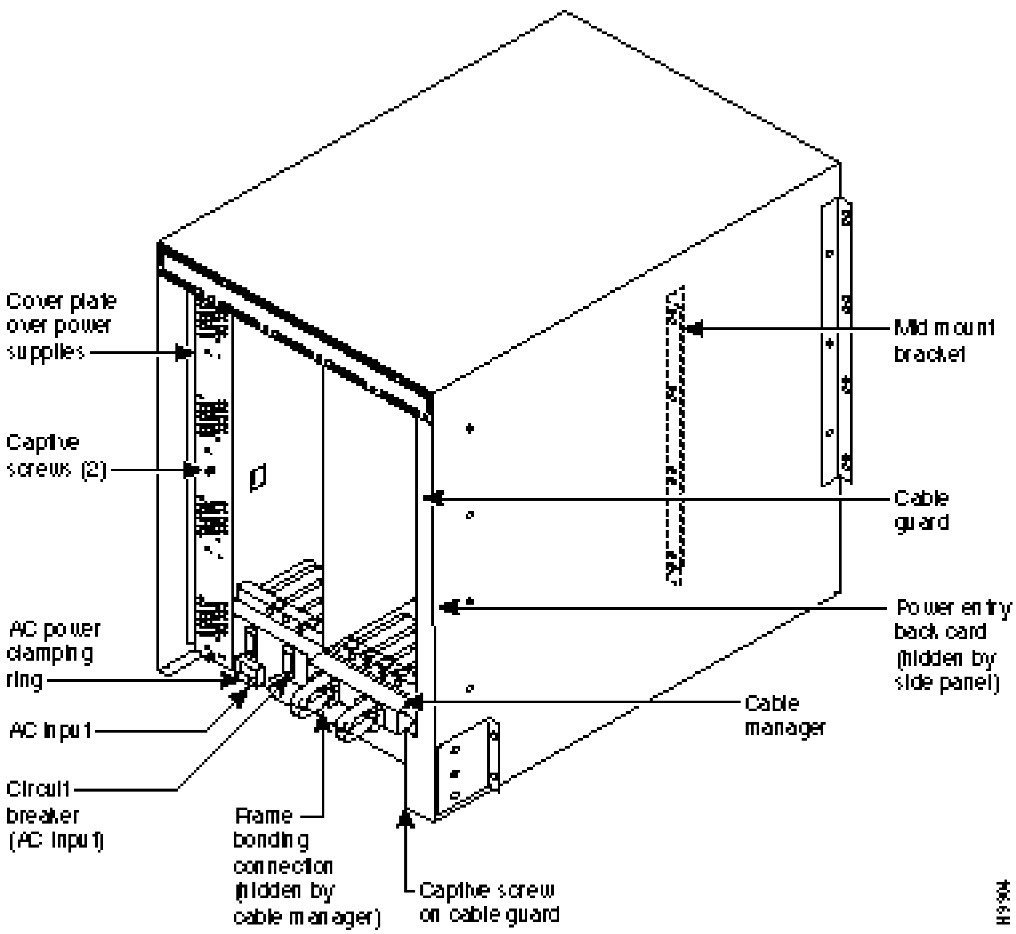
This section introduces the AC power system first for the IGX 8410 node, then the IGX 8420/8430 nodes.

AC Power in the IGX 8410 Switch

For an IGX 8410 node to use an AC power source, an AC power supply system is necessary. The IGX 8410 power supply housing holds up to four, 400-Watt power supplies. The AC system provides the system with –48 VDC from 100 to 240 VAC input. The AC power supply housing is between the card cage and the side wall of the node. The IGX 8410 node has one or, with AC redundancy, two AC power inputs.

Two types of redundancy exist: power source redundancy, in case one AC circuit fails, and AC power supply redundancy, in case a supply fails. Figure 2-13 shows two AC inputs.

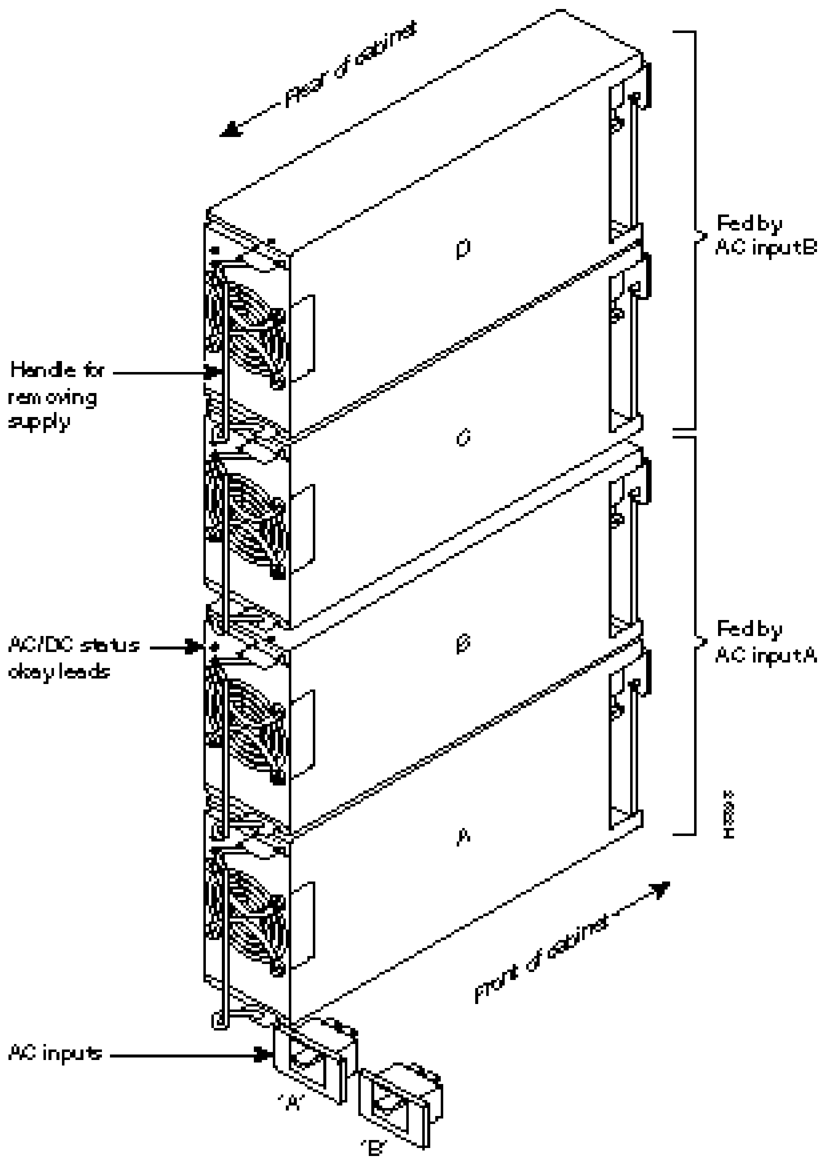
Figure 2-13 Power Supply Area Back View, AC System



The minimum requirement for an AC-powered system is one AC source and one power supply. One supply is adequate for four cards unless you specify power supply redundancy. See Table 2-1 for power supply requirements. Figure 2-14 shows the power supply slot designations and exterior.

Figure 2-14 shows a dual-input system. Facing the back of a dual-input system, AC Input A is on the left. AC Input B in on the right. In a dual-input system, the Input A supplies power supply slots A and B. Input B supplies power to slots C and D. A single AC input system does not have these distinctions: the single input receives AC power for supplies A through C.

Figure 2-14 Power Supply Slot Designations, Dual AC System



Two types of redundancy exist in the AC-powered system. One redundancy is that of AC power inputs. A redundant AC power source from a building circuit that is independent of the other AC circuit provides backup if one AC circuit at the site fails. The other redundancy is that of the 400-Watt power supply modules. Redundancy of the 400-Watt power supplies provides a backup if a power supply fails.

In supporting single and dual AC inputs, power supply arrangements differ, as follows:

- When a system uses two AC inputs, the number of supplies that receive power from AC Input A must be the same as the number of supplies that receive power from AC Input B. See Figure 2-14.
- When a system uses one AC source, the number of supplies must be installed in a contiguous arrangement, beginning with slot A, then slot B, and so on. Because only one AC input is present, the input connection has no alphanumeric designation.

Table 2-1 shows the minimal 400-Watt unit requirements for different IGX 8410 configurations. The factors that determine the number of supplies are as follows:

- The number of AC inputs
- The number of cards (one supply can power four cards)
- Power supply redundancy for backup

In Table 2-1, the System column shows the number of AC inputs. The Number of Cards column shows the number of cards at the cutoff point for more supplies. The Supply Redundancy column indicates whether the configuration includes a redundant supply for backup. For columns A through D, an X shows that the corresponding slot in the power supply housing must have a power supply to meet the configuration requirements. The part number for a power supply is 400W-PS-AC.

Table 2-1 Locations of Primary and Additional Supplies

System	Number of Cards	N+1 Supply Redundancy	A	B	C	D
1 AC Input	4 or less	No	X			
	4 or less	Yes	X	X		
	more than 4	No	X	X		
	more than 4	Yes	X	X	X	
2 AC inputs	4 or less		X		X	
	more than 4		X	X	X	X

IGX 8420/8430 Power Supply Requirements

This section introduces the AC power system and explains the concept of redundancy.

For an IGX 8420 or 8430 node to use an AC power source, an AC power supply shelf is necessary. The IGX 8420/8430 AC power tray holds up to six, 875-Watt power supplies. The AC module provides the system with -48 VDC from 208/240 VAC input. The AC power supply shelf sits below the main (lower) fan tray.

A power circuit breaker for each card shelf exists on the back panel. This allows power for each card shelf to be individually turned on and off. (An IGX 8420 node has two, card shelf circuit breakers, but only one is meaningful.) The back panel also contains one or—with AC redundancy—two AC power inputs. Figure 2-15 shows the back of the AC power supply section on an IGX 8430 node with redundancy for AC power input. In Figure 2-15, the node has a main circuit breaker on the power supply shelf for each AC power input.

Figure 2-15 IGX 8420/8430 Power Supply Area, Back View

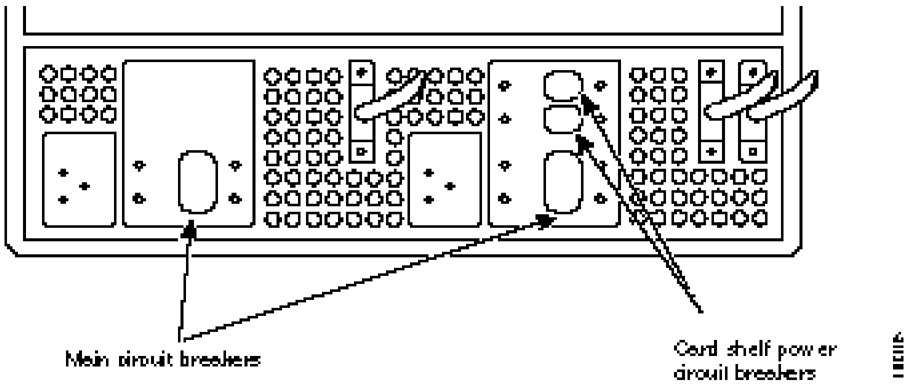
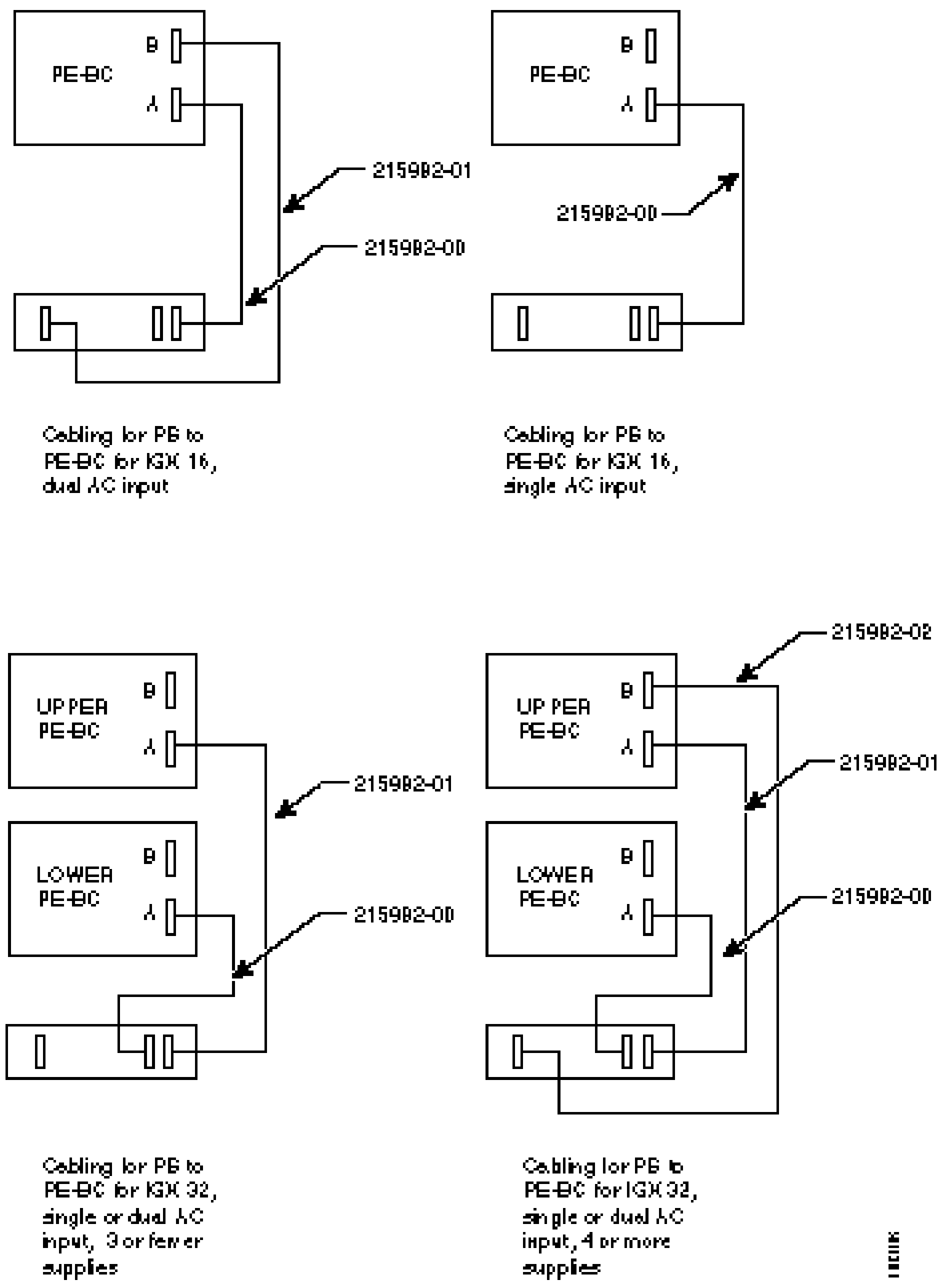


Figure 2-16 shows the possible configurations for the system power cables. Although these cables have different lengths, the pinouts are identical.

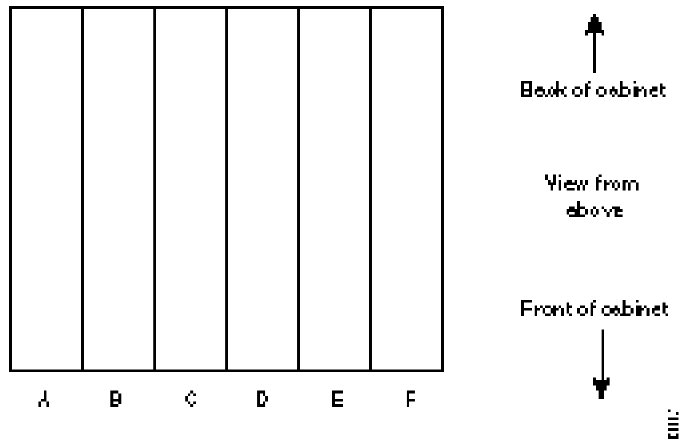
Figure 2-16 System Power Cable Diagram in AC-Powered IGX 8420/8430 Nodes



Understanding the Power Supply Configuration

This section describes the AC power configuration. The power supply configuration is based on power supply redundancy and the power requirements (load) created by the cards in the system. The minimum is 1 AC source and 1 supply. This minimum applies to the IGX 8420 node: with 12 or fewer boards, 1 supply is adequate unless redundancy is specified. Figure 2-17 shows the power supply slot designations.

Figure 2-17 Power Supply Slot Designations



Redundancy

Two types of redundancy exist in the AC power supply configuration. One redundancy is that of AC power inputs. A redundant AC power source from a building circuit that is separate from the other AC circuit provides backup if one AC circuit at the site fails. The other redundancy is that of the 875-Watt power supply modules. Redundancy of the 875-Watt supplies provides a backup if a supply fails.

In supporting the two types of redundancy, power supply arrangements differ, as follows:

- When a system uses two AC inputs, the number of supplies on the left and right sides must match. For example, if a system with dual AC inputs has four supplies, the supplies must occupy slots A, B, D, and E.
- When a system uses one AC source, the number of supplies on the left and right sides can differ. For example, three supplies on the left and one on the right is permissible.

Power Supply Quantities

Table 2-2 shows the required number of power supplies for IGX 8420/8430 systems. In Table 2-2, the locations for primary (or minimal) power supplies are marked with an X. The primary supplies reflect redundancy of AC inputs and backup supplies. An O indicates a slot that must have a supply because the card cage contains more than 12 boards.

In Table 2-2, the System column lists the IGX model number coupled with the number of AC inputs and whether the single-AC input models have power supply redundancy. The table also shows slot locations A to F and the part number of the kit that contains all the pieces for the item in the System column. Extra supplies for more than 12 boards (O) are not a part of a kit under Kit Part No. but have another part number. The part number of a supply ordered to fill extra power demands is IGX-AC-PS.

Table 2-2 Locations of Primary and Additional Supplies

System	A	B	C	D	E	F	Kit Part No.
IGX 8420: 1 AC input, no power supply redundancy	X	O					IGX8420-AC1-1
IGX 8420: 1 AC input, with power supply redundancy	X	X	O				IGX8420-AC2-1
IGX 8420: 2 AC inputs	X	O		X	O		IGX8420-AC2-2
IGX 8430:1 AC input, no power supply redundancy	X	X	O				IGX8430-AC2-1
IGX 8430: 1 AC input, with power supply redundancy	X	X	X	O			IGX8430-AC4-1
IGX 8430: 2 AC inputs	X	X	O	X	X	O	IGX8430-AC4-2

Note that, with all power supply configurations, power supply locations begin at the lowest lettered slot on either side, and the occupied positions are contiguous. For example, in a dual-AC system with four supplies, the occupied slots should not be A, C, D, and F. Rather, the supplies should occupy slots A, B, D, and E.

Cooling System

Mounted fans in a fan tray cool the system. In an IGX 8410 node, the fan tray with four fans resides immediately below the card cage. Figure 2-18 shows the IGX 8410 fan tray. In an IGX 8420 or IGX 8430 node, a fan tray sits immediately below the card cage and, if the system uses AC power, above the power supply module. An IGX 8430 node also has a booster fan tray above the upper card cage. Figure 2-19 shows front and back views of the fan tray for an IGX 8420 or IGX 8430 node.

An exhaust plenum resides at the top of each unit. Cooling air for the cards enters through a grille on the front of the fan tray beneath the card cage and exits through the rear of the exhaust plenum. In an IGX 8430 node, the booster fan tray has no grille.

Figure 2-18 IGX 8410 Fan Tray

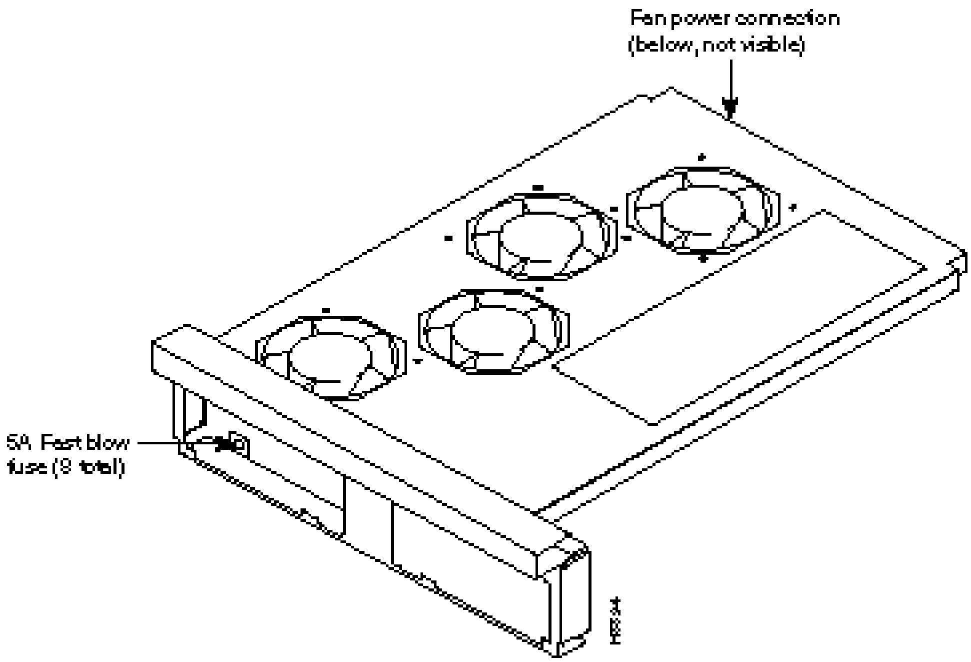
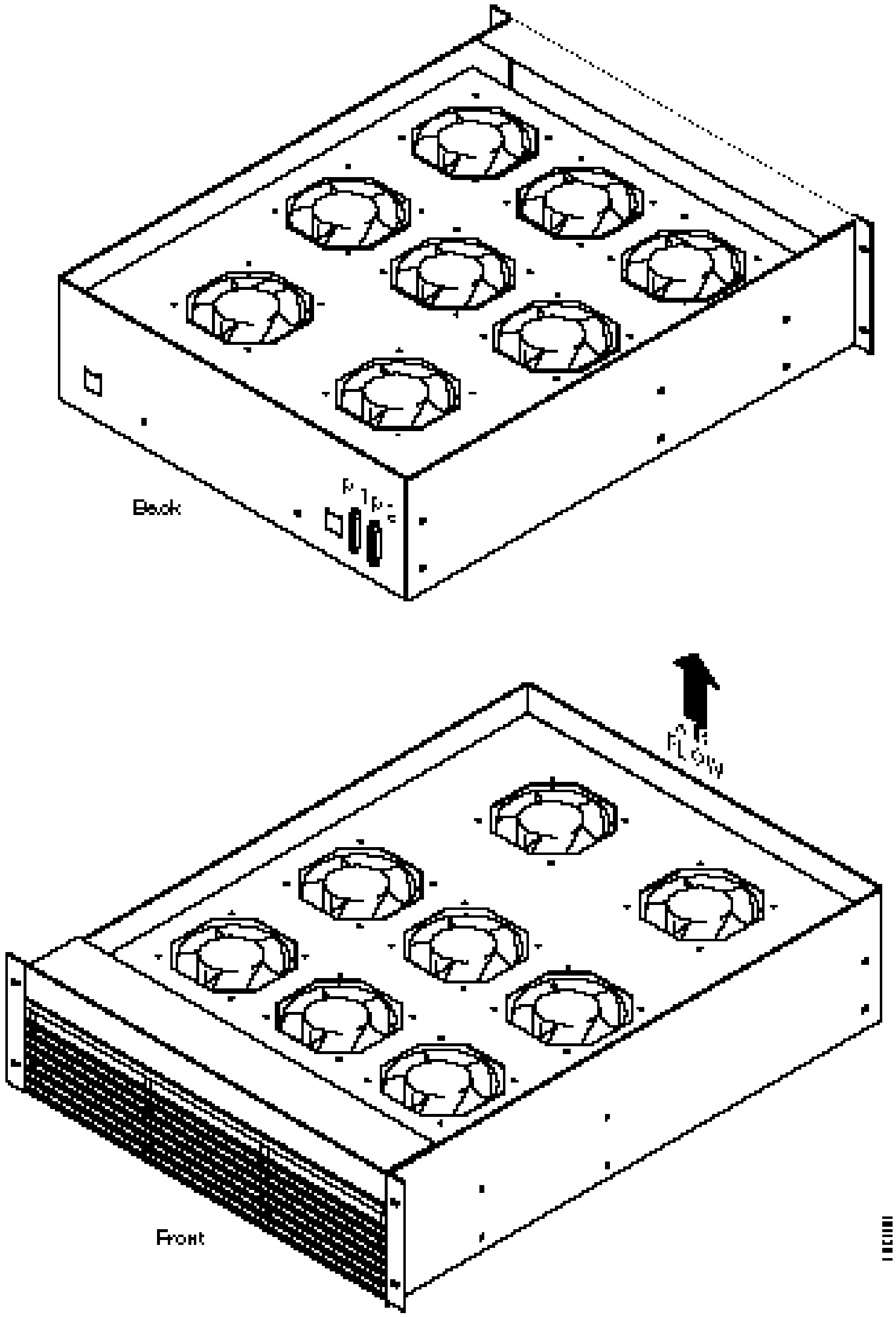


Figure 2-19 IGX 8420/8430 Fan Tray



Back Card Blanks

To maintain correct air flow and reduce Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI), all unused *back* card slots must be covered with the blank faceplates that Cisco provides.

Card Cages

An IGX card cage has 8, 16, or 32 active card slots on each side of the backplane. The PE-BC slot has no number in this scheme. An IGX 8410 node also has space for three spare cards.

In most cases, front slots contain data processing cards, such as processors, service modules, and so on. With the exception of the System Clock Module (SCM), the back slots contain system interface cards. The plug-in cards in the front slots are the system unit cards. The cards in the back slots are the network trunk and user interface cards. For a description of the cards, refer to the next chapter.

Figure 2-20 and Figure 2-21 show typical card placements in an IGX 8410 node. Figure 2-22 and Figure 2-23 show typical card placements in an IGX 8420 node (front) and IGX 8430 node (back), respectively. Most cards can reside in any vacant slot. Only the NPM and SCM have reserved slot locations.

Figure 2-20 Typical 8410 Shelf Configuration, Front View

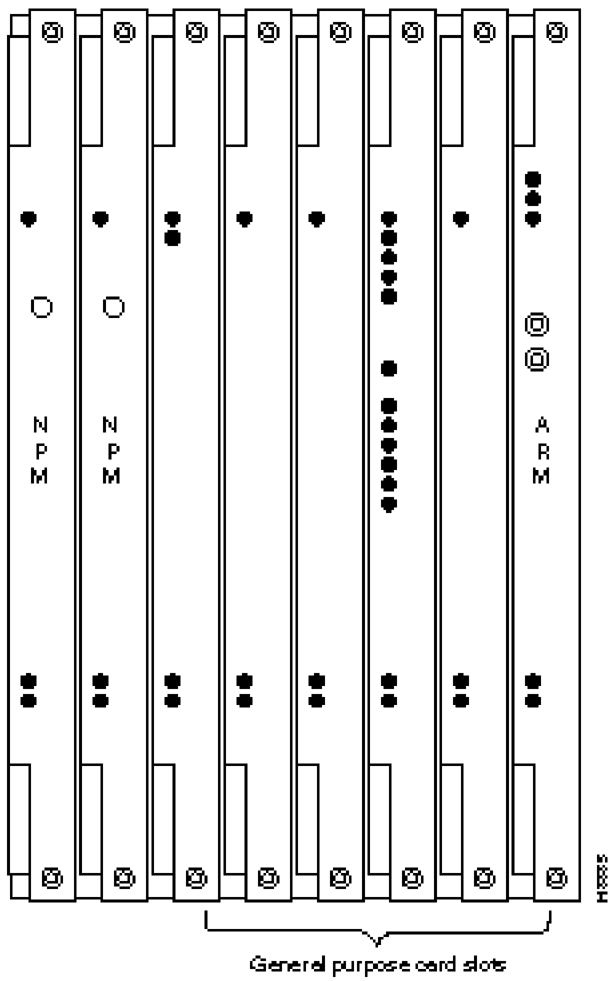


Figure 2-21 Typical IGX 8410 Shelf Configuration, Back View

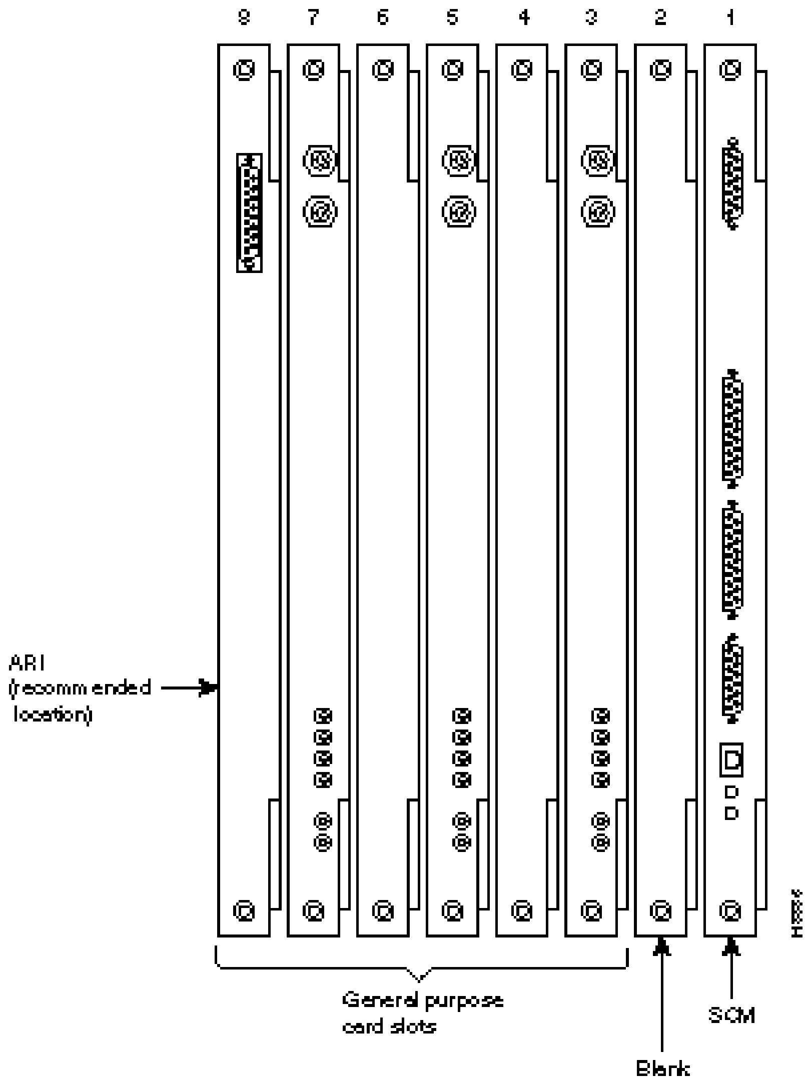


Figure 2-22 Typical IGX 8420 Shelf Configuration, Front View

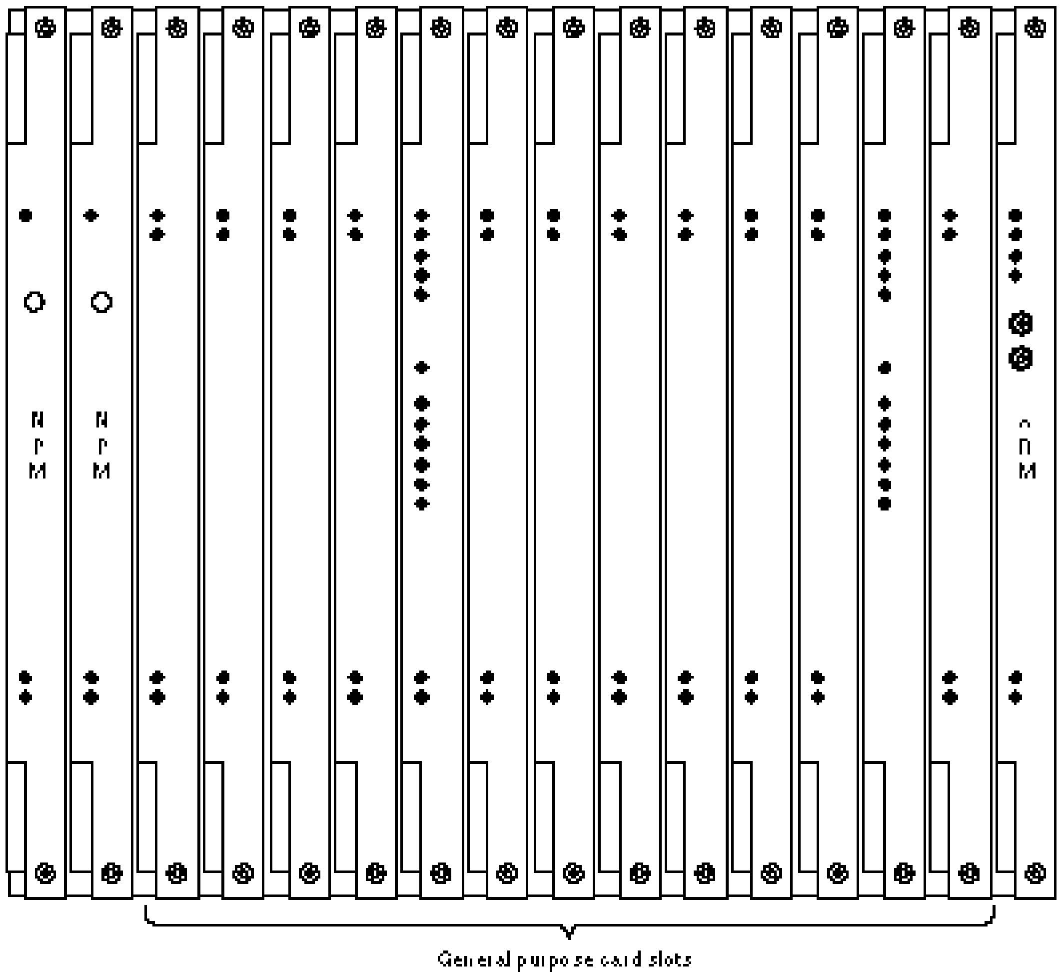
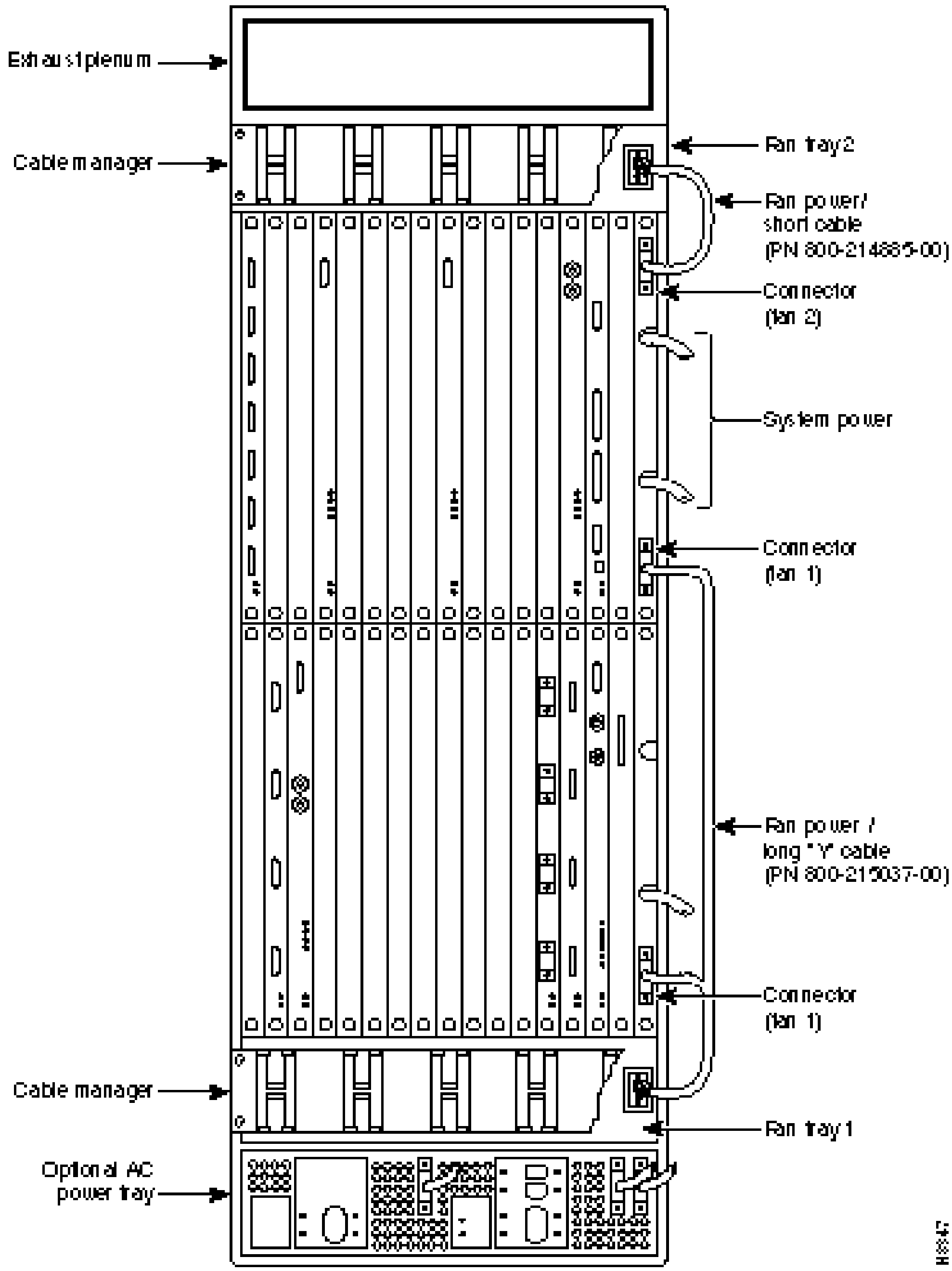


Figure 2-23 Typical IGX 8430 Shelf Configuration, Back View

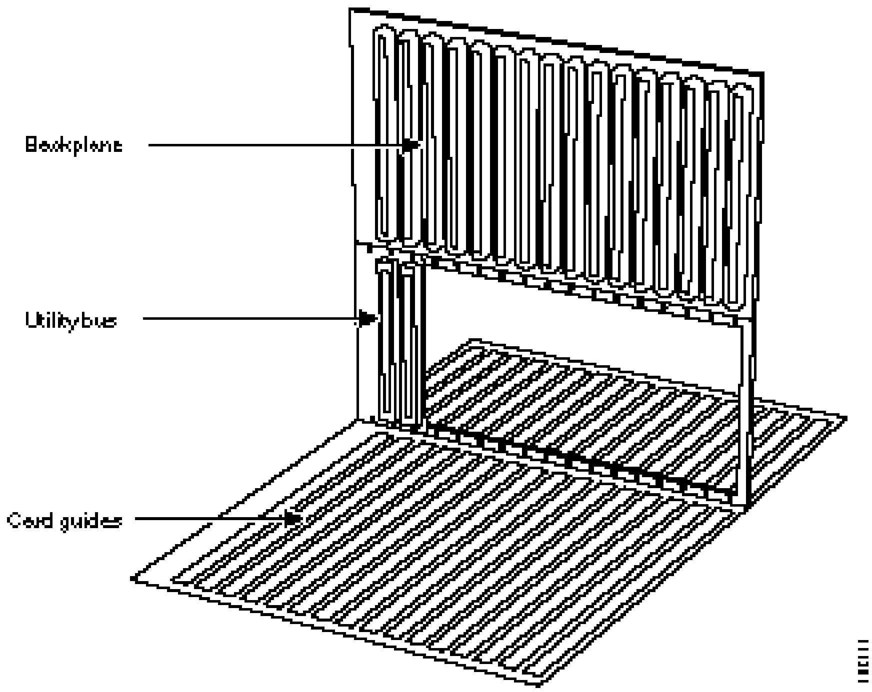


Backplane

The IGX 8410 backplane has eight 216-pin connectors. Each IGX 8420/8430 backplane has sixteen 216-pin connectors and occupies just over half the height of the card cage. The backplane sits in the upper part of the card cage and connects up to 16 front cards. Figure 2-24 shows a front view of an IGX 8420 backplane. Except for having 8 fewer card slots, the IGX 8410 card cage looks the same as the IGX 8420 backplane. The utility bus resides beneath the NPM slots at the left. Figure 2-24 also shows the card guides in the front and rear. Each front card plugs into the backplane at the upper connector (P1). In addition to the physical connectors for the cards, the backplane also contains the system bus.

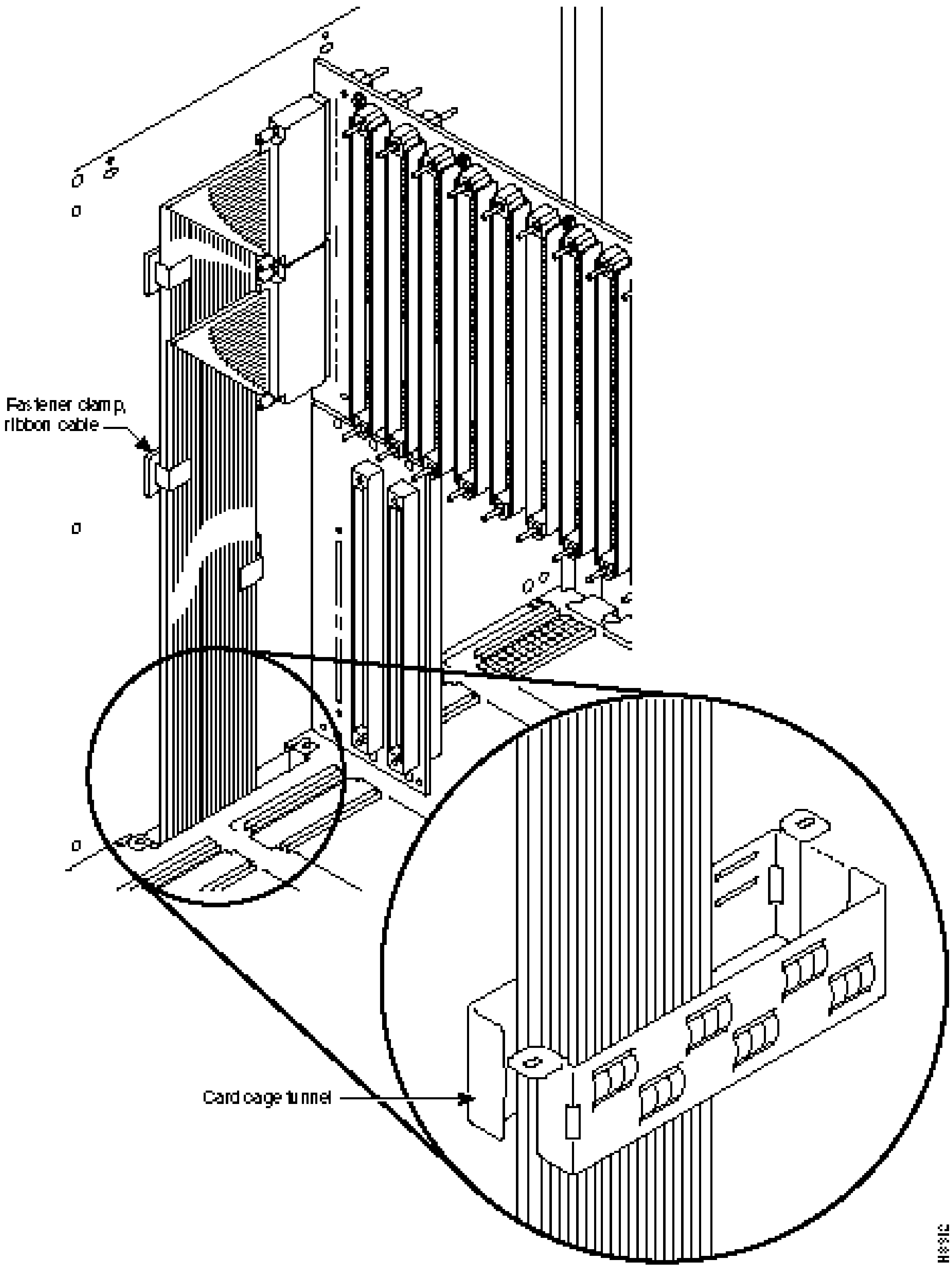
In the IGX 8430 node, the upper and lower card cages are slightly different. The upper card cage has a utility bus beneath the backplane for the NPMs and SCM. See Figure 2-24. The lower card cage in the IGX 8430 node has a backplane with no utility bus because only service cards exist on the lower shelf.

Figure 2-24 IGX Backplane, Utility Bus, and Card Guides



In an IGX 8430 node, a pair of ribbon cables carries the backplane signals between the upper and lower shelves. These ribbon cables pass through a cut-out space in the card cages. They also go through a two-piece conduit that fits together to surround the cables. The name of this two-piece conduit is the *card cage tunnel*. The cables connect to two, 100-pin connectors that reside on the front side of the backplane (the opposite side of the backplane from the Power Entry Back Card). Figure 2-25 illustrates the expansion connectors, the ribbon cables, the cutout space, and the card cage tunnel. The card cage tunnel is shown in place in the main figure and prior to insertion in the blown-up view.

Figure 2-25 IGX 8430 Backplane Extension



System Bus

The IGX system bus resides on the backplane. The system bus provides the following:

- The Cellbus carries data between various service module cards. The transfer rate on the Cellbus can reach 1 gigabit per second. This bus consists of five data lanes or highways. Four of these lanes carry data between the cards. The fifth lane provides redundancy if one of the four lanes fails.
- The Power Distribution Bus provides –48 VDC to each of the IGX cards. Each card develops its required voltages from this –48 VDC.
- Clock distribution for system timing and card synchronization.
- The Cbus and a Dbus are serial control buses. The NPM uses Cbus and a Dbus to monitor and control the other system cards and to control the flow of voice and data through the system. The NPM uses the Cbus to communicate with the various application cards. The NPM uses the Dbus to communicate with the adapter cards (see “Adapter Cards” in the next chapter).

As a safeguard against card driver failure or bus failure, the backplane contains redundant system buses. In a two-shelf system, a cable between the upper and lower backplanes extends the system bus to the lower shelf. The earlier section “Backplane” describes this cable. The backplane also contains fuses to protect it from catastrophic electrical damage. (See the chapter on repair and replacement in the *Cisco IGX 8400 Series Installation* publication.)

Utility Bus

A utility bus is used to interconnect redundant processor cards in a node. In an IGX switch, the two-slot utility bus UBS-2 interconnects the two processor cards. It occupies the positions of the lower connectors in slots 1 and 2.

Processor and Trunk Cards

This chapter describes the hardware and functionality of the processor and trunk cards. It also describes the backplane and system bus. The description of each card includes:

- Function
- System interconnect
- Faceplate indicators

Other manuals that relate to IGX operation are:

- The *Cisco IGX 8400 Series Installation* manual describes installation, troubleshooting, user-commands, repair and replacement, and the rack-mount IGX 8420-to-IGX 8430 conversion.
- The *Cisco WAN Switching Command Reference* and *Cisco WAN Switching SuperUser Command Reference* describe standard user-commands and superuser-commands.
- The *Cisco StrataView Plus Operations* manual has information on network management.

Processor, Trunk, and Alarm Card Types

Table 3-1 lists the processor cards that can operate in an IGX switch. Table 3-2 lists the trunk front cards, and Table 3-3 lists the corresponding trunk interface back cards. The card described in this chapter that is neither a processor card nor a trunk card is the Alarm Relay Module card set (ARM/ARI). In addition, a switch may use Adapter Card Modules (ACMs) to connect existing IPX 16/32 service modules and perform the adaptation that allows IPX 16/32 front cards to operate in an IGX 8410, 8420, or 8430. IPX 8-specific cards do not apply to the upgrade scheme.

Table 3-1 Processor Cards

Card Acronym	Card Name
NPM-32	Nodal Processor Module with 32 Mbytes DRAM
NPM-64	Nodal Processor Module with 64 Mbytes DRAM
NPM-32B	Nodal Processor Module with 32 Mbytes DRAM
NPM-64B	Nodal Processor Module with 64 Mbytes DRAM

Table 3-2 Trunk Front Cards

Card Acronym	Card Name
UXM	Universal Switching Module
ALM/B	ATM Line Module, Model B
BTM	Broadband Trunk Module
NTM	Network Trunk Module

Table 3-3 Interface Back Cards for Trunks

Back Card Acronym by Trunk	Card Name
UXM	
BC-UAI-4-155-MMF	4 port Multi-Mode Fiber 155Mbps
BC-UAI-4-155-SMF	4 port Single Mode Fiber 155Mbps
BC-UAI-2-155-SMF	2 port Single Mode Fiber 155Mbps
BC-UAI-6-T3	6 port T3 back card
BC-UAI-3-T3	3 port T3 back card
BC-UAI-6-E3	6 port E3 back card
BC-UAI-3-E3	3 port E3 back card
BC-UAI-8-T1-DB15	8 port T1 back card with DB15 connector
BC-UAI-8-E1-DB15	8 port E1 back card with DB15 connector
BC-UAI-8-E1-BNC	8 port E1 back card with BNC connector
BC-UAI-4-T1-DB15	4 port T1 back card with DB15 connector
BC-UAI-4-E1-DB15	8 port E1 back card with DB15 connector
BC-UAI-4-E1-BNC	4 port E1 back card with BNC connector
ALM/B	
BC-UAI-1T3	Universal ATM Interface T3 Back Card
BC-UAI-1E3	Universal ATM Interface E3 Back Card
BTM	
AIT-E3	E3 Trunk Interface Card
AIT-E2	E2 Trunk Interface Card
AIT-HSSI	HSSI Trunk Interface Card
AIT-T3	T3 Trunk Interface Card
BTI-E1	E1 Broadband Trunk Interface Card
NTM	
BC-E1	E1 Interface Card
BC-T1	T1 Interface Card
BC-Y1	Y1 Trunk Interface Card
BC-J1	J1 User (Circuit) Interface Card
BC-SR	Subrate Trunk Interface Card

Table 3-4 Other Back Cards

Card Acronym	Card Name
SCM	System Clock Module, works in conjunction with the NPM
ARI	Alarm Relay Interface, works in conjunction with the ARM card

Processor Cards

The processor card group consists of the Nodal Processor Module (NPM) and the System Clock Module (SCM). In conjunction with the system bus, the processor group is responsible for system timing, network control, and status reporting.

Nodal Processor Module (NPM)

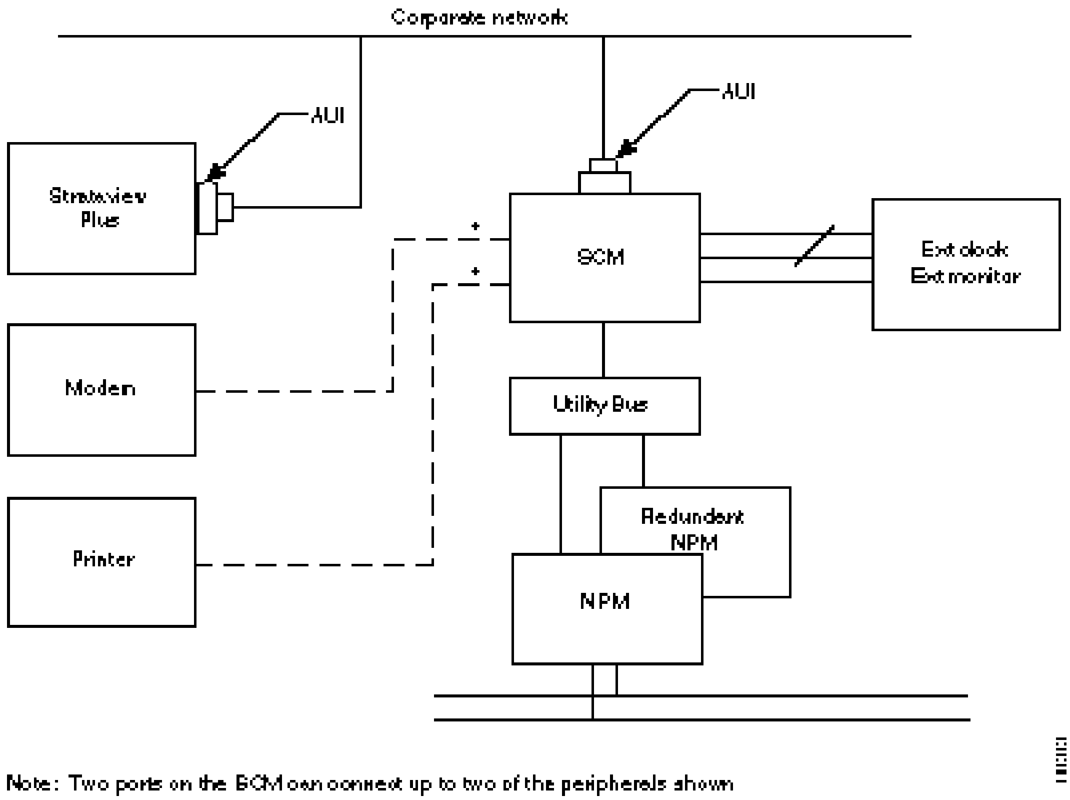
The Nodal Processor Module (NPM) is a 68040 microprocessor-based system controller that runs the software for controlling the IGX switch. The NPM communicates with the other system cards over the control bus. Figure 3-1 illustrates the relation of the NPM to other parts of the system. The NPM performs the following major functions:

- Runs the software for controlling, configuring, diagnosing, and monitoring the IGX switch
- Sends configuration and control commands over the control bus to other cards in the switch
- Receives statistics, status, and alarm messages from the other cards in the switch
- Generates all system bus control signals for directing the interpretation of address buses and controlling data transfers
- Communicates with other nodes in the network

The NPM communicates with all other nodes through a trunk that uses a reserved queue on the trunk. The NPM communication link with other nodes carries information about new connections, topology changes, and rerouting.

Two versions of the NPM exist for each model. The total of four NPMs are the NPM-32, NPM-32B, NPM-64, and NPM-64B. The B versions use +5 VDC flash memory. The next section, titled “NPM Processor and Memory Capacity,” describes NPM memory and its expandability.

Figure 3-1 NPM in Relation to the System



NPM Processor and Memory Capacity

The DRAM memory in an NPM holds the switch software for performing the regular functions of the NPM. The NPMs also have memory features that let you download new software releases over the network and maintain the system software and its configuration if the power fails. Non-volatile flash EEPROM supports software downloading over the network. Battery-backup RAM (BRAM) stores system configuration data. Table 3-5 shows the basic and expanded memory capacities of each NPM. Memory upgrades are available but must take place at the factory. Reasons for memory upgrades are, for example, expanded statistics gathering or expansion from a flat to a tiered network.

Table 3-5 NPM Memory and Expansion Capacity

NPM Version	DRAM	BRAM	Flash EEPROM
NPM-32	32 Mbytes	1 Mbyte	4 Mbytes (expandable to 8 Mbytes)
NPM-64	64 Mbytes	1 Mbyte	4 Mbytes (expandable to 8 Mbytes)
NPM-32-B	32 Mbytes	1 Mbytes	4 Mbytes (expandable to 8 Mbytes)
NPM-64-B	64 Mbytes	4 Mbytes	4 Mbytes (expandable to 8 Mbytes)

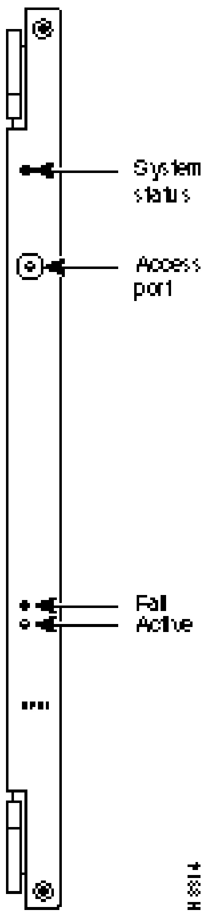
NPM Redundancy

An IGX has one NPM in a non-redundant system or two NPMs in a redundant system. In a non-redundant system, an NPM resides in either front slot 1 or front slot 2. For a redundant system, NPMs reside in slots 1 and 2. The NPM plugs into the system bus backplane. A utility bus in the backplane connects the NPMs in a redundant system.

NPM Faceplate and LEDs

The faceplate of the NPM has a green Active LED and a red Fail LED. See Figure 3-2. The NPM monitors its own activity and, if a failure is detected, the Fail LED is lit. If the node has redundant NPMs, the on-line NPM is indicated by the lit Active LED, while the standby NPM has no lit indicators. In addition to the status LEDs on the NPM faceplate, information on any NPM can be displayed at a terminal by executing the **dspcd** command.

Figure 3-2 NPM Faceplate



System Clock Module (SCM)

The System Clock Module (SCM) card provides the main clock generation function for the IGX. It generates the system clock and trunk synchronizing clocks. The SCM phase-locks the internal IGX timing to the selected clock source for network synchronization. Each IGX node must have an SCM. The SCM plugs into back card slot 1.

SCM Features and Functions

The NPM and SCM card sets are the backbone of the IGX: without an NPM and SCM, the node is inoperative. The NPM controls and monitors the SCM control buses. A single SCM can support redundant NPMs.

In addition, the SCM provides:

- Two low-speed communications paths for a control terminal, a printer, or one or two modems
- One LAN communication path for connecting the Network Management System to the IGX

The SCM circuits include the following:

- Internal clock generator for the node
- Clock detection, alarm status, and control from the NPM
- Phase lock loops
- External clock input
- Clock, power supply, temperature, and fan monitoring
- Bus expansion
- Reset circuitry
- Ports for a control terminal, printer or modem, and LAN AUI
- 2 EIA/TIA-232 serial port interfaces

The two serial EIA/TIA-232 ports provide connection to control terminals and modems for remote access to the node. In conjunction with the SCM, the NPM also supports a high-speed Ethernet LAN port for faster system statistics transfer between the node and a StrataView Plus NMS workstation. This port conforms to the requirements of IEEE standard 802.3 for Ethernet.

The SCM has duplicates of the internal clock circuitry and its associated phase lock loops and NPM-related control circuitry. One clock circuit operates off the System A Bus, and the other operates off the System B Bus. Both circuits operate independently and are monitored separately to provide complete backup if a circuit fails (which would cause the Fail LED to turn on). However, because both the System A bus and System B bus clock circuits exist on a single card, removing the SCM disrupts system operation. The lower priority SCM circuits are not duplicated. The lower priority circuits are the external clock input, control and auxiliary ports, and monitoring circuits for power supplies, cabinet temperature, and fans. A failure in a lower priority circuit does not cause a system failure, but the SCM reports the problem.

The Ext Clock connector on the faceplate of the SCM provides an interface for an external source for a high-stability clock. This clock is configurable as the primary, secondary, or tertiary clock. The input is 1.544 MHz for T1 systems and 2.048 MHz for CEPT systems. In addition, one of the trunk or circuit line inputs may also serve as a source of timing for the node. If no clock source is selected, the clock source is the internal IGX clock.

Figure 3-3 and Table 3-6 describe the SCM faceplate connectors and LEDs. When you correlate the descriptions in the table with the callouts in the figure, read from the top to the bottom.

In addition to the clock functions, the SCM provides a pair of low-speed, serial communications ports. The CONTROL TERMINAL port is a bi-directional port for connecting the IGX to a local network control terminal or to a modem for remote terminal connection. The AUXILIARY PORT connects to a maintenance log printer, an additional dumb terminal, an alarm message collector, external device window, or an auto-dial modem for automatic reporting of local IGX alarm conditions. You can program the modem to dial into the Technical Assistance Center (TAC) for assistance when a network alarm occurs. You can reach the TAC through Cisco Customer Engineering at 800-553-2447 or 408-526-4000.

Figure 3-3 SCM Faceplate

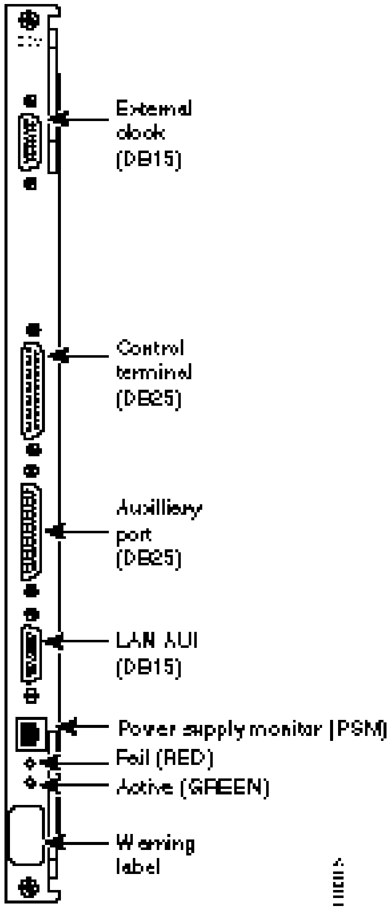


Table 3-6 SCM Faceplate Connectors and Indicators

Connector or LED	Function
External Clock	DB15 connector for connecting an external source for the system clock.
Control Terminal	A DB25 connector for a VT100 or equivalent terminal for a basic network management terminal. CONTROL TERMINAL can also connect to a dial-in modem for communication with the TAC or other network management dial-up access. This is a bidirectional EIA/TIA-232 communications port.
Auxiliary Port	A DB25 connector for a system printer. Can also be used to connect an out-dial modem for automatic reporting of alarms if the node becomes isolated. This port is bidirectional EIA/TIA-232.
LAN AUI	Ethernet LAN connection for multiple, local StrataView Plus NMSs. This port uses a DB-15 connector called the Attachment Unit Interface (AUI) connector. This name reflects the industry standard term for a LAN interface. Table 3-7 lists the AUI pin assignments.
Power Supply Monitor (PSM)	Power supply monitor. You must supply the cable to use the PSM connector. See the section titled "Using the Power Supply Monitor Connector."
Fail	Indicates an error occurred. First, reset the card with the **resetcd f** command. If the LED comes on again, call the TAC.
Active	Indicates the card is in service with active circuits.

Table 3-7 lists the pin assignments for the LAN connector.

Table 3-7 AUI Connector Pin Assignments (DB 15-connector)

Pin	Name	Pin #	Name
1	Shield	–	–
2	Collision Presence +	9	Collision Presence—
3	XMT +	10	XMT—
4	Reserved	11	Reserved
5	RCV +	12	RCV—
6	Power return	13	Power (+12V)
7	Reserved	14	Reserved
8	Reserved	15	Reserved

Using the Power Supply Monitor Connector

The Power Supply Monitor (PSM) is an RJ-45 connector with the following pinout:.

- Pin 1 = Digital Ground
- Pin 2 = AACFAIL*_OUT
- Pin 3 = BACFAIL*_OUT

Each AC power supply provides an open collector output that goes low if an AC power failure occurs. The inactive state of the status signals is high on the SCM. The signals go into a ALS244 driver, the outputs of which are connected directly to the RJ-45 connector as well as circuitry that communicates the status to the control card.

To use the PSM connector, you need a device that responds with a fail condition when a “0” TTL logic level is present on pin 2 or pin 3.

Optional Alarm Interface Cards

The alarm relay card set is optional. The set consists of an Alarm Relay Module (ARM) front card and an Alarm Relay Interface (ARI) back card. This card set provides alarm summary outputs by using relay contact closures.

The alarm outputs are typically wired to a telephone central office alarm system for remote alarm reporting to give an indication there is a problem in the associated equipment.

The alarm summary feature provided by the Alarm Relay cards provides both a faceplate visual indication of an IGX node alarm as well as a set of relay outputs (dry-contact) for indicating node and network alarm indications. A visual alarm history indication is also provided. This alarm reporting is separate and is in addition to the alarm output at the node's control port, which provides a data output to a control terminal, such as the StrataView Plus Network Management Station. Table 3-8 summarizes the alarm conditions and the resulting indications.

One set of alarm relays is used to signal a major alarm or minor alarm on the node. One pair of contacts on each relay is used for audible alarms. These contacts are in series with a faceplate alarm cut-off (ACO) switch. The other set of relay contacts are used for visual alarms and are not affected by the ACO switch. When the ACO switch is activated, a faceplate ACO indicator lights up as a reminder to the operator. If the ACO switch is activated to disable the node’s audible alarm output and a second alarm occurs, the audible alarm is re-activated. Two faceplate LEDs provide local indication of network alarms.

Table 3-8 ARM Card Set Alarm Reporting

Type	Severity	Indicator	ARM Action
Network	Major	none	Single form-C relay closed or open.
Network	Minor	none	Single form-C relay closed or open.
Node	Major	Major LED (red)	Visual and audible relay closed only (normally open).
Node	Minor	Minor LED (yellow)	Visual and audible form-C relay closed or open.
Alarm cutoff	n.a.	ACO LED (green)	Interrupts audible relay closed.
Alarm history	n.a.	Hist LED (green)	None.

A second, independent, set of alarm outputs report network alarms. If a major or minor alarm occurs anywhere in the network, the ARM activates these relays.

Major alarm relays are normally energized, providing an open circuit, so that a complete power failure (relay de-energized) at the node results in a contact closure and resulting major alarm output. Minor alarms, however, are normally de-energized to conserve power. Contact *closures* as well as contact *openings* are available for minor alarms.

When an alarm condition clears, the alarm relays return to their normal state to clear the alarm outputs. A faceplate history indicator turns on when a local alarm occurs. The indicator remains on even though an alarm may have already cleared. You can manually clear the history indicator by pressing a switch on the faceplate.

Two additional relays exist under software control to report conditions but are currently unassigned.

The alarm reporting feature requires a card set that includes an ARM front card and an ARI back card. This card set can reside in any slot except the reserved slots. However, Cisco recommends that the front card go in the slot on the far right. Since a failure of either of these cards does not affect service, card redundancy is not necessary.

Alarm Relay Module (ARM)

The alarm relays are controlled by system software through Control Bus commands. The ARM interface with the Control Bus allows the card to receive alarm signals from the NPM and to send status signals back to the NPM. The firmware on the ARM decodes the alarms. The ARM does not connect to the Cellbus because it does not packetize user-data.

The ARM faceplate contains the alarm LEDs, ACO and History Clear push buttons, and the active and fail LEDs indicating the status of the ARM card (see Figure 3-4 and Table 3-9). The ARM card is used in conjunction with an ARI card. The ARI card connects to the ARM at the P2 connector. Relay drive signals originate in the ARM to operate relays on the ARI.

The ARM periodically runs a background self-test to determine the state of the card. If the card fails this self-test, the faceplate Fail LED turns on, and the Active LED turns off.

Figure 3-4 ARM Faceplate

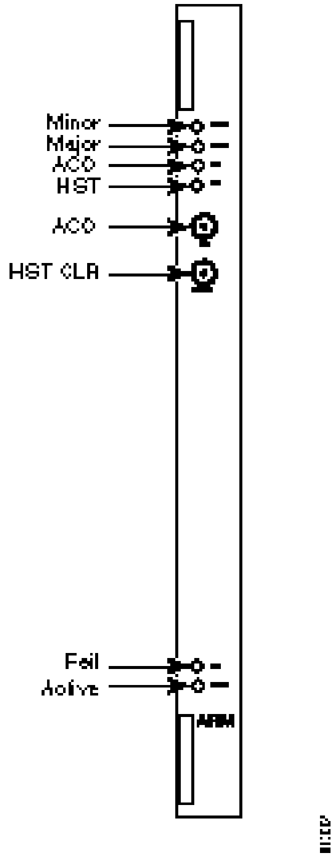


Table 3-9 ARM Faceplate Controls and Indicators

Faceplate Item	Function
Minor LED (yellow)	Indicates a failure in the local node that is not service-affecting but still should be investigated. It could indicate problems such as a loss of redundancy, a low error rate on a digital trunk (frame bit errors or bipolar errors), or other problem.
Major LED (red)	Indicates a failure in the local node that is service-affecting and which you should immediately investigate. A card failure is an example.
ACO LED (white)	Indicates that a Minor or Major alarm is present, and that the alarm cutoff (ACO) button (5) was pressed to silence an accompanying audible alarm. The ACO light is turned off when the alarm condition is cleared.
HISTory light (green)	Indicates that an alarm has occurred sometime in the past on the node. The alarm may be current or it may have cleared. Pressing the HIST CLR button (6) turns off this light if there is no current alarm.
ACO button	When pressed, silences audible alarm (visual alarms remain on) and turns on ACO light (3).
HIST CLR button	When pressed, turns off the HIST light (4) if no alarm currently exists.
Fail light (red)	Indicates that the card has failed self-test. First, reset the card with the **resetcd f** command. If the LED comes on again, call the TAC.
Active light (green)	Indicates that the card is active, has been *assigned* through the **addalmslot** command, and is functioning normally.

The installation of the ARM cards requires the removal of the node from service. The ARM can be physically installed in any front slot except slots normally reserved for the node processor cards (NPMs). For standardization, Cisco recommends that the ARM reside in the slot at the far right side of the card cage. The corresponding back slot must have an ARI card. The ARI card plugs directly in the ARM card.

User-Commands

Three commands apply to the ARM card set:

- **addalmslot**
- **delalmslot**
- **dspcd**

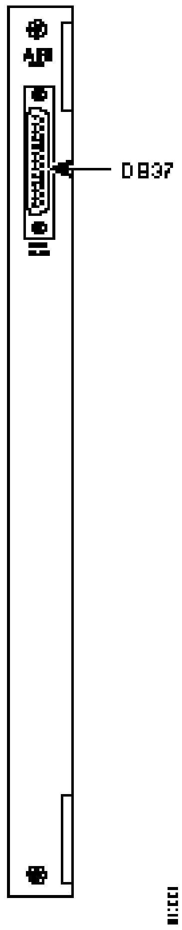
Alarm Relay Interface Description (ARI)

The Alarm Relay Interface (ARI) card contains the alarm relays and their associated relay drivers. Alarm outputs are dry contact closures or opening contacts from Form C relays. The user must supply the voltage source to be switched by the IGX. Any source or load can be switched as long as it meets the following requirements.

- Voltage source, maximum 220 Volts
- Steady-state current, maximum 0.75 Amps
- Power dissipation, maximum 60 Watts

A female DB37 connector resides on the faceplate for connection to the customer’s office alarm or alarm-reporting system. Refer to Figure 3-5 for an illustration of the ARI faceplate.

Figure 3-5 ARI Faceplate



Maintenance and Troubleshooting

The following paragraphs describe the maintenance and troubleshooting features associated with the ARM card set. Preventive maintenance is not necessary.

Card Self Test

Diagnostic routines periodically run to test the card's performance. These diagnostics run in the background and do not disrupt normal traffic. If a failure is detected during the self test, the faceplate red Fail LED turns on. In addition, you can check the status of the card by using the Display Card (**dspcd**) command at the control terminal. If a card failure is reported, the report remains until cleared. To clear a card failure, use the Reset Card (**resetcd**) command.

Two types of resets are exist. They are *hardware* and *failure*. The reset failure clears the event log of any failure detected by the card self test and does not disrupt card operation. The hardware reset reboots the firmware and resets the card, which momentarily disables the card.

Card Replacement

ARM card set replacement is the same as other card replacement. For these procedures, refer to the repair and replacement description in the *Cisco IGX 8400 Series Installation* manual.

Adapter Cards

Cisco can upgrade IPX service/interface cards for use in an IGX node. The upgrade involves the addition of one of three possible Adapter Card Modules (ACM) and possible firmware or hardware modifications. The upgrade is available only as a factory upgrade due to the complexity of the ACM.

Connecting IPX front cards to their corresponding back cards on the IPX requires the use of a utility or local bus. On upgraded IPX cards (IGX cards), the local or utility bus is not necessary.

The following IPX cards can be adapted for use in the IGX:

- NTC
- AIT
- CDP
- FRP
- FTC
- SDP
- LDP
- ARC

Trunk Interface Cards

This section describes the IGX trunks. The card groups are:

- Universal Switching Module (UXM)
- ATM Line Module B (ALM/B)
- Broadband Trunk Module (BTM)
- Network Trunk Module (NTM)

Note With Release 9.1 software, an IGX 8420 or 8430 switch can support a maximum of 32 trunks.

Trunk Operating Modes

IXG trunk cards operate in either *simple gateway* or *complex gateway* mode. Complex gateway supports *network interworking*. For a description of tiered networks, trunks, ATM protocols, and cell and header formats, refer to the *Cisco System Overview.*

The simple gateway loads 24-byte FastPacket cells into ATM cells in ways that are consistent with each application. (Each of the two FastPackets loaded into the ATM cell is loaded in its entirety, including the FastPacket header). For example, two FastPackets can go into one ATM cell if both FastPackets have the same destination.

Complex gateway is supported by streaming the frame relay data into ATM cells, cell after cell, until the frame has been completely transmitted. Since only the data from the FastPacket is loaded, the Complex gateway is an efficient transmission mechanism. Additionally, discard eligibility information carried by the frame relay bit is mapped to the ATM cell CLP bit, and vice versa.

Trunk Card Maintenance

Trunk cards require no maintenance except for replacement after a confirmed failure.

Loopback Test

A trunk loopback test runs when an ATM trunk detects an integrated alarm. The loopback test indicates if the line or the card is faulty. A loopback test “pass” means the *line* is faulty, so a line alarm is subsequently indicated. A loopback test “fail” means the *card* is faulty. If the card is faulty, a switch occurs to an available Y-Cable equipped redundant card.

Common Alarms, Controls, and Indicators

Front cards and back cards have faceplates with indicator LEDs. Most cards have both a green Active LED and a red Fail LED at the bottom of the faceplate. For definitions of the port status LEDs on a back card, refer to the section that describes the back card.

Note In slots where no back card exists, a blank faceplate must reside to block Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI) and to ensure correct air flow.

Table 3-10 Common Card Status Indicators

Indicators	Status	Meaning
Fail	ON Steady	Indicates an error occurred. First, reset the card with the **resetcd f** command. If the LED comes on again, call the TAC.
Fail	Blinking	On an NPM in a redundant system, this combination indicates that the card is being updated.
Active	ON steady	When steadily on, this combination indicates the card is active and carrying traffic or processing data.
Active	ON momentarily	When momentarily on, indicates the card executed a self-test.
BOTH	OFF	Indicates the card is either part of a redundant pair and is in standby or is not being used at all.
BOTH	ON	Indicates the card failed but remains active because no standby card is available. One or more lines failed, but others remain active.

Universal Switching Module

This description of the Universal Switching Module (UXM) covers the following topics:

- An introduction includes sections on the UXM mode of operation, trunk-mode features, interface card list, card redundancy, card mismatch, clock sourcing, Cellbus bandwidth usage, configuration for public ATM network service, and configuration for cell trunk-only routes
- Supported traffic and connection types
- Inverse Multiplexing Over ATM (IMA)
- Activation and configuration of a UXM for trunk-mode operation
- Supported traffic and connection types
- Alarms for physical lines and logical (IMA) trunks
- Descriptions of the faceplates on the back cards

The Universal Switching Module (UXM) can function in one of two modes. In *trunk mode*, the UXM supports trunks in the network. In *port mode*, it as either an ATM User-to-Network Interface (UNI) or a Network-to-Network (NNI) interface. The back cards support multiple ports operating at OC3/STM1, T3, E3, T1, or E1 rates.

Note The word "port" has two uses in a Cisco WAN switch. "Port mode" refers to the function of an interface at the edge of a network—the endpoint at which you add connections (UNI) or the interface between two networks (NNI). Examples of port cards are the UVM, UFM, ALM/A, and port-mode UXM in an IGX switch or an ASI in a BPX switch.

On the other hand, a "port" is also a layer of logical functionality that applies to port cards as well as trunk cards. For example, whether you activate a line to a router or activate an ATM trunk to the network, you must subsequently configure the logical port in either case.

For a UXM, therefore, the documentation describes a logical "port" on a port-mode UXM for a UNI or NNI at the edge of a network, yet it also refers to a "port on a UXM trunk" as a layer of logic.

Introduction to the UXM Trunk Mode

The UXM can transport ATM cells to and from the Cellbus at a maximum rate of 310 Mbps in either direction. The UXM can support up to 8000 connections in trunk mode. 4000 connections in trunk mode are reserved for gateway connections. As later paragraphs describe, a connection can be a user-connection, gateway connection, or networking connection.

The UXM communicates only ATM cells to either the network or the CPE. On the Cellbus, however, the UXM communicates either ATM cells or FastPackets according to the card type. With another UXM, it communicates only in ATM cells. With other cards, the UXM communicates in FastPackets. Through its gateway functionality, the UXM translates between FastPackets and ATM cells so it can transport voice, data, or Frame Relay traffic that other cards have put in FastPackets.

Determining the UXM's Mode of Operation

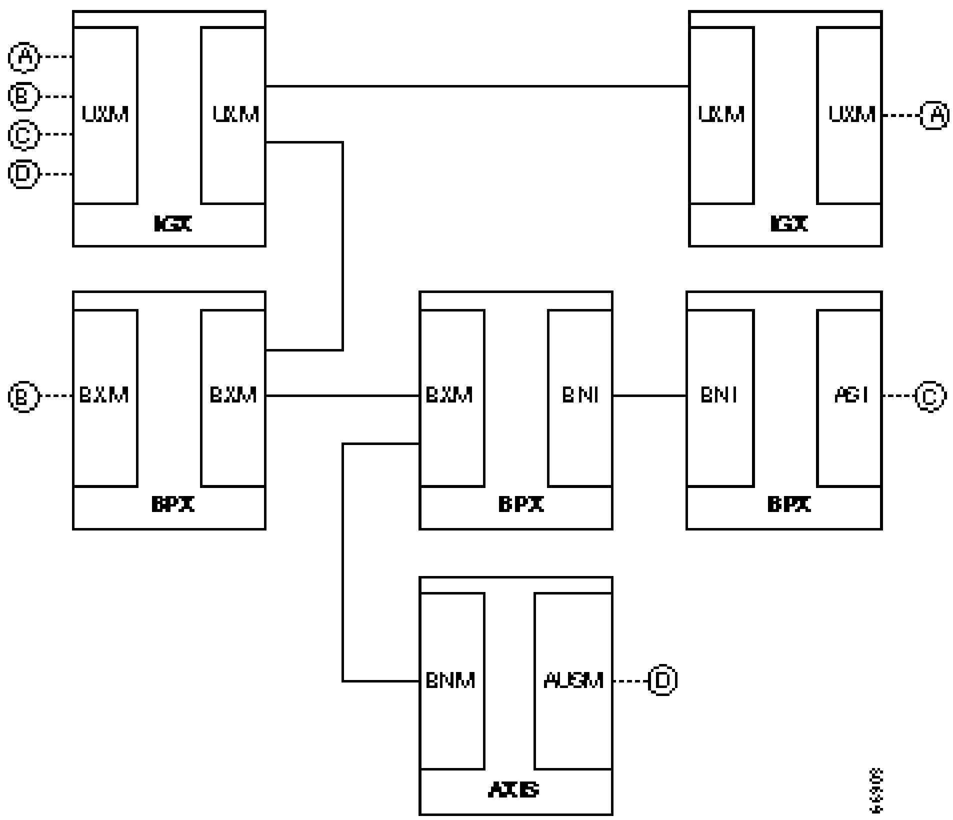
The UXM firmware detects the mode of the card and reports it to switch software when you first activate either a trunk to the network or a line on the UNI or NNI. If you activate a trunk, the UXM goes into trunk mode. If you activate a line, the UXM goes into port mode. The CLI commands for these operations are **uptrk** and **upln**, respectively. (The UXM description in this chapter lists important information about the commands that apply to the UXM, but the order of their use appears in the *Cisco IGX 8400 Series Installation* guide. For a detailed description of each command and its parameters, see the *Cisco WAN Switching Command Reference*.)

Example Networks With UXMs

Networks with both trunk mode and port mode UXMs appear in Figure 3-6 and Figure 3-7, respectively. The nodes in Figure 3-6 use only UXMs for port interfaces and trunk interfaces. Figure 3-7 shows a variety of cards providing interfaces for different traffic types.

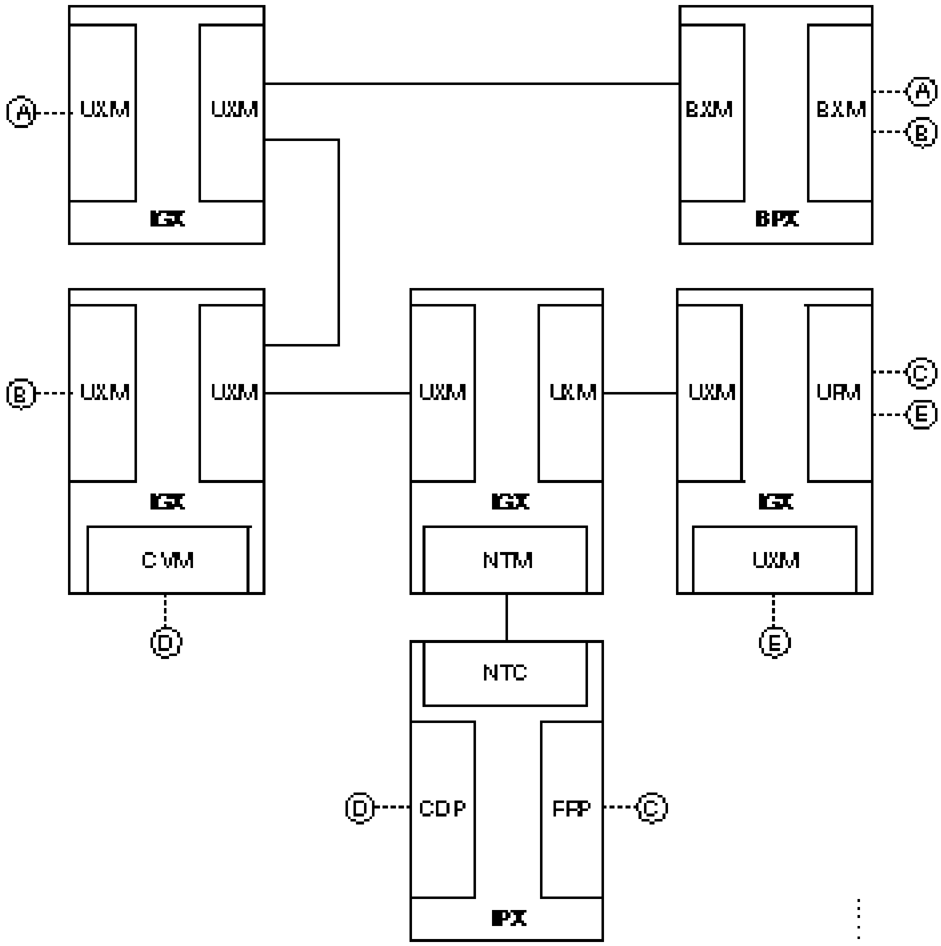
The network carrying only ATM traffic appears in Figure 3-6. Each UXM trunk card in Figure 3-6 connects to either another UXM trunk card or a BXM operating as a trunk. The ATM UNI ports are the UXM port cards (for connection A), the BXM operating in port mode (for connection B), the ASI (for connection C), and the BXM feeder trunk (for connection D). Connection D is a two-segment connection. One segment of connection D exists between the BNM and AUSM on the Cisco MGX 8220 shelf, and the other segment exists between the BXM and the UXM UNI port.

Figure 3-6 UXMs in a Network With Pure ATM Traffic



A network with ATM traffic and FastPacket-based traffic appears in Figure 3-7. Connections A and B are ATM connections that terminate on UXM UNI port cards and a BXM operating as a UNI port. Connection C is a Frame Relay connection between a UFM and an FRM. Connection D is a voice connection between a CVM and CDP. Connection E is a DAXCON between a UFM and a UXM UNI port. For connections C–E, the gateway function of the UXM packs and unpacks the FastPackets into and out of the ATM cells.

Figure 3-7 UXMs in a Network With Heterogeneous Traffic



UXM Trunk Features

The following list broadly identifies the features of a UXM trunk. After the bulleted list, the remaining sections of this introduction contain tables that list the features on particular topics, such as interworking. Actual descriptions of the features appear in the section titled "The UXM in Trunk Mode."

- The UXM uses all four lanes of the Cellbus.
- In trunk mode, the UXM supports up to 8000 connections. Of the 8000 connections, 4000 are reserved for gateway connections. For a *gateway* connection, the UXM translates between ATM cells and FastPackets.
- The maximum throughput is 310 Mbps—two times the OC3 (STM1) rate. This maximum applies whether the back card is a 2-port or 4-port back card. In practical application, this maximum rate means that most trunk applications with an OC3 interface would use the 2-port back card.
- The UXM supports ATM-to-Frame Relay network and service interworking.
- For the ABR connection types, the UXM supports EFCI marking, Explicit Rate Stamping, and Virtual Source/Virtual Destination (VS/VD).
- The UXM supports Y-cable redundancy with hot standby for very fast switchover.

- The front card has 128K cell buffers.
- For statistics support, the UXM provides real-time statistics counters and interval statistics collection for ports, lines, trunks and channels.
- The UXM can form a logical trunk by grouping more than one T1 or E1 port. The name of this (purchased) option is Inverse Multiplexing Over ATM (IMA).
- The on-board diagnostics are *loopback*, *self-test*, and *background*.

UXM Interfaces

Table 3-11 is a list of the UXM back cards. Figure 3-8 shows the UXM front card. Table 3-12 defines all possible combinations for the states of the front card status LEDs (Fail, Active, and Standby).

Table 3-11 Back Cards for the UXM

Card Name	Card Description
BC-UAI-4-155-MMF	4-port Multi-Mode Fiber 155 Mbps
BC-UAI-4-155-SMF	4-port Single Mode Fiber 155 Mbps
BC-UAI-2-155-SMF	2-port Single Mode Fiber 155 Mbps
BC-UAI-6-T3	6-port T3 back card
BC-UAI-3-T3	3-port T3 back card
BC-UAI-6-E3	6-port E3 back card
BC-UAI-3-E3	3-port E3 back card
BC-UAI-8-T1-DB15	8-port T1 back card with DB15 connector
BC-UAI-8-E1-DB15	8-port E1 back card with DB15 connector
BC-UAI-8-E1-BNC	8-port E1 back card with BNC connector
BC-UAI-4-T1-DB15	4-port T1 back card with DB15 connector
BC-UAI-4-E1-DB15	8-port E1 back card with DB15 connector
BC-UAI-4-E1-BNC	4-port E1 back card with BNC connector

Figure 3-8 UXM Front Card

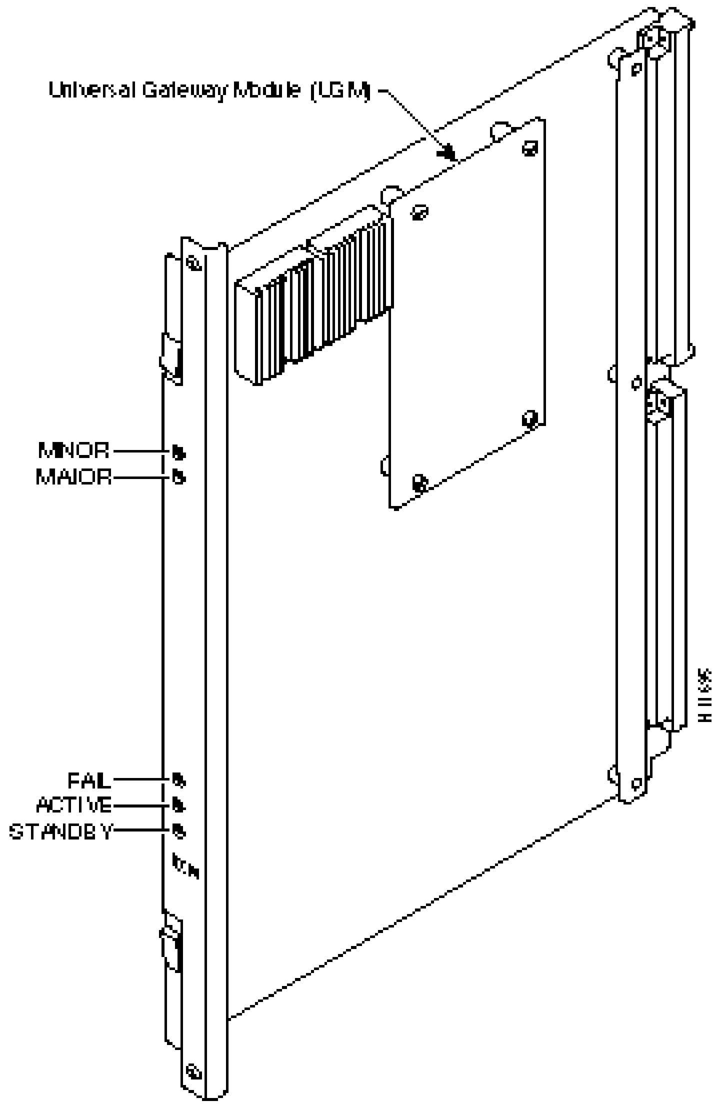


Table 3-12 UXM Status LEDs

Fail	Active	Standby	Status of Card
On	Off	Off	Failed
Blinking	Blinking	Off	Back Card Mismatch (hot standby)
Blinking	On	Off	Back Card Mismatch (active)—can be missing back card
Blinking	Off	Blinking	Back Card Mismatch (self-test)
Blinking	Off	On	Back Card Mismatch (standby)
Off	Blinking	Off	Hot Standby
Off	On	Off	Active
Off	Off	Blinking	Self-test
Off	Off	On	Standby
On	On	On	Down

Maximum Number of UXMs

Switch software limits the number of logical trunks and ports on an IGX switch. The maximum number of UNI or NNI ports in an IGX switch is 64. The maximum number of logical trunks is 32. To determine the number of each logical type in the switch, add the number of ports on multiport cards and single-port cards. These sums cannot exceed 64 ports and 32 trunks. For example, using exclusively 2-port OC3 trunks, you could install:

2 trunks per card x 16 OC3 UXMs=32 trunks

Switch software monitors the number of logical ports and trunks, not the number of UXMs. Therefore, the software keeps you from activating an excessive number of lines or trunks on the node rather than flagging the presence of too many cards.

Y-Cabled UXM Redundancy

The UXM features *hot standby* as a part of its Y-cable redundancy capability. With hot standby, the redundant card receives the configuration information as soon as you finish specifying redundancy. The standby card also receives updates to its configuration as the active card configuration changes. Hot standby lets the backup card go into operation as soon as necessary rather than waiting for the NPM to download the configuration.

Y-cable redundancy requires that both cards are active and available before you set up redundancy. Use StrataView Plus or the CLI commands **uptrk**, **addtrk**, then **addyred**. (See also descriptions of **addyred**, **delyred**, **dspyred**, and **ptyred** in the *Cisco WAN Switching Command Reference*.)

Switchover to a Redundant UXM

If the card fails, a switchover occurs to a Y-cabled, redundant UXM card set if available. If the switchover occurs, the primary UXM acquires failed status, and the Fail LED turns on.

Card Mismatch

The UXM supports two types of card mismatch notification. The notification common to all cards occurs when you connect an unsupported back card to the front card. The mismatch notification unique to the UXM occurs if you attach a supported back card but one that has a different interface or a *smaller* number of the *correct* line types than what firmware previously reported to software.

Firmware informs switch software of the number and type of interface ports when you first activate a UXM. Software retains the back card configuration data if you remove it. If you subsequently attach a card with fewer ports, switch software flags a mismatch. Replacing a back card with *more* ports of the *same* line type or exchanging SMF and MMF OC3 (STM1) cards is not a mismatch. To change the interface that software has on record, you must first down the card then re-activate it.

The UXM as a Clock Source

A UXM line or trunk can be the clock source for the node. Use the **dspclksrcs** command to display available clock sources, **dspcurclk** to show the current clock source, and **cnfclksrc** to specify a new clock source. To clear clock alarms, use **clrclkalm**.

Cellbus Bandwidth Usage

The Cellbus consists of four operational lanes plus one backup lane. (The backup lane becomes active if a lane fails.) The FastPacket-based cards can use only one lane and communicate only in FastPackets. If a FastPacket-based card controls the Cellbus, no ATM cells can be on the Cellbus.

When the UXM has control of the Cellbus, it can pass any of the following:

- ATM cells on all lanes (for example, with a daxcon between UXMs or when one UXM communicates with another UXM in the same switch)
- FastPackets on lane 1 simultaneously with ATM cells on lanes 2–4
- FastPackets on lane 1

Switch software monitors and computes Cellbus bandwidth requirements for each card in the Cisco 8400-series switches. For the UXM alone, you can change its Cellbus bandwidth allocation. (You cannot view or alter bandwidth allocation for other cards.) The unit of measure for the ATM cell and FastPacket bandwidth on the Cellbus is the universal bandwidth unit (UBU).

Switch software allocates a default number of UBUs for a card when the card's firmware identifies the back card interface to switch software. If you remove a card, switch software reserves the existing Cellbus bandwidth allocation for that card. As the number of connections through the trunk significantly grows, switch software increases the number of UBUs. If your connection additions approach oversubscription, switch software presents a warning message. Regardless of the automatic bandwidth increases and warning message, Cisco advises against oversubscription because of burstiness.

For the UXM, software increases the bandwidth to meet the requirements for the minimum cell rate (MCR) and therefore does not accommodate burstiness. Because the automatic increase does not relate to burstiness, you must monitor the UXM bandwidth requirements to determine if you should change its UBU allocation. Monitor the bandwidth requirements after you build the network and during normal operation. On the CLI, the applicable commands are **cnfbusbw** and **dspbusbw**.

You can raise, lower, or check a UXM's UBUs with **cnfbusbw**. The **cnfbusbw** privilege level is 0—superuser. To check a UXM's UBUs, use **dspbusbw** or **cnfbusbw**. Any user can use **dspbusbw**. Each command's display provides the information you need to determine if you must increase the UBUs on a particular UXM. The only value you can change is *allocated bandwidth*. An example display for **cnfbusbw** appears in Figure 3-9. The *card-based* default and maximum Cellbus bandwidth for each interface appears in Table 3-13. Note that FastPackets require substantially less Cellbus bandwidth than ATM cells. The FastPacket requirements in the figure and table reflect the restriction of FastPackets to one lane and the maximum processing rate of the gateway on the UXM. The values you can view with the **cnfbusbw** and **dspbusbw** commands are:

- *Minimum Required Bandwidth*, the necessary bandwidth that switch software has calculated for the existing connections on the local UXM. The display shows the requirements for FastPackets, ATM cells, and the equivalent in total UBUs.
- *Average Used Bandwidth* is the average bandwidth usage.
- *Peak Used Bandwidth* is the peak bandwidth usage.
- *Maximum Port Bandwidth* is the maximum bandwidth that the back card can support. The FastPackets per second field has a dash-mark because only cells pass through the port.
- *Allocated Bandwidth* is the current Cellbus allocation for the card. The field shows the UBUs, the bandwidth when only ATM cells are on the bus, and cells plus Fastpackets. The reason for cells alone and cells plus Fastpackets is that cells can exist on the Cellbus with or without FastPackets. The last field under *Allocated Bandwidth* shows the formula to which the allocated values must adhere. (A description of the formula follows the example screen.)

Note Adding connections at the local node does not automatically cause the far-end node to increase UBU allocation.

Figure 3-9 Example Display for cnfbusbw

```
StrataCom          TN     Cisco       IGX 16    9.1 Apr. 7 1998  03:15 GMT

Bus Bandwidth Usage for UXM card in slot 5   Last Updated on 04/07/98 03:15:42

                          FPkts/sec   Cells/sec    UBUs
Minimum Reqd Bandwidth:           0      100100     26
Average Used Bandwidth:           0           0      0
Peak    Used Bandwidth:           0           0      0
Maximum Port Bandwidth:           -      288000     72

Allocated    Bandwidth:                              1
           (Cell Only):           -        4000
           (Cell+Fpkt):        2000        3000
           (Fpkts / 2 + Cells)   <=        4000


Reserved     Bandwidth:           -        4000      1

This Command: cnfbusbw 5


Allocated UBU count:
```

Table 3-13 Cellbus Bandwidth Allocation for UXM Interfaces

Interface Type	No. of Ports	Default UBUs	Default Cell Traffic Only (cps)	Default Cell + Fpkt Traffic (cps and fps)	Max. UBUs	Max. Cell Traffic Only (cps)	Maximum Cell + Fpkts Traffic (cps and fps)
OC3	4 or 2	44	176,000	132,000, 88,000	235	708,000	473,000, 470,000
T3	6 or 3	24	96,000	72,000, 48,000	235	708,000	473,000, 470,000
E3	6 or 3	20	80,000	60,000, 40,000	235	708,000	473,000, 470,000
T1	8	8	32,000	24,000, 16,000	32	128,000	96,000, 64,000
T1	4	4	16,000	12,000, 8,000	16	64,000	48,000, 32,000
E1	8	10	40,000	30,000, 20,000	40	160,000	120,000, 80,000
E1	4	5	20,000	15,000, 10,000	20	80,000	60,000, 40,000

Planning for Cellbus Bandwidth Allocation

With the Network Modeling Tool™ (NMT), you can use the projected load for all UXMs in the network to estimate their Cellbus requirements. During normal operation, you can use StrataView Plus to obtain the trunk and port statistics then decide whether to use **cnfbusbw** to increase the UBU allocation. If you are using only the CLI, you would need to establish a virtual terminal (**vt**) session to each node then execute **dspbusbw** or **cnfbusbw**.

Calculating Cellbus Bandwidth Changes

To determine how many UBUs are necessary, use the values for *average bandwidth used* (see Figure 3-9) in the following formula:

$$UBUs = \frac{\frac{fps}{2} + cps}{4000}$$

In most circumstances, the *fps* and *cps* values from *average bandwidth used* are sufficient. The *peak bandwidth used* values are primarily informational.

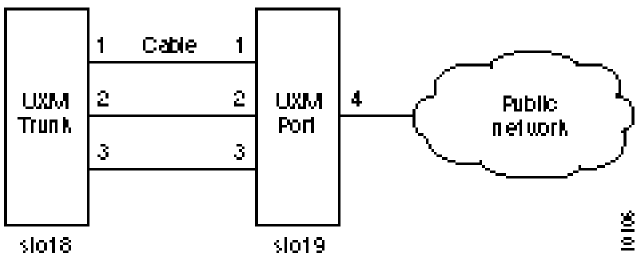
The information in Table 3-13 provides the ranges for the interface type. Note that, if you do the math according to the formula, you see that the value in the cells-alone column of Table 3-13 equals the result of adding half the FastPacket value to the cell value in the cells plus FastPackets column.

When you use **dspbusbw**, a yes/no prompt asks if you want firmware to retrieve the usage values. If you enter a “y,” the UXM reads—then clears—its registers and thus restarts statistics gathering. If you enter an “n,” switch software displays the current values that reside in control card memory (on the NPM). The values in memory come from the last update from the UXM.

ATM Across a Public ATM Network

The UXM can support trunking across a public ATM network such that both virtual channel connections (VCCs) and virtual path connections (VPCs) traverse a single virtual path trunk. This feature lets you map multiple trunks to a single port of an NNI. The NNI connects to either a public or private ATM network. The virtual trunk package is a lower-cost alternative to leased circuits but still has the full set of Cisco ATM traffic management capabilities. This application requires two UXMs and a clock from an external source. The rates can be OC-3/STM-1, T3/E3, or T1/E1.

Figure 3-10 UXMs Configured for a Public ATM Network



Refer to Figure 3-10 as you read the steps for the following example set-up:

Step 1 Connect a cable between each of the following:

- 8.1 and 9.1
- 8.2 and 9.2
- 8.3 and 9.3
- 9.4 and the public network

Step 2 Configure trunk 8.1, 8.2, and 8.3 to use VPC 101, 102, and 103 respectively.

Step 3 Add three VPC connection from 9.1, 9.2, and 9.3 to 9.4. At the remote end, use the same VPCs.

Routing Over Cell Trunks Only

You can specify *trunk cell routing only* as an option when you add a connection between UXM, ASI, or BXM ports. When you enable trunk cell routing, switch software uses only the cell-based trunk cards BNI, BXM, and UXM for routing, and no conversion to FastPackets occurs at any point along the route. If you add connections at other port cards, such as a UFM or ALM/A, switch software disables the cell routing option. On the CLI, the **addcon** prompt for this option appears as "trunk cell routing restrict y/n?" It appears after you enter either the ATM class of service or after you finish specifying all the individual bandwidth parameters that apply to the connection type you select.

The UXM in Trunk Mode

The UXM trunk can communicate ATM cells that originated at an ATM endpoint or—through its on-board gateway functionality—FastPacket-based traffic such as voice, data, and Frame Relay. A UXM trunk can connect to the following trunk cards:

- UXM
- BXM

Types of Supported Traffic

As previously stated, the UXM trunk can connect to only another UXM trunk or a BXM trunk. On the other hand, the types of traffic that traverse a UXM trunk can originate at ATM ports or other types of ports. The types of traffic that a cell on a UXM trunk can carry appear in Table 3-14 and Table 3-15. Table 3-14 shows the supported traffic that terminates on ATM ports. Table 3-15 shows the traffic types that ATM cells can carry where the payload originated as a FastPacket.

Table 3-14 Connections From ATM Endpoints

Connection Type
CBR.1
VBR.1, VBR.2, VBR.3
ABR with VSVD
ABR without VSVD
ABR with ForeSight
UBR.1, UBR.2

Table 3-15 Traffic From FastPacket-Based Cards

Traffic Type
Timestamped
Non-timestamped
Voice
Bursty data A
Bursty data B
High priority
CBR, VBR, ABR

Types of Connections on a UXM Trunk

This section introduces the connections that a UXM trunk supports. The context of each description is the trunk rather than the connection endpoints. The purpose of these descriptions is not only to inform but also help you plan the network. Some definitions overlap because a connection may qualify as more than one type.

- A *Cell connection* carries information that exists in ATM cell format throughout the path. On a UXM trunk, therefore, the only *cell* connections are those that have originated on a UXM port at one end and remain in cell format throughout the connection.
- A *Gateway connection* carries information that normally exists in ATM cell format but is translated to FastPacket format for some purpose at some point along the path. Reason for the translation could be that the connection terminates on a FastPacket-based card, is a network connection, or includes a FastPacket-based trunk card in the route.
- A *Networking connection* carries network messages between nodes and terminate as FastPackets (and therefore are also gateway connections).

- A *User-connection* is a connection that a user has added at the current node. User-connections can be cell connections or gateway connections. User connections are mutually exclusive of via connections and network connections.
- A *Via connection* passes through a node and does not terminate on the node. You can neither view nor alter a via connection because the connection does not terminate on the node (the node that owns the connection has made the via node and trunk a part of the route).
- An *Interworking connection* is a service or network interworking connection in which one end terminates as ATM and the other as Frame Relay. Interworking connections are a subset of gateway connections.

Operating as a trunk, the UXM carries up to 8000 connections. The card reserves 4000 cell connections and 4000 gateway connections. A via connection can be either a cell-type or a gateway-type.

Because network messages use gateway channels, they subtract from the total number of available gateway connections. For each *active* port, the UXM reserves 270 gateway connections for networking regardless of the interface type. Therefore, with a fully-utilized 8-E1 or 8-T1 back card, the UXM reserves up to 2160 connections. Because these numbers potentially represent a very significant reduction in the number of gateway connections for user-data, switch software lets you specify a maximum number of active ports on the back card. The most applicable interfaces for this capability are the T1 and E1 ports, especially with Inverse Multiplexing Over ATM (IMA). See the section “Inverse Multiplexing Over ATM” for the description of IMA.

You can specify the maximum number of *logical* trunks that can be active on a card through StrataView Plus or the CLI. The applicable CLI command is **cnftrkport**. For example, if you intend an eight-port card to have two logical (IMA) trunks, you can use **cnftrkport** to specify a maximum number of two trunks. Software would therefore reserve 540 connections for network messages rather than the 2160 connections if you did not specify a maximum.

Inverse Multiplexing Over ATM

Inverse Multiplexing Over ATM (IMA) lets you group physical T1 or E1 lines to form a logical trunk. A logical trunk consisting of more than one T1 or E1 line supports connections with data rates that are much higher than the T1 or E1 rate. Software lets you specify IMA so that one or more physical lines within the logical trunk can serve as a backup if a line fails.

IMA characteristics are as follows:

- All physical ports of an IMA trunk use the same line configuration.
- Physical port numbers must be sequential.
- The node maintains a set of *retained links* for the IMA trunk to keep it active: the IMA trunk does not fail unless the number of active trunks is less than the user-specified number of retained links.
- The IMA trunk can provide a clock source or clock path (see **cnftrk** command). The first (the lowest numbered) available physical line is used. If this line fails, the next available line within the IMA provides the clock source or clock path.
- Full support for individual physical line alarms and statistics.
- Automatic link-disable option.

To specify the range of ports for an IMA trunk, you can use either StrataView Plus or the CLI. To define an IMA trunk on the CLI, use the **uptrk** command in the following format:

uptrk <*slot*>.<*start_port*>-<*end_port*>

For example, you could enter **uptrk** 8.1–4. Subsequently, you would refer to this logical trunk by using only the slot number and first port number—8.1 in this example—when you use other commands, such as **addtrk**, **deltrk**, **cnftrk**, and so on. Commands for viewing IMA information also include **dspportstats**, **dspphyslns**, and **dspphyslnstathist**.

When you configure an IMA trunk through StrataView Plus or the **cnftrk** command, you enter the number of retained links. The retained links is the number of ports that must remain active for the IMA trunk itself to remain active. If a physical line goes out of service yet the number of active lines is at least as great as the retained links value, the IMA trunk remains active even though the node goes into major alarm. Also, the available load bandwidth is adjusted according to physical line status, so the switch does not reroute connections after a line failure unless the *used* bandwidth becomes greater than the *available* bandwidth.

With the Automatic Link Disable option, you can specify a failure transition rate that causes a physical port within the logical trunk to acquire failed status. If a specified number of failures occur within a specified time window, the physical line becomes inactive. After a user-specified wait period passes, the node attempts to re-activate the line and start another window for monitoring error transitions. This option is available only if the number of retained links is less than the number of physical lines in the logical trunk.

The transmit and receive rate of an IMA trunk is the sum of all physical lines less the IMA protocol overhead. The overhead for each line is one DS0. Using the previous IMA trunk example, the maximum rates are as follows:

for trunk 8.1-4 (with T1 lines),

TX rate = Rx rate = 24 * 4 DS0s – 1 DS0 = 95 DS0s

You could configure the line receive rate to be the maximum bandwidth allowed on this trunk:

total bandwidth=RX rate=95 DS0s

However, if a physical line fails (and the number of retained links are still active), the switch adjusts the total bandwidth. Using the example IMA trunk consisting of four physical T1 lines:

total bandwidth is 95 DS0s – 24 DS0s = 71 DS0s

Upon a physical line failure, connection rerouting may occur. The switch reroutes connections if the used bandwidth is greater than the new, adjusted total bandwidth. The **dsptrks** command shows the logical trunk's alarm status, and **dspphyslns** shows status of the physical lines. When a physical line is repaired, any failed connections are rerouted.

To diminish the possibility of connection rerouting after a physical line failure, set the Line Receive Rate to be at or below the aggregate rate for the retained links rather than the total number of lines in the IMA trunk. You could, in the preceding example, configure the receive rate for 71 DS0s.

Activation and Configuration of a UXM in Trunk Mode

When you insert a new UXM into the backplane or apply power to the IGX node, UXM firmware reports the card type and number of physical lines on the back card. Switch software can then determine the allowed range and characteristics of trunks for you to configure. Software thus prevents you from exceeding the maximum number of trunks on the switch as you activate them through either StrataView Plus or **uptrk** on the CLI.

Table 3-16 shows the trunk characteristics you can configure for each interface type through either StrataView Plus or the **cnftrk** command on the CLI. Table 3-16 also shows the fixed parameters.

Table 3-16 Congifurable Trunk Characteristics

Interface Type	Configurable Parameters
OC3 (STM1) SMF and MMF	• HCS masking (on or off) • Payload scramble (on or off) • Cell (line) framing (STS/SONET or STM/SDH) • Frame scramble (on or off)
T3	• HCS masking (on or off) • Payload scramble (on or off) • Cell (line) framing can be header error correction (HEC) or PLCP • Cable length (0–255 feet or greater than 255 feet)
E3	• HCS masking (on or off) • Payload scramble (on or off) • Cell (line) framing is fixed as header error Correction (HEC) • Cable length (0–255 feet or greater than 255 feet)
T1	• HCS masking (on or off) • Payload scramble (on or off) • Loop clock (enable/disable) • Line framing (ESF or D4) • Cable length (0–655 feet, ABAM cable only) • Idle code • Line coding (fixed as B8ZS)
E1	• HCS masking (on or off) • Payload scramble (on or off) • Line DS0 map (timeslots 0–31 for unframed or 1–15 and 17–31 for framed format) • Loop clock • Idle code • Line coding (fixed as HDB3) • Receive line impedance (BNC fixed at 75 Ohms; DB15 fixed at 120 Ohms)

Alarms for Physical Lines and Logical Trunks

Variations exist in the way switch software supports alarms for physical lines and logical trunks for a trunk-mode UXM. The following list summarizes the approach to physical lines and trunks:

- A UXM trunk is mapped to a physical line object.
- A physical (non-IMA) trunk is mapped one-to-one with a physical line.
- An IMA trunk is mapped to more than one physical line.
- All line alarms (LOS, LOP, and so on) are reported as physical line alarms.
- Software reports other trunk alarms (such as *communication failure*, *communication break*, and so on) as trunk alarms in a manner similar to other, non-UXM trunk alarms.
- For non-IMA trunks, the alarm includes the physical line alarm.
- For IMA trunks, the trunk and physical line alarms are separate and distinct.

The physical layer trunk alarms include LOS, LOF, AIS, Yel, LOP, Path AIS, and Path Yel. To view these alarms, use the **dspphysln** command. When you execute **dspphysln**, any existing alarms appear as the physical line status. For a trunk with one physical line (such as an OC3 trunk or T1/E1 without IMA configured), the integrated alarm status is also shown by the **dsptrks** command.

You can enable the physical line statistical alarm on the CLI through the **cnfphyslnalm** command. You can display existing alarms through the **dspphyslnerrs** command and clear the alarms through the **clrphyslnalm** command.

To enable or disable the physical line or trunk statistical alarms, use **cnftrkalm** command. To display any outstanding alarms, use **dstrkerrs**. To clear the statistical alarms, use **clrtrkalm**.

To see the physical line and trunk statistical alarm types that apply to the UXM, enter the commands for configuring the alarms.

In summary, the applicable commands are **dspphyslns**, **dspphyslnerrs**, **clrphyslnalm**, **cnflnalm**, **dsptrks**, **dsptrkerrs**, **cnftrkalm**, **clrtrkalm**, **dspalms**.

Trunk Statistics for Troubleshooting

In Release 9.1, switch software separates the UXM trunk statistics into physical statistics and logical statistics. (This separation is a deviation from other schemes for trunk statistics management.) The commands in this section are useful primarily for troubleshooting.

The CLI commands **cnfphyslnstats**, **dspphyslnstatscnf**, and **dspphyslnstathist** apply to the statistics for physical lines within an IMA trunk. You can enable the physical line statistics by using **cnfphyslnstats**, display the configuration for statistics with **dspphyslnstatcnf**, and display the statistics themselves with **dspphyslnstathist**.

The logical trunk statistics includes Qbin statistics, VI statistics, and gateway statistics. To enable statistics by using the StrataView Plus, you must use the TFTP mechanism. To configure the logical trunk statistics through the CLI, use **cnftrkstats**. The **dsptrkstatcnf** command shows the configuration of the trunk statistics. To display the logical trunk statistics, use **dsptrkstathist**. These three commands primarily apply to debugging.

Software also supports statistics for trunk ports. Use the **dspportstats** command to display these statistics.

In summary, the following commands let you manage trunk statistics: **cnfphyslnstats**, **cnftrkstats, dspphyslnstatcnf**, **dspphyslnstathist**, **dsptrkstatcnf**, **dsptrkstathist**, and **dspportstats**.

Summary Statistics

You can view summary statistics for a UXM trunk through StrataView Plus or the CLI. The CLI commands are **dspportstats** and **dsptrkstats**.

With **dspportstats**, you can view:

- Port statistics
- IMA statistics
- ILMI/ILMI statistics

With **dsptrkstats**, you can view:

- Qbin statistics
- Gateway statistics
- Virtual interface statistics

UXM Interface Cards

This section provides basic information on the interface back cards for the UXM. The information consists of a general description, an illustration of the card faceplate, and a table describing the connectors and status LEDs. For details on the line technology of each type of interface, see the appendix titled "System Specifications."

Note The T1 and E1 back cards do not have Active and Fail LEDs to indicate *card* status (rather than the port status indicated by the tri-color LEDs). If a T1 or E1 back card failure is detected, all of the tri-color LEDs turn red.

The model numbers of the back cards and the order of their appearance are:

- BC-UAI-4-155-MMF
- BC-UAI-4-155-SMF
- BC-UAI-2-155-SMF
- BC-UAI-6-T3
- BC-UAI-3-T3
- BC-UAI-8-T1-DB15
- BC-UAI-4-T1-DB15
- BC-UAI-6-E3
- BC-UAI-3-E3
- BC-UAI-8-E1-DB15
- BC-UAI-8-E1-BNC
- BC-UAI-4-E1-DB15
- BC-UAI-4-E1-BNC

OC-3/STM1 Back Cards

The OC3/STM1 back cards for the UXM have the single-mode fiber (SMF) and multi-mode fiber (MMF) connections. The cards are:

- BC-UAI-2-155-SMF
- BC-UAI-4-155-SMF
- BC-UAI-4-155-MMF

As indicated by the "2" or the "4" in the model number, these cards have two or four transmit and receive connectors. Each *line* has a tri-color LED whose color indicates its status. Each card also has a red Fail LED and a green Active LED to indicate the status of the *card*. Table 3-17 lists the connectors and LEDs. Figure 3-11 shows the four-port OC3/STM1 card. The SMF and MMF versions appear the same. Figure 3-12 shows the two-port OC3/STM1 card. For technical data on OC3/STM1 lines, see the appendix titled "System Specifications."

Table 3-17 Connectors and LEDs for SMF and MMF Back Cards

Connector/Indicator	Function
Transmit and receive	SC connector for SMF and MMF
Red (on the tri-color LED)	On indicates line is active but a local alarm was detected.
Yellow (on the tri-color LED)	On indicates line is active but a remote alarm was detected.
Green (on the tri-color LED)	On indicates line is active.
Fail light (red)	An error was detected. Reset the card with **resetcd f** to clear it. If Fail comes on again, call the TAC through Cisco Customer Engineering.
Active light (green)	The card is active and in service.

Figure 3-11 BC-UAI-4-155-SMF Faceplate

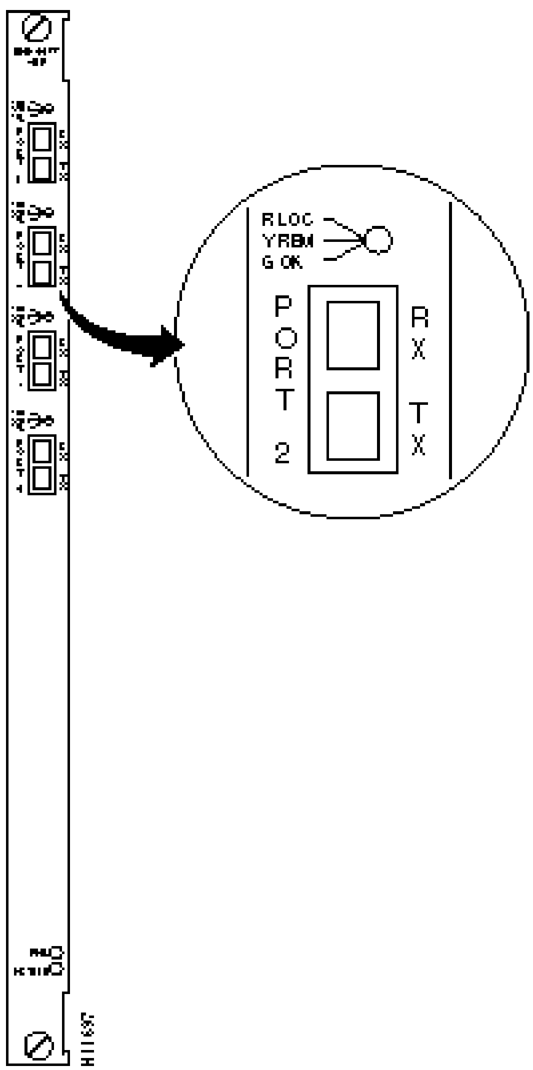
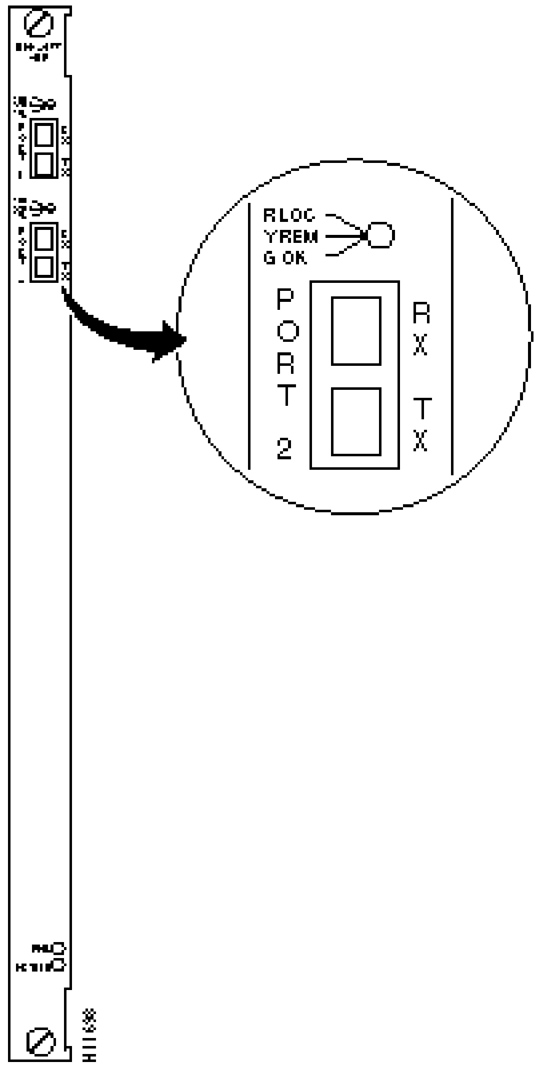


Figure 3-12 BC-UAI-2-155-SMF Faceplate



T3 Back Cards

The T3 back cards for the UXM are BC-UAI-6-T3 and BC-UAI-3-T3. These cards have six and three pairs of SMB connectors, respectively. Each *port* has a tri-color LED whose color indicates its status. Each card also has a red Fail LED and a green Active LED to indicate the status of the *card*. Table 3-18 lists the connectors and LEDs. Figure 3-13 show the six-port T3 card. Figure 3-14 shows the three-port T3 card. For technical data on T3 lines, see the appendix titled “System Specifications.”

Table 3-18 Connectors and LEDs for BC-UAI-6-T3 and BC-UAI-3-T3

Connectors/Indicator	Function
Transmit jacks	SMB connectors for transmit data.
Receive jacks	SMB connectors for receive data.
Red (on the tri-color LED)	On indicates line is active but a local alarm was detected.
Yellow (on the tri-color LED)	On indicates line is active but a remote alarm was detected.
Green (on the tri-color LED)	On indicates line is active.
Fail light (red)	An error was detected. First, reset the card with **resetcd f**. If Fail comes on again, call the TAC through Cisco Customer Engineering.
Active light (green)	The card is active and in service.

Figure 3-13 BC-UAI-6-T3 Faceplate

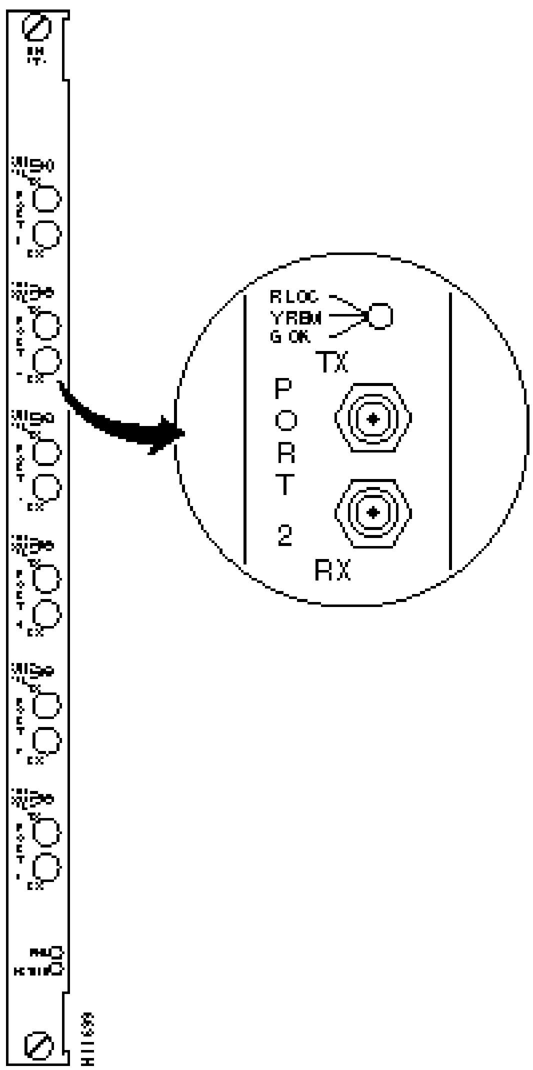
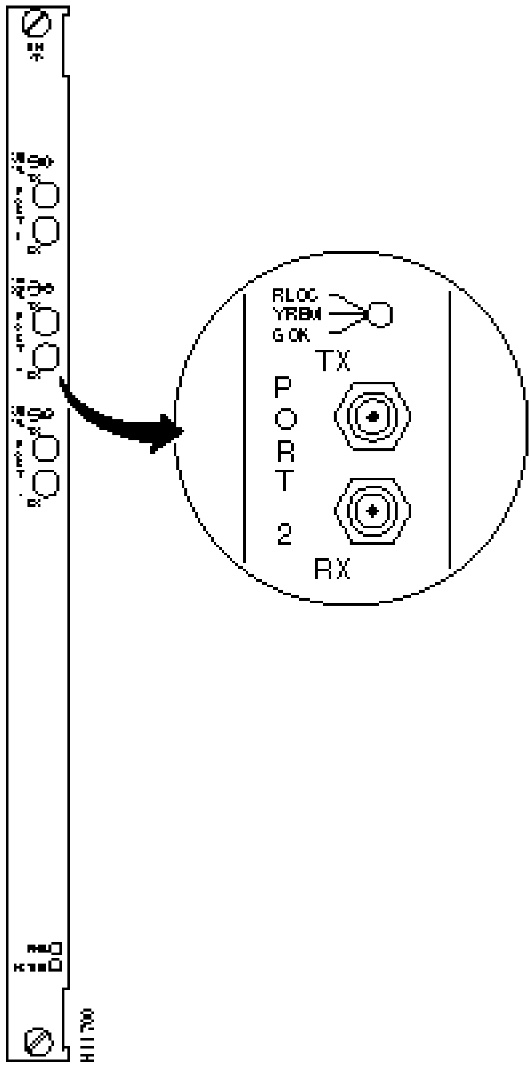


Figure 3-14 BC-UAI-3-T3 Faceplate



E3 Back Cards

The E3 back cards for the UXM are the six-port BC-UAI-6-E3 and the three-port BC-UAI-3-E3. These cards have six and three pairs of connectors, respectively. Each *line* has a tri-color LED whose color indicates its status. Each card also has a red Fail LED and a green Active LED to indicate the status of the *card*. Table 3-19 lists the connectors and LEDs. Figure 3-15 show the six-port card. Figure 3-16 shows the three-port card. For technical data on E3 lines, see the appendix titled "System Specifications."

Table 3-19 Connectors and LEDs for BC-UAI-6-E3 and BC-UAI-3-E3

Connector/Indicator	Function
Transmit Jack	SMB connector for transmit data.
Receive Jack	SMB connector for receive data.
Red (on the tri-color LED)	On indicates line is active but a local alarm was detected.
Yellow (on the tri-color LED)	On indicates line is active but a remote alarm was detected.
Green (on the tri-color LED)	On indicates line is active.
Fail light (red)	An error was detected. Reset the card with **resetcd f** to clear it. If Fail comes on again, call the TAC through Customer Engineering.
Active light (green)	The card is active and in service.

Figure 3-15 BC-UAI-6-E3 Faceplate

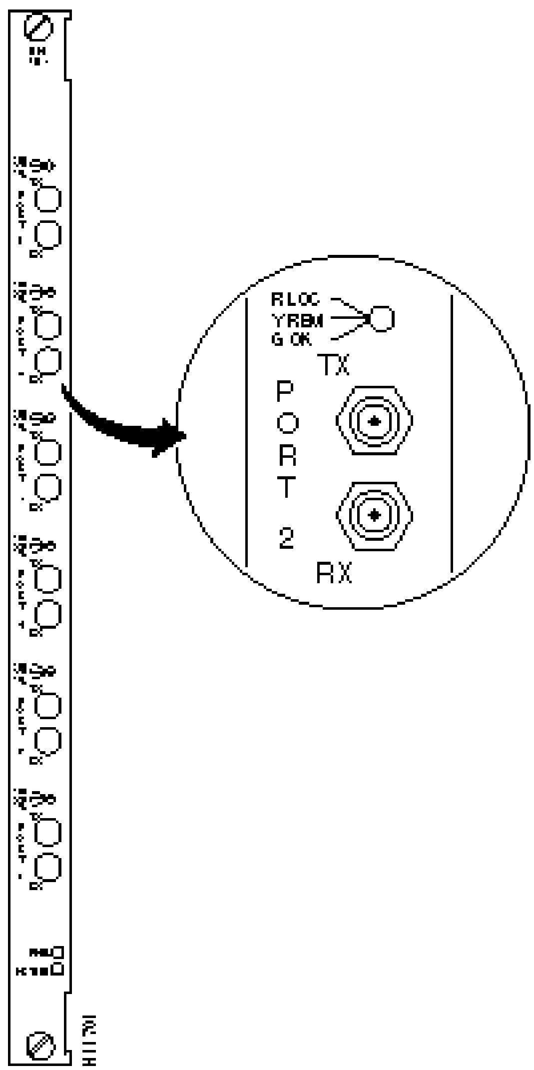
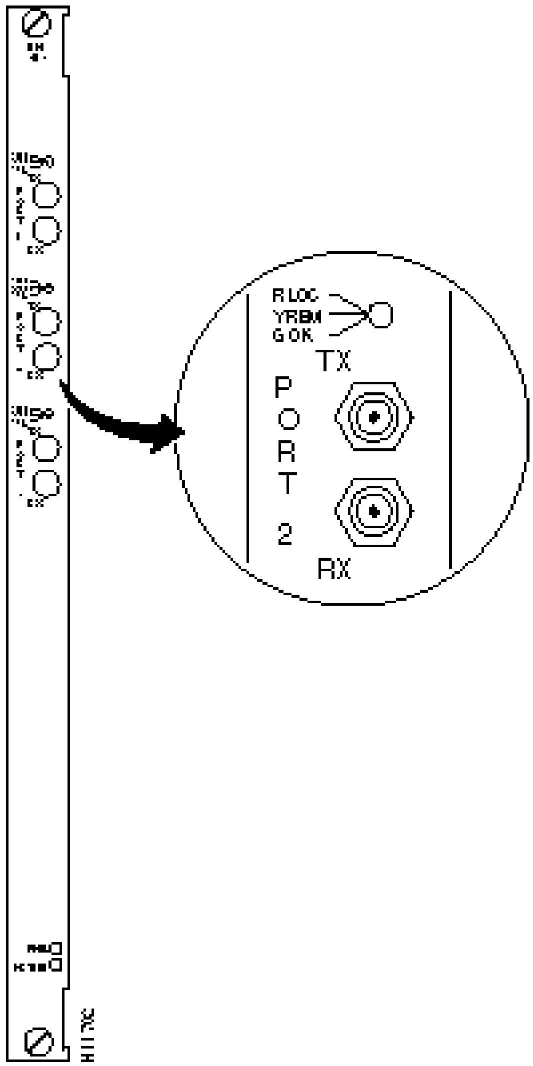


Figure 3-16 BC-UAI-3-E3 Faceplate



T1 Back Cards

The T1 back cards for the UXM are BC-UAI-8-T1 and BC-UAI-4-T1. These cards have eight and four DB15 lines, respectively. Each *line* has a tri-color LED whose color indicates its status. If a card failure occurs, all the LEDs turn red. Table 3-20 lists the connectors and LEDs. Figure 3-17 show the eight-port T1 card. Figure 3-18 shows the four-port T1 card. For technical data on T1 lines, see the appendix titled "System Specifications."

Table 3-20 Connectors and LEDs for BC-UAI-8-T1 and BC-UAI-4-T1

Connector/Indicator	Function
Four or eight DB15s	Each DB15 connector carries transmit and receive data.
Red (on the tri-color LED)	On indicates line is active but a local alarm was detected.
Yellow (on the tri-color LED)	On indicates line is active but a remote alarm was detected.
Green (on the tri-color LED)	On indicates line is active.

Figure 3-17 BC-UAI-8-T1 Faceplate

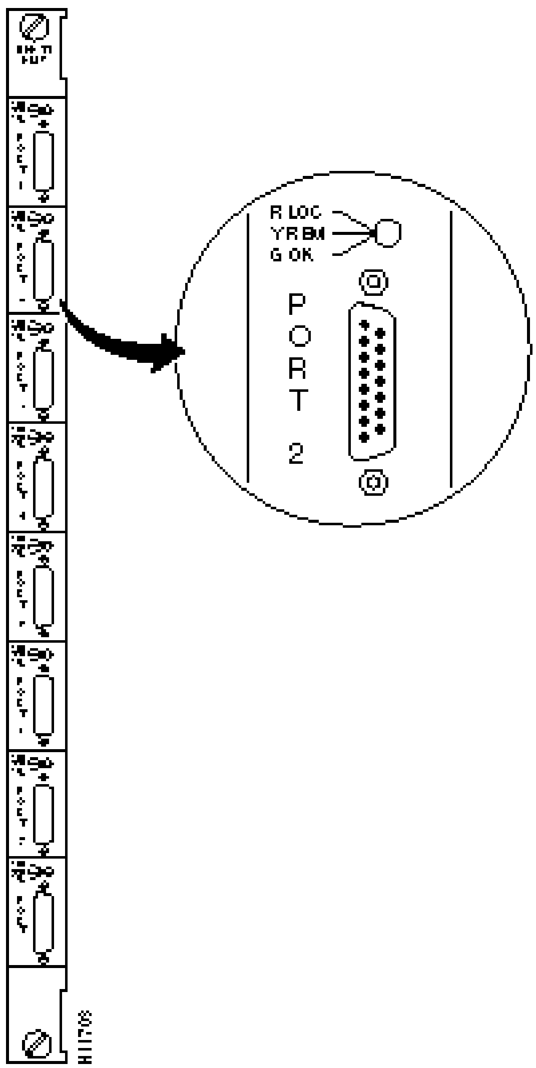
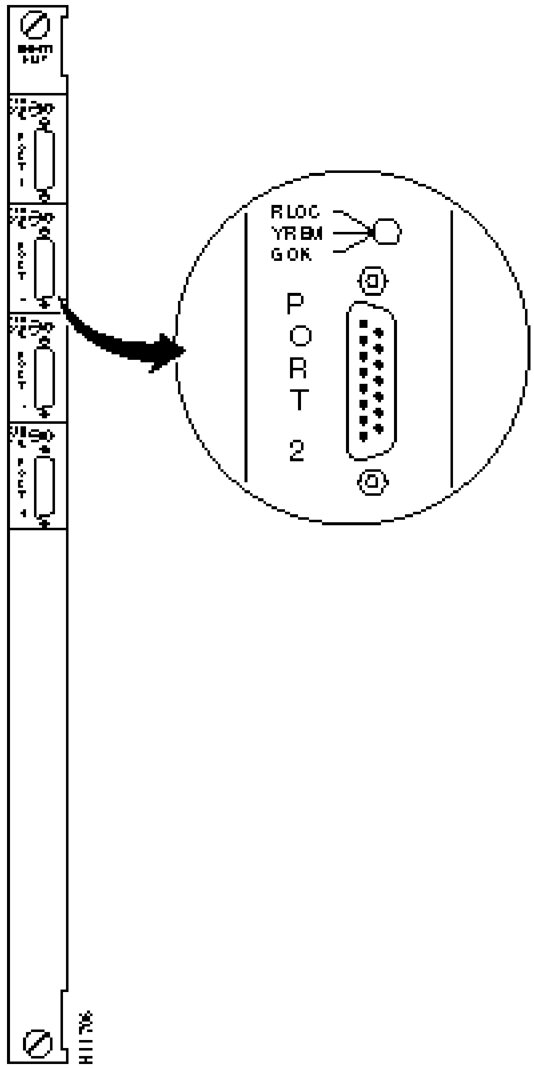


Figure 3-18 BC-UAI-4-T1 Faceplate



E1 Back Cards

The E1 back cards for the UXM are:

- BC-UAI-8-E1-BNC
- BC-UAI-8-E1-DB15
- BC-UAI-4-E1-BNC
- BC-UAI-4-E1-DB15

As the model numbers indicate, the eight and four-port E1 cards can have either BNC or DB15 connectors. Each *line* has a tri-color LED whose color indicates its status. If a card failure occurs on the back card, all LEDs turn red. Table 3-21 lists the connectors and LEDs. Figure 3-19 show the eight-port E1 card. Figure 3-20 shows the four-port T1 card. For technical data on E1 lines, see the appendix titled "System Specifications."

Table 3-21 Connectors and LEDs for BC-UAI-8-E1 and BC-UAI-4-E1

Connector/Indicator	Function
Eight or four DB15 connectors	Each DB15 connector carries transmit and receive data.
Eight or four pairs of BNC connectors	Each BNC connector carries traffic in one direction.
Red (on the tri-color LED)	On indicates line is active but a local alarm was detected.
Yellow (on the tri-color LED)	On indicates line is active but a remote alarm was detected.
Green (on the tri-color LED)	The card is active and in service.

Figure 3-19 BC-UAI-8-E1 DB15 Faceplate

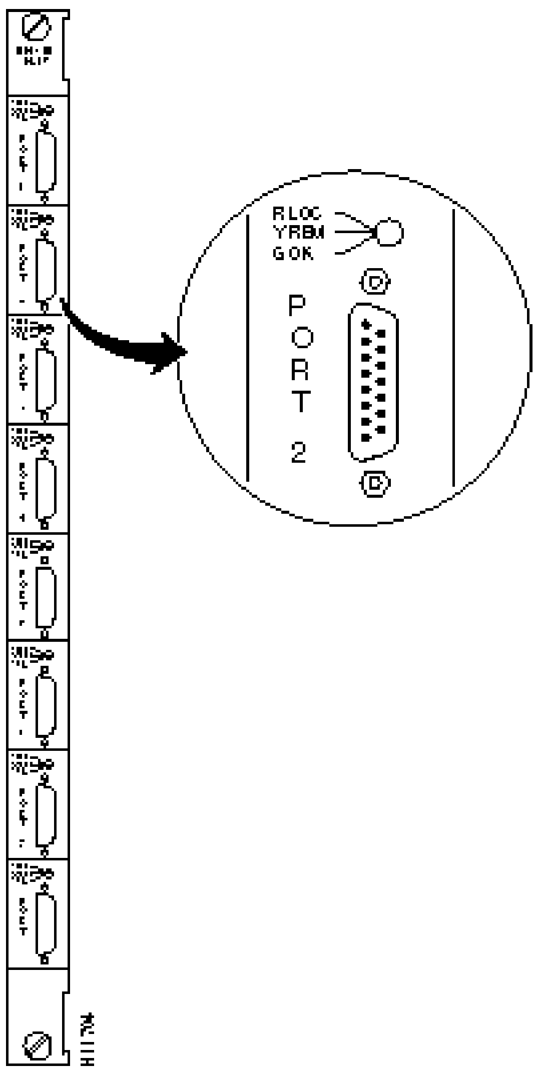


Figure 3-20 BC-UAI-8-E1 BNC Faceplate

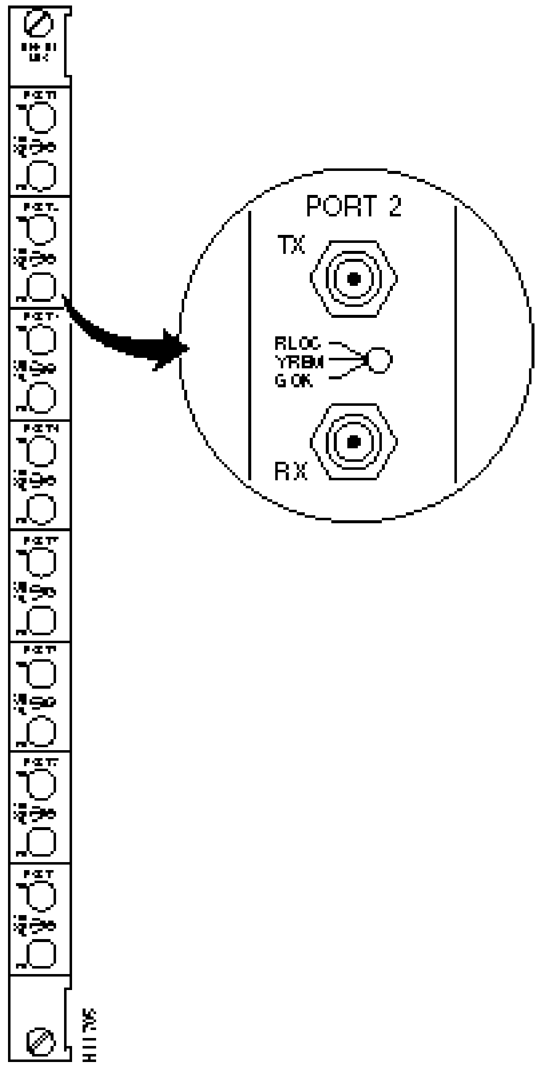


Figure 3-21 BC-UAI-4-E1 DB15 Faceplate

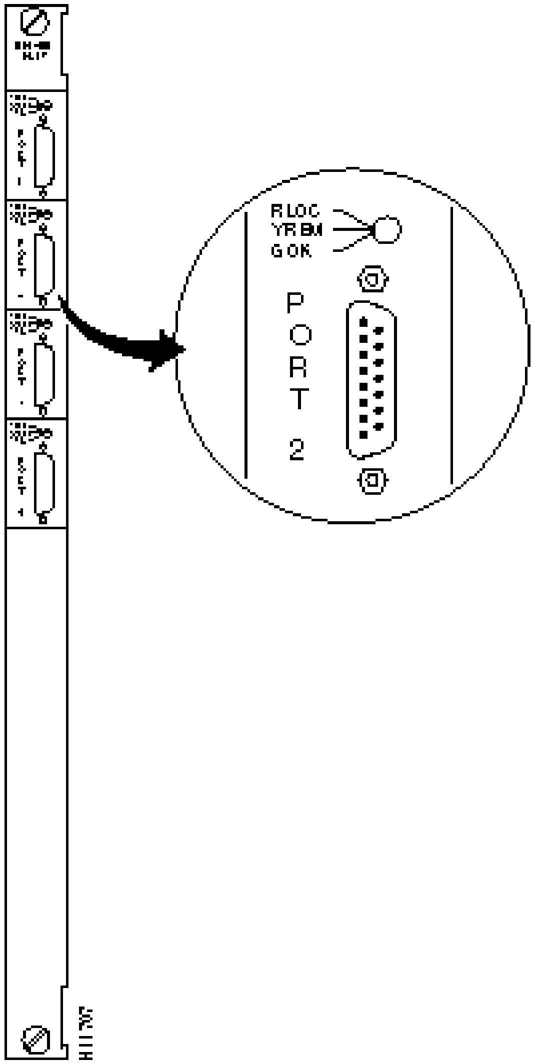
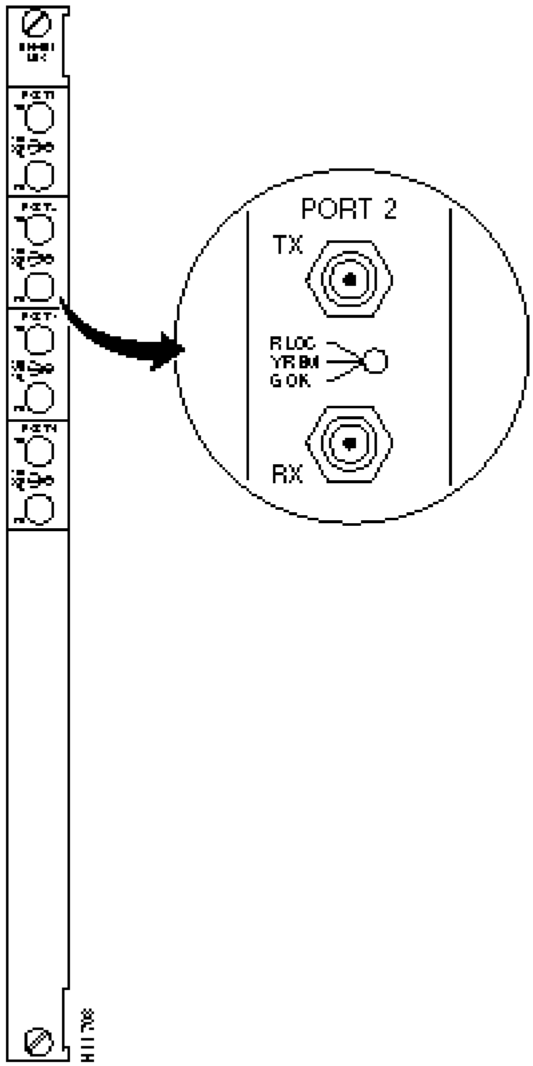


Figure 3-22 BC-UAI-4-E1 BNC Faceplate



Network Trunk Module (NTM)

The Network Trunk Module (NTM) enables FastPacket transmission on a trunk. NTM functions include the following:

- Takes FastPackets off the Cellbus and places them in queues before transmission to the trunk
- Arbitrates access to the trunk for the traffic type
- Monitors the age of each timestamped FastPacket, updates the timestamp for FastPackets at intermediate nodes, and discards FastPackets that exceed age limit
- Receives and checks FastPackets from the trunk and queues them for transmission to the Cellbus
- Provides packet alignment based on the CRC in the FastPacket header
- Extracts clocking from the trunk that can be used as a clock source on the node or as a clock path
- Collects trunk usage statistics

Note The NTM card exists in two forms. One uses an ACM1 adaptor, and the other is a single-card or “native” version. They are functionally identical, but their firmware is not interchangeable. The native NTM requires revision F or later firmware.

An NTM can occupy any available front service card slot in the range 3 to 32. The choice of back card depends on the trunk interface type.

For fractional T1 trunk lines, the NTM and BC-T1 card set can provide the interface. A fractional trunk interface uses a group of 64-Kbps channels to create a partial T1 trunk. For example, a 512-Kbps fractional T1 trunk might use every third channel among channels 1–24. The user makes the channel assignments. For the clock rate, fractional trunks use the basic trunk frequency (such as 1.544 Mbps for T1).

Fractional E1 is the same as fractional T1 except that the channels are 1–15 and 17–31 (0 and 16 reserved), and the clock rate is 2.048 Mbps.

The NTM supports subrate trunks if a BC-SR back card and appropriate local bus are present. Subrate trunks interface to the transmission facility at rates in the range 256 Kbps–2.048 Mbps. Three interface connections are possible: EIA/TIA-449, X.21, and V.35.

Y-Cable Redundancy for the NTM

You can configure the NTM for 1:1 redundancy by using a second, identical, card group in an adjacent slot and a Y-cable to connect the card sets. All NTM back cards support redundancy.

NTM Status

The faceplate of the NTM has four LEDs. The first two in the following list apply to the NTM front card. Each of the other two LEDs is a summary alarm for the back cards. Their significance is:

- The green Active LED indicates the NTM is active and functioning normally.
- The red Fail LED indicates an NTM card failure was detected.
- The yellow Minor LED indicates non-service-interrupting faults or statistical errors that have exceeded a preset threshold.
- The red Major LED indicates a service-affecting failure was detected.

For details on the significance of LEDs, see the *Cisco IGX 8400 Series Installation* manual.

The alarms and line conditions that the NTM monitors include those in the list that follows. To view errors on a trunk, use the **dsptrkerrs** command. To see a list of the (user-specified) errors that **dsptrkerrs** can display, use **dsptrkstatcnf**.

- E1 CRC4 errors
- T1 Bipolar violations
- Near end and far end frame alarms
- Alarm Information Signal (AIS)
- Loss of signal (LOS)
- Line signal frame sync losses
- Packet out of frame

T1 Interface Card (BC-T1)

The T1 Trunk Interface Card (BC-T1) card terminates a single 1.544 Mbps T1 trunk line on the NTM. The BC-T1 can reside in any rear slot 3-8 in an IGX 8410, 3-16 of the IGX 8420, or 3-32 of the IGX 8430. The BC-T1 connects directly to the NTM.

The BC-T1 provides the following:

- Trunk line interfaces to T1 trunks at 1.544 Mbps
- Software selectable AMI or B8ZS (bipolar 8 zero-suppress) line code
- Software selectable D4 or ESF (extended super-frame) framing format
- Configuration as either full or fractional T1 service
- Extraction of receive-timing from the input signal for use as the node timing
- Software selectable line buildout for cable lengths up to 655 feet
- Passes line event information to the front card

B8ZS supports clear channel operation because B8ZS eliminates the possibility of a long string of 0s. B8ZS is preferable whenever available, especially on trunks.

The BC-T1 supports two clock modes. The clock modes are *normal clocking* and *loop timing*. You select the mode through software control. With normal clocking, the node uses the receive clock from the network for the incoming data and supplies the transmit clock for outgoing data. The node can use the receive clock to synchronize itself with the network.

With loop timing, the node uses the receive clock from the network for the incoming data and redirects this receive clock to time the transmit data.

BC-T1 Faceplate Description

Figure 3-23 and Table 3-22 provide information on the faceplate of the BC-T1. When you correlate the descriptions in the table with the callouts in the figure, read from the top of the table to the bottom. The standard port connector is a female DB15.

Figure 3-23 BC-T1 Faceplate

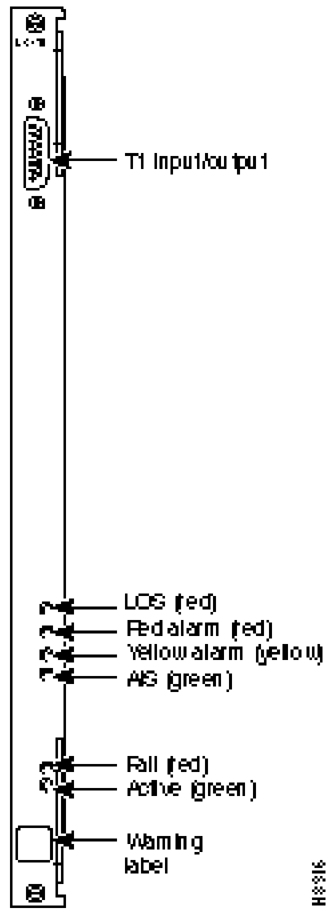


Table 3-22 BC-T1 Connections and Status LEDs

Connector/Indicator	Function
T1 INPUT/OUTPUT	Female DB15 connector for T1 line.
LOS light (red)	Indicates loss of signal at the local end.
Red alarm light (red)	Indicates loss of local E1 frame alignment, or it indicates loss of packet alignment on the NTM.
Yellow alarm light (yellow)	Indicates loss of frame alignment at remote end or loss of packet alignment (NTM).
AIS light (green)	Indicates the presence of all ones on the line.
Fail light (red)	Indicates an error occurred. First, reset the card with the **resetcd f** command to clear the error. If the LED comes on again, contact the TAC through Cisco Customer Engineering.
Active: light (green)	Indicates the card is in service with active circuits.

E1 Interface Back Card (BC-E1)

The E1 Trunk Interface Card (BC-E1) provides an E1 trunk interface for the Network Trunk Module (NTM). The BC-E1 connects directly to the NTM and can reside in any rear slot 3-8 in an IGX 8410, 3-16 in an IGX 8420, or 3-32 in an IGX 8430. The BC-E1 provides the following:

- Interfaces to CEPT E1 lines (CCITT G.703 specification)
- Support for both Channel Associated Signalling and Common Channel Signalling
- Support for unframed 32 channel (2.048 Mbps), framed 31 (1.984 Mbps), or 30 (1.920 Mbps) channel operation, or any *n* x 64 Kbps rate down to 256 Kbps
- Configuration of either full or fractional E1 lines
- CRC-4 error checking
- Support for HDB3 (clear channel operation on E1 lines) or AMI
- Passes E1 line events (Frame loss, Loss of signal, BPV, frame errors, CRC errors, CRC synchronization loss, etc.) to the front card
- Detection of loss of packet sync when used with the NTM
- 120-ohm balanced or 75-ohm balanced or unbalanced physical interfaces

The BC-E1 supports two clock modes. The clock modes are *normal clocking* and *loop timing*. You select the mode through software control. With normal clocking, the node uses the *receive* clock from the network for the incoming data and supplies the transmit clock for outgoing data. The node can use the receive clock to synchronize itself with the network.

With loop timing, the node uses the receive clock from the network for the incoming data and redirects this receive clock to time the transmit data.

Statistics are kept on most line errors and fault conditions, including the following:

- Loss of signal
- Frame sync loss
- Multi-frame sync loss
- CRC errors
- Frame slips
- Bipolar violations
- Frame bit errors
- AIS, all-1's in channel 16 (CAS mode)

Figure 3-24 shows and Table 3-23 lists status LEDs and connections on the BC-E1 faceplate. When you correlate the table and figure items, read from the top to the bottom.

Figure 3-24 BC-E1 Faceplate

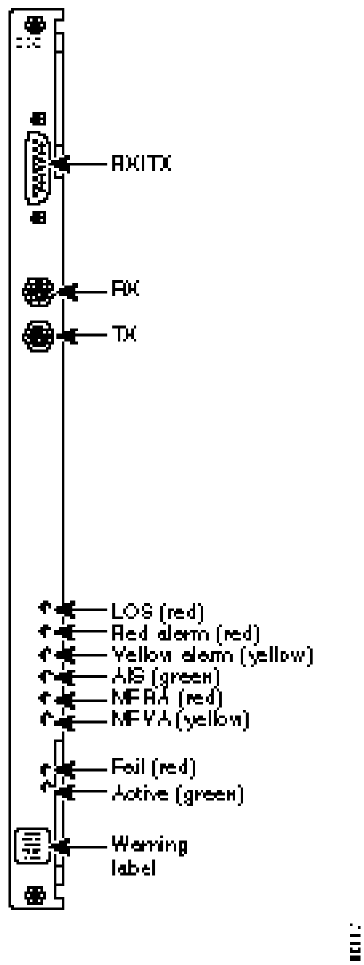


Table 3-23 BC-E1 Connections and Status LEDs

Connector/Indicator	Function
RX-TX	Female DB15 connector for XMT and RCV E1.
RX	BNC connector for receive E1 line.
TX	BNC connector for transmit E1 line.
LOS light (red)	Indicates loss of signal at the local end.
Red alarm light	Indicates loss of local frame alignment. On an NTM, Red indicates loss of packet alignment.
Yellow alarm light	Indicates loss of frame alignment at remote end. On an NTM, Yellow alarm indicates loss of packet alignment.
AIS light (green)	Indicates the presence of all ones on the line.
MFRA light (red)	Indicates loss of multiframe alignment (E1 only).
MFYA light (yellow)	Indicates loss of multiframe at remote end (E1 only).
Fail light (red)	Indicates an error. Reset the card with **resetcd f**. If the LED comes on again, call the TAC.
Active: light (green)	Indicates the card is in service with active circuits.

Subrate Interface Card (BC-SR)

The Back Card/Subrate (BC-SR) terminates subrate trunks on the NTM. A subrate trunk uses part of the E1 or T1 bandwidth. The BC-SR typically functions in tail circuits or where little traffic exists.

A subrate trunk facility interface operates in DCE mode, and the subrate channel functions like a synchronous data channel. Therefore, the IGX BC-SR always operates in DTE mode. Only leased lines are supported (no dial-up lines). Subrate trunks cannot pass clock signals between nodes.The BC-SR provides the following:

- Trunk line interfaces to subrate trunks
- Trunk rates of: 256 Kbps, 384 Kbps, 512 Kbps, 768 Kbps, 1.024 Mbps, 1.536 Mbps, 1.920 Mbps, 2.048 Mbps
- V.11/X.21, V.35, and EIA/TIA-449 interfaces
- Synchronization of the trunk clocking with looped clock option (not applicable to X.21)
- A limited set of EIA control leads monitored by the system

Figure 3-25 and Table 3-24 describe the BC-SR faceplate. When you correlate the figure and table, read from the top down.

Table 3-25 lists the data signals and EIA leads supported by the subrate interface.

Figure 3-25 BC-SR Faceplate

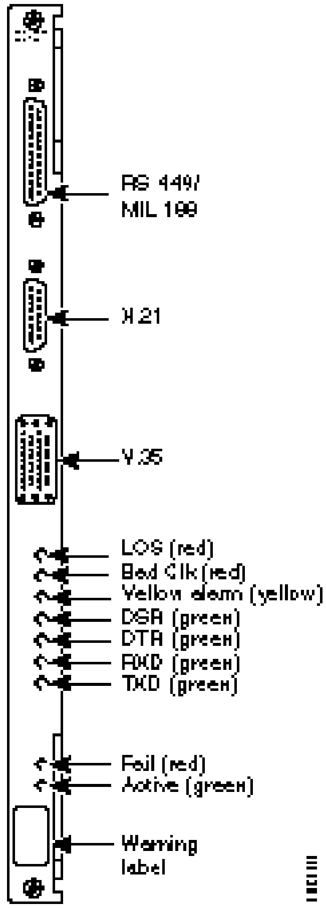


Table 3-24 BC-SR Connections and Status LEDs

Connection/Indicator	Function
EIA/TIA-449 data connector	DB37 female connector
X.21 data connector	DB15 female connector.
V.35 data connector	34-pin female MRAC connector
LOS light (red)	Loss of signal at the local end.
Bad CLK light (red)	Loss of clock or clock out of range
Yellow alarm light (yellow)	Loss of packet alignment (NTM) or frame alignment at remote end
DSR light (green)	The DSR lead is high (ON)
DTR light (green)	The DTR lead is high (ON)
RXD light (green)	The receive data line shows activity
TXD light (green)	The transmit data line shows activity.
Fail light (red)	An error occurred. First, reset the card with **resetcd f**. If the LED comes on again, contact the TAC through Cisco Customer Engineering.
Active: light (green)	The card is in service and has active circuits.

Table 3-25 Data and Control Leads Supported with BC-SR

Transmit			Receive		
Lead	**Name**	**Interface**	**Lead**	**Name**	**Interface**
TX	Transmit data	All	RX	Receive data	All
RTS	Request to Send	V.35	CTS	Clear to Send	V.35
DTR/C	Data Terminal Ready	All	DSR/I	Data Set Ready	All
LL	Local Loop	EIA/TIA-422	DCD	Data carrier select	V.35
RL	Remote Loop	EIA/TIA-422	RI/IC	Ring Incoming Call	V.35
IS	Terminal In Service	EIA/TIA-422	TM	Test mode	V.35
SS	Select standby	V.35	SB	Standby indicator	
SF	Sig rate select		SI	Signalling rate	

Y1 Interface Back Card (BC-Y1)

The BC-Y1 back card provides a Japanese Y1 trunk interface for an NTM. The BC-Y1 can reside in any rear slot 3-8 in an IGX 8410, 3-16 in an IGX 8420, or 3-32 in an IGX 8430. The BC-Y1 provides:

- An interface to Japanese “Y” Trunk (Y1) lines
- Support for Y1 Trunk formatted signalling
- Support for 24 channel, 1.544 Mbps operation
- Support for fractional rates
- Coded Mark Inversion (CMI) line coding
- Statistics for Y1 line events (loss of framing, loss of signal, framing errors, and so on.)
- Support for local and remote loopback at the Y1 interface as well as the local bus interface for fault isolation.

The BC-Y1 supports two clock modes. These are *normal clocking* and *loop timing*. The system operator selects the mode through software control. Normal clocking uses the receive clock from the network for incoming data and supplies the transmit clock for outgoing data. This clock can be used to synchronize the node.

Loop timing uses the receive clock from the network for the incoming data and turns the receive clock around for timing the transmit data.

Figure 3-26 and Table 3-26 provide descriptions of the BC-Y1 status LEDs and connections on the faceplate. When you correlate the items in the figure and table, read from the top to the bottom.

Figure 3-26 BC-Y1 Faceplate

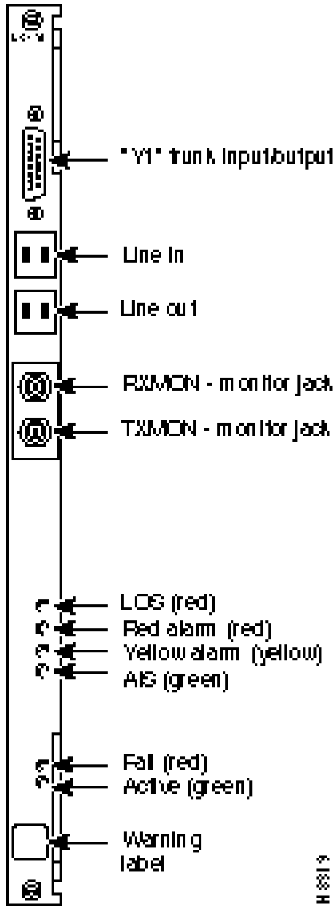


Table 3-26 BC-Y1 Connections and Status LEDs

Connector/Indicator	Function
Y1 Trunk input/output	DB15 connector for Y1 Trunk
Line in	Y1 trunk input line
Line out	Y1 trunk output line
RX MON	BNC test connector for monitoring receive Y1 line
TX MON	BNC test connector for monitoring transmit Y1 line
LOS light (red)	Indicates loss of signal at the local end.
Red alarm light (red)	Indicates loss of local frame alignment.
Yellow alarm light (yellow)	Indicates loss of frame alignment at the remote end.
AIS light (green)	Indicates the presence of all ones on the line.
Fail light (red)	Indicates an error occurred. First, reset the card with **resetcd f**. If the LED comes on again, contact the TAC through Customer Engineering.
Active light (green)	The card is in service and has active circuits.

Broadband Trunk Module (BTM)

The BTM card set provides an Asynchronous Transfer Mode (ATM) trunk interface. With a BTM, the switch can use the standard ATM cell relay protocol on the line. The BTM has a maximum throughput of 16 Mbps. Therefore, its typical use is to have multiple T1 or E1 channels up to a maximum of 8 channels. The BTM's compatibility with T3/E3 trunks supports migration of the node towards T3/E3 rates in T1/E1 increments. In addition, the BTM supports optional E2 and HSSI interfaces. The maximum E2 rate is 8 Mbps. A HSSI back card supports a rate of 50.84 Mbps, so a BTM with a HSSI back card can achieve a burst rate of up to 50.84 Mbps. Note that the use of a HSSI interface requires an external, inverse multiplexer that serves as a DCE and provides clocking.

The BTM card set consists of the BTM front card and either an AIT-T3, AIT-E3, AIT-E2, AIT-HSSI, or BTI-E1 back card. The card set works in the following arrangements:

- IGX-to-IGX node (BTM-to-BTM)
- IGX-to-BPX communication over broadband ATM trunks (BNI)
- IGX-to-IPX node (BTM on the IGX to AIT on the IPX)
- IGX frame relay connections terminating on a Cisco MGX 8220 (using complex gateway)

LED Indicators and Alarms

The faceplate of the BTM has four LEDs. The Active LED indicates the card is active and functioning. A BTM card failure triggers the Fail LED. The other two LEDs are a summary alarm for the AIT back card conditions. A yellow Minor LED indicates either a fault that does not interrupt service or that error statistics have exceeded a preset threshold. A red Major LED indicates a service-affecting failure. See Figure 3-27.

Maintenance and Troubleshooting

The BTM card set requires no maintenance. If a card has a solid or a (confirmed) intermittent failure, replace it. The only indicators on the BTM faceplate are the Active and Fail LEDs. For purposes of troubleshooting, you should view the BTM/AIT card set as a trunk. The **tstcon** command does not work on a BTM because the card cannot be isolated from the IGX or the other, connected BTM.

A trunk loopback test runs when the BTM detects an integrated alarm. The loopback test verifies if the line or the card is faulty. A loopback test "pass" means that the line is faulty, and a line alarm is indicated. A loopback test "fail" means that the card is faulty. In the case of a faulty card, a switch to a Y-Cable equipped redundant card occurs if available.

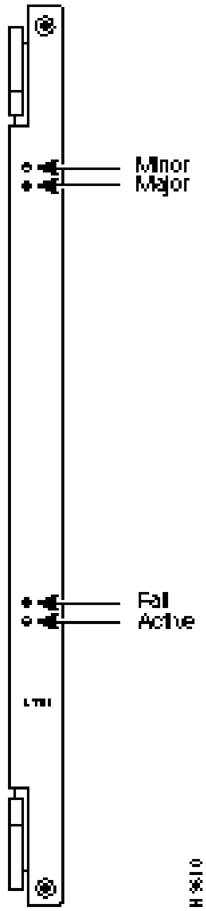
Y-Cable Redundancy

The BTM card set supports Y-cable redundancy on ATM trunks in IGX to IGX, IGX to IPX and IGX to BPX applications. Y-cable redundancy requires that both cards are upped and added through either StrataView Plus or the CLI before you assign redundancy. The CLI commands are **uptrk**, **addtrk**, and **addyred**. (In the *Cisco WAN Switching Command Reference*, see descriptions of **addyred**, **delyred**, **dspyred**, and **ptyred**.)

Switchover to a Redundant BTM

If the card fails, a switchover occurs to a Y-cabled, redundant BTM trunk card set if one is available. If the switchover occurs, the primary ATM trunk card acquires failed status, and the red Fail indicator turns on. If Y-cable redundancy is not available and the failed trunk is the clock source, the node switches to another clock source and marks the line as a failed clock source.

Figure 3-27 BTM Faceplate



Descriptions of BTM Back Cards

The back card provides the interface to the trunk line and performs all necessary CRC generation and checking. The back card faceplate has six LEDs. They indicate the status of the port and various alarm conditions. Refer to the back card figures and tables accompanying each card description for details. The BTM back cards are as follows:

- AIT-T3, which has a single T3 port (maximum throughput 16 Mbps)
- AIT-E3, which has a single E3 port (maximum throughput 16 Mbps)
- AIT-E2, which has a single E2 port
- AIT-HSSI, which carries aggregated T1 lines on a single connector
- BTI-E1, which has a single E1 port

AIT-T3 Back Card

The AIT -T3 back card has two SMB connectors and six LED indicators, as Figure 3-28 shows. Table 3-27 lists these faceplate items. When you correlate the items in the figure and table, read from the top.

Figure 3-28 AIT-T3 Back Card Faceplate

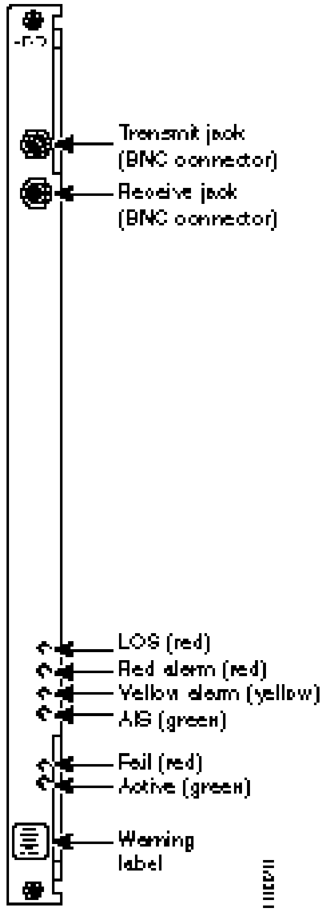


Table 3-27 AIT-T3 Connections and Indicators

Connector/Indicator	Function
Transmit Jack	SMB connector for transmit data.
Receive Jack	SMB connector for receive data.
LOS light (red)	Loss of signal at the local end.
Red alarm light (red)	Loss of local T3 or E3 frame alignment or loss of cell alignment.
Yellow alarm light (yellow)	Loss of frame alignment at remote end or loss of cell alignment.
AIS light (green)	All ones on the line.
Fail light (red)	An error was detected. First, reset the card with **resetcd f**. If the LED comes on again, contact the TAC through Customer Engineering.
Active: light (green)	The card is in service and has active circuits.

BTI-E1 Back Card

The BTI-E1 back card provides an E1 trunk interface for the BTM front card. It has unbalanced and balanced connectors for line connections. In general, the functions of the BTI-E1 are to:

- Receive and transmit ATM cells
- Report trunk status to the front card
- Support loopbacks
- Support Y-cable redundancy

The tables in this section provide more detailed characteristics of the BTI-E1. Figure 3-29 shows the BTI-E1 faceplate. Table 3-28 describes the connectors and status LEDs. Table 3-29 lists the general E1 line characteristics of the BTI-E1. Table 3-30 lists the ATM characteristics of the BTI-E1. Table 3-31 lists the trunk parameters you can configure by using **cnftrk**.

Figure 3-29 BTI-E1 Back Card Faceplate

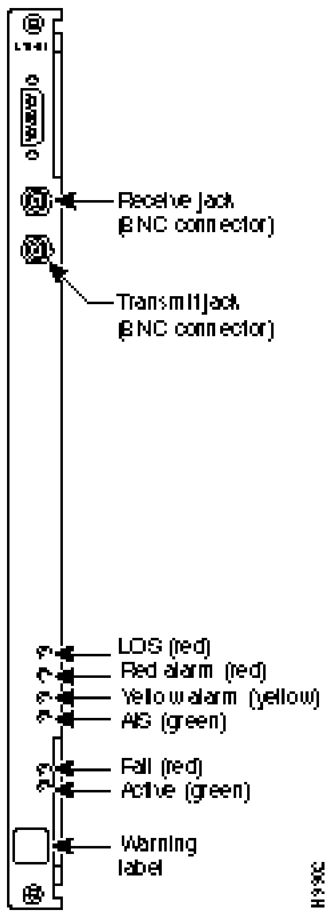


Table 3-28 BTI-E1 Connections and Indicators

Connector/Indicator	Function
DB15	120 Ohm DB15 connector for receive and transmit directions (balanced).
Transmit Jack	75 Ohm, female BNC connector for transmit data (unbalanced).
Receive Jack	75 Ohm, female BNC connector for receive data (unbalanced).
LOS light (red)	Loss of signal at the local end.
Red alarm light (red)	Loss of local frame alignment or loss of cell alignment.
Yellow alarm light (yellow)	Loss of frame alignment at remote end or loss of cell alignment.
AIS light (green)	Alarm Indication Signal, indicates all 1s received, also known as a blue alarm.
Fail light (red)	An error occurred. Reset the card with **resetcd f**. If the LED comes on again, call the TAC through Cisco Customer Engineering.
Active: light (green)	The card is in service and has active circuits.

Table 3-29 shows the E1 line specifications for the BTI-E1. For a more detailed list of E1 characteristics, see the appendix titled “System Specifications.”

Table 3-29 Line Specifications for the BTI-E1

Category	Description
Line rate	2.048 Mbps, ± 50 bps per ITU-T G.703.
Signal characteristics	RZ, Alternating Bipolar Pulses per G.703.
Maximum line length	The maximum line length is 100 meters (328 feet).
Jitter	Transmit output jitter, receive jitter tolerance, and jitter gain meet G.823.

Table 3-30 describes the ATM interface parameters for the BTI-E1.

Table 3-30 ATM Interface Specifications

Category	Description
Interface types	User-to-Network (UNI) per I.361 specification or Cisco’s proprietary STI.
Data rate	2.048 Mbps ±50 ppm.
ATM layer	ATM direct cell mapping (ADM) per G.804.
Transmit cell rate	Up to 4830 cells per second for complex gateway, unframed E1. Up to 4679 cells per second for framed E1.
Receive FastPacket rate	Up to 10538 packets per second for complex gateway, unframed E1. Up to 10208 packets per second for complex gateway, framed E1
Adaptation layer	AAL5
PVCs per card	Up to 255
Traffic queues	CBR, VBR, and ABR

The **cnftrk** command lets you configure parameters for the interface provided by the BTI-E1. Table 3-31 shows the particular ranges and defaults for the BTI-E1.

Table 3-31 BTI-E1 Configuration

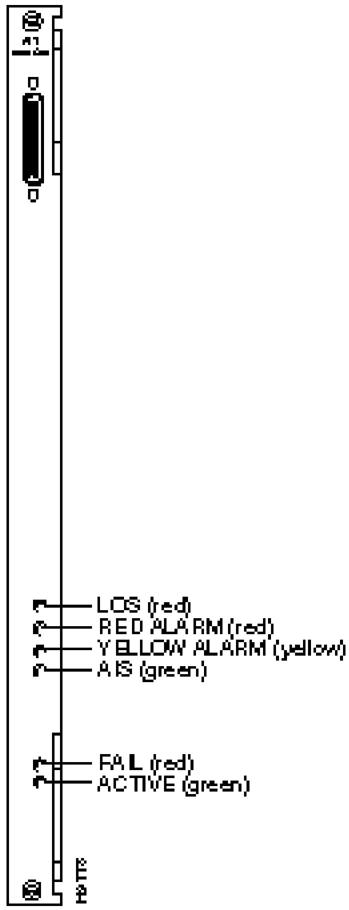
Parameter	Possible Values and the Default
Clock mode	The clock mode for the BTI-E1 is always *normal*. Pass sync default is Yes.
Framing format	Unframed, basic frame, or CRC-4 multi-frame per G.704 and G.706.
DS-0 mapping	Full E1 or fractional E1 in any combination up to 32 timeslots.
Line code	Framed E1: AMI or HDB3. Unframed E1: HDB3 only. Default: HDB3.
Idle code format	Any 8-bit pattern. The default is 7F hex.
Payload scramble	Can be Yes or No. The default is Yes.
Restrict PCC traffic	Can be Yes or No. The default is No.
Statistical reserve	The statistical reserve is in packets per second. The default is 600 pps.
Header format	STI (Cisco proprietary) or UNI (User-Network Interface). The default is STI
VPI address	0–255 (Virtual Path Address for UNI mode).
VCI address	0–2, 5–65535 (Virtual Circuit Address for UNI mode)
Gateway header type	BAM, SAM, or CAM (BPX addressing mode, simple addressing mode, or cloud addressing mode). The default is BAM.
Link type	Terrestrial or satellite. The connection route restriction algorithm uses the link type. The default is terrestrial.
HCS masking	Always Yes. The HCS is masked with hexadecimal AA to improve the reliability of cell delineation.
End supp BData	Always Yes.
End supp FST	Always Yes.

AIT-HSSI Back Card

The AIT-HSSI back card supplies a single HSSI interface to the AIT trunk. For its implementation, the AIT-HSSI requires an external DSU such as an inverse mux or a fractional T3 DSU. Figure 3-30 shows the faceplate of the AIT-HSSI. The HSSI connector has 50 pins.

The range of bit rates for the AIT-HSSI on a BTM is 4 Mbps to 16 Mbps. The range of rates is across aggregated T1 channels. The command that configures the rate is **cnftrk**. The **dsptrkcnf** command displays the existing parameters for a trunk. For specifications on HSSI, see the appendix titled "System Specifications."

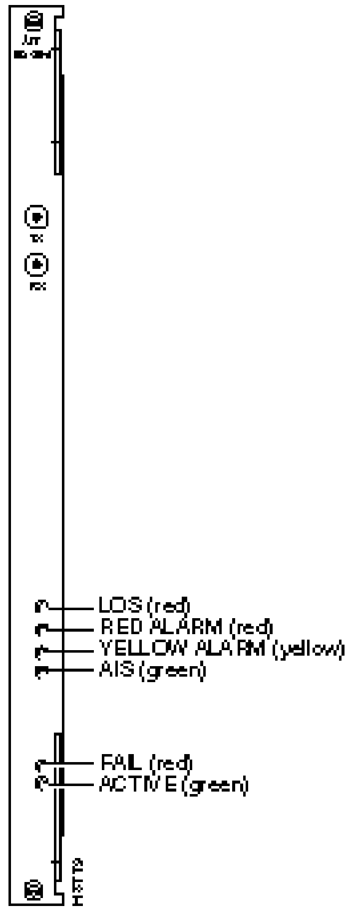
Figure 3-30 AIT-HSSI Faceplate



AIT-E2 Back Card

The AIT-E2 back card supplies a single E2 interface to the 16-Mbps BTM front card. The line rate is 8.448 Mbps. The AIT-E2 operates between only Cisco WAN switches, so it does not support a UNI interface. For specifications on this E2 line, see the appendix titled "System Specifications." Figure 3-31 shows the AIT-E2 faceplate.

Figure 3-31 AIT-E2 Faceplate



ATM Line Module B (ALM/B)

The ATM Line Module B (ALM/B) card set provides a trunk with a full T3 or E3 rate. Back cards for the ALM/B are the BC-UAI-1T3 and the BC-UAI-1E3. They support either a single T3 trunk or a single E3 trunk. For characteristics of T3 and E3 trunks, see the appendix titled “System Specifications.” For information on how to bring up an ALM/B trunk, refer to the *Cisco IGX 8400 Series Installation* manual. Figure 3-32 illustrates an ATM cloud using the ALM/B.

ALM/B Features

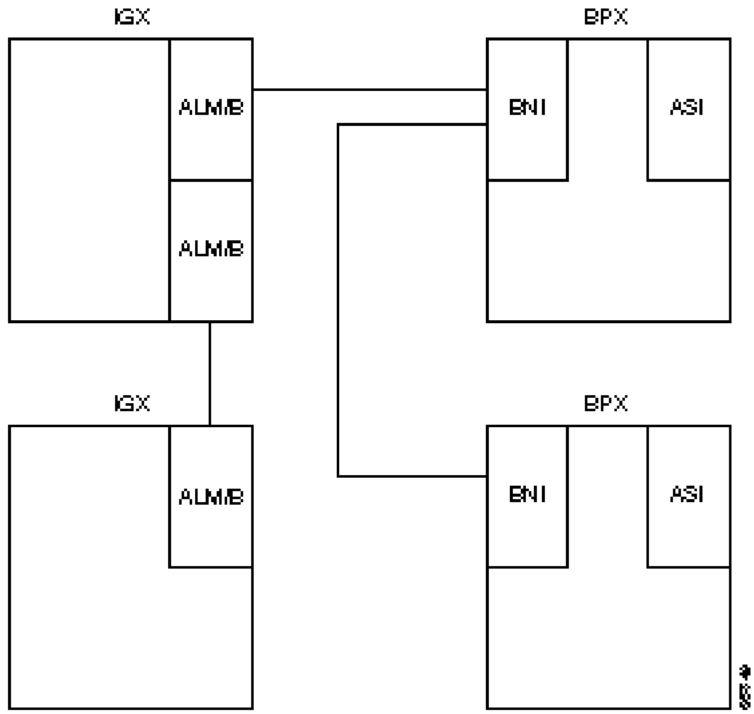
The ALM/B supports the following:

- An aggregate throughput of 45 Mbps
- STI or NNI cell header format
- Buffer capacity of 65535 cells
- Support for all connection classes
- 1771 complex gateway (CGW) connections
- Optional Y-cable redundancy

The ALM/B card set consists of the ALM/B front card and either a BC-UAI-1T3 or a BC-UAI-1E3. The card set works in the following arrangements:

- IGX-to-IGX node (ALM/B-to-ALM/B or ALM/B-to-BTM)
- IGX-to-BPX communication over broadband ATM trunks (BNI)
- IGX-to-IPX node (ALM/B on the IGX to AIT on the IPX)
- IGX frame relay connections terminating on a Cisco MGX 8220 (complex gateway)

Figure 3-32 ALM/Bs in a Network



Operating Modes

On a per-connection basis, the ALM/B operates in either *simple gateway* or *complex gateway* mode. Complex gateway supports *network interworking*. For a description of tiered networks, trunks, ATM protocols, and cell and header formats, refer to the *Cisco System Overview.*

The simple gateway loads 24-byte FastPacket cells into ATM cells in ways that are consistent with each application. (Each of the two FastPackets loaded into the ATM cell is loaded in its entirety, including the FastPacket header). For example, two FastPackets can be loaded into one ATM cell if both FastPackets have the same destination.

Complex gateway is supported by streaming the frame relay data into ATM cells, cell after cell, until the frame has been completely transmitted. Since only the data from the FastPacket is loaded, the Complex gateway is an efficient transmission mechanism. Additionally, discard eligibility information carried by the frame relay bit is mapped to the ATM cell CLP bit, and vice versa.

Maintenance and Troubleshooting

The ALM/B card set requires no maintenance. If an ALM/B card set has either a solid or an intermittent but confirmed failure, replace it. The only indicators on the ALM/B faceplate are the Active and Fail LEDs. For purposes of troubleshooting, you should view the ALM/B card set as a trunk. The **tstcon** command does not work on an ALM/B because the card cannot be isolated from the IGX or the other, connected trunk card set.

A trunk loopback test executes when the ALM/B detects an integrated alarm. The loopback test determines if the line or the card is faulty. A loopback test “pass” means the line is faulty, so a line alarm is flagged. A loopback test “fail” means the card is faulty. If a card is faulty and a Y-cabled secondary is available, a switch to the secondary card occurs.

LED Indicators and Alarms

The faceplate of the ALM/B has four LEDs. See Figure 3-33.The Active LED indicates the card is active and functioning. An ALM/B card failure triggers the Fail LED. The other two LEDs are a summary alarm for the back card conditions. A yellow Minor LED indicates either a fault that does not interrupt service or that error statistics have exceeded a preset threshold. A red Major LED indicates a service-affecting failure.

Y-Cable Redundancy

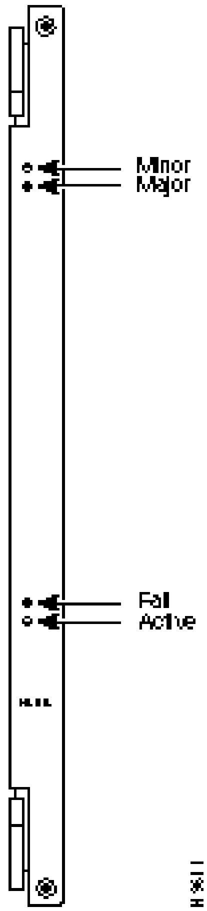
The ALM/B card set supports Y-cable redundancy on ATM trunks in IGX-to-IGX, IGX-to-IPX and IGX-to-BPX applications. (In the *Cisco WAN Switching Command Reference*, see descriptions of **addyred**, **delyred**, **dspyred**, and **ptyred**.)

Y-cable redundancy requires that both cards are upped (**uptrk**) and added (**addtrk**) before you assign redundancy with the **addyred** command.

Switchover to a Redundant ALM/B

If the card fails, a switchover occurs to a Y-cabled, redundant ALM/B trunk card set if one is available. If the switchover occurs, the primary ATM trunk card acquires failed status, and the red Fail indicator turns on. If Y-cable redundancy is not available, the ATM trunk switches to another clock source and marks the line as a failed clock source.

Figure 3-33 ALM/B Faceplate



Interface Back Cards for the ALM/B

The back card provides the interface to the trunk line and performs all necessary CRC generation and checking. The following are the ALM/B back cards:

- Back Card/Universal ATM Interface T3 (BC-UAI-1T3)
- Back Card/Universal ATM Interface E3 (BC-UAI-1E3)

The trunk ports consist of one SMB connector for transmit data and one SMB connector for receive data. The back card faceplate has six LED indicators. The LEDs indicate the status of the port and various alarm conditions. See Figure 3-34 and Table 3-32 for details on the T3 card and Figure 3-35 and Table 3-33 for details on the E3 card. Correlate items in each figure and table as you read from the top down. For technical specifications on T3 and E3 lines, see the appendix titled "System Specifications."

Figure 3-34 BC-UAI-1T3 Faceplate

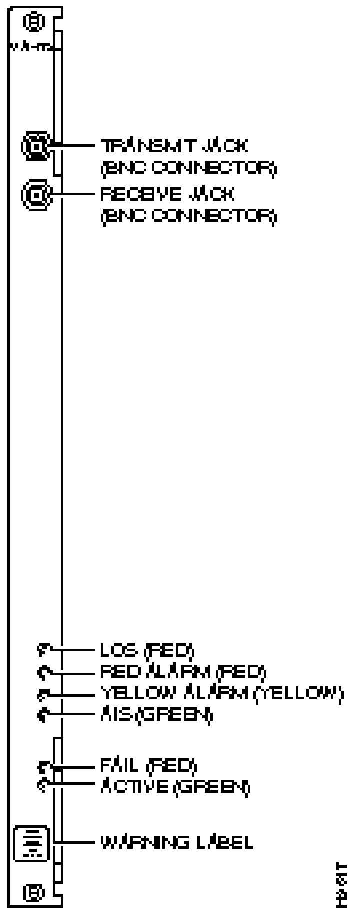


Table 3-32 BC-UAI-1T3 Connections and Indicators

Connector/Indicator	Function
Transmit jack	SMB connector for transmit data.
Receive jack	SMB connector for receive data.
LOS light (red)	Loss of signal at the local end.
Red alarm light (red)	Loss of local T3 or E3 frame alignment or loss of cell alignment.
Yellow alarm light (yellow)	Loss of frame alignment at remote end or loss of cell alignment.
AIS light (green)	All ones on the line.
Fail light (red)	An error was detected. First, reset the card with **resetcd f**. If the LED comes on again, contact the TAC through Cisco Customer Engineering.
Active light (green)	The card is in service and has active circuits.

Figure 3-35 BC-UAI-1E3 Faceplate

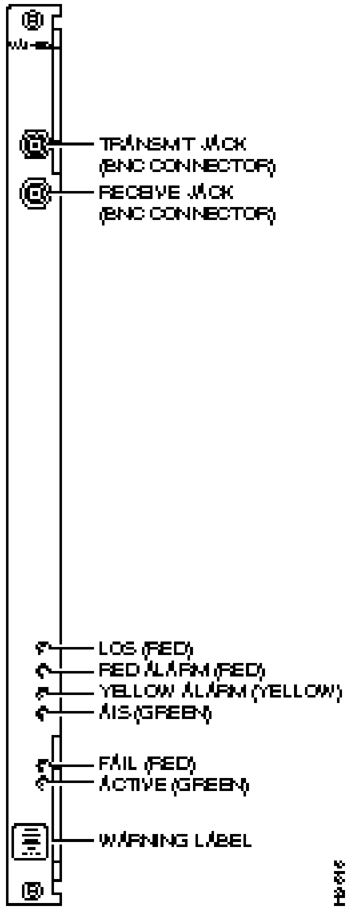


Table 3-33 BC-UAI-1E3 Connections and Indicators

Connector/Indicator	Function
Transmit Jack	SMB connector for transmit data.
Receive Jack	SMB connector for receive data.
LOS light (red)	Loss of signal at the local end.
Red alarm light (red)	Loss of local T3 or E3 frame alignment or loss of cell alignment.
Yellow alarm light (yellow)	Loss of frame alignment at remote end or loss of cell alignment.
AIS light (green)	All ones on the line.
Fail light (red)	An error was detected. (Reset the card with **resetcd f**. If the LED comes on again, contact the TAC through Cisco Customer Engineering.)
Active: light (green)	The card is in service and has active circuits.

Line Interface Cards

This chapter describes the hardware and related functions for each line card in an IGX node. The description of each card includes:

- Function
- System interconnect
- Faceplate indicators

A brief description of optional peripherals and third-party equipment appears at the end of the chapter. For system specifications, such as protocols and standards, refer to Appendix A.

For all matters relating to installation, troubleshooting, user-commands, and repair and replacement, refer to the *Cisco IGX 8400 Series Installation* manual.

Other manuals that relate to IGX operation are:

- The *Cisco WAN Switching Command Reference* and *Cisco SuperUser Command Reference* describe standard user commands and superuser commands.
- The *Cisco System Overview* contains general Cisco network information.
- The *StrataView Plus Operations* contains information on Cisco network management.

Line Card Groups

This chapter introduces each of the following line card groups:

- ATM UNI Card Group
- Voice Card Group
- Frame Relay Card Group
- Serial Data Card Group

List of IGX Cards

Table 4-1 lists the front cards that operate in an IGX switch. Table 4-2 lists the ATM UNI interface cards, and Table 4-3 lists the interface cards for all other transport types that an IGX node supports.

In addition to the native front and back cards, an IGX switch can use existing IPX 16/32 service module cards in conjunction with an Adapter Card Module (ACM). The ACM cards connect to IPX 16/32 front cards and perform the adaptation necessary to allow IPX cards to operate in an IGX node. Note that this IPX upgrade feature cannot utilize IPX 8-specific cards. Beyond this limitation, IPX back cards can operate in an IGX system without modifications.

Table 4-1 Front Cards

interface Type, Card Acronym	Card Name
ATM UNI	
UXM	Universal Transmission Module
ALM/A	ATM Line Module, Model A
Voice	
UVM	Universal Voice Module
CVM-ADPCM	Channelized Voice Module, ADPCM
CVM-T1	Channelized Voice Module, T1
CVM-E1	Channelized Voice Module, E1
Frame Relay	
UFM-4C	Universal Frame Module-Channelized (supports 4 lines on back card)
UFM-8C	Universal Frame Module-Channelized (supports 8 lines on back card)
UFM-U	Universal Frame Module-Unchannelized (for HSSI, V.35, or X.21)
FRM	Frame Relay Module, unchannelized, V.35/X.21
FRM-2	Frame Relay Module, Port Concentrator only
FRM-31	Frame Relay Module, channelized, with 31 channels
Serial Data	
HDM	High-speed Serial Data Module
LDM	Low-speed Serial Data Module
Access Device	
FTM	Frame Trunk Module

Table 4-2 ATM UNI Back Cards

Card Acronym	Card Name
UXM ATM UNI	
BC-UAI-4-155-MMF	4-port Multi-Mode Fiber 155 Mbps
BC-UAI-4-155-SMF	4-port Single Mode Fiber 155 Mbps
BC-UAI-2-155-SMF	2-port Single Mode Fiber 155 Mbps
BC-UAI-6-T3	6-port T3 back card
BC-UAI-3-T3	3-port T3 back card
BC-UAI-6-E3	6-port E3 back card
BC-UAI-3-E3	3-port E3 back card
BC-UAI-8-T1-DB15	8-port T1 back card with DB15 connector
BC-UAI-8-E1-DB15	8-port E1 back card with DB15 connector
BC-UAI-8-E1-BNC	8-port E1 back card with BNC connector
BC-UAI-4-T1-DB15	4-port T1 back card with DB15 connector
BC-UAI-4-E1-DB15	8-port E1 back card with DB15 connector
BC-UAI-4-E1-BNC	4-port E1 back card with BNC connector
ALM/A	
BC-UAI-1T3	Universal ATM Interface T3 Back Card
BC-UAI-1E3	Universal ATM Interface E3 Back Card

Table 4-3 Voice, Frame Relay, Data, and Access Device Interface Cards

Interface Type, Card Acronym	Card Name
Voice	
BC-UVI-2TIEC	Universal Voice Interface T1 Card
BC-UVI-2E1EC	Universal Voice Interface E1 Card
BC-UVI-2J1EC	Universal Voice Interface J1 Card
BC-E1	E1 Interface Card
BC-T1	T1 Interface Card
BC-Y1	Y1 Trunk Interface Card
BC-J1	J1 User (Circuit) Interface Card
BC-SR	Subrate Trunk Interface Card
Frame Relay	
UFI-8T1-DB15	Universal Frame Interface 8 T1 Card (with DB15 connectors)
UFI-8E1-DB15	Universal Frame Interface 8 E1 Card (with DB15 connectors)
UFI-8E1-BNC	Universal Frame Interface 8 E1 Card (with BNC connectors)
UFI-4HSSI	Universal Frame Interface 4 HSSI (supports 4 HSSI lines)
UFI-12V.35	Universal Frame Interface 12 V.35 (supports 12 V.35 lines)
UFI-12X.21	Universal Frame Interface 12 X.21 (supports 12 X.21 lines)
FRI-T1	Frame Relay Interface Card (supports T1)
FRI-E1	Frame Relay Interface Card (supports E1)
FRI-V.35	Frame Relay Interface Card (supports V.35)
FRI-X.21	Frame Relay Interface Card (supports X.21)
Data	
SDI	Synchronous Data Interface: EIA/TIA-232C, EIA/TIA-232D, EIA/TIA-422/449, X.21, V.24, and V.35
LDI	Low-Speed Data Interface: EIA/TIA-232C/D, 4-port, 8-port V.24, 4-Port, 8-Port
Access Device	
FPC	Frame Port Card

Note EIA/TIA-232 and EIA/TIA-449 existed as recommended standards RS-232 and RS-449 before the Electronics Industries Association (EIA) and Telecommunications Industry Association (TIA) accepted them as standards.

Common Alarms, Controls, and Indicators

Front cards and back cards have faceplates with indicator LEDs and, on some front cards, push-button controls. In addition, back card faceplates have cable connectors. In slots where no back card exists, a blank faceplate must reside to contain Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI) and to ensure correct air flow.

The LED indicators are on the front and back card faceplates. Each plug-in card has both a green Active LED and a red Fail LED at the bottom of the faceplate. In general, the meaning of each LED is indicated in Table 4-4. Some other cards have additional indicators, connectors, or controls, which the appropriate sections describe.

Table 4-4 Common Card Status Indicators

Indicators	Status	Meaning
Fail	ON Steady	Indicates an error occurred. Reset the card with the **resetcd f** command. If the LED comes on again, call the TAC.
Fail	Blinking	On an NPM in a redundant system, this combination indicates that the card is being updated.
Active	ON steady	When steadily on, this combination indicates the card is active and carrying traffic or processing data.
Active	ON momentarily	When momentarily on, indicates the card executed a self-test.
both	OFF	Indicates the card part of a redundant pair and is in the standby mode or not being used at all.
both	ON	Indicates the card failed but remains active because no standby card is available. In the case of an HDM or LDM card, this could indicate that one or more of the data channels failed, but the others are still active.

Adapter Cards

Cisco can upgrade IPX service/interface cards for use in an IGX node. This allows the IGX node to provide all the services of the IPX with cards of proven efficiency, functionality, and reliability. The upgrade is available only as a factory upgrade. The factory upgrade consists of an adding one of three possible Adapter Card Modules (ACM) and possible firmware or hardware modifications. Due to the complexity of the ACM, field upgrades of IPX cards are not possible.

Connecting IPX front cards to their corresponding back cards on the IPX requires the use of a utility or local bus. On upgraded IPX cards (IGX cards), the local or utility bus is not necessary.

The following IPX cards can be adapted for use in the IGX node:

- NTC
- AIT
- CDP
- FRP
- FTC
- SDP
- LDP
- ARC

Universal Switching Module

This description of the Universal Switching Module (UXM) covers the following topics:

- An introduction includes sections on the UXM mode of operation, trunk-mode features, interface card list, card redundancy, card mismatch, clock sourcing, Cellbus bandwidth usage, configuration for public ATM network service, and configuration for cell trunk-only routes
- Supported traffic and connection types
- Inverse Multiplexing Over ATM (IMA)
- Activation and configuration of a UXM for trunk-mode operation
- Supported traffic and connection types
- Alarms for physical lines and logical (IMA) trunks
- Descriptions of the faceplates on the back cards

The Universal Switching Module (UXM) can function in one of two modes. In *port mode*, the UXM serves as either an ATM User-to-Network Interface (UNI) or a Network-to-Network (NNI) interface. In *trunk mode*, the UXM supports trunks in the network. The back cards support multiple ports operating at OC3/STM1, T3, E3, T1, or E1 rates.

Note The word “port” has two uses in a Cisco WAN switch. “Port mode” refers to the function of an interface at the edge of a network—the endpoint at which you add connections (UNI) or the interface between two networks (NNI). Examples of port cards are the UVM, UFM, ALM/A, and port-mode UXM in an IGX switch or an ASI in a BPX switch.

On the other hand, a “port” is also a layer of logical functionality that applies to port cards as well as trunk cards. For example, whether you activate a line to a router or activate an ATM trunk to the network, you must subsequently configure the logical port in either case.

For a UXM, therefore, the documentation describes a logical “port” on a port-mode UXM for a UNI or NNI at the edge of a network, yet it also refers to a “port on a UXM trunk” as a layer of logic.

Introduction to the UXM Port Mode

The UXM can transport ATM cells to and from the Cellbus at a maximum rate of 310 Mbps in either direction. The UXM can support up to 4000 connections in port mode. As later paragraphs describe, a connection can be a user-connection, gateway connection, or networking connection.

The UXM communicates only ATM cells to either the network or the CPE. On the Cellbus, however, the UXM communicates either ATM cells or FastPackets according to the card type. With another UXM, it communicates only in ATM cells. With other cards, the UXM communicates in FastPackets. Through its gateway functionality, the UXM translates between FastPackets and ATM cells so it can transport voice, data, or Frame Relay traffic that other cards have put in FastPackets.

Determining the UXM’s Mode of Operation

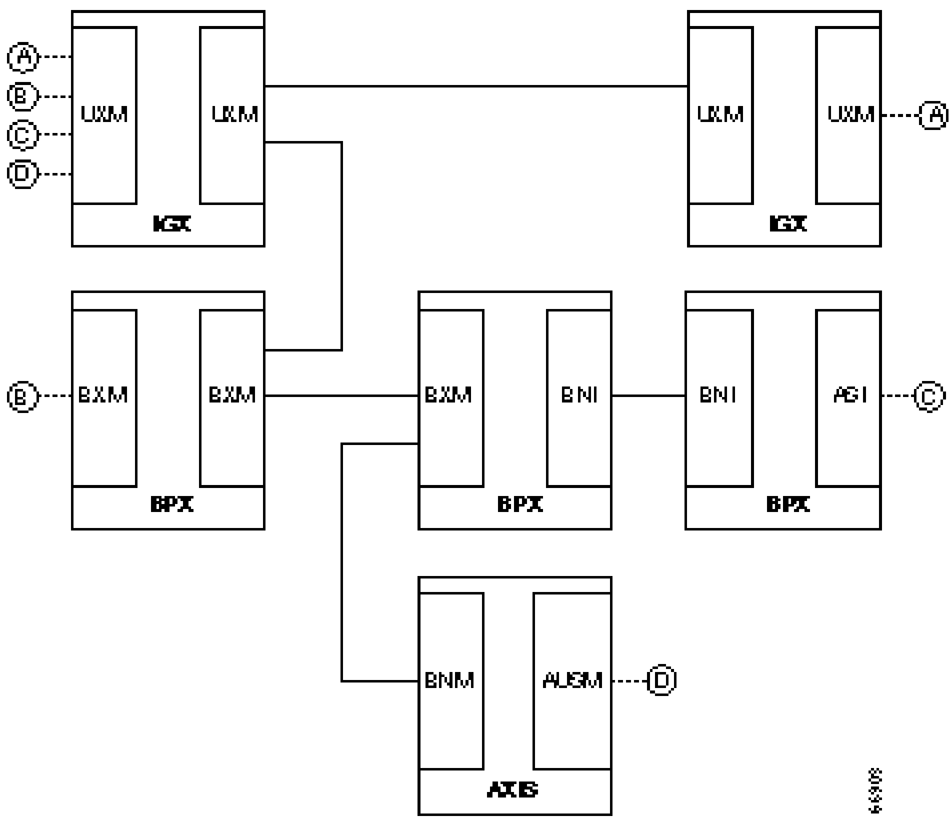
The UXM firmware detects the mode of the card and reports it to switch software when you first activate either a line to the UNI or NNI side or a trunk to the network. If you activate a line, the UXM goes into port mode. If you activate a trunk, the UXM goes into trunk mode. The command line interface (CLI) commands for these operations are **upln** and **uptrk**, respectively. (The UXM description in this chapter lists important information about the commands that apply to the UXM, but the order of their use appears in the *Cisco IGX 8400 Series Installation* guide. For a detailed description of each command and its parameters, see the *Cisco WAN Switching Command Reference*.)

Example Networks With UXMs

Networks with both trunk mode and port mode UXMs appear in Figure 4-1 and Figure 4-2, respectively. The nodes in Figure 4-1 use only UXMs for port interfaces and trunk interfaces. Figure 4-2 shows a variety of cards providing interfaces for different traffic types.

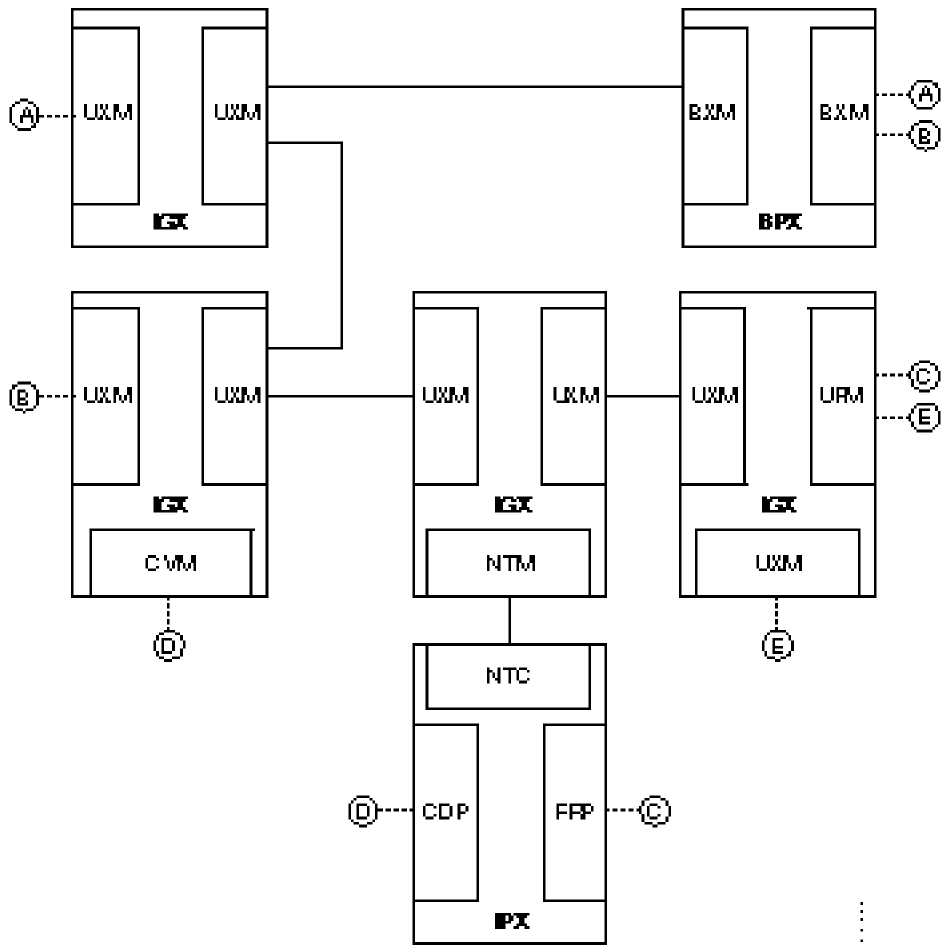
The network carrying only ATM traffic appears in Figure 4-1. Each UXM trunk card in Figure 4-1 connects to either another UXM trunk card or a BXM operating as a trunk. The ATM UNI ports are the UXM port cards (for connection A), the BXM operating in port mode (for connection B), the ASI (for connection C), and the BXM feeder trunk (for connection D). Connection D is a two-segment connection. One segment of connection D exists between the BNM and AUSM on the Cisco MGX 8220 shelf, and the other segment exists between the BXM and the UXM UNI port.

Figure 4-1 UXMs in a Network With Pure ATM Traffic



A network with ATM traffic and FastPacket-based traffic appears in Figure 4-2. Connections A and B are ATM connections that terminate on UXM UNI port cards and a BXM operating as a UNI port. Connection C is a Frame Relay connection between a UFM and an FRM. Connection D is a voice connection between a CVM and CDP. Connection E is a DAXCON between a UFM and a UXM UNI port. For connections C–E, the gateway function of the UXM packs and unpacks the FastPackets into and out of the ATM cells.

Figure 4-2 UXMs in a Network With Heterogeneous Traffic



UXM Features

The following list broadly identifies the features of the UXM. After the bulleted list, the remaining sections of this introduction contain tables that list the features on particular topics, such as interworking. Actual descriptions of the features appear in the section titled “The UXM in UNI/NNI Port Mode.”

- The UXM uses all four lanes of the Cellbus.
- The UXM port card supports up to 4000 connections.
- At the ATM UNI, the UXM supports the connection types CBR, VBR, ABR, and UBR. The section titled “The UXM in UNI/NNI Port Mode” provides the details.
- The maximum throughput is 310 Mbps—two times the OC3 (STM1) rate. This maximum applies whether the back card is a 2-port or 4-port back card. The 4-port OC3 back card permits over-subscription.
- For each virtual connection on a UXM port, a dual leaky bucket scheme polices the traffic. Trunk mode does not use dual-leaky bucket policing.
- The UXM supports ATM-to-Frame Relay network and service interworking.

- For the ABR connection types, the UXM supports EFCI marking, Explicit Rate Stamping, and Virtual Source/Virtual Destination (VS/VD).
- For each VC, the UXM supports arbitrary assignments for VPIs/VCIs.
- The UXM supports Y-cable redundancy with hot standby for very fast switchover.
- The front card has 128K cell buffers.
- For statistics support, the UXM provides real-time statistics counters and interval statistics collection for ports, lines, trunks and channels.
- For optimal buffer management, the UXM supports dynamic per-VC and per-VI thresholds.
- The on-board diagnostics are loopback, self-test, and background.
- You can specify that the node route a connection over only ATM cell trunks (UXM or BXM).

Interfaces for the UXM

Table 4-5 is a list of the UXM back cards. Figure 4-3 shows the UXM front card. Table 4-6 defines all possible combinations for the states of the front card status LEDs (Fail, Active, and Standby).

Table 4-5 Interface Back Cards for the UXM

Card Name	Card Description
BC-UAI-4-155-MMF	4-port Multi-Mode Fiber 155 Mbps
BC-UAI-4-155-SMF	4-port Single Mode Fiber 155 Mbps
BC-UAI-2-155-SMF	2-port Single Mode Fiber 155 Mbps
BC-UAI-6-T3	6-port T3 back card
BC-UAI-3-T3	3-port T3 back card
BC-UAI-6-E3	6-port E3 back card
BC-UAI-3-E3	3-port E3 back card
BC-UAI-8-T1-DB15	8-port T1 back card with DB15 connector
BC-UAI-8-E1-DB15	8-port E1 back card with DB15 connector
BC-UAI-8-E1-BNC	8-port E1 back card with BNC connector
BC-UAI-4-T1-DB15	4-port T1 back card with DB15 connector
BC-UAI-4-E1-DB15	8-port E1 back card with DB15 connector
BC-UAI-4-E1-BNC	4-port E1 back card with BNC connector

Figure 4-3 UXM Front Card

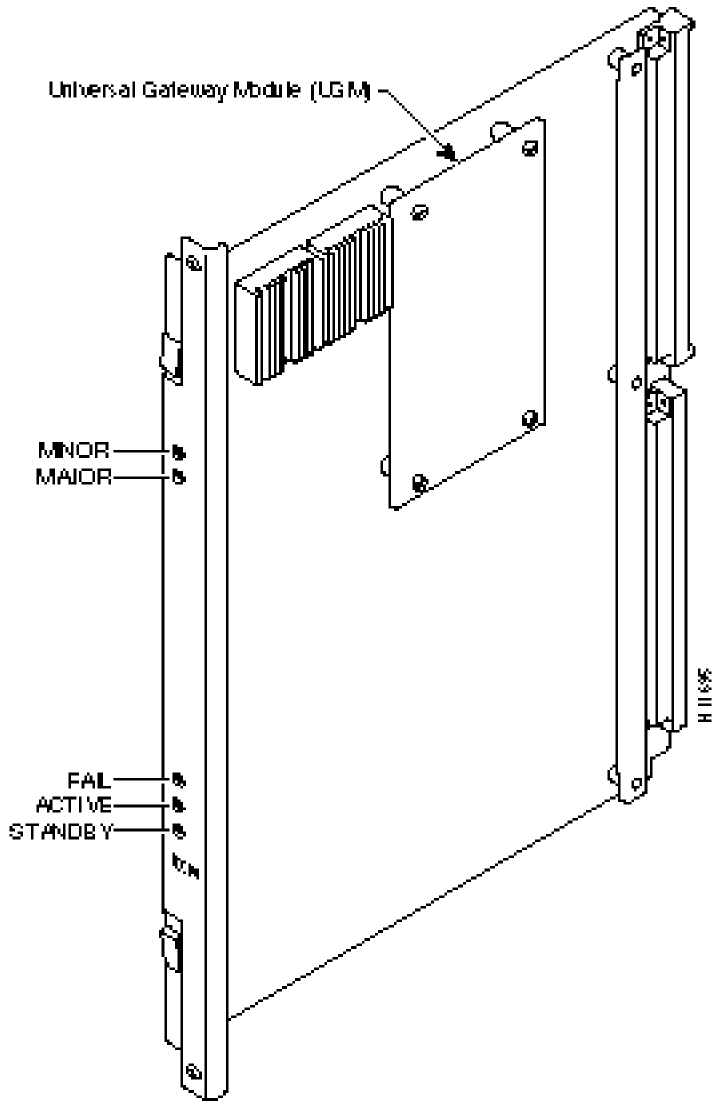


Table 4-6 UXM Status LEDs

Fail	Active	Standby	Status of Card
On	Off	Off	Failed
Blinking	Blinking	Off	Back Card Mismatch (hot standby)
Blinking	On	Off	Back Card Mismatch (active)—can be missing back card
Blinking	Off	Blinking	Back Card Mismatch (self-test)
Blinking	Off	On	Back Card Mismatch (standby)
Off	Blinking	Off	Hot Standby
Off	On	Off	Active
Off	Off	Blinking	Self-test
Off	Off	On	Standby
On	On	On	Down

Maximum Number of UXMs

Switch software limits the number of logical trunks and ports on an IGX switch. The maximum number of UNI or NNI ports in an IGX switch is 64. The maximum number of logical trunks is 32. To determine the number of each logical type in the switch, add the number of ports on multiport cards and single-port cards. These sums cannot exceed 64 ports and 32 trunks. For example, using exclusively 2-port OC3 trunks, you could install:

2 trunks per card x 16 OC3 UXMs=32 trunks

Switch software monitors the number of logical ports and trunks, not the number of UXMs. Therefore, the software keeps you from activating an excessive number of lines or trunks on the node rather than flagging the presence of too many cards.

Y-Cabled UXM Redundancy

The UXM features *hot standby* as a part of its Y-cable redundancy capability. With hot standby, the redundant card receives the configuration information as soon as you finish specifying redundancy. The standby card also receives updates to its configuration as the active card configuration changes. Hot standby lets the backup card go into operation as soon as necessary rather than waiting for the NPM to download the configuration

Y-cable redundancy requires that both cards are active and available before you set up redundancy. Use StrataView Plus or the CLI commands **upln**, then **addyred**. (See also descriptions of **addyred**, **delyred**, **dspyred**, and **ptyred** in the *Cisco WAN Switching Command Reference*.)

Switchover to a Redundant UXM

If the card fails, a switchover occurs to a Y-cabled, redundant UXM card set if available. If the switchover occurs, the primary UXM acquires failed status, and the Fail LED turns on.

Card Mismatch

The UXM supports two types of card mismatch notification. The notification common to all cards occurs when you connect an unsupported back card to the front card. The mismatch notification unique to the UXM occurs if you attach a supported back card but one that has a different interface or a *smaller* number of the *correct* line types than what firmware previously reported to software.

Firmware informs switch software of the number and type of interface ports when you first activate a UXM. Software retains the back card configuration data if you remove it. If you subsequently attach a card with fewer ports, switch software flags a mismatch. Replacing a back card with *more* ports of the *same* line type or exchanging SMF and MMF OC3 (STM1) cards is not a mismatch. To change the interface that software has on record, you must first down the card then re-activate it.

Traffic Management Features

Table 4-7 is a list of the traffic management features of the UXM.

Table 4-7 Traffic Management Features

Card Mode	Supported Management Technology
UNI/NNI Port and Trunk	Traffic classes are CBR, VBR, ABR, and UBR as well as ATM-to-Frame Relay service interworking (SIW) and network interworking (NIW).
Trunk	Additional traffic classes are FastPacket-based or interworked connections: high-priority, time-stamped, non time-stamped, bursty data A, bursty data B.
UNI/NNI Port	PCR-linked policing of ABR connections.
UNI/NNI Port	Frame-based GCRA policing on AAL5 VCs.
UNI/NNI Port and Trunk	Partial packet discard (or tail packet drop) and early packet discard for AAL5 VCs.
UNI/NNI Port	ABR options: • End-to-end (ABR loop end-to-end) but without VS/VD • VS/VD segmented ABR within a network and ABR on external segments • VS/VD segmented ABR within a network and UBR or VBR on external segments • ForeSight within a network and UBR or VBR on external segments • ForeSight within a network and ABR on external segments
UNI/NNI Port	Per-VC queuing for ABR or UBR connections.
UNI/NNI Port	Per-VC queuing for statistics for all connection types.
UNI/NNI Port	User-configurable, per-VC congestion thresholds.
UNI/NNI Port and Trunk	User-configurable, per-Qbin congestion thresholds.
UNI/NNI Port	EFCI, Relative Rate, or Explicit Rate control options for an ABR connection—if the ABR control loop does not terminate at the connection endpoints.

The UXM as a Clock Source

A UXM line or trunk can be the clock source for the node. Use the **dspclksrcs** command to display available clock sources, **dspcurclk** to show the current clock source, and **cnfclksrc** to specify a new clock source. To clear clock alarms, use **clrclkalm**.

Cellbus Bandwidth Usage

The Cellbus consists of four operational lanes plus one backup lane. (The backup lane becomes active if a lane fails.) The FastPacket-based cards can use only one lane and communicate only in FastPackets. If a FastPacket-based card controls the Cellbus, no ATM cells can be on the Cellbus.

When the UXM has control of the Cellbus, it can pass any of the following:

- ATM cells on all lanes (for example, with a daxcon between UXMs or when one UXM communicates with another UXM in the same switch)
- FastPackets on lane 1 simultaneously with ATM cells on lanes 2–4
- FastPackets on lane 1

Switch software monitors and computes Cellbus bandwidth requirements for each card in the Cisco 8400-series switches. For the UXM alone, you can change its Cellbus bandwidth allocation. (You cannot view or alter bandwidth allocation for other cards.) The unit of measure for the ATM cell and FastPacket bandwidth on the Cellbus is the universal bandwidth unit (UBU).

Switch software allocates a default number of UBUs for a card when the card's firmware identifies the back card interface to switch software. If you remove a card, switch software reserves the existing Cellbus bandwidth allocation for that card. As you add a significant number of connections, switch software automatically allocates more UBUs. If the additions approach oversubscription, switch software presents a warning message. Regardless of the automatic bandwidth increases and warning message, Cisco advises against oversubscription because of burstiness.

For the UXM, software increases the bandwidth to meet the requirements for the minimum cell rate (MCR) and therefore does not accommodate burstiness. Because the automatic increase does not relate to burstiness, you must monitor the UXM bandwidth requirements to determine if you should change its UBU allocation. Monitor the bandwidth requirements after you build the network and during normal operation. On the CLI, the applicable commands are **cnfbusbw** and **dspbusbw**.

You can raise, lower, or check a UXM's UBUs with **cnfbusbw**. The **cnfbusbw** privilege level is 0—superuser. To check a UXM's UBUs, use **dspbusbw** or **cnfbusbw**. Any user can use **dspbusbw**. Each command's display provides the information you need to determine if you must increase the UBUs on a particular UXM. The only value you can change is *allocated bandwidth*. An example display for **cnfbusbw** appears in Figure 4-4. The *card-based* default and maximum Cellbus bandwidth for each interface appears in Table 4-8. Note that FastPackets require substantially less Cellbus bandwidth than ATM cells. The FastPacket requirements in the figure and table reflect the restriction of FastPackets to one lane and the maximum processing rate of the gateway on the UXM. The values you can view with the **cnfbusbw** and **dspbusbw** commands are:

- *Minimum Required Bandwidth*, the necessary bandwidth that switch software has calculated for the existing connections on the local UXM. The display shows the requirements for FastPackets, ATM cells, and the equivalent in total UBUs.
- *Average Used Bandwidth* is the average bandwidth usage.
- *Peak Used Bandwidth* is the peak bandwidth usage.
- *Maximum Port Bandwidth* is the maximum bandwidth that the back card can support. The FastPackets per second field has a dash-mark because only cells pass through the port.
- *Allocated Bandwidth* is the current Cellbus allocation for the card. The field shows the UBUs, the bandwidth when only ATM cells are on the bus, and cells plus Fastpackets. The reason for cells alone and cells plus Fastpackets is that cells can exist on the Cellbus with or without FastPackets. The last field under *Allocated Bandwidth* shows the formula to which the allocated values must adhere. (A description of the formula follows the example screen.)

Note Adding connections at the local node does not automatically cause the far-end node to increase UBU allocation.

Figure 4-4 Example Display for cnfbusbw

```
sw197          TN    StrataCom       IGX 16    9.1 Apr. 7 1998  03:15 GMT

Bus Bandwidth Usage for UXM card in slot 5   Last Updated on 04/07/98 03:15:42

                          FPkts/sec   Cells/sec    UBUs
Minimum Reqd Bandwidth:           0      100100     26
Average Used Bandwidth:           0           0      0
Peak    Used Bandwidth:           0           0      0
Maximum Port Bandwidth:           -      288000     72

Allocated    Bandwidth:                              1
           (Cell Only):           -        4000
           (Cell+Fpkt):        2000        3000
           (Fpkts / 2 + Cells)   <=        4000


Reserved     Bandwidth:           -        4000      1

This Command: cnfbusbw 5


Allocated UBU count:
```

Table 4-8 Cellbus Bandwidth Allocation for UXM Interfaces

Interface Type	No. of Ports	Default UBUs	Default Cell Traffic Only (cps)	Default Cell + Fpkt Traffic (cps and fps)	Max. UBUs	Max. Cell Traffic Only (cps)	Maximum Cell + Fpkts Traffic (cps and fps)
OC3	4 or 2	44	176,000	132,000, 88,000	235	708,000	473,000, 470,000
T3	6 or 3	24	96,000	72,000, 48,000	235	708,000	473,000, 470,000
E3	6 or 3	20	80,000	60,000, 40,000	235	708,000	473,000, 470,000
T1	8	8	32,000	24,000, 16,000	32	128,000	96,000, 64,000
T1	4	4	16,000	12,000, 8,000	16	64,000	48,000, 32,000
E1	8	10	40,000	30,000, 20,000	40	160,000	120,000, 80,000
E1	4	5	20,000	15,000, 10,000	20	80,000	60,000, 40,000

Planning for Cellbus Bandwidth Allocation

With the Network Modeling Tool™ (NMT), you can use the projected load for all UXMs in the network to estimate their Cellbus requirements. During normal operation, you can use StrataView Plus to obtain the trunk and port statistics then decide whether to use **cnfbusbw** to increase the UBU allocation. If you are using only the CLI, you would need to establish a virtual terminal (**vt**) session to each node then execute **dspbusbw** or **cnfbusbw**.

Calculating Cellbus Bandwidth Changes

To determine how many UBUs are necessary, use the values for *average bandwidth used* (see Figure 4-4) in the following formula:

$$UBUs = \frac{\frac{fps}{2} + cps}{4000}$$

In most circumstances, the *fps* and *cps* values from *average bandwidth used* are sufficient. The *peak bandwidth used* values are primarily informational.

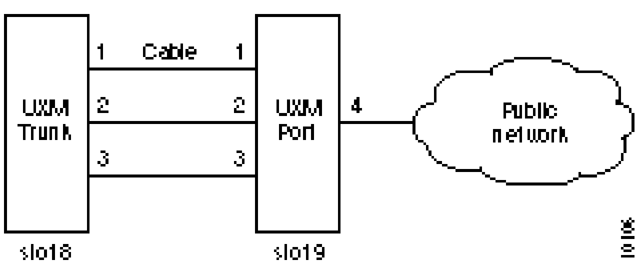
The information in Table 4-8 provides the ranges for the interface type. Note that, if you do the math according to the formula, you see that the value in the cells-alone column of Table 4-8 equals the result of adding half the FastPacket value to the cell value in the cells plus FastPackets column.

When you use **dspbusbw**, a yes/no prompt asks if you want firmware to retrieve the usage values. If you enter a “y,” the UXM reads—then clears—its registers and thus restarts statistics gathering. If you enter an “n,” switch software displays the current values that reside in control card memory (on the NPM). The values in memory come from the last update from the UXM.

ATM Across a Public ATM Network

The UXM can support trunking across a public ATM network such that both virtual channel connections (VCCs) and virtual path connections (VPCs) traverse a single virtual path trunk. This feature lets you map multiple trunks to a single port of an NNI. The NNI connects to either a public or private ATM network. The virtual trunk package is a lower-cost alternative to leased circuits but still has the full set of Cisco ATM traffic management capabilities. This application requires two UXMs and a clock from an external source. The rates can be OC-3/STM-1, T3/E3, or T1/E1.

Figure 4-5 UXMs Configured for a Public ATM Network



Refer to Figure 4-5 as you read the steps for the following example set-up:

Step 1 Connect a cable between each of the following:

- 8.1 and 9.1
- 8.2 and 9.2
- 8.3 and 9.3
- 9.4 and the public network

Step 2 Configure trunk 8.1, 8.2, and 8.3 to use VPC 101, 102, and 103 respectively.

Step 3 Add three VPC connection from 9.1, 9.2, and 9.3 to 9.4. At the remote end, use the same VPCs.

The UXM in UNI/NNI Port Mode

In port mode, the UXM can support up to 4000 virtual circuit (VC) or virtual path (VP) ATM connections and can operate as either an NNI or a UNI. The connections can be either ATM connections or FastPacket-based (gateway). A "gateway" connection is one that requires the gateway function on the UXM to convert FastPackets from the Cellbus to and from ATM cells so the UXM can process them. For ATM cell-based traffic, no conversion takes place: only ATM cells in the ingress and egress directions traverse the Cellbus between the UXM port card and UXM trunk card.

Because the maximum number of lines an IGX switch can support is 64 and the maximum number of lines on a UXM back card is 8 (for a 8-T1 or 8-E1 port card), the maximum number of UXM cards that an IGX 8420 or 8430 switch can support is 8. The maximum in an IGX 8410 node is 6.

Operating in port mode, the UXM provides an interface for the following classes of ATM service: CBR, VBR, standard ABR with and without *virtual source/virtual destination* (VS/VD), ABR with ForeSight, and UBR. The connections on a port-mode UXM—including interworked and cell-forwarded connections—can terminate on the following endpoints:

- UXM operating as a UNI or NNI port
- ALM/A
- UFM or FRM for ATM-to-Frame Relay service interworking (SIW) or network interworking (NIW)
- FRP in an IPX node for an interworked, ATM-to-Frame Relay connection
- ASI in a BPX node
- BXM operating as a either a port card or a trunk in a BPX node
- AUSM in a Cisco MGX 8220 shelf
- FRSM in a Cisco MGX 8220 shelf

Supported Connection Types

The cards that serve as connection endpoints determine the possible types of connections. Table 4-9 shows the possible connection type according to the endpoints. In Table 4-9, *VC connection* is a virtual channel connection; *VP connection* is a virtual path connection; and *ABRFST* is ABR with ForeSight. Note that the cards at both ends of a connection must support VS/VD for you to add an ABR connection with VS/VD. For more detailed information on the connection types, refer to the ATM connection description in the *Cisco System Overview* or the description of the **addcon** command in the "ATM Connections" chapter of the *Cisco WAN Switching Command Reference*.

Table 4-9 ATM Endpoints and Connection Types

Endpoints	Connection Types
UXM and UXM	VP connections and VC connections: CBR.1, VBR.1-3, UBR.1-2, ABRFST, ABR.1 (with VS/VD), ABR.1 (without VS/VD)
UXM and ALM/A	VC connections: CBR.1, VBR.1-3 ATM-Frame Relay network interworking connections: VBR.3 ATM-Frame Relay service interworking connections: VBR.3
UXM and BXM	VP connections and VC connections: CBR.1, VBR.1-3, UBR.1-2, ABRFST ABR.1 (with VS/VD), ABR.1 (without VS/VD)
UXM and ASI-T3 or ASI-E3	VP connections and VC connections: CBR.1, VBR.1-3, UBR.1-2, ABRFST ABR.1 (without VS/VD)
UXM and ASI-OC3	VP connections and VC connections: CBR.1, VBR.1-3, UBR.1-2, ABR.1 (without VS/VD)
UXM and AUSM	VP connections and VC connections: CBR.1, VBR.1-3, UBR.1-2, ABRFST ABR.1 (without VS/VD)
UXM and UFM	ATM frame forwarding connections (HDLC frames to single VPI/VCI on an ATM interface): VBR.3, ABRFST ATM-Frame Relay network interworking connections: VBR.3, ABRFST ATM-Frame Relay service interworking connections: VBR.3, ABRFST
UXM and FRP or FRM	ATM frame forwarding connections (HDLC frames to single VPI/VCI on an ATM interface): VBR.3, ABRFST ATM-Frame Relay network interworking connections: VBR.3, ABRFST ATM-Frame Relay service interworking connections: VBR.3, ABRFST
UXM and FRSM	ATM frame forwarding connections (HDLC frames to single VPI/VCI on an ATM interface): VBR.3, ABRFST ATM-Frame Relay network interworking connections: VBR.3, ABRFST ATM-Frame Relay service interworking connections: VBR.3, ABRFST ATM-FUNI connections: VBR.3, ABRFST

Routing Over Cell Trunks Only

You can specify *trunk cell routing only* as an option when you add a connection between UXM, ASI, or BXM ports. When you enable trunk cell routing, switch software uses only the cell-based trunk cards BNI, BXM, and UXM for routing, and no conversion to FastPackets occurs at any point along the route. If you add connections at other port cards, such as a UFM or ALM/A, switch software disables the cell routing option. On the CLI, the **addcon** prompt for this option appears as “trunk cell routing restrict y/n?” It appears after you enter either the ATM class of service or after you finish specifying all the individual bandwidth parameters that apply to the connection type you select.

Activation and Configuration of a UXM in Port Mode

When you insert a new UXM into the backplane or apply power to the IGX node, UXM firmware reports the card type and number of lines on the back card. Switch software can then determine the allowed range and characteristics of logical and physical parameters for you to configure. Software thus prevents you from exceeding the maximum number of logical ports on the switch as you activate logical lines through either StrataView Plus or **upln** on the CLI. Applicable, line-specific commands are **upln**, **dnln**, **cnfln**, **dsplns**, **prtlns**, and **dsplncnf**.

Table 4-10 shows the line characteristics you can configure for each interface type through either StrataView Plus or the **cnfln** command on the CLI. Table 4-10 also shows the fixed parameters.

Table 4-10 Configurable Line Characteristics

Interface Type	Configurable Parameters
OC3 (STM1) SMF and MMF	• HCS masking (on or off) • Payload scramble (on or off) • Cell (line) framing (STS/SONET or STM/SDH) • Frame scramble (on or off)
T3	• HCS masking (on or off) • Payload scramble (on or off) • Cell (line) framing can be header error correction (HEC) or PLCP • Cable length (0–255 feet or greater than 255 feet)
E3	• HCS masking (on or off) • Payload scramble (on or off) • Cell (line) framing is fixed as header error Correction (HEC) • Cable length (0–255 feet or greater than 255 feet)
T1	• HCS masking (on or off) • Payload scramble (on or off) • Loop clock (enable/disable) • Line framing (ESF or D4) • Cable length (0–655 feet, ABAM cable only) • Idle code • Line coding (fixed as B8ZS)
E1	• HCS masking (on or off) • Payload scramble (on or off) • Line DS0 map (timeslots 0–31 for unframed or 1–15 and 17–31 for framed format) • Loop clock • Idle code • Line coding (fixed as HDB3) • Receive line impedance (BNC fixed at 75 Ohms; DB15 fixed at 120 Ohms)

Port Activation and Characteristics

You can activate and configure logical ports as well as configure port queues through StrataView Plus or the CLI. Software prevents you from activating over 64 ports. After activating a port, you can specify a UNI or NNI cell header and optionally specify LMI or ILMI protocol. The CLI commands are **upport**, **dnport**, **cnfport**, **cnfportq**, **dspport**, **dspports**, **dspportq**, and **cnfabrparm**.

You can specify the depths as well as high and low thresholds for the CBR, VBR, and ABR queues. (UBR service shares the ABR queue.) You can configure all queues to have the maximum queue size. If congestion occurs, firmware scales down the maximum queue size on the active ports. The maximum size for each queue for the ingress and egress directions is 64000 cells each, so the total for a logical port is 128000 cells.

For ABR queues, additional parameters are available through StrataView Plus or the **cnfabrparm** command. The additional parameters are Ingress/Egress Congestion Information (CI) Control and Egress Explicit Rate Stamping (ER). The settings apply to all ports. With CI Control enabled, the CI bit in each resource management (RM) cell in the queue is set if the EFCI threshold is exceeded. If you enable ABR ER, the cell rate for the ABR connection is placed in each of the RM cells.

Summary Statistics

On the CLI, you can specify summary statistics for a UXM port.

With the **dspportstats** command, you can specify:

- Port statistics
- Virtual interface statistics (which are identical to port statistics in Release 9.1)
- IMA statistics
- ILMI and LMI statistics

With the **dspchstats** command, you can specify:

- Cells received and cells transmitted
- EOF cells received and non-compliant cells received
- Cells received with CLP=0 and those with CLP=1
- Cells transmitted with CLP=0 and those with CLP=1
- Average receive and transmit VC queue depth
- Ingress/egress VSVD allowed cell rate
- OAM state

Statistics Commands for Troubleshooting

You can configure bucket statistics through StrataView Plus for logical lines, ports, and channels (connections). Statistics configuration in StrataView Plus requires the TFTP mechanism. You can also enter commands on the CLI. Refer to the *Cisco WAN Switching Command Reference* and the *Cisco SuperUser Command Reference* for descriptions of the following commands:

- Logical line statistics: **cnflnstats**, **dsplnstatcnf**, and **dsplnstathist**
- Port statistics (for both Frame Relay and ATM): **cnfportstats**, **clrportstats**, **dspportstats**, **dspportstatcnf, dspportstathist**, and, for link statistics for a Port Concentrator, **dspfrcportstats**
- Channel (connection) statistics: **cnfchstats**, **clrchstats**, **dspchstats**, **dspchstatcnf**, **dspchstathist**

Integrated and Statistical Line Alarms

Integrated alarms for the UXM consist of LOS, LOF, AIS, YEL, LOC, LOP, Path AIS, Path YEL, Path Trace, and Section alarms. The display for the **dsplns** command lists an alarm if the related event occurs. You can configure the event duration that qualifies and clears an alarm with **cnflnparm**.

You can configure the class, rate, and duration for setting and clearing of statistical alarms with the **cnflnalm** command. Refer to the description of **cnflnalm** in the *Cisco WAN Switching Command Reference* for a list of all possible line alarm types. The display for the **dsplnerrs** command shows data for existing alarms. To clear the statistical alarms on a line, use the **clrlnalm** command.

Loopback and Test Commands

The UXM supports local and remote loopbacks. You can establish a local loopback on either a connection or a port. Remote loopbacks are available for connections only. No line loopbacks are available for the UXM.

UXM Interface Cards

This section provides basic information on the interface back cards for the UXM. The information consists of a general description, an illustration of the card faceplate, and a table describing the connectors and status LEDs. For details on the line technology of each type of interface, see the appendix titled “System Specifications.”

Note The T1 and E1 back cards do not have Active and Fail LEDs to indicate *card* status (rather than the port status indicated by the tri-color LEDs). If a T1 or E1 back card failure is detected, all of the tri-color LEDs turn red.

The model numbers of the back cards and the order of their appearance are:

- BC-UAI-4-155-MMF
- BC-UAI-4-155-SMF
- BC-UAI-2-155-SMF
- BC-UAI-6-T3
- BC-UAI-3-T3
- BC-UAI-8-T1-DB15
- BC-UAI-4-T1-DB15
- BC-UAI-6-E3
- BC-UAI-3-E3
- BC-UAI-8-E1-DB15
- BC-UAI-8-E1-BNC
- BC-UAI-4-E1-DB15
- BC-UAI-4-E1-BNC

OC-3/STM1 Back Cards

The OC3/STM1 back cards for the UXM have the single-mode fiber (SMF) and multi-mode fiber (MMF) connections. The cards are:

- BC-UAI-2-155-SMF
- BC-UAI-4-155-SMF
- BC-UAI-4-155-MMF

As indicated by the “2” or the “4” in the model number, these cards have two or four transmit and receive connectors. Each *line* has a tri-color LED whose color indicates its status. Each card also has a red Fail LED and a green Active LED to indicate the status of the *card*. Table 4-12 lists the connectors and LEDs. Figure 4-8 shows the four-port OC3/STM1 card. The SMF and MMF versions appear the same. Figure 4-9 shows the two-port OC3/STM1 card. For technical data on OC3/STM1 lines, see the appendix titled “System Specifications.”

Table 4-11 Connectors and LEDs for SMF and MMF Back Cards

Connector/Indicator	Function
Transmit and Receive	SC connector for SMF and MMF
Red (on the tri-color LED)	On indicates line is active but a local alarm was detected.
Yellow (on the tri-color LED)	On indicates line is active but a remote alarm was detected.
Green (on the tri-color LED)	On indicates line is active.
Fail light (red)	An error was detected. Reset the card with **resetcd f** to clear it. If Fail comes on again, call the TAC through Cisco Customer Engineering.
Active light (green)	The card is active and in service.

Figure 4-6 BC-UAI-4-155-SMF Faceplate

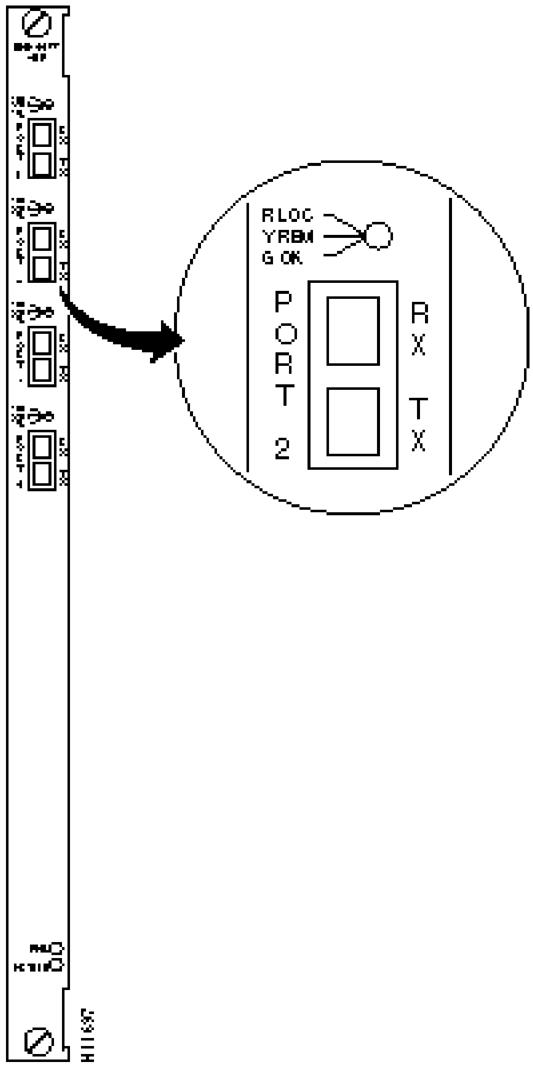
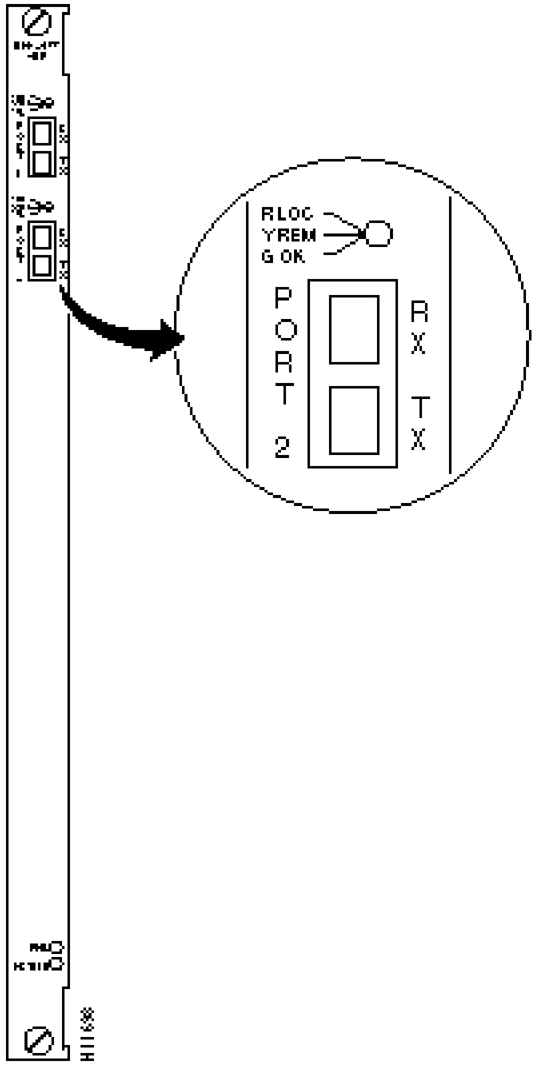


Figure 4-7 BC-UAI-2-155-SMF Faceplate



T3 Back Cards

The T3 back cards for the UXM are BC-UAI-6-T3 and BC-UAI-3-T3. These cards have six and three pairs of SMB connectors, respectively. Each *port* has a tri-color LED whose color indicates its status. Each card also has a red Fail LED and a green Active LED to indicate the status of the *card*. Table 4-12 lists the connectors and LEDs. Figure 4-8 show the six-port T3 card. Figure 4-9 shows the three-port T3 card. For technical data on T3 lines, see the appendix titled “System Specifications.”

Table 4-12 Connectors and LEDs for BC-UAI-6-T3 and BC-UAI-3-T3

Connectors/Indicator	Function
Transmit Jacks	SMB connectors for transmit data.
Receive Jacks	SMB connectors for receive data.
Red (on the tri-color LED)	On indicates line is active but a local alarm was detected.
Yellow (on the tri-color LED)	On indicates line is active but a remote alarm was detected.
Green (on the tri-color LED)	On indicates line is active.
Fail light (red)	An error was detected. First, reset the card with **resetcd f**. If Fail comes on again, call the TAC through Cisco Customer Engineering.
Active light (green)	The card is active and in service.

Figure 4-8 BC-UAI-6-T3 Faceplate

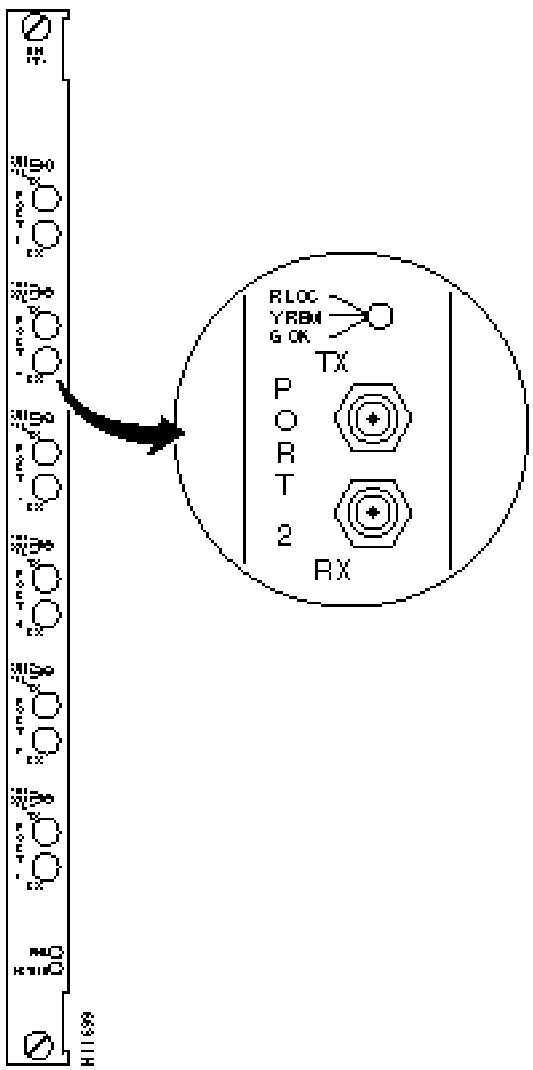
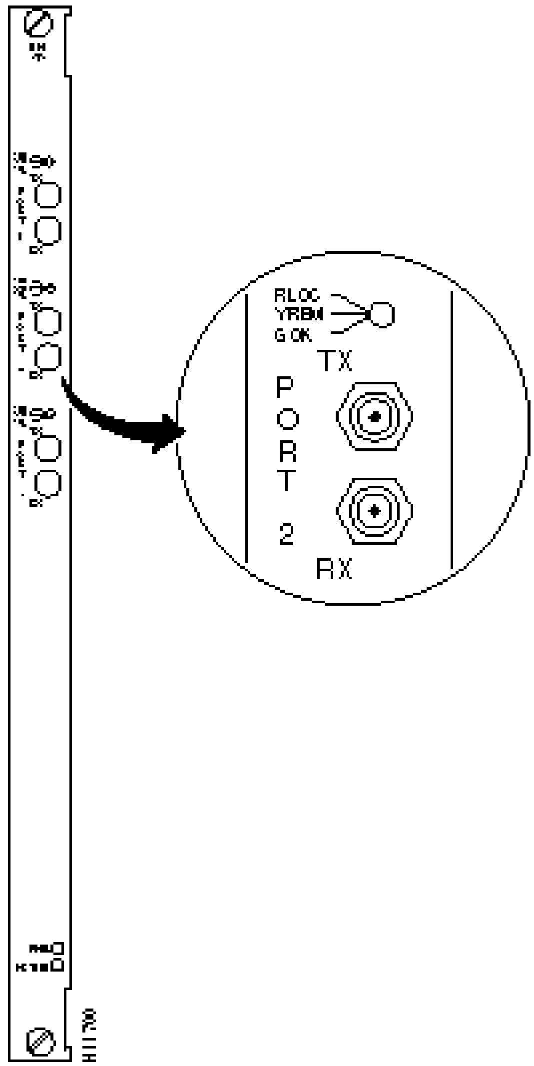


Figure 4-9 BC-UAI-3-T3 Faceplate



E3 Back Cards

The E3 back cards for the UXM are the six-port BC-UAI-6-E3 and the three-port BC-UAI-3-E3. These cards have six and three pairs of connectors, respectively. Each *line* has a tri-color LED whose color indicates its status. Each card also has a red Fail LED and a green Active LED to indicate the status of the *card*. Table 4-13 lists the connectors and LEDs. Figure 4-10 show the six-port card. Figure 4-11 shows the three-port card. For technical data on E3 lines, see the appendix titled “System Specifications.”

Table 4-13 Connectors and LEDs for BC-UAI-6-E3 and BC-UAI-3-E3

Connector/Indicator	Function
Transmit Jack	SMB connector for transmit data.
Receive Jack	SMB connector for receive data.
Red (on the tri-color LED)	On indicates line is active but a local alarm was detected.
Yellow (on the tri-color LED)	On indicates line is active but a remote alarm was detected.
Green (on the tri-color LED)	On indicates line is active.
Fail light (red)	An error was detected. Reset the card with **resetcd f** to clear it. If Fail comes on again, call the TAC through Customer Engineering.
Active light (green)	The card is active and in service.

Figure 4-10 BC-UAI-6-E3 Faceplate

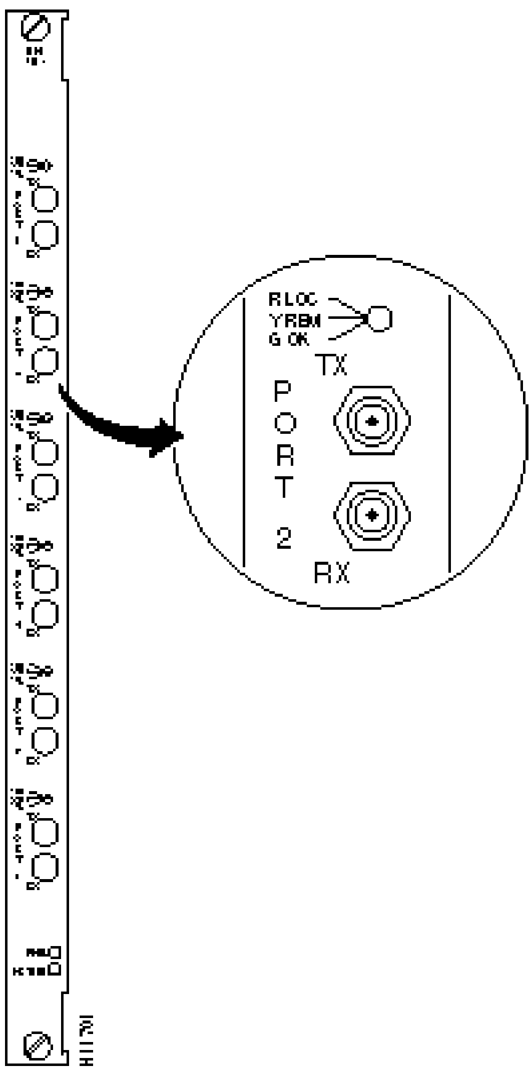
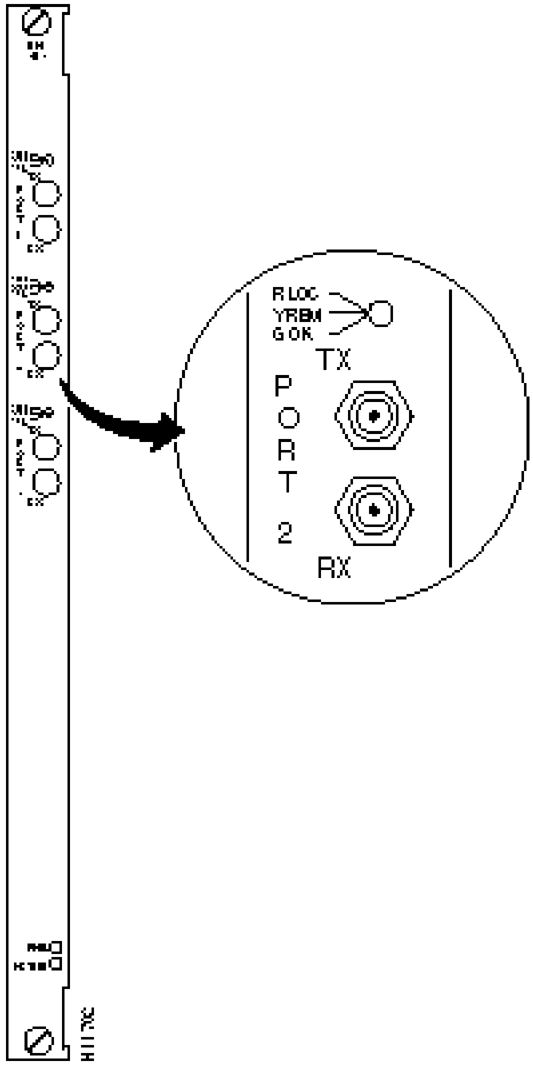


Figure 4-11 BC-UAI-3-E3 Faceplate



T1 Back Cards

The T1 back cards for the UXM are BC-UAI-8-T1 and BC-UAI-4-T1. These cards have eight and four DB15 lines, respectively. Each *line* has a tri-color LED whose color indicates its status. If a card failure occurs, all the LEDs turn red. Table 4-14 lists the connectors and LEDs. Figure 4-12 show the eight-port T1 card. Figure 4-13 shows the four-port T1 card. For technical data on T1 lines, see the appendix titled "System Specifications."

Table 4-14 Connectors and LEDs for BC-UAI-8-T1 and BC-UAI-4-T1

Connector/Indicator	Function
Four or Eight DB15s	Each DB15 connector carries transmit and receive data.
Red (on the tri-color LED)	On indicates line is active but a local alarm was detected.
Yellow (on the tri-color LED)	On indicates line is active but a remote alarm was detected.
Green (on the tri-color LED)	On indicates line is active.

Figure 4-12 BC-UAI-8-T1 Faceplate

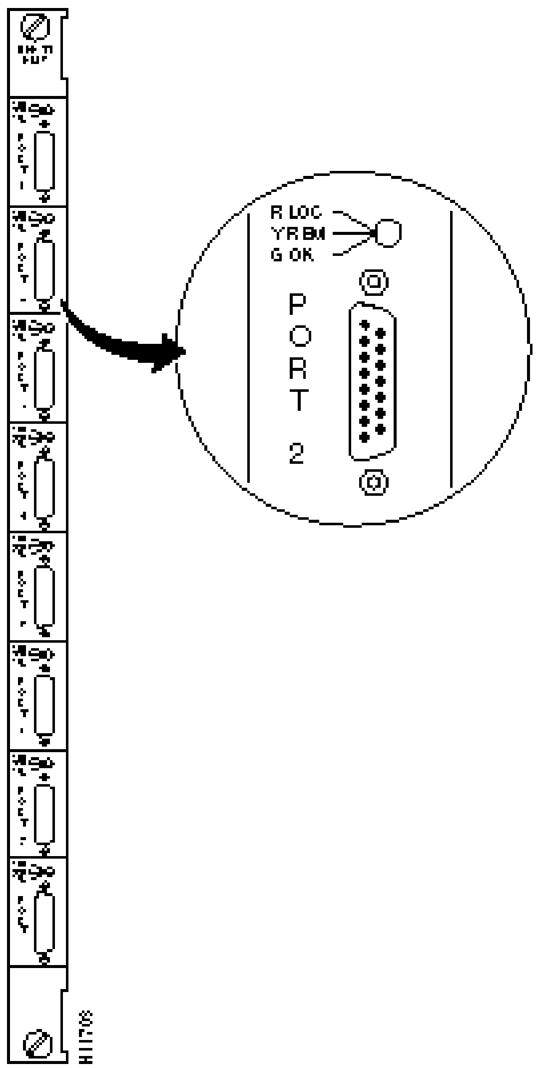
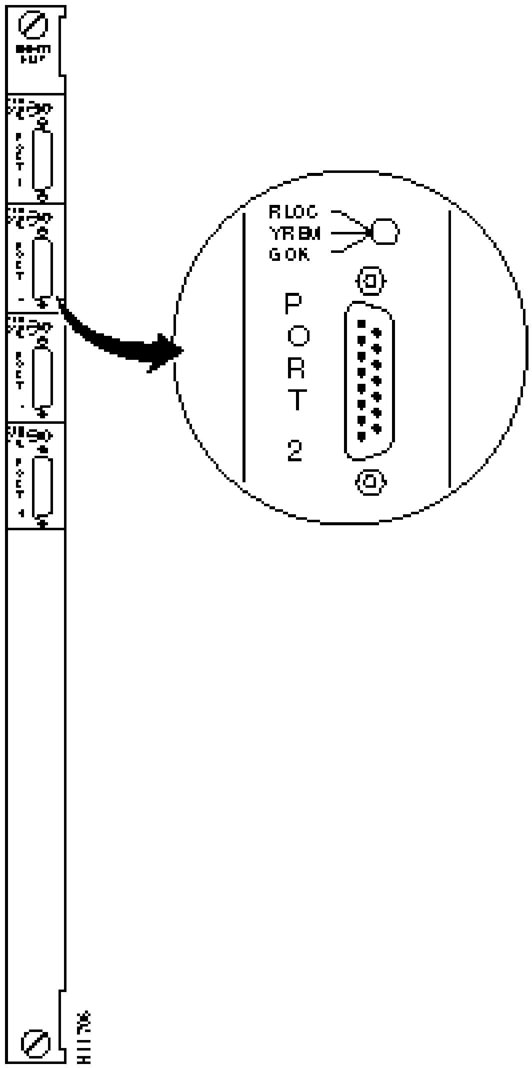


Figure 4-13 BC-UAI-4-T1 Faceplate



E1 Back Cards

The E1 back cards for the UXM are:

- BC-UAI-8-E1-BNC
- BC-UAI-8-E1-DB15
- BC-UAI-4-E1-BNC
- BC-UAI-4-E1-DB15

As the model numbers indicate, the eight and four-port E1 cards can have either BNC or DB15 connectors. Each *line* has a tri-color LED whose color indicates its status. If a card failure occurs on the back card, all LEDs turn red. Table 4-12 lists the connectors and LEDs. Figure 4-8 show the eight-port E1 card. Figure 4-9 shows the four-port T1 card. For technical data on E1 lines, see the appendix titled “System Specifications.”

Table 4-15 Connectors and LEDs for BC-UAI-8-E1 and BC-UAI-4-E1

Connector/Indicator	Function
Eight or Four DB15 Connectors	Each DB15 connector carries transmit and receive data.
Eight or Four Pairs of BNC Connectors	Each BNC connector carries traffic in one direction.
Red (on the tri-color LED)	On indicates line is active but a local alarm was detected.
Yellow (on the tri-color LED)	On indicates line is active but a remote alarm was detected.
Green (on the tri-color LED)	The card is active and in service.

Figure 4-14 BC-UAI-8-E1 DB15 Faceplate

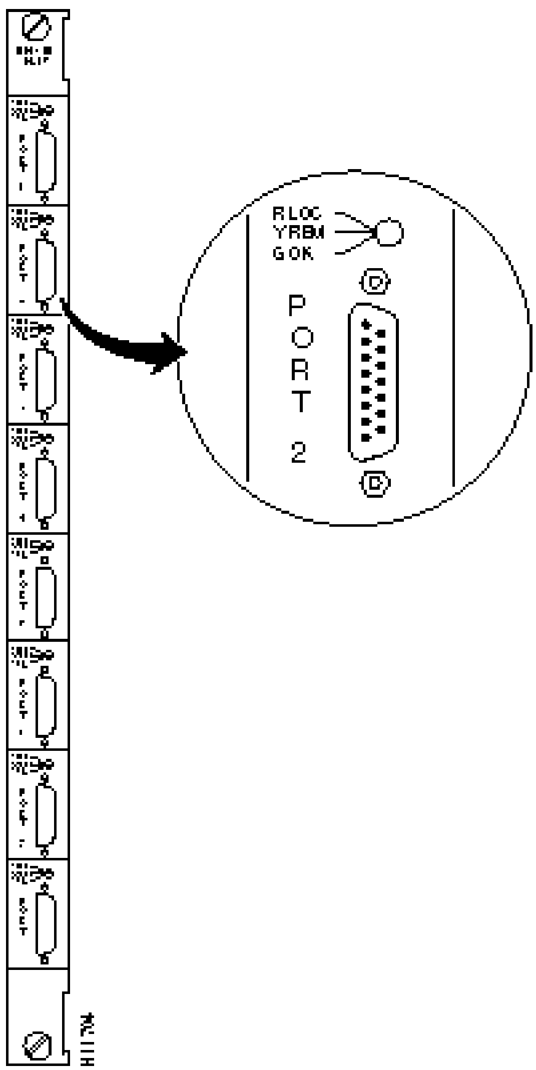


Figure 4-15 BC-UAI-8-E1 BNC Faceplate

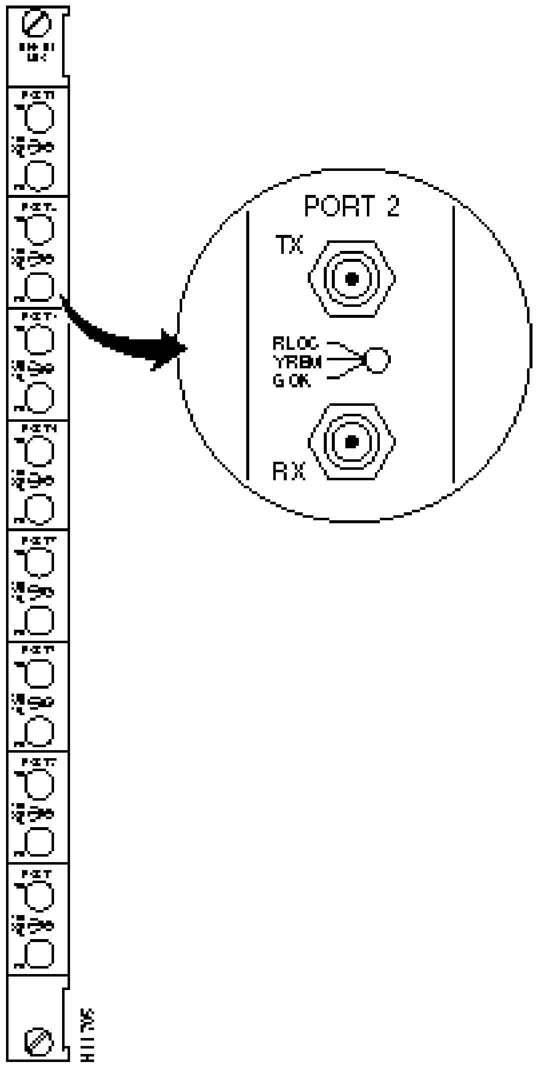


Figure 4-16 BC-UAI-4-E1 DB15 Faceplate

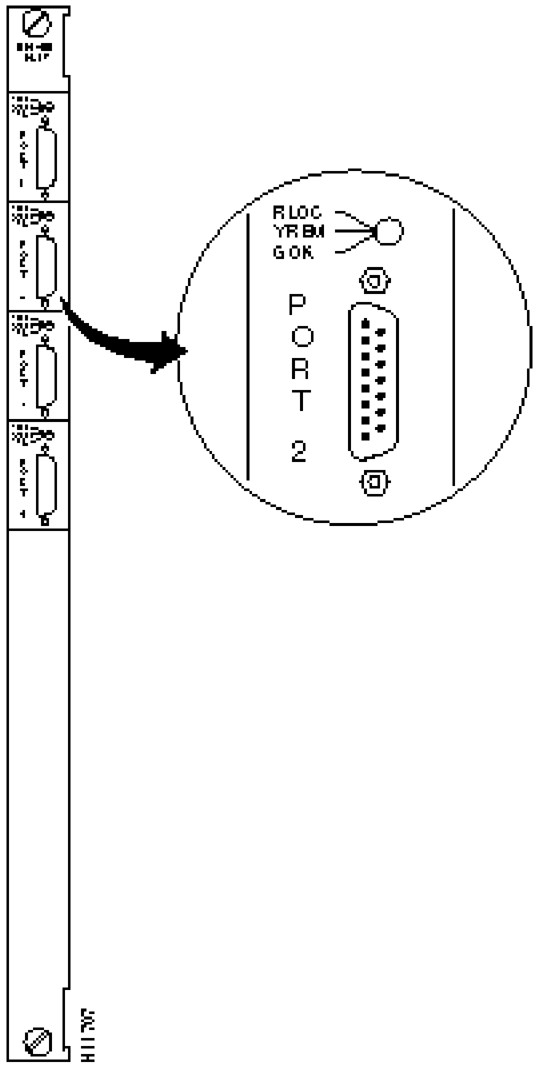
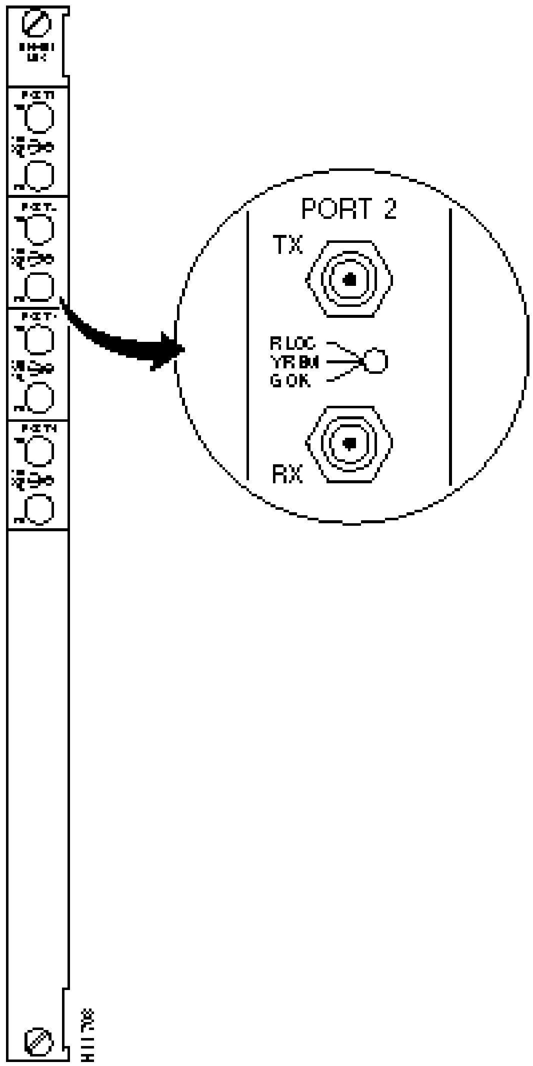


Figure 4-17 BC-UAI-4-E1 BNC Faceplate



ATM Line Module A

The ATM Line Module A (ALM/A) provides an ATM UNI port that allows devices such as routers or ATM switches to support VPCs and VCCs across the IGX node. The ALM/A operates as a cell relay interface that supports basic connectivity to IGX interfaces or BPX ASI interfaces through a Cisco Stratacom network. The ALM/A supports ATM connections that terminate at either ATM or Frame Relay endpoints. With the processing that the IGX node provides, cells can cross either an ATM trunk or a FastPacket trunk. This ALM/A description covers the following topics:

- General ALM/A features
- Traffic management (ingress policing)
- Connection types
- Operational parameters
- Back cards

Using the **addcon** command, you can add connections between the following endpoints

- ALM/A and ALM/A
- ALM/A and ASI
- ALM/A and UFM in IGX node (using Frame Relay and ATM service interworking)
- ALM/A and FRM in IGX node or FRP in IPX (ATM-frame forwarding)

Figure 4-18 shows an example of a network using ALMs. The network contains connections from an ALM/A to another ALM/A, a UFM, and an ASI. The dashed lines show virtual connections. The solid lines between the trunk cards and the ATM cloud are trunks.

Figure 4-19 shows the ALM/A faceplate.

Figure 4-18 ALMs in a Network

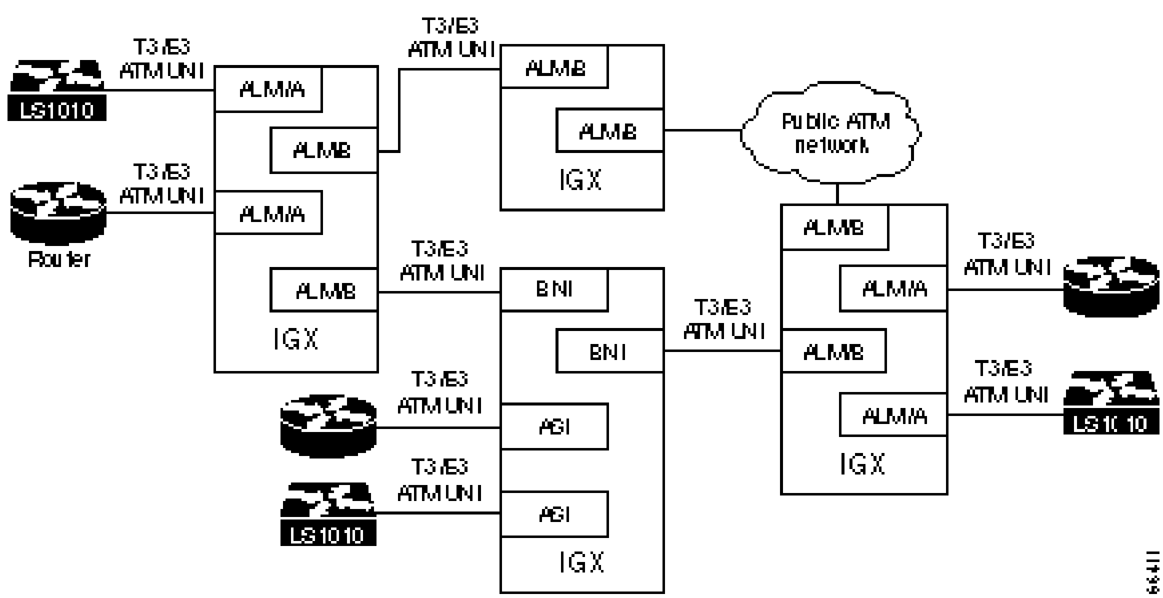
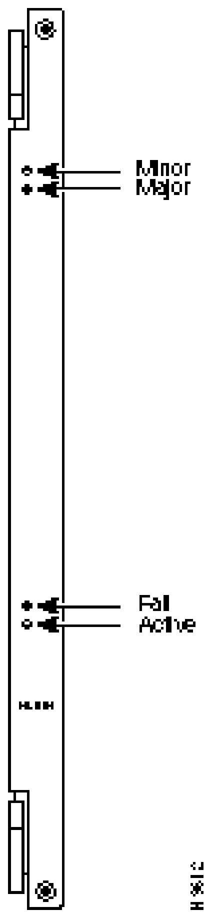


Figure 4-19 ALM/A Faceplate



ALM/A Features

A general list of ALM/A characteristics follows. (Subsequent sections have more particular information on interworking, traffic management, and back cards.)

- An aggregate throughput of 45 Mbps
- PVC rate of 150–96000 cells per second—symmetric connections only
- ATM Forum UNI v3.0 and v3.1 headers
- CBR, VBR, ATFR, ATFT, and ATFX connection types
- PLCP DS-3 framing
- G.804 E3 framing
- Interworking between Frame Relay and ATM endpoints
- Ingress policing
- Per VC queuing with an overall capacity of 65535 cells
- Up to 1000 connections per card at an aggregate rate up to DS-3
- Optional Y-cable redundancy
- Support for line and card statistics and alarms

Connection Types

The ALM/A supports CBR, VBR, ATFR, ATFT, and ATFX connection types. Thus, the card supports ATM, cell forwarding, and both network and service interworking connections. Table 4-16 shows the card combinations and connections types. The *Cisco IGX 8400 Series Installation* manual describes where and when to specify the connection type. For more information on the interworking connections, see the *System Manual* and the **addcon** description for Frame Relay and ATM connections in the *Cisco WAN Switching Command Reference*.

Table 4-16 ALM/A Connection Types

Far-End Card	Possible Connection Types on the ALM/A
ALM/A	VBR, CBR, ATFR, ATFT, ATFX
UFM	ATFR, ATFT, ATFX
FRM	ATFR
ASI	VCCs only: VBR, CBR, ATFT, ATFR

Traffic Management

The ALM/A uses per-VC queue thresholds and credit-based servicing to control the ingress flow of data to the network and guarantee card resources for each connection.

Using **addcon** for an ATM or cell-forwarding connection, you specify the VC queue depth and the rate for the connection. If you do not specify a queue depth, the system calculates the queue depth for the connection based on the cell rate. The connection rate determines the service credits. If 80% of the VC queue depth is exceeded, cells with CLP=1 are discarded. If a connection's VC queue is full and the cell rate is exceeded long enough, cells are discarded from the affected queue. Therefore, if a high level of bursty traffic expected for given cell rate, specify a deeper queue for a connection.

For cell forwarding connections, you can explicitly assign VC queue depth for each connection. For ATFR connections, you can assign a VC queue depth by choosing or modifying a Frame Relay class and specifying the queue depth in bytes. Either way, you can over-subscribe the buffer pool on the card. Actually, buffers are dynamically assigned to VC queues as cells arrive and depart. In this scheme, no data is lost unless you over-subscribe and all buffers are occupied. If you do not specify VC queue depth when adding a connection, switch software assigns a percentage of buffers equal to the connection's cell rate divided by the total ALM/A bandwidth. With this approach, over-subscription is not a problem.

ALM/A Operational Parameters

The ALM/A has the following operational parameters:

- If both endpoints are on ALM/As, both cards must be in either VCC or VPC mode. Refer to the *Cisco IGX 8400 Series Installation* manual for set-up details.
- If the endpoints are an ALM/A and an ASI, the connection must be a VCC.
- The %util for ALM/A connections is always 100%.
- For the cell forwarding gateway or service interworking, the AIT, BTM, or ALM/B trunk cards in the IPX or IGX node must have firmware that supports these technologies.
- UBR is not supported.

- On VPCs that have a VCI=3 (a reserved value), the ALM/A drops segment OAM cells without processing them.
- The ALM/A does not support ILMI.
- The ALM/A drops cells with CLP=1 when the associated VC queue exceeds 80% of either the user-specified depth or the system-specified depth.
- The ALM/A does not support per-connection or port statistics.
- The Frame Relay endpoints must be capable of supporting the type of Frame Relay traffic, such as forwarding of HDLC frames.

Back Cards for the ALM/A

The ALM/A T3 and E3 back cards are the BC-UAI-1T3 and BC-UAI-1E3, respectively. Each back card has two BNC connectors and six LED indicators. For the BC-UAI-1T3 faceplate items, refer to Figure 4-20 and Table 4-17. For the BC-UAI-1E3 faceplate items, refer to Figure 4-21 and Table 4-18. As you read from the top-down, the items in the figure and table correlate to each other. For technical specifications on T3 and E3 lines, refer to the appendix titled “System Specifications.”

Table 4-17 BC-UAI-1T3 Connections and Indicators

Connector/Indicator	Function
Transmit Jack	BNC connector for transmit data.
Receive Jack	BNC connector for receive data.
LOS light (red)	Loss of signal at the local end.
Red alarm light (red)	Loss of local T3 or E3 frame alignment or loss of cell alignment.
Yellow alarm light (yellow)	Loss of frame alignment at remote end or loss of cell alignment.
AIS light (green)	All ones on the line.
Fail light (red)	An error was detected. Reset the card with **resetcd f**. If the LED comes on again, call the TAC.
Active light (green)	The card is in service and has active circuits.

Figure 4-20 BC-UAI-1T3 Faceplate

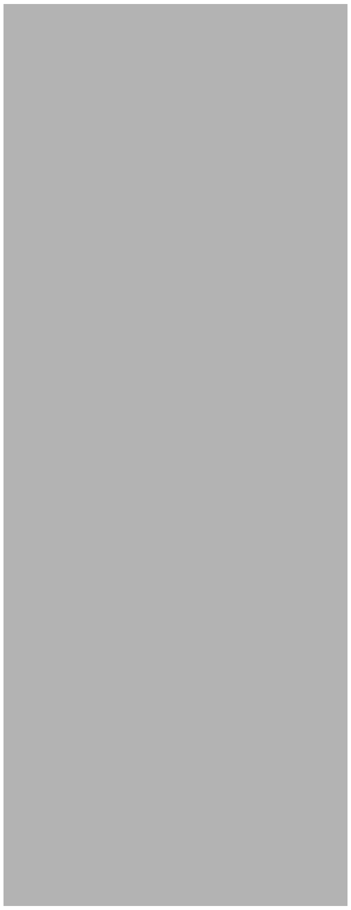


Figure 4-21 BC-UAI-1E3 Faceplate

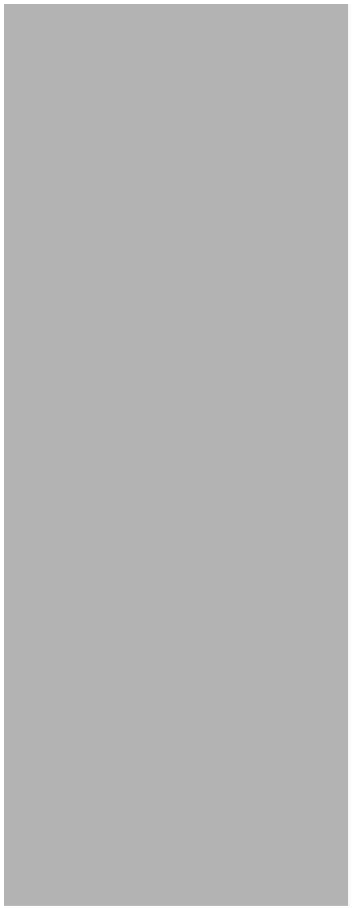


Table 4-18 BC-UAI-1E3 Connections and Indicators

Connector/Indicator	Function
Transmit Jack	BNC connector for transmit data.
Receive Jack	BNC connector for receive data.
LOS light (red)	Loss of signal at the local end.
Red alarm light (red)	Loss of local T3 or E3 frame alignment or loss of cell alignment.
Yellow alarm light (yellow)	Loss of frame alignment at remote end or loss of cell alignment.
AIS light (green)	All ones on the line.
Fail light (red)	An error was detected. Reset the card with **resetcd f**. If the LED comes on again, call the TAC.
Active: light (green)	The card is in service and has active circuits.

Universal Voice Module

This section describes the Universal Voice Module (UVM) and its interface cards. The topics are:

- Inroduction to the UVM
- Feature list
- An introduction to the connections on a UVM
- Descriptions of the standard and superuser commands that apply to the UVM
- A brief description of UVM voice processing
- Channel pass-through
- A brief description of UVM data processing
- UVM signaling support
- FAX relay
- Loopbacks on the UVM card set
- Line statistics
- Clock modes
- Channel associated signaling (CAS)
- CAS-switching
- D-channel compression
- Front card faceplate descriptions
- Back card descriptions

For installation and configuration instructions, see the *Cisco IGX 8400 Series Installation* manual.

Introduction to the UVM

The UVM card set is a multi-purpose module capable of supporting channelized T1, E1, or J1 lines for carrying voice, data, or both these types of traffic. The voice coding that the UVM supports are:

- Pulse code modulation (PCM)
- Adaptive differential pulse code modulation (ADPCM) per G.726
- Low delay code-excited linear predictive coding (LDCELP) per G.728
- Conjugate structure algebraic code-excited linear predictive coding (CSACELP) per G.729 and G.729A

G.729 and G.729A are two versions of CSACELP. G.729A is simpler and can permit a greater number of channels on a UVM. On the other hand, G.729A does not support certain features, such as FAX relay. The applicability of G.729 or G.729A appears as needed throughout this UVM description. The text frequently distinguishes connection types by referring the standard.

A UVM can terminate connections to a:

- UVM
- Cisco 3810 access device (at its FTM interface)
- CVM (except for connections that use LDCELP or CSACELP compression)
- CDP (except for connections that use LDCELP or CSACELP compression)

UVM Feature Descriptions

The sections that follow (and continue to the descriptions of the UVM faceplate) describe the UVM features. Lists of connection types and CLI commands also appear in the forthcoming sections.

UVM Feature List

The features of the UVM are:

- Packet assembly/disassembly (PAD) for voice or data connections
- Software configurable ports on T1, E1, or J1 back cards
- Maximum of 32 channels on the two T1, E1, or J1 lines, with echo cancellation
- Up to 64 ms. integral echo cancelling per channel for all voice connection types
- D-channel compression for Voice Network Switching (VNS) signaling support
- Voice SVC caching in conjunction with VNS
- PCM at 64 Kbps, on a maximum of 32 channels per card
- Standard data rate connections of 64 Kbps
- Super-rate data connections—which can be an aggregate of *n* x 64 Kbps (*n* <= 8)
- ADPCM voice compression at 32 Kbps or 24 Kbps per G.726
- LDCELP voice compression at 16 Kbps per G.728, on a maximum 16 channels per card
- CSACELP compression at 8 Kbps on 32 channels per G.729 or 16 channels per G.729A
- IGX-to-Cisco 3810 interworking by using 32-Kbps ADPCM or 8-Kbps CSACELP
- Channel associated signaling (CAS) and common channel signaling (CCS)
- Voice activity detection (VAD), which increases the compression ratio by decreasing the trunk utilization of the connection by about 50%
- FAX relay, for compressing G3 FAX traffic to 9.6 Kbps through the network cloud
- A-law or µ-law voice encoding on a per-channel basis
- Programmable voice circuit gain in the range –8 dB through +6 dB
- Support for many domestic and international signaling types
- Flexible signaling-bit conditioning when a circuit alarm occurs
- Per-channel, automatic bandwidth upgrade for modem or FAX circuits
- Self-test of all on-board circuits
- Y-cable redundancy
- Local and remote loopbacks for port and circuit testing

For voice connections that use PCM, ADPCM, or G.729A, the UVM can operate in either 24-channel mode (T1) or 30-channel mode (E1 or J1). If the compression is LDCELP or G.729 CSACELP, the UVM supports up to 16 channels. If more than 16 channels on a T1, E1, or J1 line are to carry traffic with G.729 or LDCELP, the UVM must pass the remaining DS0s on to an second, adjacent UVM for processing. The name of this setup is *pass-through*.

When your configuration requires pass-through, one UVM port connects to user-equipment, and the other port connects to another UVM. For a detailed description of pass-through, see the forthcoming section titled “Channel Pass-Through.”

Note For voice technology specifications, refer to the appendix titled “System Specifications.” For information on the application of the UVM card set to VNS, refer to the *VNS Information and Operation* manual.

Types of Voice and Data Connections on the UVM

A brief description of each type of voice and data connection appears in Table 4-19. To specify the connections, use either StrataView Plus or the CLI. The CLI command is **addcon**.

Table 4-19 Types of UVM Connections

Type	Description
p	Carries 64-Kbps PCM voice and supports A-law or μ-law encoding and conversion, gain adjustment, and signaling.
v	Carries 64-Kbps PCM voice with VAD.
t	Carries clear channel data at 64 Kbps.
td	Carries compressed data for VNS signaling. The typical rate is 16 Kbps or lower.
a32 a24	Specifies ADPCM only. You can specify 32 Kbps or 24 Kbps. This type of connection is also permissible for modems.
c32 c24	Specifies both ADPCM and VAD. You can specify 32 Kbps or 24 Kbps.
l16	LDCELP compression of voice to 16 Kbps.
l16v	LDCELP compression of voice to 16 Kbps with VAD.
g729r8	CSACELP voice compression at 8 Kbps according to G.729.
g729r8v	CSACELP voice compression at 8 Kbps with VAD according to G.729.
g729ar8	CSACELP voice compression at 8 Kbps according to G.729A.
g729ar8v	CSACELP voice compression at 8 Kbps with VAD according to G.729A.
n x 64K	Superrate (data) connections where *n* <= 8.

Note The UVM must have the required firmware to support CSACELP per G.729 or G.729A. Check the 9.1 Release Notes to determine the firmware requirements.

The “t,”, “td,” and “n x 64” connections carry signalling or user-data. All other types carry voice. You can configure any of the voice connections for FAX or modem upgrade.

Standard-rate (64 Kbps) voice connections terminate on CVM or UVM cards. The CVM can terminate a connection from a UVM only if the connection does not use LDCELP or CSACELP. You can specify voice compression through the **addcon** command and specify echo-cancelling. Through StrataView Plus or by using **cnfchec** on the CLI, you can select voice compression of 64 Kbps (no compression), 32 Kbps (2:1 compression), 24 Kbps (3:1 compression), 16 Kbps with LDCELP (4:1 compression), or 8 Kbps with CSACELP (8:1). To specify A-law or μ-law encoding, use **cnfln**.

Applicable Commands for the UVM

This section contains a list of the standard commands and the superuser commands you can use on the CLI for voice and data connections on the UVM. Table 4-20 lists the standard commands. Table 4-21 lists the superuser commands. For details on command syntax and parameters, refer to the *Cisco WAN Switching Command Reference* and the *Cisco SuperUser Command Reference*. Note that the superuser commands have infrequent use, and many of them are strictly for debugging.

Table 4-20 Standard user-commands for UVM

Command	Function
• **upln**	Use **upln** to activate the line.
• **cnfln**	Use **cnfln** to specify the characteristics of the T1, E1, or J1 line for voice or data. Use **cnfln** to specify A-law or μ-law encoding, enable the line for voice SVC caching, and so on (see the **cnfln** description in the *Cisco WAN Switching Command Reference*).
• **cnfcassw**	If the UVM must convert CAS/DTMF to CCS signaling for a Voice Network Switch (VNS), use **cnfcassw** to configure the UVM for CAS-switching. For CAS-switching, the minimum UVM firmware is Model B. Note that CAS-switching is incompatible with pass-through. Before you use **addcon** to add signaling channels (to *slot.port*.25 or *slot.port*.16 for T1 or E1, respectively), specify "PBX-end" mode with **cnfcassw**.
• **cnflnpass**	For a UVM intended to carry voice traffic with LDCELP or G.729 CSACELP, **cnflnpass** configures the UVM lines for the pass-through feature if necessary. Before you can execute **cnflnpass**, you must activate the lines (**upln**) and configure them (**cnfln**). Note that pass-through is *not* compatible with CAS-switching.
• **cnfchadv**	Configures the channel for adaptive voice (ADV).
• **cnfchdl**	Configures a channel's dial-type. The options are inband, pulse, and user-configured.
• **cnfchec**	Configures the echo canceller for the channel. The command enables or disables the echo canceller for a range of voice channels, sets the echo return loss to high or low and enables/disables the tone disabler, convergence, and non-linear processing.
• **cnfchgn**	Configures the amount of gain inserted in a voice channel.
• **cnfcond**	Configures a conditioning template for the channel.
• **cnfrcvsig**	Configures receive signaling for the channel.
• **cnfxmtsig**	Configures transmit signaling for the channel.
• **cnfvchtp**	Configures a voice interface type for the channel.
• **cnfchutl**	Configures channel utilization (the description is in the "Optimizing Traffic Routing and Bandwidth" chapter of the *Cisco WAN Switching Command Reference*).
• **addyred**	Enables redundancy for the UVM card set.
• **dsplncnf**	Use **dsplncnf** to make sure you have correctly configured the line.
• **addcon**	Adds voice or data connections.

Table 4-21 Superuser commands for the UVM

Command	Function
• **clrcderrs**	Clears the history of card failures (errors) associated with the specified slot.
• **cnfchstats**	Enables statistics collection for various channel parameters for different cards, some of which apply to the UVM.
• **cnfclnparm**	Configures the alarm integration time for a line.
• **cnfclnsigparm**	Configures signaling parameters.
• **cnfclnstats**	Customizes statistics collection on each circuit line.
• **cnfcmparm**	Configures parameters that affect adaptive voice, rerouting, and courtesy up/down. These parameters apply at only the local node.
• **cnfecparm**	Configures more specific details of integrated echo canceller (IEC) operation for a specified voice line.
• **cnfuvmchparm**	Configures defaults for the following parameters for a channel or range of channels: voice codec unit (VCU) level, PCM interface unit (PIU) level, VAD threshold, modem threshold, and silence threshold.
• **cnfvchparm**	Specifies the following UVM card parameters: voice activity detection (VAD), background noise injection, voice frequency channel loss, echo suppression, and automatic bandwidth upgrade level upon modem tone detection.
• **dchst**	Displays card parameters—for debug purposes.
• **dspcderrs**	Displays detailed card failure information resulting from card diagnostics running on the local node.
• **dspchan**	Displays the configuration of voice channels for debug purposes. It lets you inspect the data structure defining a channel.
• **dspecparm**	Displays statistics configured for a selected echo canceller. The **cnfecparm** command sets up the statistics.
• **dsplnstatcnf**	Displays statistics configured for a line.
• **dspsig**	Displays the current signaling state received at the node from a voice channel.
• **dspslot**	Displays system information associated with a specific card in the node.
• **dsputl**	Displays the utilization factor for all voice connections on a circuit line.
• **tststats**	Displays a summary of the test statistics that result from performing a **tstcon** command on network connections.

Channel Pass-Through

Pass-through is a setup in which two, locally connected UVMs support the maximum number of channels on a T1, E1, or J1 line.

Note This section does not apply to configurations that use only PCM, ADPCM, or G.729A.

A single UVM can support mixed connection types and compression algorithms. For example, you can add a combination of ADPCM, LDCELP, or CSACELP connections. Any combination is possible if the configuration does not exceed the capacity of the card.

The maximum number of channels that can use G.728 (LDCELP) or G.729 compression is 16, so not all possible channels on a line are used if they are using LDCELP or G.729 CSACELP. To use all possible channels on a line with these compression types, you must configure pass-through by using a second UVM. Pass-through, for example, lets a PBX trunk use all of its bandwidth when the only compression is LDCELP or G.729 CSACELP.

In the pass-through scheme, a *primary* UVM connects through a cable to a *secondary* UVM. The primary UVM passes the unprocessed channels to the secondary UVM. Pass-through applies to LDCELP or CSACELP that adheres to G.729. The G.729A version CSACELP does not require pass-through because one UVM can support all the channels on a line.

You can configure pass-through by using StrataView Plus or the command line interface (CLI). The CLI command for specifying pass-through is **cnflnpass**. For a description of how to set up pass-through, refer to the *Cisco IGX 8400 Series Installation* manual. For a detailed description of the **cnflnpass** command, refer to the *Cisco WAN Switching Command Reference.*

When you are setting up pass-through, switch software does not allow you to duplicate the channel numbers once you have added the channels to the primary UVM. With UVMs in slots 7 and 8, for example, if you add 16 channels with LDCELP to the primary UVM in slot 7 (7.1.1-16), the system prevents you from adding channels 8.1.1-8. Instead, you would add 8.1.17-24.

Note The secondary UVM supports all connection types except “t,” “td,” and *n* x 64.

The possible arrangements for E1 or J1 lines appear in Figure 4-22. It shows:

- Example A shows the pass-though configuration.
- Example B shows no pass-through.

The three possible arrangements of UVMs with T1 lines appear in Figure 4-23. It shows:

- Example A shows no pass-through.
- Example B shows UVM 1 set to pass channels it cannot support to UVM 2.
- Example C shows an arrangement of three UVMs that would support two T1 lines with all channels configured for LDCELP.

Figure 4-22 Pass-through and non pass-through modes for E1 or J1

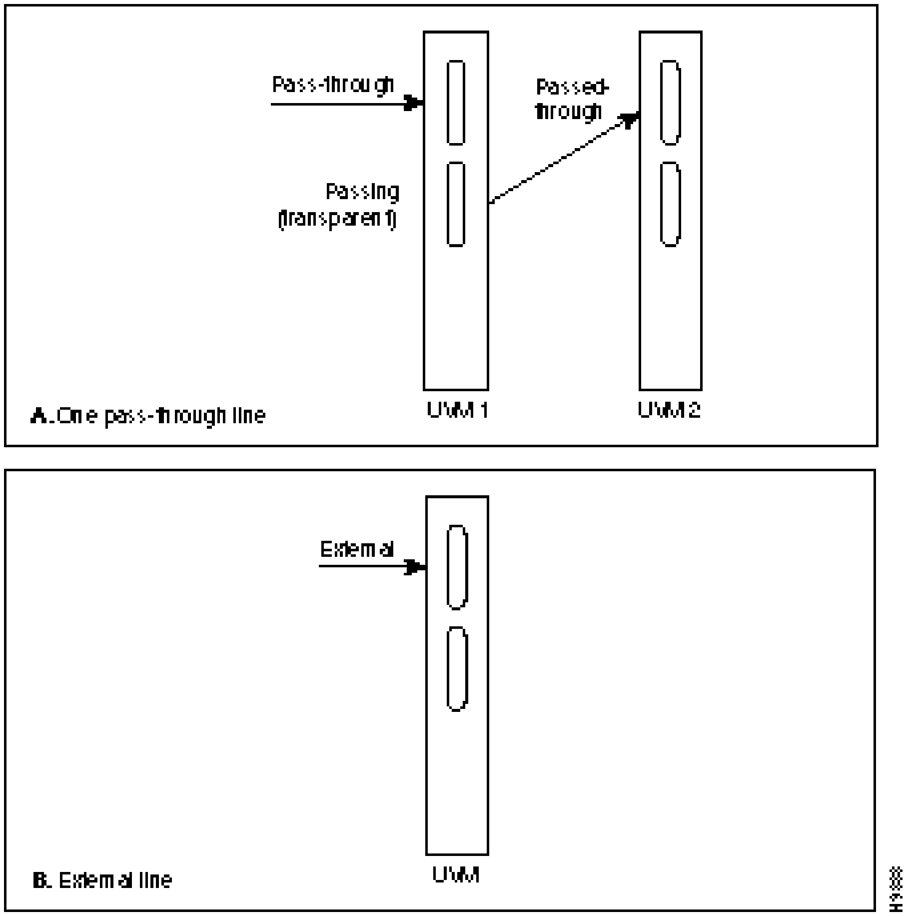
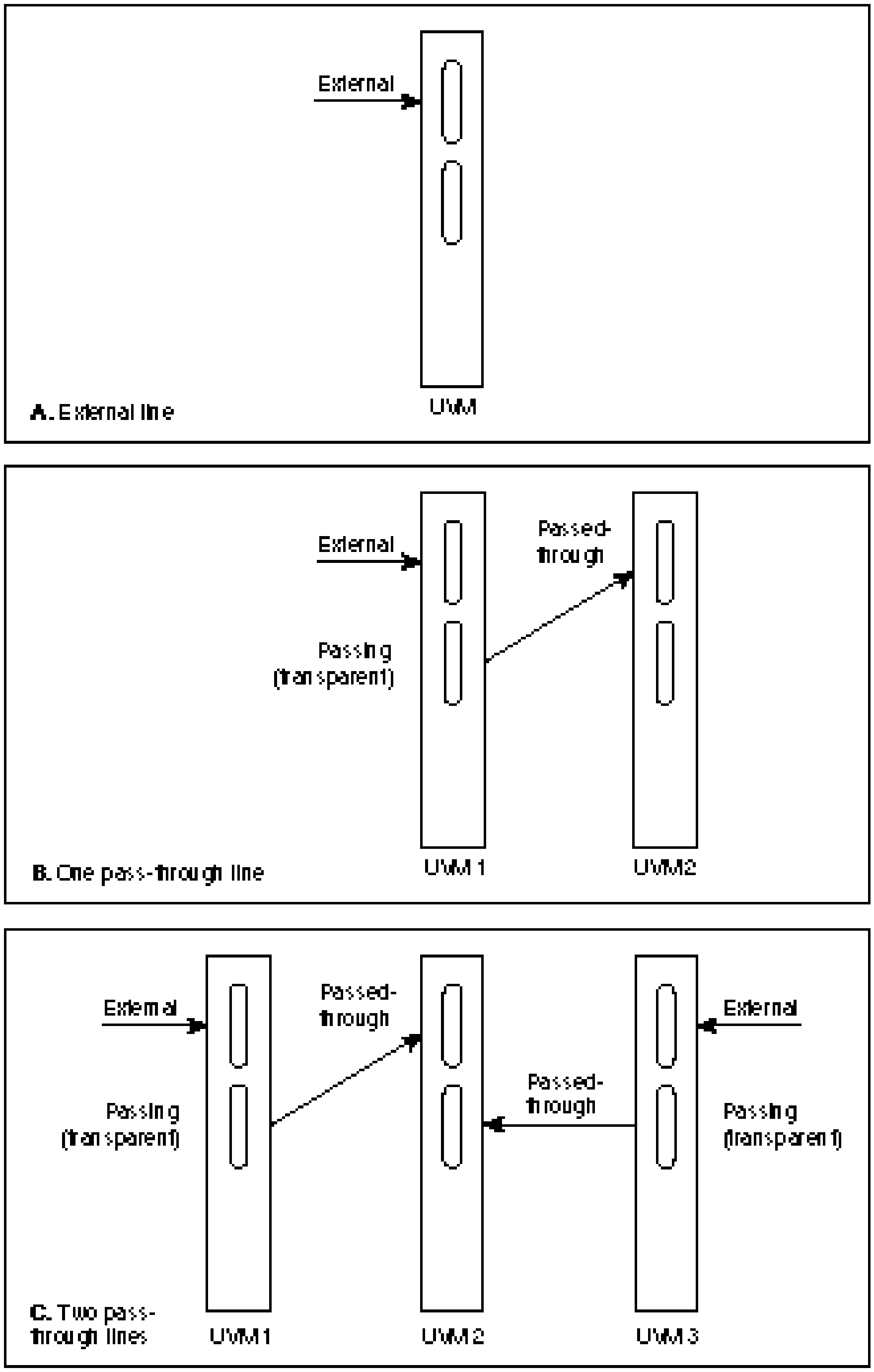


Figure 4-23 Pass-through and non pass-through modes for T1



UVM Data Operation

The UVM supports standard, 64-Kbps data connections and super-rate (*n* x 64) data connections. Data connections can terminate on a CVM or a UVM. The super-rate connections can support an aggregate of up to eight, 64-Kbps channels—frequently used for video. These super-rate channels should be contiguous or, if necessary, alternating.

Signaling on the UVM

The UVM extracts information from the CAS signaling bits in the T1, E1, or J1 frame. When a signaling bit changes state, the UVM sends signaling packets to the card at the other end of the connection. CSS signaling, such as DPNSS and ISDN signaling, are supported through a clear (transparent) channel. The supported combinations of signaling and line configurations are:

- T1 can use CCS, ABAB, or ABCD signaling bits when the line framing is ESF.
- T1 can use CCS or AB signaling bits when the line framing is D4.
- T1 can use CCS in timeslot 24 on applicable PBXs if the application requires CAS to be off.
- E1 and J1 use either CCS or, if you selected CAS, ABCD signaling bits. For CCS data, configure channel 16 as a t-type connection (bringing the total number of channels to 31).

In addition to the preceding, the UVM can set, invert, and clear AB or ABAB bits (T1) or ABCD bits (for E1 or J1) to accommodate some signaling conversions.

On the CLI, use **cnfln** to specify the signaling and **dsplncnf** to see the signaling configuration.

Up to 23 voice interface types, such as 2-W E&M, FXO/FXS, or DPO/DPS, can be selected from a template to condition the VF signaling. You can also customize the signal conditioning. Refer to the descriptions for the **cnfcond** and **cnfvchtp** commands in the *Cisco WAN Switching Command Reference* for details. You can program voice channel signaling for any of the following:

- Robbed bit (either D4 or ESF frame format)—for T1 lines
- Channel Associated Signaling (CAS)—for E1 or J1 lines
- Transparent CCS (ISDN & DPNSS)—for all lines
- E&M-to-DC5A and DC5A-to-E&M conversion—for international applications

FAX Relay

The FAX relay feature compresses the DS0 bit stream of a G3 FAX (9.6 Kbps) connection to 9.6 Kbps for transport through the network. (If the bit stream for the FAX is lower, the UVM compresses it to that lower rate.) The UVM supports FAX relay for LDCELP and G.729 (but not G.729A) connections. Interworked connections between an IGX node and Cisco 3810 access device can also carry FAX relay data.

You can specify FAX relay by using the **cnfchfax** command. The maximum number of FAX relay channels on a UVM is 16. Once you have enabled it, FAX relay overrides the automatic FAX upgrade feature—but a data modem still upgrades to PCM or ADPCM. (The automatic upgrade feature suspends compression when a modem or FAX tone appears on a voice connection.)

Voice SVC Caching

The UVM supports a feature that accelerates call setup and teardown for frequently used channels. The feature is *voice SVC caching*. It works in conjunction with VNS. The only consideration for the UVM is that you must configure each line to accommodate voice SVC caching.

On the CLI, use the **cnfln** command to configure the line for this feature and **dsplncnf** to see the configuration. If you configure a line for voice SVC caching, you can still add standard voice connections on that line. However, voice SVC caching is not possible on pass-through lines.

For a more detailed description of voice SVC caching, refer to the VNS documentation.

Loopbacks on the UVM Card Set

You can set up local and remote loopbacks to check UVM-terminated connections. A local loopback functions at the system bus interface. It returns data and supervision back to the local facility to test the local UVM card set and the customer connection. Remote loopbacks extend to the UVM card at the far-end and check both transmission directions and much of the far-end UVM. For descriptions of the commands that support loopbacks, refer to the *Cisco WAN Switching Command Reference*.

Line Statistics

The UVM card set monitors and reports statistics on the following input line conditions:

- Loss of signal
- Frame sync loss
- Multi-frame sync loss
- CRC errors (for E1 and J1 only)
- CRC sync loss
- Frame slips
- Frame bit errors
- AIS—all 1s in channel 16 (CAS mode)
- Remote (yellow) alarm

Clock Modes

The back cards support two clock modes. You select the mode through software control. The clock modes are *normal clocking* and *loop timing*.

With normal clocking, the node uses the receive clock from the network for the incoming data and supplies the transmit clock for outgoing data. The node can use the receive clock to synchronize itself with the network.

With loop timing, the node uses the receive clock from the line for the incoming data and redirects this receive clock to synchronize the transmit data.

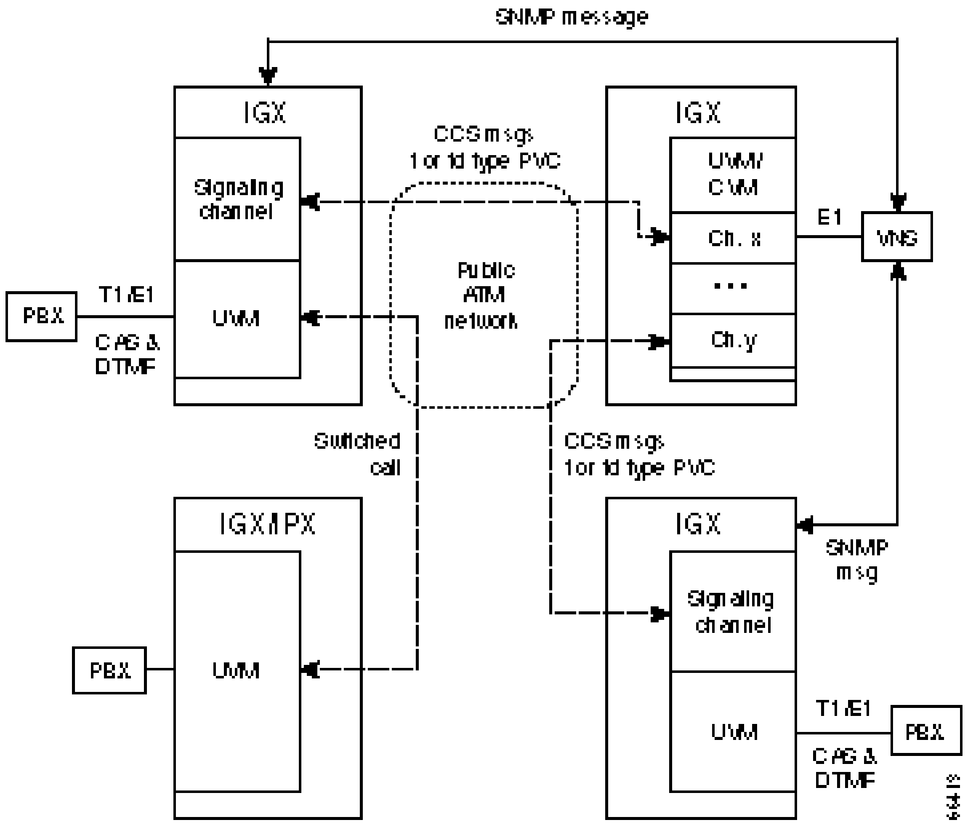
CAS Switching

The UVM supports CAS for Voice Network Switching (VNS) by converting CAS signaling and DTMF tones to CCS call-control messages. These signal conversions let the VNS unit route calls from a PBX over a WAN. For setup instructions, see the VNS documentation and the *Cisco WAN Switching Command Reference*.

The converted CCS messages for all channels on the line travel on a regular t-type or a special td-type PVC connection from the UVM to another UVM card. The VNS device can receive the CCS messages from t-type or td-type PVC connections on the signaling channel of CAS-switching UVM cards in the network.

When the VNS unit receives a CCS call-control message, it determines the destination from the control message and issues SNMP commands to add a connection from a channel on the CAS switching line to the destination across the network. CAS-switching in a network appears in Figure 4-24.

Figure 4-24 CAS-Switching



The limitations on CAS switching with Model C or Model D firmware are:

- Pass-through is not supported.
- LDCELP and G.729 are not supported.
- Hot standby is not available for a Model C or Model D UVM with Y-cable redundancy that connects to a PBX.
- Only one line on the UVM card can support CAS-switching.
- A UVM with CAS switching is compatible with only another UVM with Model C or Model D firmware.
- All UVMs in the CAS-Switching network must use Model C or Model D firmware.

Refer to VNS documentation for a full description of this product.

D-Channel Compression

D-channel compression applies to the Cisco Voice Network Switching (VNS). The minimum VNS release is 3.1. This feature compresses the signaling traffic between the application UVM and the network (VNS) UVM. D-channel compression reduces the consumed bandwidth from 64 Kbps per VNS signaling channel to 16 Kbps or less. It applies to CCS lines or CAS lines that where the CAS-switching feature is operating.

D-channel compression switches on when you add the signaling connection through StrataView Plus or by using the **addcon** command on the CLI. To turn on D-channel compression, specify the connection type as "td." The maximum number of "td" connections on a UVM is 32.

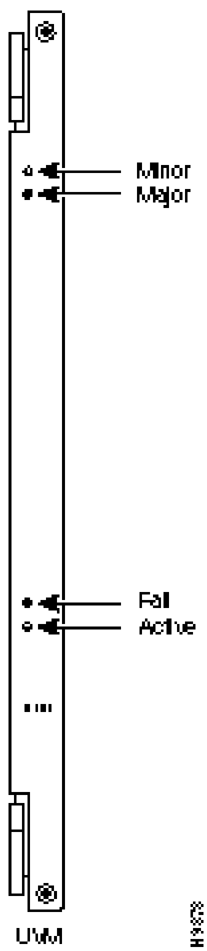
UVM Front Card Faceplate

Table 4-22 and Figure 4-25 describe the front card faceplate.

Table 4-22 UVM Faceplate Indicators

LED	Meaning
Active (green)	Indicates card is active.
Fail (red)	Indicates self-test has detected a card failure.
Major (red)	A line failure has been detected on the receive (local) side.
Minor (yellow)	A line failure has been detected at the remote end.

Figure 4-25 UVM Front Card Faceplate



Universal Voice Interface Back Card (BC-UVI-2T1EC)

The BC-UVI-2T1EC back card provides two T1 line interfaces for a UVM card. The features of the BC-UVI-2T1EC are:

- Interfaces to T1 lines at 1.544 Mbps
- Software selectable ZCS, AMI, or B8ZS line code
- Software selectable D4 or ESF (extended super-frame) framing format
- Extraction of receive-timing from the input signal for use as the node timing
- Software selectable line buildout for cable lengths up to 655 feet
- Passes T1 line event information to the front card (events include frame loss, loss of signal, bi-polar violations, and frame errors)

B8ZS supports clear channel operation because B8ZS eliminates the possibility of a long string of 0s. B8ZS is preferable whenever available.

Figure 4-26 and Table 4-23 provide information on the faceplate of the BC-UVI-2T1EC. When you correlate the descriptions in the table with the callouts in the figure, read from the top of the table to the bottom. The standard port connector is a female DB15.

Figure 4-26 BC-UVI-2T1EC Faceplate

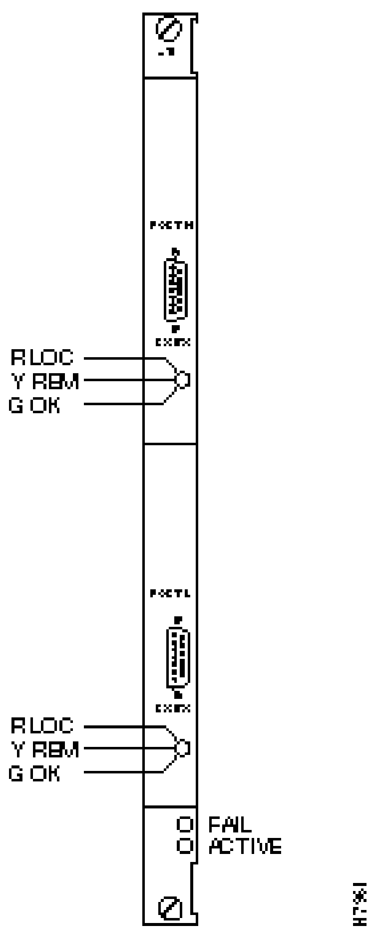


Table 4-23 BC-UVI-2T1EC Connections and Status LEDs

Connector/Indicator	Function
Transmit/Receive (2)	Two, bi-directional DB 15 connectors—one for each port.
Port Status LED (2)	Tri-color LED, 1 per port. Green=active port. Yellow=remote alarm. Red=local alarm.
Fail LED (red)	Error detected. Reset card with **resetcd f**. If LED comes on again, call the TAC.
Active LED (green)	The card is in service and has active circuits.

Universal Voice Interface Back Card (BC-UVI-2E1EC)

The BC-UVI-2E1EC back card provides an E1 circuit line interface for a UVM. The BC-UVI-2E1EC provides the following features:

- Interfaces to CEPT E1 lines (CCITT G.703 specification)
- Support for both CAS and CCS
- Support for 30-channel operation
- CRC-4 error checking
- Support for HDB3 (clear channel operation on E1 lines) or AMI
- Passes E1 line events to the front card (events include Frame loss, Loss of signal, bi-polar violation, frame errors, CRC errors, and CRC synchronization loss)
- 120-ohm balanced or 75-ohm balanced or unbalanced physical interfaces

Figure 4-27 shows and Table 4-24 lists status LEDs and connections on the BC-UVI-2E1EC faceplate. When you correlate the table and figure items, read from the top to the bottom.

Figure 4-27 BC-UVI-2E1EC Faceplate

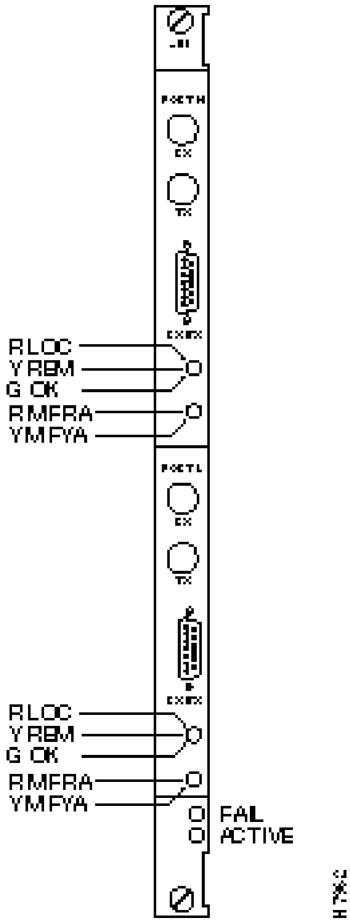


Table 4-24 BC-UVI-2E1EC Connections and Status LEDs

Connector/Indicator	Function
Transmit/Receive DB 15 (2)	Two, bi-directional DB 15 connectors—one for each port.
Transmit/Receive BNC (4)	Two pairs of BNC connectors—one receive connector and one transmit connector for each port.
Port Status LED (2)	Tri-color LED, 1 per port. Green=active port. Yellow=remote alarm. Red=local alarm.
Fail LED (red)	Error detected. Reset the card with **resetcd f**. If LED comes on again, call the TAC.
Active LED (green)	The card is in service and has active circuits.
RMFRA/YMFYA	Two-color LED: Red (RMFRA) indicates local loss of multiframe alignment. Yellow (YMFYA) indicates loss of multiframe alignment at remote end.

Universal Voice Interface Back Card (BC-UVI-2J1EC)

The BC-UVI-2J1EC back card provides a J1 line interface for a UVM card. The BC-UVI-2J1EC does the following:

- Provides interfaces for Japanese TTC-2M (J1) lines at 2.048 Mbps specified by JJ-20-11
- Supports Channel Associated Signaling (CAS) and Common Channel Signaling (CCS)
- Supports 30-channel operation
- Uses Coded Mark Inversion (CMI) line coding
- Automatically starts local loopback tests in response to certain line alarms
- Passes J1 line event information to the front card (for events such as frame loss, loss of signal, and frame errors)
- CRC-4 error checking
- 110-ohm, balanced connectors

Figure 4-28 shows and Table 4-25 lists status LEDs and connections on the BC-UVI-2J1EC faceplate. When you correlate the table and figure items, read from the top to the bottom.

Figure 4-28 BC-UVI-2J1EC Faceplate

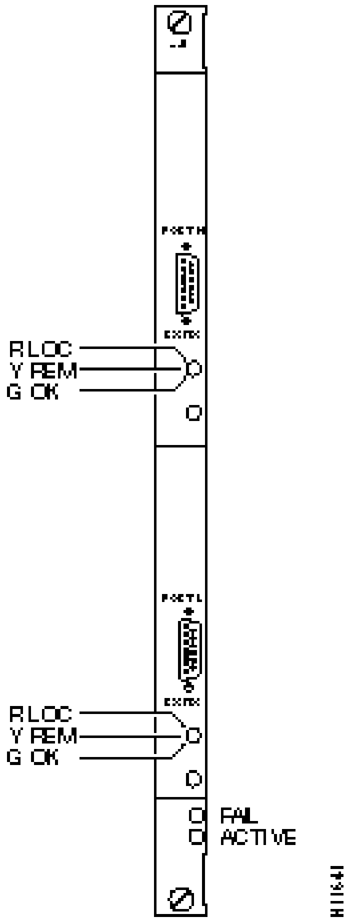


Table 4-25 BC-UVI-2J1EC Connections and Status LEDs

Connector/Indicator	Function
DB15 connectors	Two, bi-directional DB15 connectors—one for each port.
Port Status LED (two)	Tri-color LED, one per port. Green=active port. Yellow=remote alarm. Red=local alarm.
Fail LED (red)	Error detected. Reset card with **resetcd f**. If the LED comes on again, call the TAC.
Active LED (green)	The card is in service and has active circuits.

Channelized Voice Module (CVM)

This section introduces the Channelized Voice Module (CVM) and its related back cards. The topics covered in this section are as follows:

- A CVM overview and feature list
- An introduction to the modes of CVM data and voice processing
- A brief description of CVM voice processing
- A brief description of CVM data processing
- CVM signaling support
- Loopbacks on the CVM card set
- Front card and back card faceplate descriptions
- TDM Transport (support for older TDM equipment)

For setup instructions, see the *Cisco IGX 8400 Series Installation* manual and the relevant commands in the *Cisco WAN Switching Command Reference* (voice-specific commands are in the chapter titled “Voice Connections”).

Introduction to the CVM

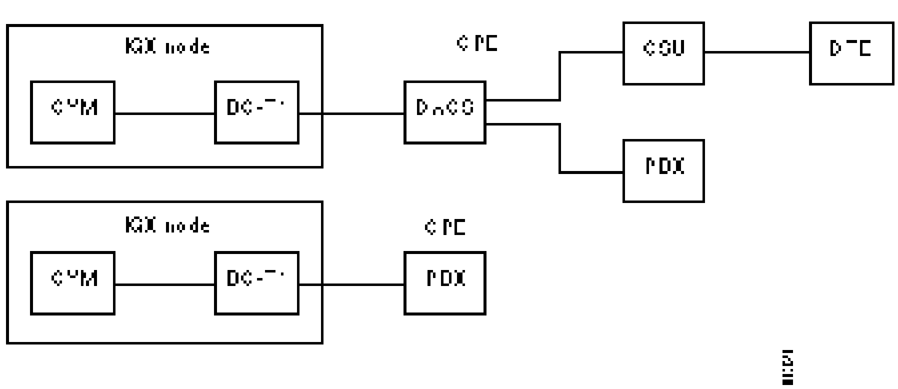
The CVM is a multi-purpose front card. A CVM circuit line can carry the following types of traffic:

- Voice
- Data
- A combination of voice and either low-speed or high-speed data

The default mode for a channel on a CVM is voice. In addition to other CVMs, a CVM can communicate with a CDP in an IPX or one of the ports on a UVM. Figure 4-29 illustrates different traffic configurations. You can use the CVM in either 24-channel mode (T1) or 30-channel mode (E1). You assign the circuits on a CVM hop on a per-timeslot basis within a T1 or E1 frame.

The CVM cards can reside in any non-reserved slot in an IGX node. The front card operates with either a BC-T1, BC-E1, or BC-J1 back card. For details on back cards, see the forthcoming sections titled “T1 Interface Back Card (BC-T1),” “E1 Interface Back Card (BC-E1),” or “BC-J1 Description.”

Figure 4-29 CVM Application Diagram



CVM Features

The following is a list of CVM features.

- Packet assembly/disassembly (PAD) for voice or data connections
- Software configurable ports on T1, E1, or J1 back cards
- Support for Voice Network Switching (VNS), including voice SVC caching
- Local and remote loopbacks for port and circuit testing
- Self-test of all on-board circuits, including optional echo cancellers
- Y-cable redundancy
- Up to 4:1 voice compression using adaptive differential pulse code modulation (ADPCM) with integral voice activity detection (VAD)
- Integral, per-channel, echo cancelling (requires optional circuits on the front card)
- A-law or µ-law voice encoding on a per-channel basis
- Programmable voice circuit gain in the range –8 dB through +6 dB
- Support for many domestic and international signaling types
- Flexible signaling-bit conditioning when a circuit alarm occurs
- Per-channel tone detection to disable compression for modem or FAX circuits
- Sub-rate, standard rate, and super-rate data connections
- Support for transparent TDM channels through a network
- A transparent data channel for CCS

Note For information on operational parameters of voice service, refer to the appendix titled "System Specifications." For information on the application of the CVM card set to the Cisco Voice Network Switching (VNS) product, refer to the VNS documentation.

Modes of CVM Operation

This section describes the operational parameters you can specify for the CVM card set. Table 4-26 is a list of the types of CVM operation. The sections that follow further describe the listed subjects.

The first two entries in Table 4-26 are the two types of 64-Kbps operation. The "p" indicates uncompressed PCM voice. The "t" indicates 64 Kbps clear channel data. The table then shows voice and data modes, transmit/receive rates, and indications of compression and ZCS (zero code suppression). A "c" or an "a" preceding a numerical value indicates compression. A "c" indicates compression with *voice activity detection* (VAD), so "c" does not apply to data connections. An "a" indicates compression without VAD. The "a" can apply to either voice or data. The numerical value following the "a" or "c" is the bit rate. Table 4-26 also explains the significance of the other characters that may follow the bit rate.

Standard-rate (64 Kbps) voice connections terminate on CVM or UVM T1 or E1 lines. (The CVM can terminate a connection from a UVM only if the connection does not use LDCELP.) You can configure the voice compression, and echo cancelling for each channel, and—when circumstances make it appropriate—A-law or µ-law encoding. You can select voice frequency compression of 64 Kbps (no compression), 32 Kbps (2:1), 24 Kbps (3:1), or 16 Kbps (4:1). The compression ratios approximately double when you also enable the internal VAD.

Table 4-26 Types of CVM Connections

Type	Description
p	A p-connection carries 64 Kbps PCM voice and supports A-law or µ-law encoding and conversion, gain adjustment, and signaling.
v	A v-connection carries compressed voice.
t	The t-connections carry 64 Kbps clear channel data traffic.
c*xx*	c*xx* signifies compression with VAD. When you use a CVM for voice and specify compression, you must specify the level of ADPCM compression by the *xx* field after the "c"." Enter 32 for 2:1 compression, 24 for 3:1 compression, or 16 for 4:1 compression. For example "c16" indicates 4:1 voice compression with VAD.
a16z c16z	c16z and a16z use a 4-sample, 16-Kbps ADPCM that does not ensure ones-density. The "z" directs the node not to route a16z or c16z-type connections across ZCS-configured trunks.
a16 c16	c16 and a16 are non-standard forms of compression. They use a 4-sample, 16-Kbps ADPCM that ensures ones-density but results in a loss of voice quality. You can route a16 and c16-type connections across ZCS-configured trunks.
a32d c32d	a32d and c32d provide compression for FAX on a high-speed line (such as Enhanced Instafax) without causing errors. Compression begins when the CDP/CVM/UVM detects a high speed modem. You must specify a32d or c32d (**cnfvchparm** on the CLI). If you do not specify a32d or c32d, the circuit operates at 56/64 Kbps when the card detects a high-speed modem or FAX. Note that, if you choose c32d (compression with VAD), it provides the bandwidth savings associated with VAD only when the line is actually being used for voice.
a32 a24	Specifies ADPCM only. You can specify 32-Kbps or 24-Kbps.
c32 c24	Specifies both ADPCM and VAD. You can specify 32-Kbps or 24-Kbps.

CVM Voice Operation

The particular voice features are:

- High-speed modem and FAX circuits.
- Transparent, 64-Kbps transport of CCS signaling.
- CAS, by transporting signaling transitions across the network in packets.
- Optional circuit for the CVM is the on-board Integrated Echo Canceller (IEC): the two models of the IEC are the 24-channel (T1) and the 31-channel (E1) versions.
- Selectable A-law or µ-law encoding when the circumstances require it. (Normally, T1 automatically uses µ-law, and E1 uses A-law.)

In addition to the preceding, the CVM can set, invert, and clear AB or ABAB bits (T1) or ABCD bits (E1) to accommodate some signaling conversions.

CVM Data Operation

A CVM can provide data connections to the network. Data connections that originate on a CVM can terminate on a CVM, UVM, HDM, or LDM in an IGX switch. In an IPX switch, data connections that originated on a CVM can terminate on a CDP, SDP, or LDP.

Two categories of data connections exist on the CVM. The categories are *super-rate* and *subrate*. A super-rate connection is an aggregate of DS0s. A super-rate connection can consist of any combination of 56 or 64 Kbps-connections up to a maximum of 8 DS0s. The channels must be contiguous or alternating. The 56-Kbps channels are bit-stuffed up to 64 Kbps on the line. The CVM removes the bits prior to packetization. Note that super-rate connections carry no supervisory bits.

A subrate data connection has a rate less than 64 Kbps and exists within a DS0. Supported rates are 2.4, 4.8, 9.6, and 56 Kbps. The type of subrate data connection that Cisco supports is DS0A. In-band DS0A link codes are translated into EIA control lead states for HDM or LDM-to-CVM connections. Fast EIA, Repetitive Pattern Suppression (RPS), and isochronous clocking are not available.

Signaling on the CVM

The CVM extracts information from the signaling bits in the E1 or T1 frame. When a signaling bit changes state, the CVM generates signaling packets to the CVM at the other end of the connection. DPNSS and ISDN signaling are supported through a clear channel (transparent mode). The supported combinations of signaling and line configurations are as follows:

- T1 uses ABAB or ABCD signaling bits when the line framing is ESF.
- T1 uses AB signaling bits when the line framing is D4.
- T1 can use CCS in timeslot 24 on applicable PBXs if the application requires CAS to be off.
- E1 uses either CCS or, if you selected CAS, ABCD signaling bits. For CCS, configure channel 16 as a t-type connection to carry the signaling, making a possible total of 31 channels.

Up to 23 voice interface types, such as 2-W E&M, FXO/FXS, or DPO/DPS, can be selected from a template to condition the VF signaling. You can also specify customized signal conditioning. Voice channel signaling is programmable for any of the following:

- Robbed bit (either D4 or ESF frame format)—for T1 lines
- Channel Associated Signaling (CAS)—for E1 lines
- Transparent CCS (ISDN & DPNSS)—for T1 or E1 lines
- E&M-to-DC5A and DC5A-to-E&M conversion—for international applications

Line Statistics

The CVM card set monitors and reports statistics on the following input line conditions:

- Loss of signal
- Frame sync loss
- Multi-frame sync loss (for E1 only)
- CRC errors (for E1 or T1 BSF only)
- Frame bit errors
- Frame slips
- Bipolar violations
- AIS—all 1s in channel 16 (CAS mode)
- Remote (yellow) alarm

On the CLI, use **cnfln** to specify the signaling and **dsplncnf** to see the signaling configuration.

Voice SVC Caching

The CVM supports a feature that accelerates call setup and teardown for frequently used channels. The feature is *voice SVC caching*. It works in conjunction with VNS. The only consideration for the CVM is that you must configure the line to accommodate voice SVC caching. On the CLI, use the **cnfln** command to configure the line for this feature and **dsplncnf** to see the configuration. If you configure a line for voice SVC caching, you can still add standard voice connections on that line. For a more detailed description of voice SVC caching, refer to the VNS documentation.

Loopbacks on the CVM Card Set

You can set up local and remote loopbacks to check CVM-terminated connections. A local loopback functions at the system bus interface. It returns data and supervision back to the local facility to test the local CVM card set and the customer connection. Remote loopbacks extend to the CVM card at the other end and check both transmission directions and much of the far-end CVM.

CVM Faceplate Description

The CVM faceplate has four LED indicators: Active, Fail, Major, and Minor (see Table 4-27). The label on the faceplate also shows the type of CVM card.

Table 4-27 CVM Faceplate Indicators

LED or Label	Description
Active (green)	Indicates card is active.
Fail (red)	Indicates self-test has detected a card failure in the main card or optional integrated echo canceller board.
Major (red)	A line failure has been detected on the receive (local) side.
Minor (yellow)	A line failure has been detected at the remote end.
CVM	A label indicating standard CVM
CVM ADPCM T1	A label indicating T1 with echo cancelling circuitry
CVM ADPCM E1	A label indicating E1 with echo cancelling circuitry

T1 Interface Back Card (BC-T1)

The BC-T1 back card provides a T1 line interface for a CVM card. The BC-T1 provides the following features:

- Trunk line interfaces to T1 trunks at 1.544 Mbps
- Software selectable AMI or B8ZS line code
- Software selectable D4 or ESF (extended super-frame) framing format
- Configuration as either full or fractional T1 service
- Extraction of receive-timing from the input signal for use as the node timing
- Software selectable line buildout for cable lengths up to 655 feet
- Passes T1 line event information to the front card (events include Frame loss, Loss of signal, bi-polar violations, and frame errors)

B8ZS supports clear channel operation because B8ZS eliminates the possibility of a long string of 0s. B8ZS is preferable whenever available, especially on trunks.

The BC-T1 supports two clock modes. The clock modes are *normal clocking* and *loop timing*. You select the mode through software control. With normal clocking, the node uses the *receive* clock from the network for the incoming data and supplies the transmit clock for outgoing data. The node can use the receive clock to synchronize itself with the network.

With loop timing, the node uses the receive clock from the line for the incoming data and redirects this receive clock to time the transmit data.

BC-T1 Faceplate Description

Figure 4-30 and Table 4-28 provide information on the faceplate of the BC-T1. When you correlate the descriptions in the table with the callouts in the figure, read from the top of the table to the bottom. The standard port connector is a female DB15.

Figure 4-30 BC-T1 Faceplate

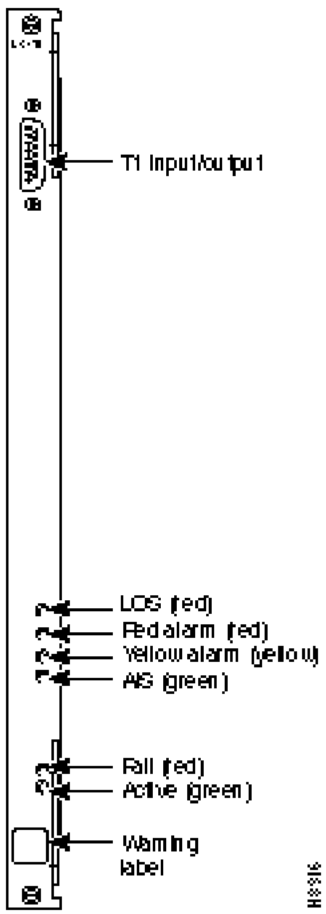


Table 4-28 BC-T1 Connections and Status LEDs

Connector/Indicator	Function
T1 input/output	Female DB15 connector for T1 line.
LOS light (red)	Indicates loss of signal at the local end.
Red alarm light (red)	Indicates loss of local E1 frame alignment, or it indicates loss of packet alignment on the CVM.
Yellow alarm light (yellow)	Loss of frame alignment at remote end or loss of packet alignment (CVM).
AIS light (green)	Indicates the presence of all ones on the line.
Fail light (red)	Indicates an error occurred. Reset the card with the **resetcd f** command. If the LED comes on again, call the TAC.
Active: light (green)	Indicates the card is in service with active circuits.

E1 Interface Back Card (BC-E1)

The BC-E1 back card provides an E1 circuit line interface for a CVM card. The BC-E1 back card plugs into the P2 connector on the CVM front card. The BC-E1 provides the following features:

- Interfaces to CEPT E1 lines (CCITT G.703 specification)
- Support for both Channel Associated Signaling and Common Channel Signaling
- Support for 30-channel (1.920 Mbps) operation
- CRC-4 error checking
- Support for HDB3 (clear channel operation on E1 lines) or AMI
- Passes E1 line events to the front card (events include Frame loss, Loss of signal, BPV, frame errors, CRC errors, and CRC synchronization loss)
- Detection of loss of packet sync when used with the CVM
- 120-ohm balanced or 75-ohm balanced or unbalanced physical interfaces

The BC-E1 supports two clock modes. The clock modes are *normal clocking* and *loop timing*. You select the mode through software control. With normal clocking, the node uses the receive clock from the network for the incoming data and supplies the transmit clock for outgoing data. The node can use the receive clock to synchronize itself with the network.

With loop timing, the node uses the receive clock from the line for the incoming data and redirects this receive clock to time the transmit data.

Statistics are kept on most line errors and fault conditions, including the following:

- Loss of signal
- Frame sync loss
- Multi-frame sync loss
- CRC errors
- Frame slips
- Bipolar violations
- Frame bit errors
- AIS, all-1’s in channel 16 (CAS mode)

Figure 4-31 shows and Table 4-30 lists status LEDs and connections on the BC-E1 faceplate. When you correlate the table and figure items, read from the top to the bottom.

Figure 4-31 BC-E1 Faceplate

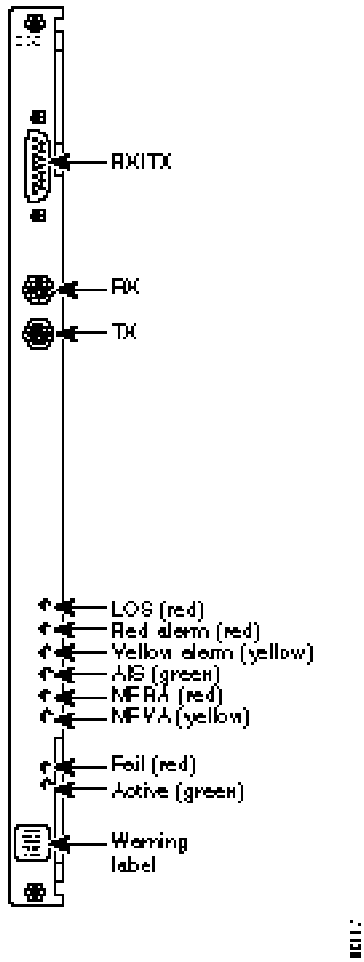


Table 4-29 BC-E1 Connections and Status LEDs

Connector or LED	Function
RX-TX	Female DB15 connector for XMT and RCV E1.
RX	BNC connector for receive E1 line.
TX	BNC connector for transmit E1 line.
LOS light (red)	Loss of signal at the local end.
Red alarm (red)	Loss of local E1 frame alignment. On CVM, Red indicates loss of packet alignment.
Yellow alarm (yellow)	Loss of frame alignment at remote end. On CVM, Yellow shows loss of packet alignment.
AIS light (green)	Indicates the presence of all ones on the line.
MFRA (red)	Loss of multiframe alignment.
MFRY (yellow)	Loss of multiframe at remote end.
Fail light (red)	Indicates an error occurred. Reset the card with **resetcd f**. If the LED comes on again, call the TAC.
Active: light (green)	Indicates the card is in service with active circuits.

BC-J1 Description

The BC-J1 back card provides a Japanese J1 circuit line interface for a CVM. The BC-J1 does the following:

- Provides interfaces for Japanese TTC (J1) lines specified by JJ-20-10, JJ-20-11, and JJ-20-12
- Supports Channel Associated Signaling (CAS) and Common Channel Signaling (CCS)
- Supports 30-channel, 2.048-Mbps operation
- Uses Coded Mark Inversion (CMI) line coding
- Automatically starts local loopback tests in response to certain line alarms
- Passes J1 line event information to the front card (for events such as frame loss, loss of signal, bi-polar violations, and frame errors)

The BC-J1 supports two clock modes. The modes are *normal clocking* and *loop timing*. You select the mode through software control.

With normal clocking, the node uses the receive clock from the network for the incoming data and supplies the transmit clock for outgoing data. The node can use the receive clock to synchronize itself with the network.

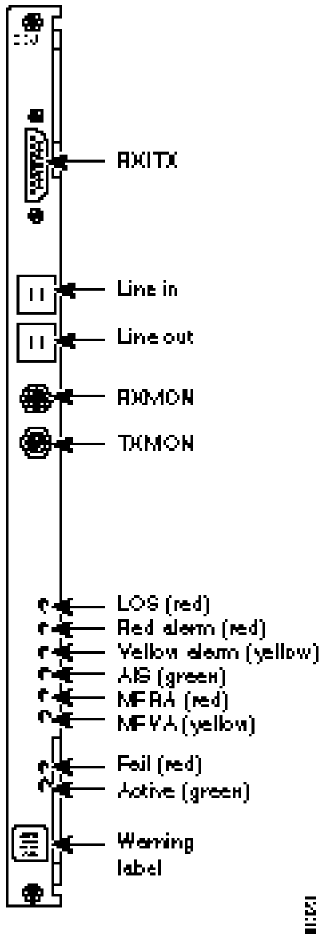
With loop timing, the node uses the receive clock from the line for incoming data and redirects the receive clock to synchronize the transmit data.

Figure 4-32 shows a BC-J1 faceplate. Table 4-30 lists BC-J1 connections and status LEDs.

Table 4-30 BC-J1 Connections and Status LEDs

Connector or LED	Function
RX-TX	Female DB15 connector for XMT and RCV J1.
Line in	J1 trunk input line.
Line out	J1 trunk output line.
RX MON	BNC test connector for monitoring receive J1 line.
TX MON	BNC test connector for monitoring transmit J1 line.
LOS light (red)	Indicates loss of signal at the local end.
Red alarm light (red)	Indicates loss of local frame alignment.
Yellow alarm light (yellow)	Indicates loss of frame alignment at the remote end.
AIS light (green)	Indicates the presence of all ones on the line.
MFRA light (red)	Indicates loss of multiframe alignment.
MFYA light (yellow)	Indicates loss of multiframe at the remote end.
Fail light (red)	Indicates an error occurred. (First, reset the card with **resetcd f**. If the LED comes on again, call the Cisco TAC.
Active light (green)	Indicates the card is in service and that circuits are active.

Figure 4-32 BC-J1 Faceplate



The TDM Transport Feature

This section applies to only CVMs (and CDPs in an IPX node) that are Model C. Model C provides a service called Time Division Multiplexing Transport (TDM Transport). TDM Transport bundles DS0s to form a single, transparent connection through the network. TDM Transport is most valuable for transporting TDM data from trunks in older, non-Cisco WANs. For setup instructions, see the *Cisco IGX 8400 Series Installation* manual and the command descriptions in the *Cisco WAN Switching Command Reference*.

Model C Features

The Model C firmware features are as follows:

- A collection of properly configured data connections behaves as a single, transparent connection. A single connection can be from 1 to 8 DS0s (64 to 512 Kbps).
- TDM Transport supports inverse multiplexing support.
- The maximum rate is 2 Mbps.
- The supported line coding is 8/8 on the circuit and trunk interfaces.
- TDM Transport service preserves DS0 alignment within frames.

Model C Limitations

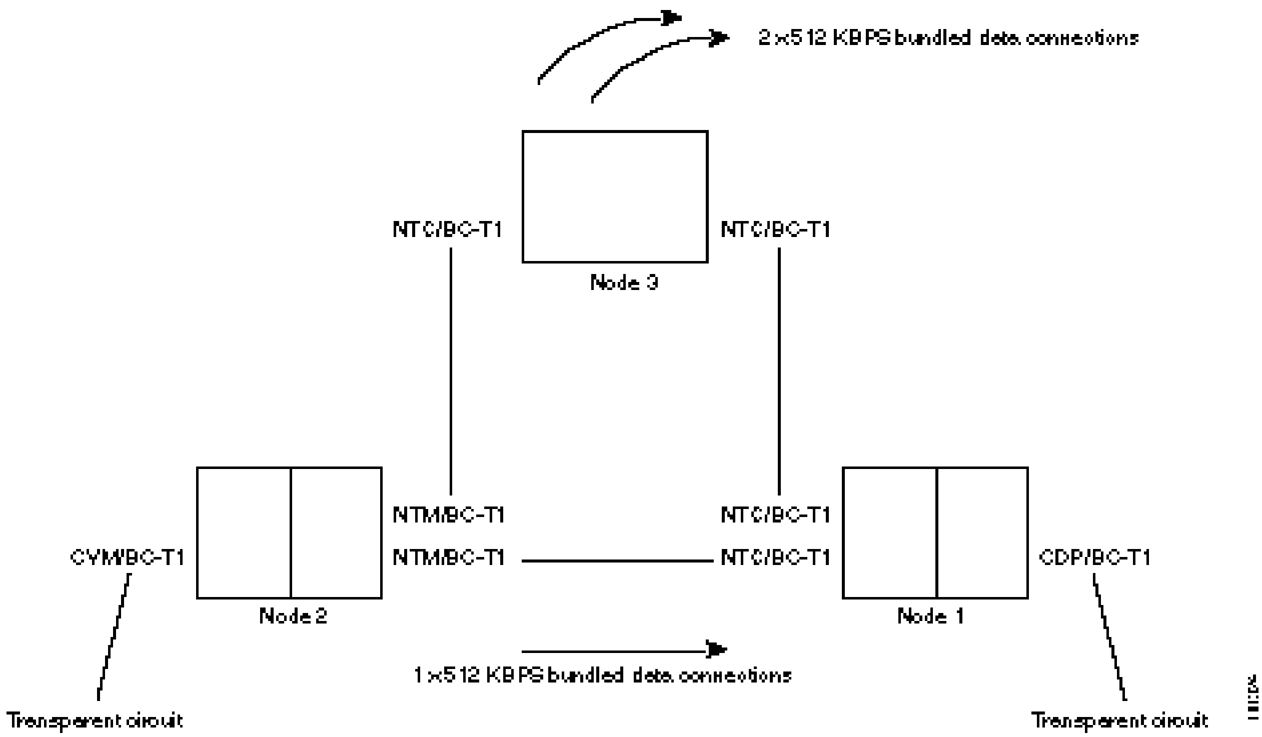
The limitations on TDM Transport within Model C firmware are as follows:

- TDM Transport supports bundled data connections only—no voice or DS0A.
- Circuit timing cannot come from user equipment.
- Pleisochronous clocking is not allowed.
- Super-frame alignment is not preserved.
- Framing bits are not transported.
- A CDP or CVM with Model C firmware is compatible only with other CDPs or CVMs that have Model C firmware.
- Connections on any CVM or CDP with Rev. C firmware must terminate on only one other CVM or CDP.
- The parameter “Max. Network Delay of CDP-CDP High Speed Data Connections” must not exceed 45 ms.
- The difference in delay due to propagation and maximum trunk queuing cannot exceed 25 ms. For example, one connection taking one hop and another taking six hops is not allowed. Likewise, a connection over a satellite link and another over a terrestrial link is not allowed.
- For loopbacks on a CDP or CVM with Rev. C firmware, the card must have only one connection.

Inverse Multiplexing

To achieve full T1 and E1 rates on a single CVM or CDP, TDM Transport supports inverse multiplexing. Figure 4-33 shows a simple example. In this example, the three, bundled 512-Kbps data connections symbolized by the arrows add up to a T1 connection.

Figure 4-33 Inverse Multiplexing



Frame Relay Cards

This section describes the Frame Relay service cards. The Frame Relay cards consist of the UFM (Universal Frame Module) family of front and back cards and the FRM (Frame Relay Module) family of front and back cards. The first part of this section contains information that applies to both the UFM and FRM card sets. Subsequent sections contain information that is particular to individual front and back cards. The Frame Relay and individual card topics are:

- Introduction to Frame Relay on the IGX switch
- UFM front cards
- UFI back cards, which have the T1, E1, V.35, X.21, and HSSI interfaces
- FRM front cards, which exists in a channelized and an unchannelized version
- FRI back cards, which have the T1, E1, V.35, and X.21 interfaces
- FRM-2 front card and FRI-2 back card, which support the Port Concentrator Shelf (PCS)
- Frame relay port redundancy
- Card self-test
- Port Testing

See the *Cisco IGX 8400 Series Installation* manual for installation steps. For technical details on the line types of individual back cards, see the appendix titled “System Specifications.” For a description of Frame Relay on a FastPAD, see the section titled “Data Cards” later in this chapter.

Introduction

This section lists information that applies to Frame Relay service. The first list describes functions at the node-level and the network interface. The second list contains card-specific information.

An IGX Frame Relay network features the following:

- A Permanent Virtual Circuit (PVC) service.
- Three Local Management Interface (LMI) protocols: ANSI Annex D, the ITU-T (CCITT) Annex A, and a Cisco LMI. LMI protocols operate between the user device and the network. LMI is the only supervisory signaling on a logical port.
- A frame-forwarding service. This service forwards all valid HDLC frames from one port to a single port in the network without Frame Relay header processing or LMI control. For example, a workstation that transmits HDLC frames can connect to a single Frame Relay port on an FRM. To use this feature, the entire physical port must be dedicated to that workstation.

  The UFM supports frame-forwarding with network interworking but not service interworking.
- Bundled connections.
- Explicit congestion notification.

The FRM and UFM front cards perform the following functions:

- Packetize and depacketize Frame Relay data frames.
- Provide frame multiplexing and demultiplexing by using the DLCI field.
- Regulate the flow of data frames into the network to prevent congestion.
- Inspect frames to ensure they are within size limits and consist of an integer number of octets.
- Support service interworking (UFM series only).
- Support intelligent communication with user devices to share information on addition, deletion, congestion, and alarms of the multiple PVCs on each port.
- Perform CRC check to detect transmission errors.
- Perform (and report the results of) loopback tests for internal, local external, and remote external tests to modems or NTUs. (Loopback tests do not apply to T1 or E1 lines.)

  On the receiving end, the UFM, FRM, or FRM-2 card set checks arriving frames against the embedded Frame Check Sequence (FCS) code and discards any non-compliant frames.

The card places Frame Relay data into FastPackets. Frame relay flag bytes and bit-stuffing provide frame delimiting and transparency. If a user-data byte has a value of hexadecimal 7E, the card changes it by inserting 0s, so that the card does not process the byte as a flag. (The Frame Relay card uses flag bytes to fill partial FastPackets.)

Maximum Connections Per Port With Signaling Protocols

For any Frame Relay card set that has a maximum frame length of 4510 bytes, the type of signaling protocol you may (optionally) specify with **cnffrport** results in a limit on the number of connections per physical or logical port. The maximum number of connections per port for each protocol is:

- For Annex A: 899
- For Annex D: 899
- For StrataLMI: 562

Neither **addcon** nor **cnffrport** prevents you from adding more than the maximum number of connections on a port. (You might, for example, use **cnffrport** to specify an LMI when too many connections for that particular LMI already exist.) If the number of connections is exceeded for a particular LMI, the LMI does not work on the port, the full status messages that result are discarded, and LMI timeouts occur on the port. A port failure results and also subsequently leads to a-bit failures in other segments of the connection path.

Frame Relay Over T1 and E1 Lines

On an IGX node, Frame Relay over a T1 or E1 line requires one of the following combinations:

- FRM front card with an FRI-T1 or FRI-E1 back card
- UFM-4C or UFM-8C front card with UFI-8T1-DB15, UFI-8E1-DB15, or UFI-8E1-BNC

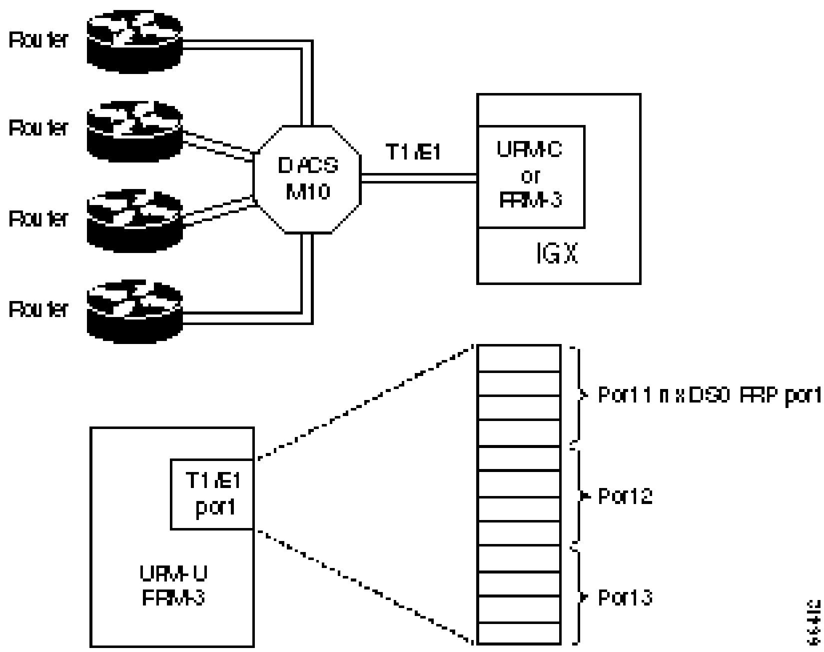
A Frame Relay T1/E1 connection can terminate on any Frame Relay Interface—V.35, X.21, T1 or E1.

Frame relay over a T1 or E1 interface supports groups of DS0 timeslots in a *logical port*. A logical port is a single DS0 or a group of contiguous DS0s. Logical ports consisting of multiple DS0s operate at the full rate of 64 Kbps per timeslot. If a logical port consists of a single DS0, you can configure either 56 Kbps or 64 Kbps. See Figure 4-34.

If the rate on a logical port is 56 Kbps, the Frame Relay interface strips the least significant (signaling) bit from the incoming octet and puts a 1 in the least significant bit of the outgoing octet. The 56-Kbps rate typically applies to a groomed Digital Data Services (DDS) circuit that uses a T1/E1 line.

Note E1 reserves timeslot 16, so timeslot 16 is unavailable for channel-associated signaling (CAS). With common channel signaling (CCS), however, timeslot 16 carries data. See **cnfln** in the *Cisco WAN Switching Command Reference* for information on how to specify signaling.

Figure 4-34 Multiple and Single DS0s Forming a Logical Port



Universal Frame Module

The Universal Frame Module (UFM) cards support a much higher port density than the FRM cards and support ELMI and Frame Relay-to-ATM service interworking. The front card (UFM-4C or UFM-8C) can support Frame Relay traffic on a maximum of 4 or 8 T1 or E1 ports on a back card. The front card (UFM-U) can support Frame Relay traffic on 12 V.35 ports, 12 X.21 ports, or 4 HSSI ports on a back card.

The next sections describe the UFM-C card sets. Subsequent sections describe the UFM-U card sets.

UFM-C Front Card

The Universal Frame Model (UFM-C) supports either 4 or 8 T1 or E1 ports per back card. The UFM-4C supports 4 ports regardless of the presence of the 8 connectors on the UFI back card. The UFM-8C supports all 8 ports. Both models of the UFM-C support 1 to 24 or 1 to 31 DS0s per physical line.

The UFM-C can also operate unchannelized for E1 only, with 32 DS0s constituting one unchannelized E1. In the unchannelized mode, one logical E1 port maps to one E1 line.

Table 4-31 lists the front and back cards described in this and subsequent sections.

Table 4-31 Channelized UFM Card Sets

Front Cards	Back Cards
UFM-4C	UFI-8T1-DB15 UFI-8E1-DB15
UFM-8C	UFI-8E1-BNC

The characteristics and functions of the UFM-C are as follows:

- Up to 1000 logical channels per card. All 1000 logical channels can be on a single physical line or configured across multiple lines.
- Maximum total throughput of 16 Mbps—2.048 Mbps per port
- Up to 248 logical ports, which map in any contiguous manner to the physical lines. The numbers available for identifying the logical ports is actually 1–250.
- Frame forwarding is available for each logical port (specified with the **addcon** command).
- Front card support for either four or eight T1 or E1 lines on the eight-line back card.
- Each T1 (DS1) is configurable for 1 to 24 (T1) or 31 (E1) Frame Relay data streams.
- The rate of each data stream is configurable as 56 Kbps or *n* x 64 Kbps (where 1 <= *n* <= 24 for T1 and 1 <= n <= 32 for E1). If a data stream occupies more than one timeslot, the timeslots must be contiguous. The total for all rates is no more than 1.536 Mbps for T1 (56 Kbps occupy 64 Kbps channels for the calculation of this limit).
- Maps, segments, and reassembles Frame Relay frames to and from FastPackets.
- Each stream meets ANSI T1.618 using two-octet header.
- Interfaces configurable as a Frame Relay UNI or a Frame Relay NNI.
- Generates CLLM messages for congestion notification across NNIs.
- Supports CCITT Q.933 Annex A, ANSI T1.617 Annex D, and Cisco LMI local management for Semi-Permanent Virtual Circuits.
- With back card, consumes up to 60 Watts at -48 VDC.
- Usage Parameter Control (UPC) in accordance with ITU-T recommendation I.370.
- Supports the basic connection types of normal, grouped, and frame forwarding (no bundling).
- Supports service interworking.
- Supports E-LMI (Enhanced LMI).

Figure 4-35 shows a UFM-C faceplate. If the label on the faceplate shows “UFM C,” the front card is a UFM-8C, which most UFMs are. The UFM-4C label shows “UFM-4C.”

Figure 4-35 UFM-C Faceplate

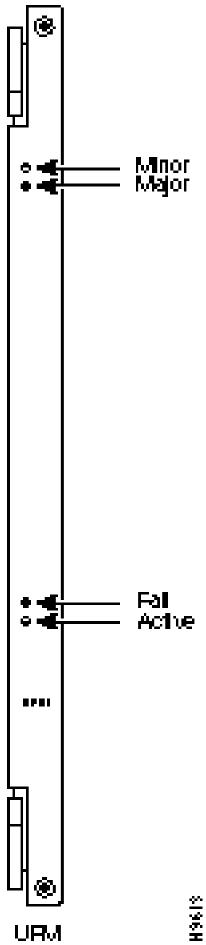


Table 4-32 UFM-C Faceplate Indicators

LED	Meaning
Active (green)	On indicates card is active.
Fail (red)	On indicates self-test has detected a card failure.
Major (red)	A line failure has been locally detected on one or more of the receive ports.
Minor (yellow)	A line failure has been detected at the remote end on one or more of the receive ports.

UFI-8T1 Back Card

The Universal Frame Interface 8T1 (UFI-8T1-DB15) back card has 8, bi-directional, DB15 connectors. See Figure 4-36. For each port, one tri-color LED displays the status, as the emphasized area of Figure 4-36 shows. The line is inactive if the LED is off. See Table 4-33.

Figure 4-36 UFI-8T1-DB15 Faceplate

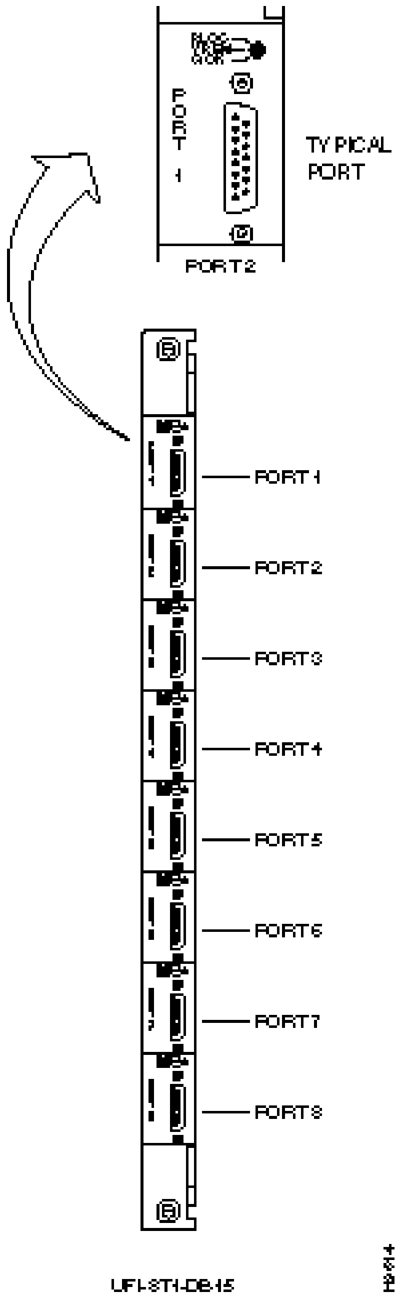


Table 4-33 UFI 8T1 Port LED Indicators

LED	Meaning
Green	On indicates line is active.
Red	On indicates line is active, but a local alarm was detected.
Yellow	On indicates line is active, but a remote alarm was detected.

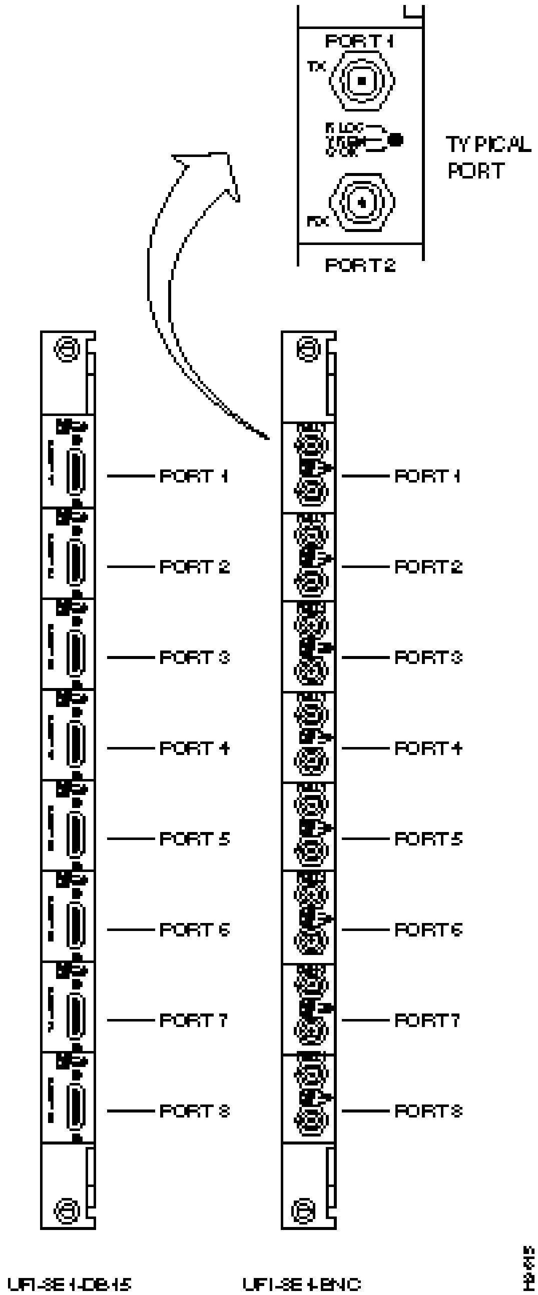
UFI-8E1 Back Cards

Universal Frame Interface 8E1 cards have connectors for 8 E1 ports. The UFI-8E1-DB15 has 8 bi-directional DB15 connectors. The UFI-8E1-BNC has 16 BNC connectors (2 per port). See Figure 4-37. Each port has a tri-color LED for status display. See Table 4-34. The line is inactive if the LED is off.

Table 4-34 UFI 8E1 Faceplate Indicators

LED	Meaning
Green	On indicates line is active.
Red	On indicates line is active, but a local alarm was detected.
Yellow	On indicates line is active, but a remote alarm was detected.

Figure 4-37 UFI-8E1-DB15 and UFI-8E1-BNC Faceplates



UFM-U Front Card

This section contains the following:

- An outline of the operational features of the UFM-U card set.
- A table and description of the user-selected modes of the UFM-U card set
- A table and description of the cables in the UFM-U card set
- An illustration and explanation of the UFM-U faceplate with its LED indicators

The back cards that provide line interfaces to the UFM-U are the:

- UFI-12V.35 (12 ports)
- UFI-12X.21 (12 ports)
- UFI-4HSSI (4 ports)

The features and operational characteristics of the UFM-U card sets are as follows:

- Maximum port speeds of 16 Mbps on the HSSI and 10 Mbps on the V.35 and X.21 interface.
- The UFM-U can sustain an aggregate throughput of up to 16 Mbps.
- The sum of all clock rates can be 24 MHz even though the actual throughput is 16 Mbps.
- Supports up to 1000 channels. You can allocate the channels across the Frame Relay data streams.
- Provides delimiting, alignment, and transparency (bit-stuffing) for HDLC frames.
- Meets ANSI T1.618 (a 2-octet DLCI Frame Relay Data Transfer Protocol is supported).
- Supports E-LMI (enhanced LMI), StrataLMI, T1.617 Annex D, and CCITT Q.933 Annex A Frame Relay Signaling protocols.
- The front card maps, segments and reassembles Frame Relay data streams to and from FastPackets by using protocols and methods compatible with an FRP or FRM.
- Supports Frame Relay UNI or NNI on a per channel basis.
- The UFM-U generates CLLM messages for congestion notification across NNIs and UNIs.
- Supports policing on the ingress direction.
- Supports Explicit Congestion Notification.
- Applies zero-suppression to the payload space of FastPackets.
- Collects statistics for ports and connections.
- Supports internal and external loopback terminations.
- Supports per PVC loopback termination at the Cellbus.
- Supports Frame Relay to ATM service interworking.
- Detects and discards frames that are corrupted during transmission on the IGX node.
- Supports frame forwarding.
- Supports CIR=0 as well as a CIR of less than 56 Kbps.
- Supports looped clocks (V.35 only).
- Supports Y-cable redundancy on all ports for V.35 and X.21, one port on HSSI.
- The UFM-U monitors port speed. It allows up to 2% over-speed for data rates above 1 Mbps and 5% over-speed for data rates below 1Mbps. Over-speed causes a minor alarm.

The aggregate throughput you can *configure* across all ports is 24.576 Mbps. The 24.576 Mbps is the maximum line speed and is the *over-subscription* ceiling. The *actual* data throughput of the card depends on the hardware and the frame size. As the frame size decreases, the throughput decreases. With a frame size of 200 bytes of more, for example, the sustainable throughput is 16.384 Mbps. With 100-byte frames, data may be dropped if the rate is 16.384 Mbps for significant time periods.

For a description of Cisco Frame Relay technology, see the *Cisco System Overview.*

UFM-U Faceplate

Figure 4-38 shows the faceplate of the UFM-U. Table 4-35 describes its LED indicators. The first two columns of Table 4-35 shows the names of the LEDs and possible combinations of on and off states. The “Description” column describes the meaning of the LED states.

Figure 4-38 UFM-U Faceplate

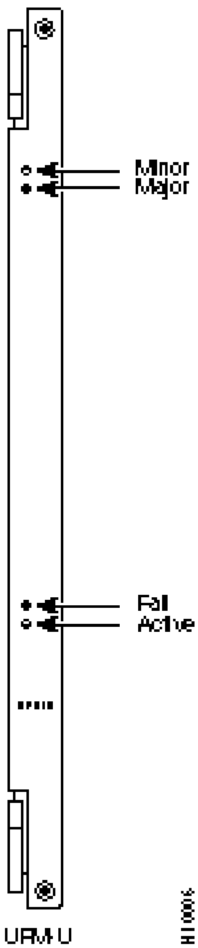


Table 4-35 UFM-U Card LED Indicators

		Description
Major LED	**Minor LED**	The Major and Minor LEDs are unused on the UFM-U.
Active LED	**Fail LED**	
Unlit	Unlit	Card power is off.
Unlit	Red	Card power is on, but no activation has been received; or an activation message has been received, but the card failed.
Green	Red	A background diagnostic has failed.
Green	Unlit	The card is active, and no failures have been detected.

Port Speeds on the Unchannelized UFM

This section describes how to specify *active* ports and the *maximum speed* allowed on each active port. Specifying the maximum speed for active ports requires careful planning, and this section provides the information for understanding and planning the port specification.

The UFM-U hardware does not permit random combinations of speeds across the ports. Speeds are constrained to certain combinations of maximum rates and ports. The combination of maximum speeds and active port number is called the *mode* of the card. Table 4-36 shows the maximum bit rate in Mbps on each port for the modes.

Table 4-36 also *groups* the ports under a letter. If you need to change the mode of a card that has active connections, you must consider these port groups. The forthcoming section titled "Changing the Mode of a UFM-U" describes the application of port groups.

In the port columns of Table 4-36, the numeric value is the maximum bit rate for that port. The maximum aggregate throughput is 16 Mbps. Note that, although the **cnfmode** command lets you specify the maximum for each active port, you specify the *actual* bit rate for a port with either the **cnfport** or **cnffrport** command. In Table 4-36:

- 3 means 3.072 Mbps.
- 8 means 8.192 Mbps.
- 10 means 10.240 Mbps.
- - Indicates the port is not usable for this mode.

Table 4-36 Maximum Port Speed Modes on the UFI Back Cards

	V.35 and X.21 Ports												HSSI Ports			
	Group A				Group B				Group C				A		B	
Mode	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1	3	3	3	3	3	3	3	3	3	3	3	3	8	8	8	8
2	8	-	8	-	8	-	8	-	8	-	8	-	16	-	16	-
3	10	-	-	-	10	-	-	-	10	-	-	-	16	-	-	-
4	8	-	8	-	3	3	3	3	3	3	3	3				
5	10	-	-	-	3	3	3	3	3	3	3	3				
6	8	-	8	-	8	-	8	-	3	3	3	3				
7	10	-	-	-	8	-	8	-	3	3	3	3				
8	10	-	-	-	10	-	-	-	3	3	3	3				
9	10	-	-	-	8	-	8	-	8	-	8	-				
10	10	-	-	-	10	-	-	-	8	-	8	-				
11	3	3	3	3	8	-	8	-	3	3	3	3				
12	3	3	3	3	3	3	3	3	8	-	8	-				
13	3	3	3	3	10	-	-	-	3	3	3	3				
14	3	3	3	3	3	3	3	3	10	-	-	-				
15	8	-	8	-	3	3	3	3	8	-	8	-				
16	3	3	3	3	8	-	8	-	8	-	8	-				
17	8	-	8	-	10	-	-	-	3	3	3	3				
18	8	-	8	-	3	3	3	3	10	-	-	-				
19	3	3	3	3	8	-	8	-	10	-	-	-				
20	3	3	3	3	10	-	-	-	8	-	8	-				
21	10	-	-	-	3	3	3	3	8	-	8	-				
22	10	-	-	-	3	3	3	3	10	-	-	-				
23	3	3	3	3	10	-	-	-	10	-	-	-				
24	8	-	8	-	10	-	-	-	8	-	8	-				
25	8	-	8	-	8	-	8	-	10	-	-	-				
26	10	-	-	-	8	-	8	-	10	-	-	-				
27	8	-	8	-	10	-	-	-	10	-	-	-				

Changing the Mode of a UFM-U

Initially, an unchannelized UFM card set comes up in mode 1. To specify another mode, use either **cnfmode** or **cnfufmumode**. The preferable time to specify a mode is before you add connections. After connections exist on the card, you must delete some or all connections and down ports before you change the mode. To change the mode of a card set, you must first delete all the connections in a group and down all the active ports in a group if any maximum port speed changes in a group as a result of the mode change. This requirement means you may or may not have to delete connections in a particular group. Use Table 4-36 to follow two examples that illustrate what you must do before you change modes.

1. If you change from mode 1 to mode 4 and connections exist on ports 1, 3, and 9–12, you must delete connections on 1 and 3 only and down these ports (no change in maximum speed on 9–12).
2. If you change from mode 2 to 9 and connections exist on all active ports, you must remove connections from ports 1 and 3 then down these ports (and relocate the connections from port 3 to port 1).

The steps for changing the mode of a UFM-U when connections exist on the card is as follows:

Step 1 Use the **delcon** command to remove all connections in any group where any maximum port speed changes because of the mode change.

Step 2 Use the **dnport** command to deactivate all ports in any group where any maximum port speed changes because of the mode change.

Step 3 Use the **cnffrport** command to configure new port speeds (at or below the new maximum resulting from the mode change).

Step 4 Use the **cnfmode** command to change the mode.

Step 5 Use the **upport** command to activate the inactive ports that are operational under the new mode.

Step 6 Use **addcon** to add connections as needed.

Cabling for the UFM-U Back Cards

This section describes the standard cabling and the Y-cabling scheme for the unchannelized back cards. The back cards are the UFI-12V.35, UFI-12X.21, and UFI-4HSSI. Because of the port variety and because the cables are either DCE or DTE, a significant number of cable configurations exist. Table 4-37 shows cable names, part numbers, and descriptions.

The connectors on the UFI cards are high density. Each UFI-12V.35 and UFI-12X.21card has 6, 60-pin connectors. Each of these connectors has two ports. If your specification dictates that both ports on a connector are active, you must have a cable with wiring for two ports. If a part number in Table 4-37 has the form “CAB-2...,” the cable has wiring for two ports. Note that if both ports on a connector are active, both ports must be either DCE or DTE because the cable itself is either DCE or DTE. If a connector has only one active port, the cable can be the less expensive, single-port version. A HSSI connector has 50 pins and supports one port.

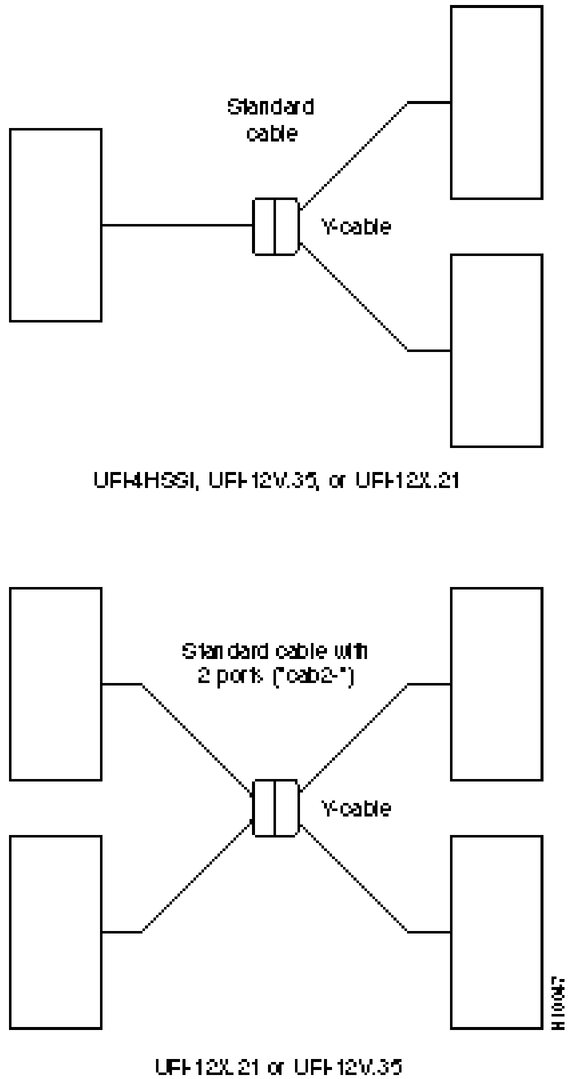
Table 4-37 UFM-U Cables

Card	Model Number	PCB Connector	Destination Connector	Cable Description
HSSI	CAB-HSI 1	50-pin Male	50-pin Male	HSSI Cable, UFI is DCE
HSSI	CAB-HS1-DTE	50-pin, Male	50-pin Male	HSSI Cable, UFI is DTE
HSSI	CAB-Y-HS1	Two, 50-pin Male	50-pin Male	HSSI Y-cable, 3 feet
V.35	CAB-V35MC	DB60F	V.35	V.35 Cable, DCE, Male, 10 ft.
V.35	CAB-V35MT	DB60F	V.35	V.35 Cable, DTE, Male, 10 ft.
V.35	CAB-V35FC	DB60F	V.35	V.35 Cable, DCE, Female, 10 ft.
V.35	CAB-V35FT	DB60F	V.35	V.35 Cable, DTE, Female, 10 ft.
X.21	CAB-X21MT	DB60F	X.21	X.21 Cable, DTE, Male, 10 ft.
X.21	CAB-X21FC	DB60F	X.21	X.21 Cable, DCE, Female, 10 ft.
V.35	CAB-2V35MT	DB60 Male	Two V.35	V.35 Cable, DTE, Male 10 feet
V.35	CAB-2V35FC	DB60 Male	Two V.35	V.35 Cable, DCE, Female 10 ft.
V.35 & X.21	CAB-Y-UFI	2xDB60 Male	DB60 Female	UFI-specific Y-cable
X.21	CAB-2X21MT	DB60 Male	Two X.21	X.21 Cable, DTE, Male, 10 ft.
X.21	CAB-2X21FC	DB60 Male	Two X.21	X.21 Cable, DCE, Female, 10 ft.

Port redundancy through the use of a Y-cable requires two card sets, at least one Y-cable, and the standard cabling. On a UFI-4HSSI, Port 1 is the only port that supports Y-cable redundancy. On the V.35 and X.21 UFIs, redundancy at more than one connector requires a corresponding number of Y-cables and standard cables. The standard cables are either single-port for HSSI, V.35, or X.21 or dual-port for the X.21 and V.35 UFIs.

To set up the Y-cabling, you attach a branch of the "Y" at the primary and redundant connectors then attach the near end of the standard cable to the base of the "Y." Figure 4-39 illustrates single and dual-cabling in a Y-cable setup. The single-cable arrangement applies to HSSI, V.35, and X.21. The dual-port redundancy setup applies to a UFI-12X.21 or UFI-12V.35, where both ports within the UFI connector are used in a Y-cable redundancy scheme.

Figure 4-39 Y-Cabling With a UFI-4HSSI, UFI-12V.35, or UFI-12X.21 Port



UFI-12V.35 Back Card

The UFI-12V.35 has six connectors. Each connector contains two V.35 ports. Each port has a tri-color LED to indicate its status. Because each connector supports two ports, each connector has two associated LEDs. Figure 4-40 shows the faceplate of the UFI-12V.35, and Table 4-38 describes the significance each color of the LED.

You can configure each port on the UFI-12V.35 to use normal clocking or a looped clocking, then configure the port to run at one of the following speeds:

- 56 Kbps
- n x 64 Kbps (where n=1 ... 32)
- n x 1.024 Mbps (where n=2 ... 10)

Figure 4-40 UFI-12V.35 Faceplate

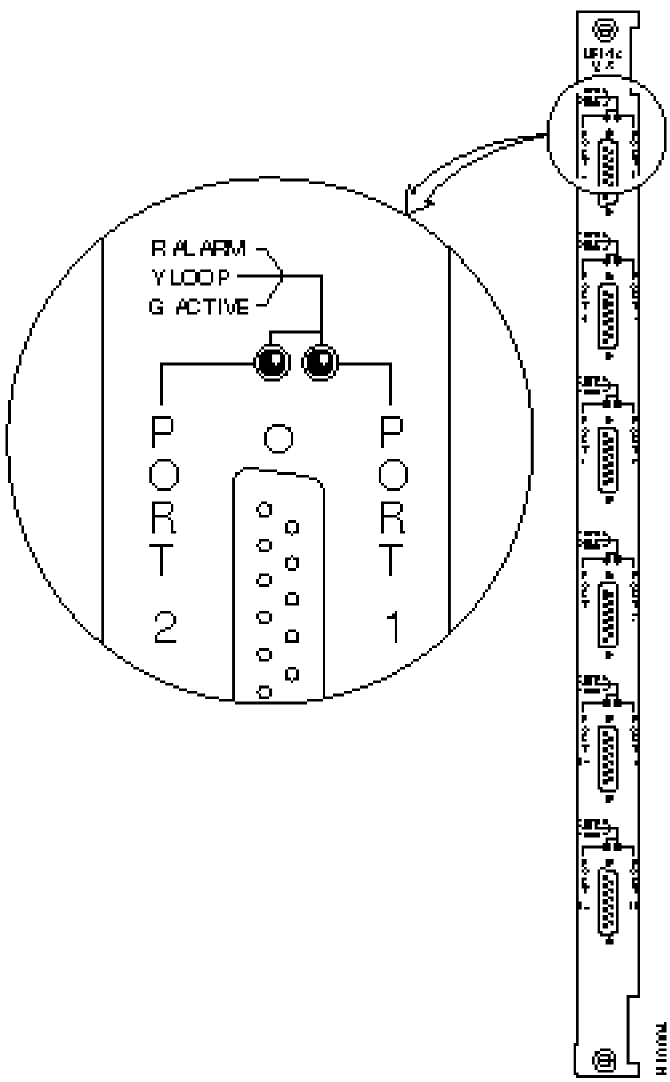


Table 4-38 UFI-12V.35 Faceplate Indicators

LED	Meaning
Green	Indicates line is active and functional.
Red	Indicates line is active but either has no cable or the wrong cable or is running over-speed.
Yellow	Indicates the line is active and in loopback mode.
Off	Indicates that either the port is inactive or has no power.

UFI-12X.21 Back Card

The UFI-12X.21 has six connectors. Each connector contains two X.21 ports. Each port has a tri-color LED to indicate its status. Because each connector supports two ports, each connector has two associated LEDs.

You can configure each port on the UFI-12X.21 to use normal clocking or a looped clocking, then configure the port to run at one of the following speeds:

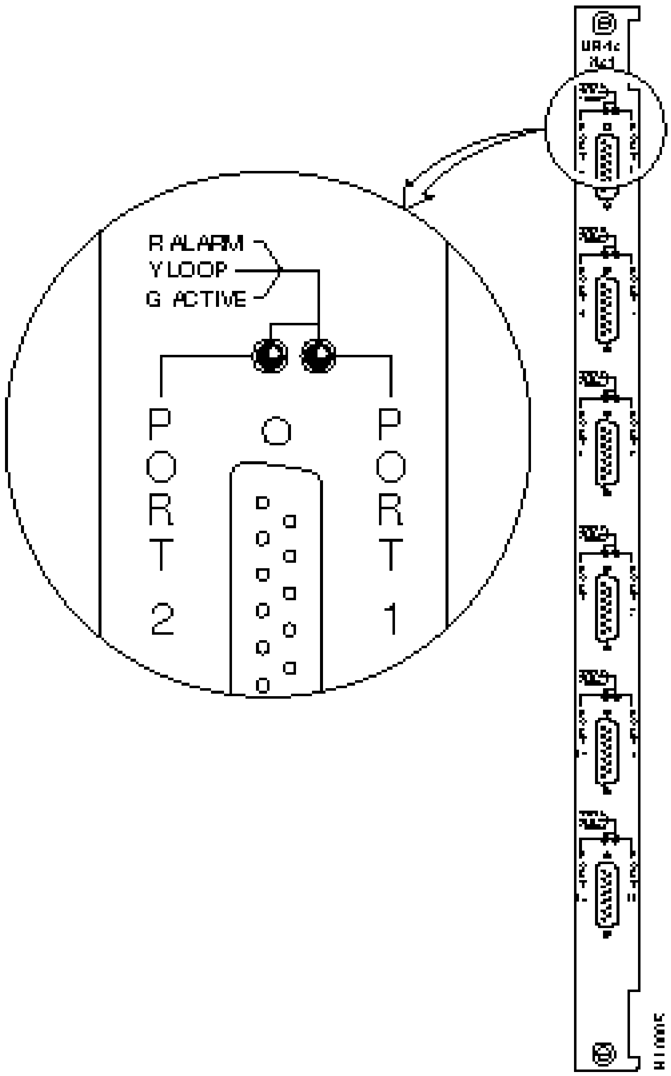
- 56 Kbps
- n x 64 Kbps (where n=1 ... 32)
- n x 1.024 Mbps (where n=2 ... 10)

Figure 4-41 shows the faceplate of the UFI-12X.21, and Table 4-39 describes the significance each color of the LED.

Table 4-39 UFI 12-X.21 Faceplate Indicators

LED	Meaning
Green	Indicates line is active and functional.
Red	Indicates line is active but either has no cable or the wrong cable or is running over-speed.
Yellow	Indicates the line is active and in loopback mode.
Off	Indicates that either the port is inactive or has no power.

Figure 4-41 UFI-12X.21 Faceplate



UFI-4HSSI Back Card

The UFI-4HSSI has four connectors. Each connector has a tri-color LED for status. Figure 4-42 shows the UFI-4HSSI faceplate. Table 4-40 describes the significance each color of the LED. Using **cnffrport**, you can configure each port with a speed that is a multiple of 1 Mbps up to the maximum for the *mode* of the card (see the section titled "Port Speeds on the Unchannelized UFM").

Figure 4-42 UFI-4HSSI Faceplate

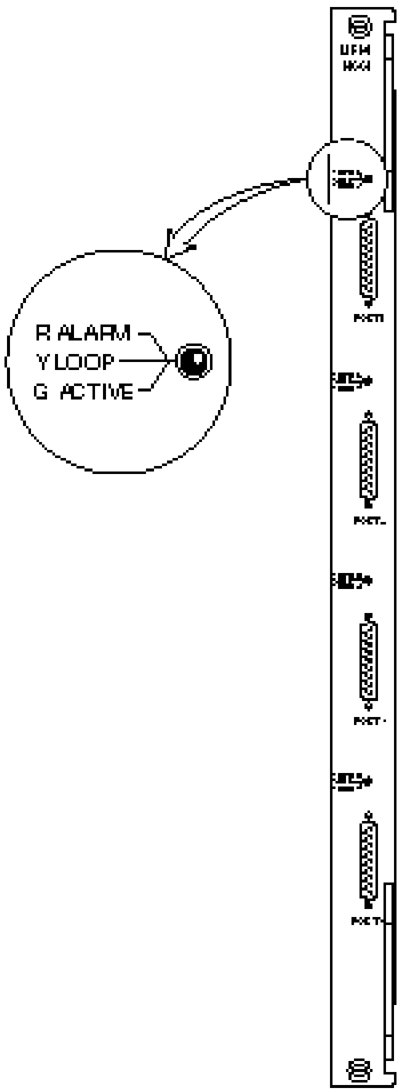


Table 4-40 UFI-4HSSI Faceplate Indicators

LED	Meaning
Green	Indicates line is active and functional.
Red	Indicates line is active but either has no cable or the wrong cable or is running over-speed.
Yellow	Indicates the line is active and in loopback mode.
Off	Indicates that either the port is inactive or has no power.

Frame Relay Module (FRM)

The Frame Relay Module (FRM) front card supports 1 to 4 data ports and, in single-port mode, operates at up to 2.048 Mbps.

Note FRM front cards exist in two forms. One uses an ACM1 adaptor. The other is a single-card or "native" version. Functionally they are identical. For the single-card version, the minimum firmware revision is "V."

Table 4-41 Frame Relay Module (FRM) Card Sets

Front Card	Model	Back Card	Model
FRM Frame Relay Module, unchannelized	D	FRI-V.35	B
		FRI-X.21	A
FRM Frame Relay Module, channelized (with 31 channels)	E	FRI-T1 or FRI-E1	A
FRM2 Frame Relay Module, Port Concentrator Shelf	F	FRI2-X.21	A

FRM Features and Functions

The FRM supports a maximum port speed of 2.048 Mbps plus the following features:

- Bundled connections
- Frame forwarding
- GMT request/response
- Explicit Congestion Notification (ECN)
- Multicast services
- ForeSight dynamic congestion avoidance
- AIP applications
- Enhanced V.35 loopback test
- T1 and E1 Frame Relay port interfaces
- Network-to-Network Interface (NNI) ports for V.35 and X.21 Frame Relay connections that extend across a Cisco network to a foreign network
- Network-to-Network Interface (NNI) ports for T1 and E1 Frame Relay connections

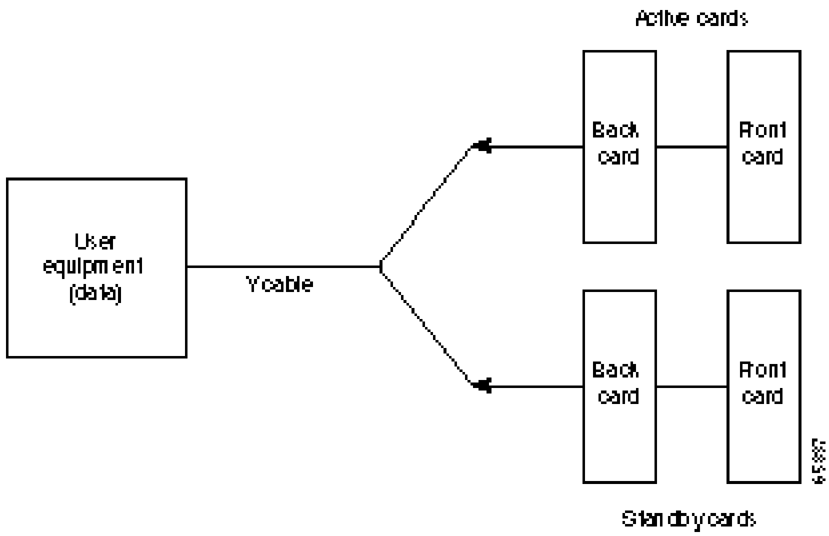
The FRM can support a maximum of 252 virtual circuits (PVCs). PVC distribution can cross all four ports if they do not exceed the 252 PVC limit and the limit of 2.048 Mbps per FRM.

Bundled and grouped connections are software groupings of multiple virtual circuits within a single routing connection. Grouping allows a node to support up to 1024 virtual circuits, which is the logical equivalent of four FRMs.

Frame Relay Card Redundancy

Frame relay card redundancy can be provided through a second card set in adjacent slots and a Y-cable between each port that connects to the user-equipment. See Figure 4-43 for an illustration. The hardware kits for this feature contain a second Frame Relay card set, a set of Y-cables to interconnect the two card sets, and any other pieces that apply to the card types. Y-cable redundancy is not possible using back cards with different interfaces, such as an FRI T1 and FRI V.35.

Figure 4-43 Frame Relay Port Redundancy



Frame Relay Interface (FRI) V.35 Card

The Frame Relay Interface V.35 (FRI-V.35) is a four-port back card to the FRM card. Two models of the FRI-V.35 can support the FRM:

- FRI-V.35 Model A—supports composite data rates up to 1.024 Mbps and provides a CCITT V.35 interface for each port.
- FRI-V.35 Model B—supports composite data rates to 2.048 Mbps with V.35 interface.

The FRI-V.35 has the following functions and features:

- Interfaces 1 to 4 Frame Relay ports via 34-pin MRAC connector (Winchester, female)
- RTS, CTS, DSR, DTR, DCD, LLB, RLB, and TM control leads supported
- Handles up to 252 virtual circuits per card
- Hardware jumpers to configure the interface as DCE or DTE
- Supports normal and looped clocking

Figure 4-44 Frame Relay V.35 Connectors and Indicators

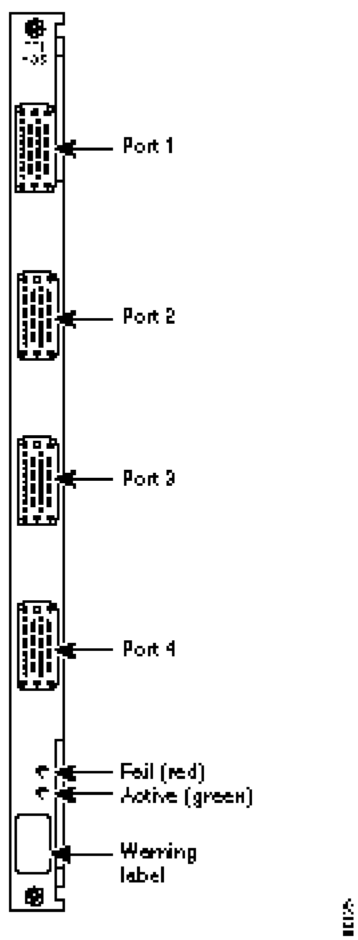


Table 4-42 shows the relationship between the number of ports used on the FRI and maximum operating speed for each port. Model A FRM and FRI cards are included for early users who may not have updated the cards. Note that the port numbers start at the top on the FRI faceplate.

Table 4-42 Port Speed Combinations

Firmware	One Port	Two Ports	Three Ports	Four Ports
A/A	≤ 256	≤ 256	≤ 256	≤ 256
	1024	0	0	0
B/A	≤ 256	≤ 256	≤ 256	≤ 256
	≤ 336	≤ 336	≤ 336	0
	≤ 512	≤ 512	0	0
	1024	0	0	0
C/A	≤ 256	≤ 256	≤ 256	≤ 256
	≤ 336	≤ 336	≤ 336	0
	≤ 512	≤ 512	0	0
	1024	0	0	0
C/B D/B	One port can operate at 2048 or 1920. Combinations of ports can add up to 2048 Kbps. If one port is 1920 or 2048, no other port can be active.			

Frame Relay V.35 Port Numbering

Each Frame Relay logical channel has a number in the form:

slot.port.dlci

where

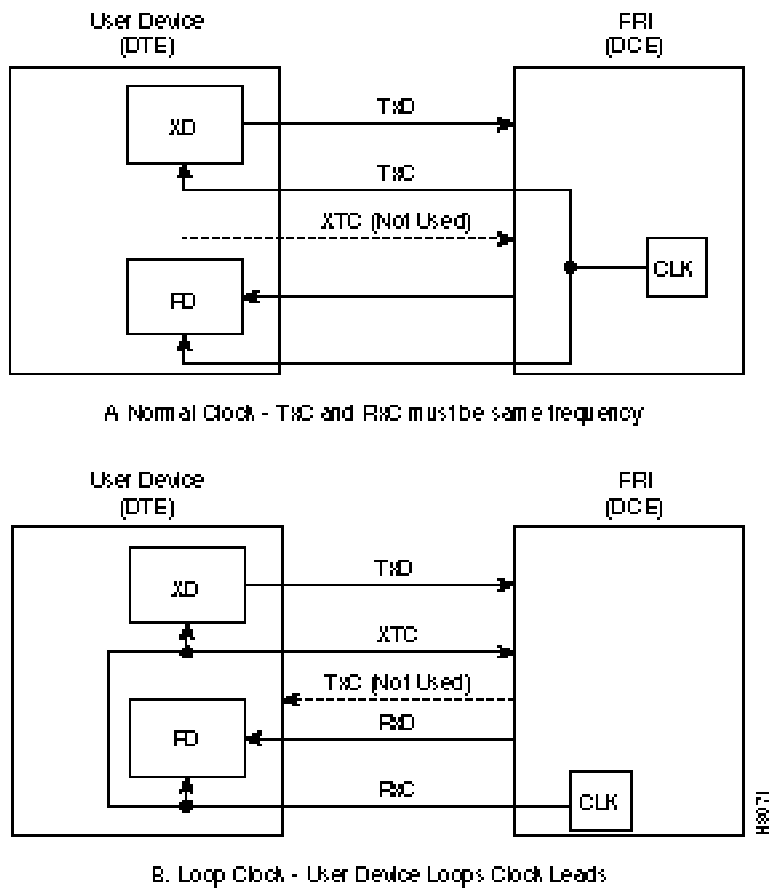
- Slot is the number of the front and back slots where the FRM and FRI-V.35 reside.
- Port is the back card port number in the range 1 to 4.
- DLCI is the identification number for the PVC. The usable range of DLCIs is 16–1007. The reserved DLCIs are 0–15 and 1008–1023.

FRI-V.35 Data Clocking

The two clocking modes that the FRI supports are *normal* and *looped*. Figure 4-45 illustrates the two modes. Note that the direction for the clock and data is reversed for the two FRI mode configurations (DCE or DTE), as follows:

- If the FRI is DCE with normal clocking, it provides both transmit and receive clock to the user device.
- If the FRI is DTE with normal timing, the user device provides both the transmit and the receive clock.
- If the FRI is a DCE with looped timing, the user device provides the transmit clock on the EXT XMT CLK line, and the FRI provides the receive clock to the user device.
- If the FRI is DTE with looped timing, it provides the transmit clock on the EXT XMT CLK line, and the user device provides the receive clock.

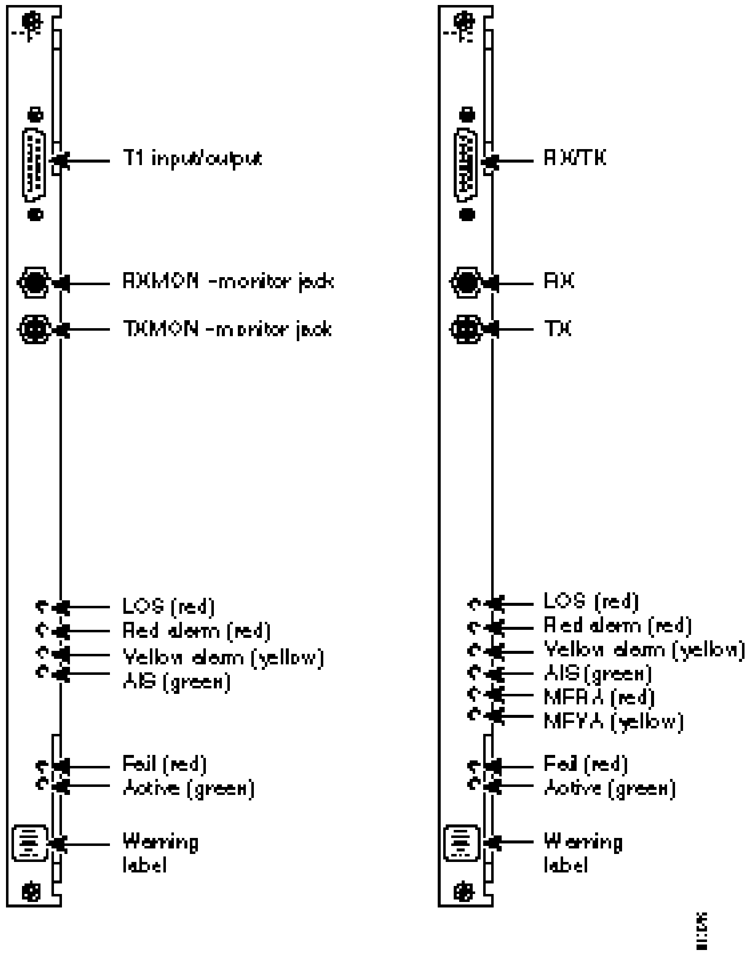
Figure 4-45 Frame Relay Data Clocking Modes



Note Clock is looped by the FRI instead of the user device.

Figure 4-46 illustrates the FRI-T1 and FRI-E1 back cards.

Figure 4-46 Frame Relay T1/E1 Back Cards



Loopbacks

The IGX node does not support port loopbacks (**tstport** and **addextlp** command) towards the IGX node. In contrast, for V.35 and X.21 interfaces only, you can set up connection loopbacks towards the facility by using the **addloclp** and **addrmtlp** commands.

FRM-FRI Compatibility

The firmware on the front card must match the type of interface on the back card. Rev D firmware on the FRM supports X.21 and V.35 protocols. Rev E firmware on the FRM supports T1 and E1 protocols. The Display Card (**dspcd**) command indicates the type of back card that the FRM firmware supports and reports any mismatch.

Frame Relay Interface for X.21

The FRI-X.21 back card provides an X.21 interface to the user equipment. The two model D FRI cards are the FRI-V.35 and FRI-X.21. They differ only in the physical connectors (see Table 4-43). The operating rates of each port and the composite data rate supported by the FRI-X.21 card is the same as the FRI-V.35. You can configure each port as either a DCE or a DTE. Another FRI card is the FRI-2-X.21. This is the back card that provides the interface between the Port Concentrator Shelf (PCS) and the FRM-2. See the section titled “FRM-2 Interface to the Port Concentrator Shelf.”

The FRI-X.21 uses leased line service for international networks. The V.35 version is for domestic (U.S.) use and also uses a leased line service for its connections. The FRI-X.21 back card features:

- Four Frame Relay data ports with CCITT X.21 interface through DB15 connectors.
- Support for all standard X.21 data rates up to 2.048 Mbps.
- Support for C (control) and I (indication) control leads.
- Daughter board used to configure FRI as DCE or DTE.
- Card redundancy option provided by Y-cable and standby card pair.

FRI configuration supports one to four ports. The configuration depends on the maximum speed requirement (the card itself has a maximum composite speed). Figure 4-47 shows the FRI faceplate. Table 4-44 lists the available port operating speeds.

Any one port can operate at 2048 Kbps. Any combination of ports can equal 2048 Kbps. If a port is operating at 2048 Kbps, it must be port 1, and no other port can be active. Numbering of the 4 DB15 connectors starts at the top of the faceplate. Table 4-45 lists the cable and pinouts for an X.21 port.

Table 4-43 FRI Card Types

Back Card	Interface Type	Ports	Connector
FRI-X.21	X.21	4 ports	DB15 Sub miniature, female
FRI-V.35	V.35	4 ports	34-pin MRAC type (Winchester), female

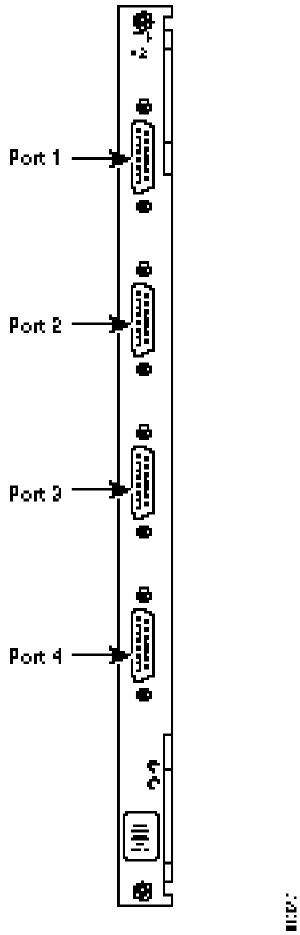
Table 4-44 Frame Relay Port Speeds Available

Individual Timeslots	Maximum Aggregate Rate
Any multiple of 56 Kbps	Up to 1.792 Mbps
Any multiple of 64 Kbps	Up to 2.048 Mbps

Table 4-45 FRI-X.21 Port Pin Assignments (DB 15-connector)

Pins	Mnemonic	Full Name	Mode
1	Gnd.	Protective (Shield) ground	DTE and DCE
8	Sig. Gnd.	Signal ground	DTE and DCE
3/10	C	Control	DTE and DCE
5/12	I	Indication	DTE and DCE
2/9	TxD	Transmit Data from DTE	DTE
4/11	RxD	Receive Data to DTE	DCE
6/13	S	Clock Out (DCE), Clock In (DTE)	DCE

Figure 4-47 Frame Relay X.21 Connectors and Indicators

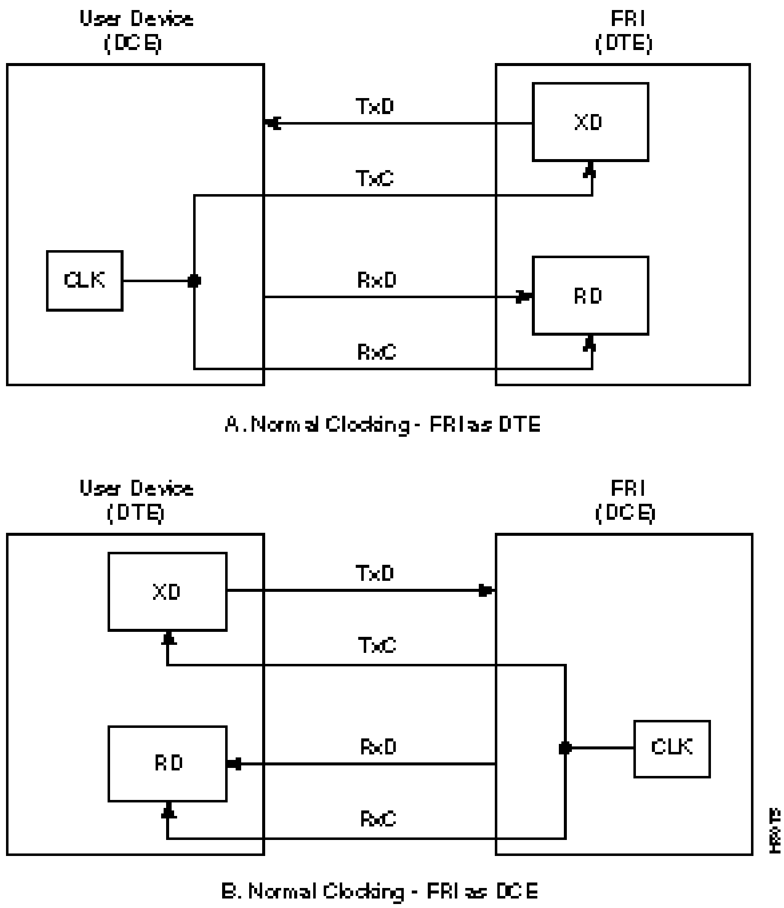


X.21 Data Clocking

The FRI-X.21 supports only *normal* clock mode. The direction of the clock and data lines is reversed if the FRI is configured as a DCE or as a DTE as follows (see Figure 4-48):

- If the FRI is configured as a DCE, it provides a clock signal to the user device (DTE) on the S (clock) lead. This clock is synchronous with the node timing.
- If the FRI is configured as a DTE, the FRI-X.21 receives clock from the user device (DCE) on the S (clock) lead.

Figure 4-48 Frame Relay Data Clocking Modes



Y-Cable Redundancy and Port Modes

The Y-cable redundancy kits for the FRI-X.21 and FRI-V.35 contain four extra daughter cards for specifying individual ports as either DCE or DTE. The extra daughter cards are 200-Ohm versions for the FRI already installed. The higher impedance cards are necessary because of circuit behavior at higher speeds when the two interfaces are in parallel (by way of the Y-cable).

Card Self Test

As with all IGX cards, the FRI-X.21 includes internal diagnostic routines that periodically test the card's performance. These self-test diagnostics automatically start and run in background. They do not disrupt normal traffic. If a failure is detected during the self test, the faceplate red Fail LED is turned on. The operator can also view the status at the control terminal by executing the Display Card (**dspcd**) command.

A report of a card failure remains until cleared. A card failure is cleared by the Reset Card (**resetcd**) command. The two types of reset that **resetcd** can do are *hardware* and *failure*. The failure reset clears the event log of any failure detected by the card self-test but does not disrupt operation of the card. A reset of the card firmware is done by specifying a hardware reset. This reboots the firmware and momentarily disables the card. If a redundant card is available, the hardware reset causes a switch over to the standby card.

Port Testing (X.21)

The X.21 Frame Relay ports and any associated external modems, CSUs, or NTUs can be tested using data loopback points in the circuit path. The three possible loopbacks for X.21 Frame Relay ports are:

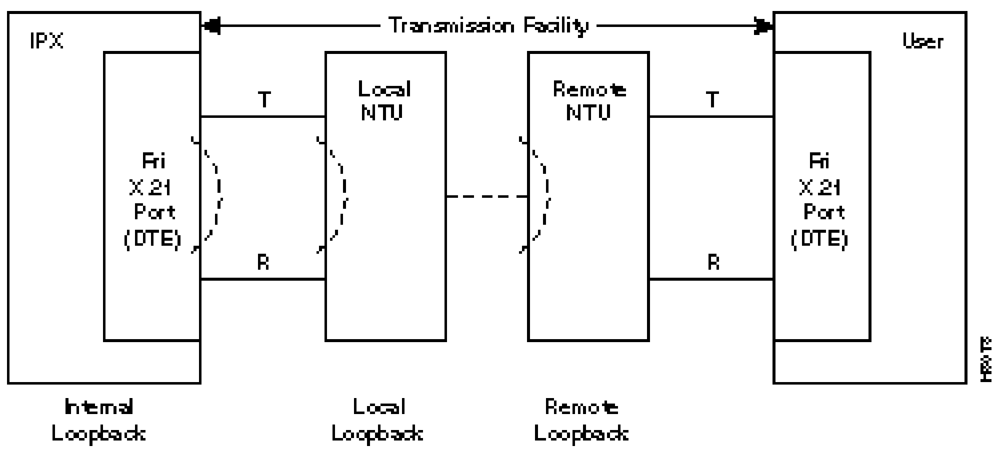
- An internal loopback of the port
- A loopback of the near end (local) modem
- A loopback of the other end (remote) modem

The modems must be compatible with the Cisco loopback protocol. For information on supported modems and protocols, refer to the appendix titled “Peripherals Specifications” in the *Cisco IGX 8400 Series Installation* manual. Also, refer to the *Cisco WAN Switching Command Reference* for protocol requirements for the **addextlp**, **addloclp**, and **addrmtlp** commands. For information that applies to loopbacks on the FRM-2/FRI-2 and PCS, see the descriptions of these loopback commands in the *Cisco WAN Switching Command Reference*. If these sources fail to clarify a particular situation, contact the Cisco TAC.

All three loopbacks are set up using the **tstport** command. Only one port at a time can be in loopback mode for testing.

The internal loopback point is established inside the FRI card. Figure 4-49 illustrates the setup. The FRM generates a test pattern, sends it out on the transmit circuitry, and detects this pattern on the receive circuitry. This test takes several seconds and momentarily interrupts traffic on the port. The test runs on a port that is in either DCE or DTE mode.

Figure 4-49 Frame Relay Loopback Modes



For ports configured for DTE, the two additional tests (local loopback and remote loopback) are available. For these ports there are two methods of loopback testing:

- In Test Mode, the card transmits a loopback data pattern to initiate a loopback. The modems or NTUs may not recognize this pattern to perform the loopback. The FRI does not care and waits a programmable period of time (default=10 seconds) to send the test pattern. After the test is completed, pattern transmission terminates, and the circuit returns to normal operation. A Model D FRM is required for this test. Use **tstport** to display test results on the IGX control terminal.
- Some external equipment supports loopback testing but does not recognize the test pattern (Test Mode) in the data stream. In these cases, the FRM/FRI toggles the V.35 LLB (local loopback) and the RLB (remote loopback) leads then runs the test pattern. The FRM/FRI still waits the user-specified time (default=10 seconds) before running the data test pattern. A Model D FRM is required for this testing. Use **tstport** to display test results on the IGX control terminal.

Unit Replacement

FRI card replacement is the same as other back card replacement. For back card replacement procedures, refer to the *Cisco IGX 8400 Series Installation* manual.

FRM-2 Interface to the Port Concentrator Shelf

This section introduces the Port Concentrator Shelf (PCS) for Frame Relay traffic. The PCS is an external device that expands the capacity of a Frame Relay Module (FRM) to 44 low-speed ports. This ability to increase the port density of an IGX switch supports more efficient usage for the common switch equipment. The port parameters are as follows:

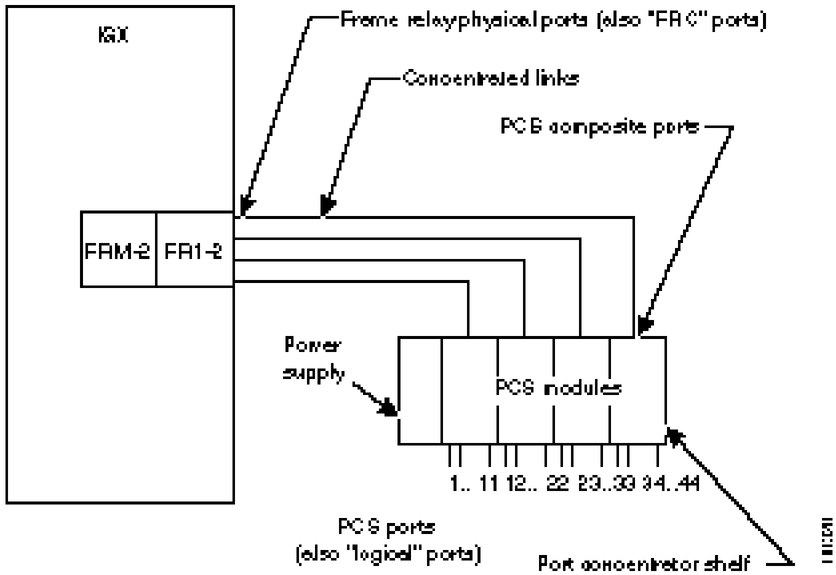
- The per-port range is 9.6 Kbps through 384 Kbps.
- The typical configured rate is 64 Kbps per port or less.
- The maximum total throughput for the 44 ports is 1792 Kbps.

The PCS requires a version of the FRM/FRI card set that is exclusively dedicated to the PCS. The front card is the FRM-2. The back card that interfaces the FRM-2 to the PCS is the FRI-2-X.21. Figure 4-50 illustrates the relation ship between the FRM/FRI card set and the PCS. It provides one or more X.21 links. Each X.21 link is called a *concentrated link*. In a full configuration, each concentrated link services one of four 11-port modules in the PCS. This makes a total of 44 ports on the FRM-2.

Note FRM-2 front cards exist in two forms. One uses an ACM1 adaptor. The other is a single-card or "native" version. Functionally they are identical, and the firmware is the same.

For more detailed information on the PCS, refer to the section on the Port Concentrator Shelf in the *System Manual*. For detailed installation instructions, refer to the *Port Concentrator Installation* document that comes with each unit. Cabling information for the PCS appears in the cabling appendix and in the *Port Concentrator Installation* document.

Figure 4-50 Port Concentrator Shelf Components



Terminology

The following terms are used to identify PCS components:

- “FRC” (Frame Relay Concentrator) ports—FRM-2-X.21 ports connected to the PCS, used in commands such as **dspfrcport.** These are also known as PCS “physical” ports.
- Frame relay logical ports—each of the 44 PCS ports, from the perspective of the IGX interface, is a logical port. This distinguishes it from a physical Frame Relay port.

Operation and User Interface

Other than front panel LEDs, the PCS has no user interface because the PCS functions as an extension of the FRM-2. PCS ports are operated and maintained from the IGX user interface.

The PCS operates within the IGX environment as a Frame Relay card with 44 ports. Existing Frame Relay commands (**cnffrport**, **upfrport**, **dnfrport**, **addcon**, **delcon**, etc.) are the same in syntax and function. The difference is that a range of 44 ports can be specified instead of 4. The configuration of each of the PCS logical ports is similar to that of non-PCS Frame Relay ports. A Frame Relay card connected to a PCS notifies the system database and permits the additional ports to be specified.

PCS-to-IGX Interface

This section describes the interface between the PCS and IGX node.

Compatibility

The PCS requires the following:

- System software version 8.1 or later
- FRM-2 front card and FRI-2-X.21 back card

Note Use of the PCS with the FRM-2 is exclusive: the PCS does not work with any other model of the FRM, and only a PCS works with the FRM-2. For example, if fewer than four PCS modules are used, unused Frame Relay ports cannot connect to something other than the PCS.

Concentrated Link

The concentrated link refers to the connection between port concentrator and Frame Relay card. Each module supporting 11 external ports is connected to 1 of the 4 ports on the FRI-2-X.21 back card.

Configuration

Each of the four composite links between an PCS and IGX node has a fixed configuration of:

- Speed: 512 Kbps
- FRM-2 physical port: FRI-2-X.21 DCE
- PCS composite port: X.24/V.11 DTE

The PCS Concentrated Link cable is illustrated in the cabling appendix. Its maximum length is 25 feet. You cannot use a modem to extend this distance.

Activation

FRM-2 firmware interacts with the PCS over composite links only if the FRM-2 is active. The FRM-2 changes from standby to active state when its first logical port is activated.

upfrport Command

A PCS logical port associated with an FRM-2 card is activated with the **upfrport** command. The **upfrport** command requires the slot number of the FRM-2 to which the PCS is connected. Enter the slot number and a logical port in the range of 1-44 (assuming a connection exists for all 4 composites between the PCS and IGX node).

Example: upfrport 4.1

This example indicates that the FRM-2 in slot 4 and concentrated link 1 are connected.

Entering the **upfrport** command for one port activates all four ports. The following events are generated by successful activation of four concentrated links. The display is from the example "**upfrport** 4.1:"

"Info FRM 4 Activated"
"Info FRM Port 4.1 Activated
"Info FRM Concentrated Link 4.1 Failure Cleared"
"Info FRM Concentrated Link 4.2 Failure Cleared"
"Info FRM Concentrated Link 4.3 Failure Cleared"
"Info FRM Concentrated Link 4.4 Failure Cleared"

A noticeable delay occurs after **upfrport** begins executing on the first port. During initial **upfrport** execution, the FRM-2 performs first-time configuration, diagnostic, and up/download functions.

If a concentrated link is not connected or fails to come up, the logical port remains in a failed state until either the link comes up or the port is deactivated with the **dnfrport** command.

De-activation: the dnfrport Command

The FRM-2 card set returns to the standby state after you de-activate all 44 logical ports by executing the **dnfrport** command.

PCS Port Configuration

When the Frame Relay ports are activated, the IGX node recognizes them as PCS-connected ports. Subsequently, all applicable Frame Relay port management commands accept logical port numbers in the form *slot.port*. The range for *port* is 1 to 44. Table 4-46 shows the logical ports the PCS supports. In Table 4-46, slot is the IGX slot in which the FRM-2 resides.

Table 4-46 PCS Logical Ports

Composite Link	PCS Ports
Composite L1	*slot*.1—*slot*.11
Composite L2	*slot*.12—*slot*.22
Composite L3	*slot*.23—*slot*.33
Composite L4	*slot*.34—*slot*.44

Interface Hardware Configuration

The interface and clocking characteristics for each PCS port is independently configured to be V.11 (X.21), V.35, or V.28 by inserting the required interface card (or "ICARD") into the associated slot in the PCS. For detailed information on PCS hardware interfaces, refer to the *Port Concentrator Installation* document. This document comes in the PCS shipping container.

The IGX node does not have the capacity to read the type of interface present for the PCS port. The values you enter under *Interface Type* with the **cnffrport** command appear in the display only and cannot be checked against the hardware.

The cnffrport Command

You configure a PCS with the **cnffrport** command. With the following limitations, all parameters for the **cnffrport** command are supported:

1. For each group of 11 logical ports, the total speed must be 384 Kbps or less. The remaining 64 Kbps of composite link speed is reserved for control information. This total consists of only active ports.
2. The default port speed is 38.4 Kbps (instead of 256 Kbps for non-PCS ports).
3. Each PCS logical port supports speeds of 9.6, 14.4, 16, 19.2, 32, 38.4, or 48 Kbps. Higher speeds (56 to 384 Kbps) are valid as long as your configuration stays within limitation 1, above.
4. Only the active *Interface Control Template* is supported by the PCS.

Port Statistics

All Frame Relay summary and interval statistics are kept for PCS ports. The PCS and FRM-2 share responsibility for statistics collection on PCS ports. The PCS maintain counters for:

- CRC errors on received frames
- Aborted/underrun received frames
- Transmit Frames Discards
- Transmit Bytes Discards

All remaining statistics counters are collected by the FRM-2. Although an IGX node supports ForeSight for PCS connections, CLLM (ForeSight) statistics are not available in Release 8.1. These fields are present but not valid.

PCS Monitoring Functions

Monitoring functions generally apply to the PCS except that you can specify up to 44 logical ports for a FRM-2 slot. For descriptions of the monitoring commands, refer to the “Troubleshooting” chapter of the *Cisco WAN Switching Command Reference.* Note that commands **dspchcnf**, **dspchstats**, **dspportstats**, and **dspbob** fail when the required concentrated link is down. Trying to execute one of these commands on a concentrated link that is down causes an error message to appear.

Collecting the Monitoring Information

The sections that follow describe the collection of various types of monitoring information.

Logical Port Speed

The PCS measures the speed of receive data on logical ports if the port is configured as a DTE interface. To see the measured speed, use the **dspbob** command. The PCS measures port speed after any of the following occurs:

- When the PCS is first powered up.
- When a port is configured with the **cnffrport** command. After the port is reconfigured, speed of incoming data is measured.
- When signals are displayed for the port with the **dspbob** command, you are given the option of measuring port speed at that time.
- When the PCS is reset or power is interrupted for any reason.

The process of measuring port speed sends out two 1-byte frames with no CRC on the port.

Physical Port Speed

The IGX node measures the physical port speed for FRI-2-X.21 ports once per minute. The current measured speed is displayed with the **dspfrcport** command and should always read 512 Kbps when the port is active.

PCS Front Panel LEDs

Table 4-47 describes the LEDs on the PCS front panel.

Table 4-47 PCS Module Front Panel LEDs

LED Name	Function
State	OFF = No power. RED = power applied but software not running. GREEN = Operating software running.
Rx	Flashes for frames received on concentrated link. With no activity on link, Link Rx blinks once per second. With steady activity on link, Link Rx is on continuously.
Tx	Flashes for frames transmitted on concentrated link With no activity on link, Link Tx blinks once per second. With steady activity on link, Link Tx is on continuously.
CPU A	On solid when operating software on CPU A is running. Should always be On during operation.
CPU B	On solid when operating software on CPU B is running. Should always be On during operation.
Port 1	On for module connected to FRM-2 Port 1. Should always be On for Module 1.
Port 2	On for module connected to FRM-2 Port 2. Should always be On for Module 2.
Port 3	On for module connected to FRM-2 Port 3. Should always be On for Module 3.
Port 4	On for module connected to FRM-2 Port 4. Should always be On for Module 4.
Download	Flashes when frames are received during software download from FRM-2.

Card Insertion and Removal

If the FRM-2 or FRI-2.X21 card is removed for any reason, be sure to maintain card compatibility upon card replacement: the FRM-2 card is compatible with only the FRI-2-X.21 back card. The IGX node declares a mismatch state for any other back card inserted into an active FRM-2 slot. Inserting compatible hardware is the only way to clear the mismatch. Similarly, once an IGX slot is active with an FRM-2, a mismatch is declared if any other front card is inserted into this slot. Before the slot can be used for any other type of card, the slot must be de-activated as a PCS-capable Frame Relay card.

PCS Command Summary

The commands in the list that follows apply to PCS Frame Relay ports. Most commands have the syntax described in the *Cisco WAN Switching Command Reference* with the exception that system software recognizes 44 ports per FRM-2 instead of 4. Some commands are PCS-specific.

Table 4-48 Commands for the Port Concentrator Shelf

Command	Purpose	Command	Purpose
addcon	Adds Frame Relay connections.	**dncon**	Deactivate a Frame Relay connection.
addloclp	Create local loopback for test purposes.	**dspchcnf**	Display channel configuration.
addrmtlp	Create remote loopback for test purposes.	**dspchstats**	Display PCS Frame Relay channel statistics.
cnfchpri	Configure Frame Relay channel priority.	**dspfrcportstats**	Display specifically PCS FRI-2-X.21 physical port statistics.
cnfchutl	Optimizes Frame Relay channel utilization.	**dspfrcbob**	Display specifically PCS FRI-2-X.21 physical port signals.
cnffrcls	Configure Frame Relay class of service (also **cnfcos** command for connection)	**dspfrport**	Display PCS logical port.
cnffrcon	Configure Frame Relay connection parameters.	**dspfrcport**	Display FRI-2-X.21 physical port.
cnffrcport	Configure the concentrated link between the FRM-2 cards and the PCS.	**dsppcs**	Display PCS-unit information.
cnffrport	Configure port parameters.	**dspportstats**	Display PCS Frame Relay port statistics.
cnfpref	Configure preferred route for Frame Relay connection.	**dspcon**	Display connections.
clrchstats	Clear PCS Frame Relay channel statistics.	**prtcons**	Print Frame Relay connections.
clrfrcportstats	Clear specifically PCS FRI-2-X.21 physical port statistics.	**prtchcnf**	Print Frame Relay channel configuration.
clrportstats	Clear PCS Frame Relay port statistics.	**tstcon**	Test Frame Relay connection.
delcon	Delete a Frame Relay connection.	**tstdelay**	Test Frame Relay connection delay.
delcongrp	Delete a Frame Relay connection group.	**tstpc**	Test the PCS.
dellp	Delete loopback condition.	**resetpc**	Reset the PCS.

PCS Port Failures

A PCS logical port failure is defined as a minor alarm. The *FTC/FRP Port Comm Failure* icon appears in the **dspalms** screen. Any connection that terminates on a failed port is also failed. Three causes of a port failure are defined, as described under Alarms and Events.

Conditioning

A failed connection on a PCS logical port is conditioned in the same manner as a failed connection on a non-PCS FRP port. Only the active control template is supported on PCS ports. The “conditioned” control template should not be used for PCS logical ports.

PCS General Operation

Firmware Download

When it detects a Port Concentrator on one of its links, the FRM-2 checks for a compatible firmware revision on the Port Concentrator. If the FRM8-2 detects that the firmware on the Port Concentrator is incompatible, the FRM8-2 downloads the current firmware to the Port Concentrator. This download operation takes about two minutes. An event is logged when a firmware download has either started or failed.

Operating software on the Port Concentrator is stored in Flash memory. Download should be required only if the PCS is connected to an FRM-2 with newer firmware or a PCS module is replaced and a software version difference exists.

Automatic Diagnostics—FRM-2 and FRI-2-X.21 Cards

The FRM-2 card runs a self-test diagnostic when it is in the standby state. The system software uses a reserved channel on the FRM-2 card to perform background loopback tests that include both the FRM-2 and FRI-2-X.21. This test verifies that all components up to the FRI-2-X.21 physical port are functioning. These diagnostics do not test the PCS.

StrataView Plus Interface

Information about PCS logical ports and Frame Relay connections automatically goes to StrataView Plus. StrataView Plus can also manage connections and other FRM-2 port functions.

SNMP Manager

The SNMP agent supports Port Concentrator logical ports. This includes configuring PCS port parameters, adding, or deleting Frame Relay connections, and retrieving statistics.

The SNMP agent also supports provisioning for 44 Frame Relay ports for FRM-2; the existing MIB variables are extended to the expanded number of logical ports. SNMP management functions are not supported for the Port Concentrator concentrated links.

User Interface

Interaction between the FRM-2 and PCS automatically updates the database to display the number of connected logical FRM-2 ports at the PCS. As a result, both the IGX user interface and the StrataView Plus interface automatically display the additional capacity of 44 ports for the FRM-2.

Concentrated Link Failure

If, during normal operation, communication between FRM-2 and PCS over a concentrated link stops, a concentrated link failure alarm results.

In addition, during start-up, a concentrated link is failed for any of the following reasons:

- Port Concentrator is not present.
- Code download from FRM-2 to Port Concentrator fails.
- Port Concentrator self-test fails.
- Cable is unplugged or bad.

Frame Trunk Module (FTM)

The Frame Trunk Module (FTM) supports devices that provide access for various types of traffic to the IGX node. Two lines of access devices are supported by the FTM. One series is the FastPAD family of products. The FastPADs support Frame Relay, voice, and serial data. The other series is the Cisco line of access devices.

The Cisco Line of Access Devices for WAN Switches

An example of the Cisco line of access devices for the IGX WAN switches is the Cisco 3800 family of products. The Cisco access devices run the Cisco IOS (operating system) and have a control terminal separate from the node's control terminal. The access device itself takes IOS commands, but once a control session has been established, you control the interface between the node and the access device through StrataView Plus or by using commands on the command line interface (CLI). For descriptions of the CLI commands that apply to the FTM and connections to the Cisco access devices, refer to the *Cisco WAN Switching Command Reference*. Individual manuals also exist for the Cisco access devices. Currently, you can refer to the *Cisco Access Products 3800 Series Installation Guide* and the *Cisco 3800 Series Software Configuration Guide and Command Reference*.

For the Cisco access devices, you can add connections between the following endpoints.:

- FTM and FTM or FTC
- FTM and CVM or CDP
- FTM and FRM or FRP

Note that, when you add connections between a 3800 on an FRM to a CDP or CVM, you must add the connections at the CDP or CVM. The FTM and FRP or FRM endpoints, you can add connections at either end. For more information on setting up connections between the Cisco 3800 access devices and an FTM, FRP/FRM, or CVM, refer to the *Cisco IGX 8400 Series Installation* manual.

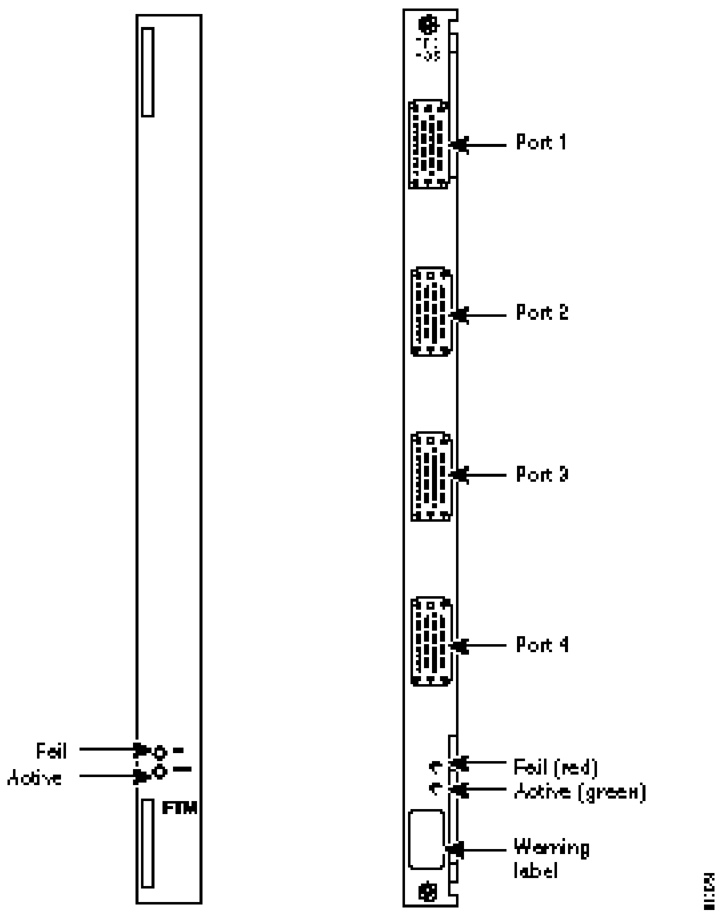
The FastPAD Line of Access Devices

The interface cards for FastPADs are the FTM front card and FPC back card. The back card provides either a T1, E1, V.35, or X.21 interface. Each FPC V.35 or FPC X.21 provides four ports. Each port can support one FastPAD either locally or remotely (via modem). The T1 card has a DB15 for RX/TX and an alternate pair of RX/TX BNC connectors. The E1 connections are the same except for additional RX/TX-monitoring BNC connectors. Y-cable redundancy is also supported.
Figure 4-51 shows the FTM front card and the FPC-V.35.

Note FTM front cards exist in two forms. One uses an ACM1 adaptor. The other is a single-card or "native" version. Functionally, they are identical and use the same firmware.

You enter commands that manage the FTM/FPC, FastPAD, and their ports and connections. StrataView Plus collects statistics related to cards, ports, and FastPADs. FTM/FPC card management includes detection of card installation or removal, mis-matched back cards, or Y-cable redundancy.

Figure 4-51 FastPAD Cards: FTM and FPC (V.35)



Port management includes EIA signaling, LMI alarms, upping and downing of ports, and the collection of port statistics available to StrataView Plus.

FastPAD management permits the management of cards and ports on the FastPAD device from the IGX node. This management includes card and card removal detection, card mismatch, uploads and downloads between the FastPAD and the IGX node.

Connection management involves mapping FastPAD connection to Frame Relay-type virtual circuits. Connections that originate at a FastPAD must terminate at another FastPAD. Each FTM/FPC card set supports up to 252 connections. The card set collects statistics on these connections and provides them to StrataView Plus. For descriptions of the FastPAD commands and detailed information on the FastPAD, refer to the *FastPAD User's Guide.* Refer also to the *StrataView FastPAD User's Guide.*

Data Cards

A data circuit has a direct interface to the IGX node through either a High-speed Data Module (HDM) or Low-speed Data Module (LDM) card set. The HDM set consists of an HDM front card and a Synchronous Data Interface (SDI) back card. The LDM set consists of an LDM front card and a Low-speed Data Interface (LDI) back card. The back cards match the circuit type to the front card. Synchronous data card sets are listed in Table 4-49. An IGX 8430 node can have up to 25 HDM/LDM sets in a non-redundant system, for support of up to 200 full-duplex data connections.

The synchronous data cards support the ability to configure and monitor EIA leads; the ability to configure each channel for clocking, data rate, and DTE or DCE interface type; and complete loopback testing capability. Data channels can support null modem emulation as well as constant-carrier and switched-carrier operation. Data interfaces are transparent with respect to protocol. Asynchronous, binary synchronous, and bit synchronous protocols are supported with no impact on host or terminal software.

Table 4-49 Synchronous Data Cards Available

Front Card	Back Card
HDM, High-speed Data Module	SDI, EIA/TIA-449 synchronous data interface (for X.21 or EIA/TIA-422).
	SDI, V.35 synchronous data interface.
	SDI, EIA/TIA-232D synchronous data interface.
	SDI, EIA/TIA-232C synchronous data interface (for V.24).
LDM, Low -speed Data Module	LDI, EIA/TIA-232C (V.24) four-port and eight-port low-speed data interface, non-interleaved EIA. 4-port models limited to 56 Kbps., 8-port models up to 19.2 Kbps.
	LDI, EIA/TIA-232D four-port and 8-port, low-speed data interface, up to 19.2 Kbps., non-interleaved EIA.

High-speed Data Module (HDM)

The HDM front card in an IGX node is a programmable communications processor that can support one to four high speed, synchronous data channels. It operates at speeds from 1.2 Kbps up to 1344 Kbps on all four ports while performing link error monitoring.

The HDM front data card:

- Performs cell adaptation
- Supports normal, looped, and split clocking
- Provides isochronous clocking circuitry
- Packetizes and depacketizes EIA lead sampling information
- Provides loopback capabilities, testing, and diagnostics

An internal baud rate generator provides transmit and receive data clocks to the SDI card at the selected rate. The HDM can accept data from an external data device with a non network synchronized clock (isochronous clock) up to 112 Kbps. With isochronous clocking, the HDM sends a clock control signal to the other end of the circuit to synchronize the far end HDM receive clock to the isochronous clock received at the near end.

Unless specified, a packet of data for EIA control lead information is built only at a very low rate or when a change of state is detected on one or more of the control leads. The data rate is specified as either “fast” or “not fast” (the default) by the **addcon** command for data connections. A fast EIA lead transmission can be specified in the software to send EIA control lead information in every FastPacket (interleaved EIA mode). This tightly couples the EIA lead states with the transmitted data but reduces the bandwidth efficiency.

The HDM card is installed in a front slot. An SDI back card plugs directly into the P2 connector of the front card. The SDI back card provides the proper data channel interface.

The faceplate of the HDM has message lights and buttons for loopback control and signal monitoring. The buttons relate to loopback testing or scrolling through the FastPacket data ports for a snapshot of selected data port conditions (indicated by Port, Port Under Test, loopback, and communication line state lights). Figure 4-52 illustrates and Table 4-50 lists the controls and indicators. When correlating the figure to the table, read from the top down.

Figure 4-52 HDM Controls and Indicators

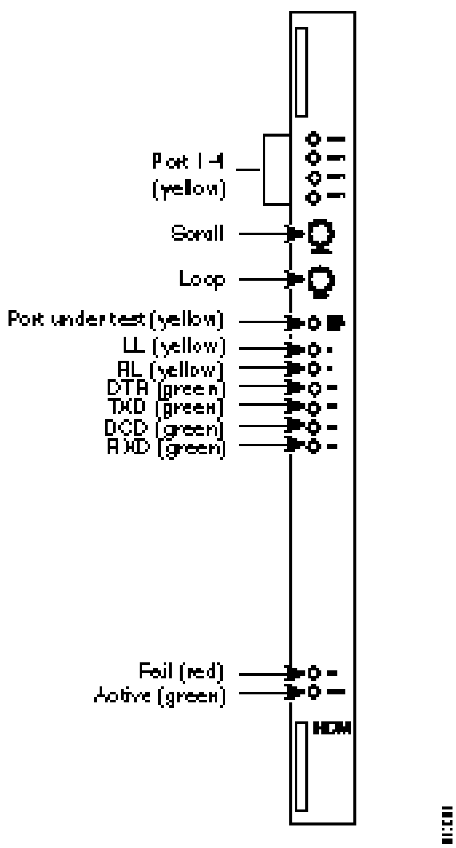
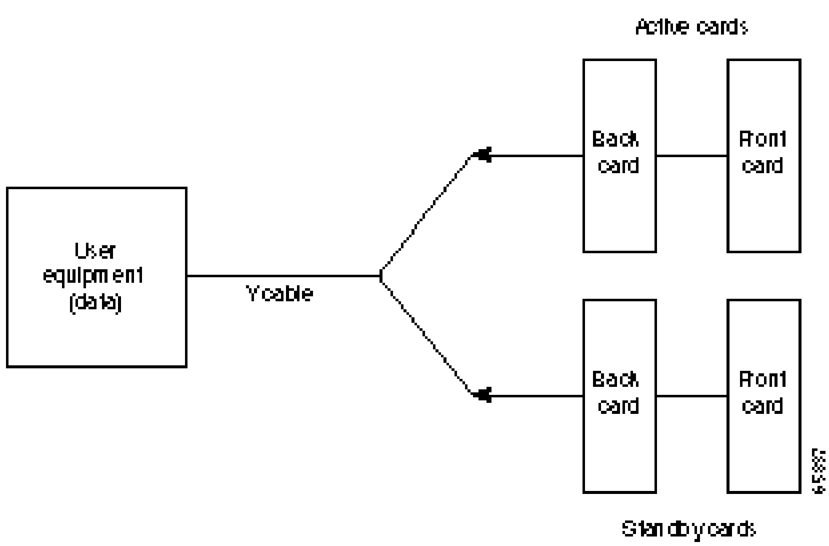


Table 4-50 HDM Controls and Indicators

Faceplate Item	Function
Port light (yellow)	Indicates which data port on the back card is currently monitored.
Scroll push-button	When pressed toggles through to the desired port. Information that is displayed by the remaining lights on the HDM faceplate applies to the port whose corresponding light is on.
Loopback push-button	When pressed, toggles through the three loopback states—no loopback, local loopback, and remote loopback—on the port whose corresponding light is on. You can disable this button by using the **cnffunc** command.
Port Under Test light (yellow)	Indicates one of the ports has gone into loopback mode. If this is not the current port, press the Scroll button to toggle in the port being tested.
LL light (yellow)	Indicates a local loopback is present on a port.
RL light (yellow)	Indicates a remote loopback is present on a port.
DTR light (green)	Indicates the Data Terminal Ready signal is ON at the selected port terminal.
TXD light (green)	Indicates that the Transmit Data signal is ON at the selected port terminal.
DCD light (green)	Indicates the Data Carrier Detect signal is ON at the selected port terminal.
RXD light (green)	Indicates that the Receive Data signal is ON at the selected port.
Fail light (red)	Indicates an error occurred. Reset the card with the **resetcd f** command. If the LED comes on again, call the Cisco TAC.
Active light (green)	Indicates that the card is active and functioning normally.

Redundancy for HDM data cards can be provided with a second front and back card set and a Y-cable connection on each port to the customer equipment. See Figure 4-53.

Figure 4-53 HDM Data Port Redundancy



Synchronous Data Interface Card (SDI)

The SDI card is a synchronous data interface back card that directly connects to a front HDM card. Each SDI card has four connectors and provides the physical and electrical connection interface to four data ports. Each port is independently configurable for DTE or DCE mode, baud rate, and so on. One for one port redundancy is provided with a second card set and a standard Y-cable arrangement.

The SDI card:

- Provides four ports for interfacing to the data equipment.
- Provides EIA control circuitry and samples EIA lead information.
- Performs serial to parallel conversion of data.
- Provides a jumper strap for configuring the ports as DTE or DCE.

Four types of SDI back cards can provide an interface between an HDM front card and the customer data equipment. Table 4-51 distinguishes each type of SDI card.

Table 4-51 SDI Physical Interfaces

Interface	Ports	Connector
EIA/TIA-232C/V.24	4 ports	DB25 Subminiature, female
EIA/TIA-232D/V.24	4 ports	DB25 Subminiature, female
EIA/TIA-449/X.21	4 ports	DB37 Subminiature, female
V.35	4 ports	34-pin MRAC type (Winchester), female

Three clocking modes are available on the SDI for clocking in transmit data and clocking out receive data. In addition, the SDI can operate as either a DCE or DTE, which makes possible six combinations of clocking. (See Figure 4-54 and Figure 4-55.) With loop clocking, the user device must loop the RxC to the XTC for clocking out the transmit data.

When the SDI is configured as DTE, the user device is the source of clock timing and is generally not synchronous with the network (IGX node) timing. This is *isochronous* clocking. Isochronous clocking allows the customer data sets at each end of a circuit to operate at slightly different rates (non-synchronously) with minimum delay and loss of data. This feature limits the amount of data allowed to accumulate in the HDM receive buffers and forces a re-synchronization before the delay reaches an unacceptable level.

Figure 4-54 Clocking Modes for SDI in DCE Mode

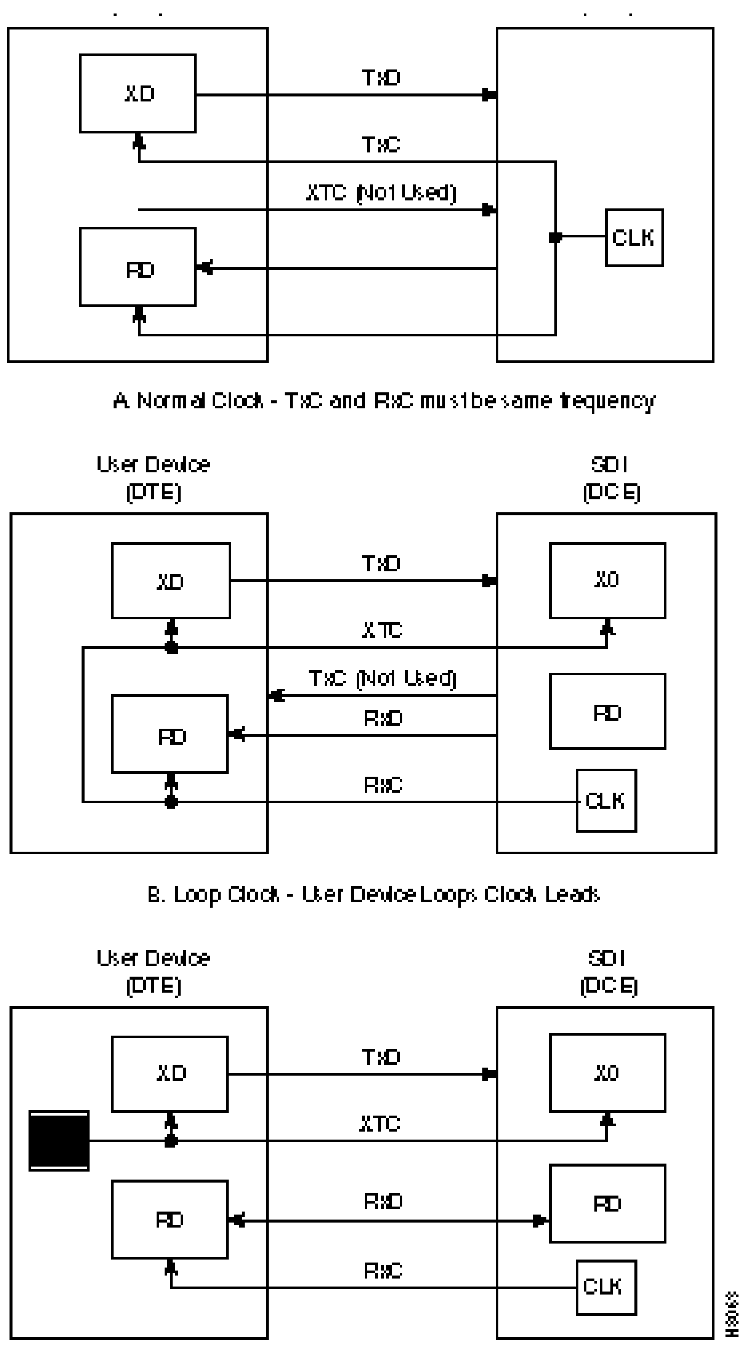
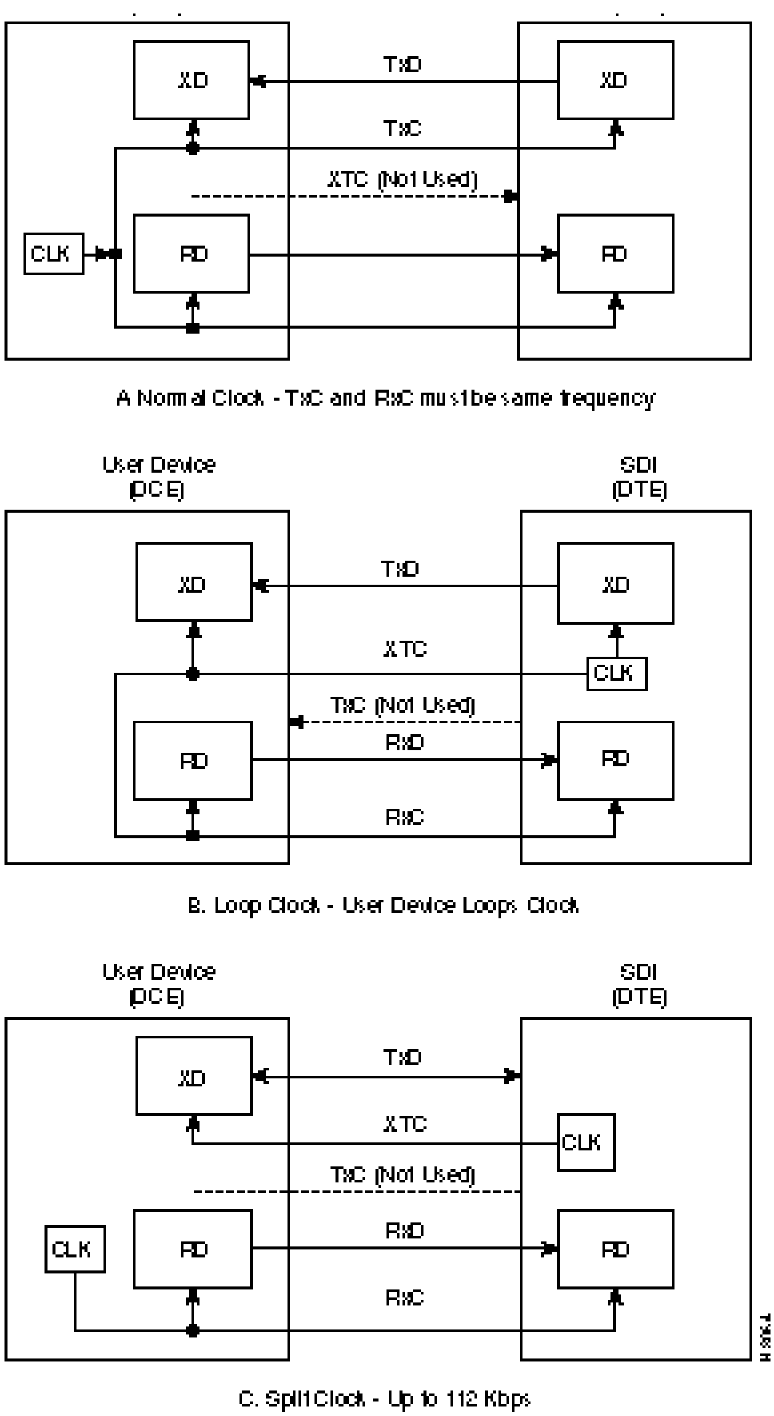


Figure 4-55 Clocking Modes for SDI in DTE Mode



Isochronous clocking lets a node at the far end compensate for an unstable clock in a near-end device. Transmission in an isochronous network is reliable up to 112 Kbps. Only one input per port at a time can use isochronous clocking. The SDI does not support two isochronous clock inputs in the same direction (as required by some modems that independently generate TxC and RxC).

Note The switch automatically uses isochronous mode when the DTE/DCE endpoints justify it.

Split clocking uses the user-device timing for timing data transmission in one direction and the IGX timing for the other direction.

Low Speed Data Module (LDM)

The LDM front card supports up to 8 synchronous or asynchronous data ports. Each port is independently configurable for DTE or DCE mode, baud rate, and so on. The LDM card is a low speed data module for use on EIA/TIA-232C ports with data rates up to 19.2 Kbps, where the higher speed capabilities of an HDM are unnecessary.

The LDM can process either synchronous or non-synchronous input data. With non-synchronous inputs, the data is over-sampled at a rate determined by how much jitter your equipment can tolerate. Using an external device is also possible for synchronizing the asynchronous data before the data enters the IGX node.

The LDM front data card:

- Performs cell adaptation of customer data and EIA control leads.
- Supports normal and looped clocking.
- Provides loopback capabilities, testing and diagnostics.

Additional features, such as embedded (fast) EIA, sixth EIA lead support, and pleisochronous clocking, are also supported. The fast EIA control lead lets the user include the RTS/CTS EIA control leads in the same FastPacket as customer data. The EIA control lead status is encoded as the eighth data bit in each data byte. This provides a quick EIA response without significantly affecting bandwidth requirements. It is limited to data rates of 19.2 Kbps and below.

The LDM can reside in any empty front slot and requires an LDI back card. The LDI card plugs directly into the P2 connector of the LDM card.

The faceplate of the LDM has message lights and buttons for loopback control and signal monitoring. Figure 4-56 shows and Table 4-52 lists these indicators and buttons. When correlating the figure to the table, read from the top down. The buttons are for loopback testing and scrolling through the FastPacket data ports to obtain a snapshot of selected port conditions (indicated by Port, Port Under Test, loopback, and communication line status lights).

Figure 4-56 LDM Connections and Indicators

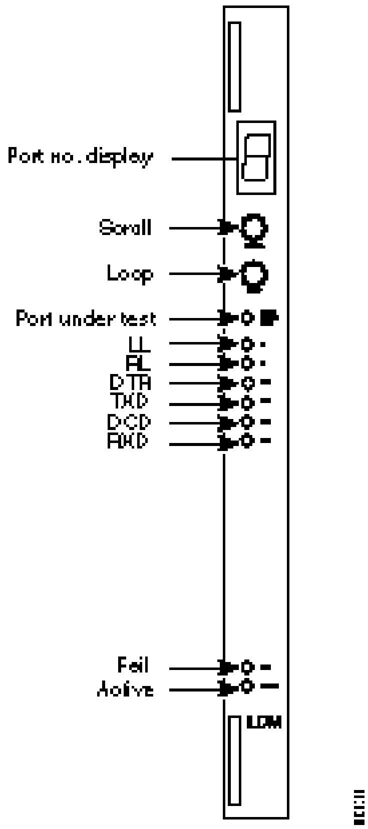
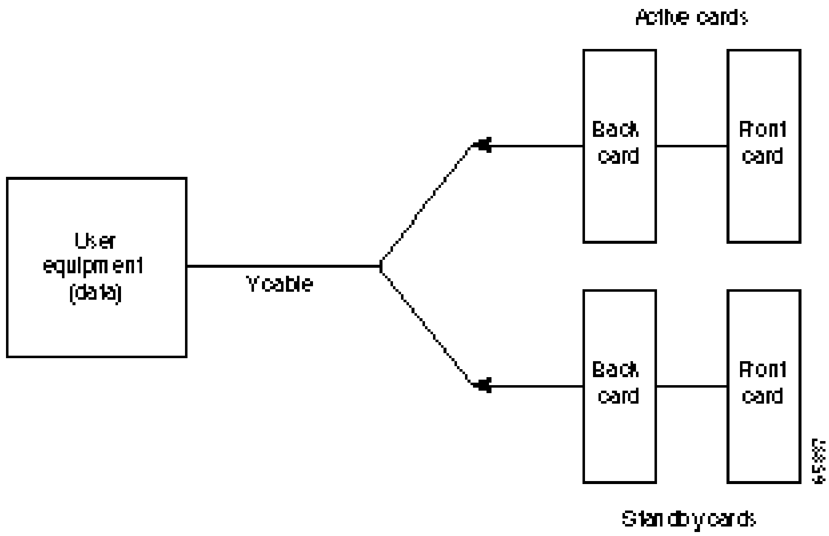


Table 4-52 LDM Connections and Indicators

Faceplate Item	Function
Port Readout Display	Indicates which FastPacket port (1–8) on the back card is currently viewed.
Scroll push-button	When pressed, toggles through the ports. Information displayed by other LEDs on the faceplate applies to the port shown by the 7-segment display.
Loopback push-button	When pressed, toggles through the three loopback states on the port whose light is on. These states are: no loopback, local loopback, remote loopback.
Port under test light (yellow)	Indicates that a port has gone into the loopback mode. If this is not the current port, push the Scroll button to toggle in the port being tested.
LL light (yellow)	Indicates that a local loopback is occurring on one of the ports.
RL light (yellow)	Indicates a remote loopback is occurring on one a port.
DTR light (green)	Indicates the Data Terminal Ready signal is ON at the selected port terminal.
TXD light (green)	Indicates the Transmit Data signal is ON at the selected port terminal.
DCD light (green)	Indicates the Data Carrier Detect signal is ON at the selected port terminal.
RXD light (green)	Indicates that the Receive Data signal is ON at the selected port.
Fail light (red)	Indicates an error occurred. Reset the card with the **resetcd f** command. If the LED comes on again, call the TAC.
Active light (green)	Indicates that the card is active and functioning normally.

Redundancy for LDM data card types is available through a second front and back card set and a Y-cable connection on each port to the customer data equipment. Figure 4-57 illustrates redundancy.

Figure 4-57 LDM Data Port Redundancy



The 4-port and 8-port LDM supports only a subset of the full EIA/TIA-232C/D control leads. The LDM supports only non-isochronous DCE normal and DCE or DTE looped clocking modes, transmission of 3 EIA lead states (non-interleaved), and baud rates of up to 19.2 Kbps on the 8-port version and 38.4 Kbps on the 4-port version. Split clock mode is not supported.

Low Speed Data Interface Card (LDI)

The Low-Speed Data Interface (LDI) card is a low-speed data interface back card that operates in conjunction with an LDM front card. The LDI provides the physical and electrical connection interface between the user low-speed data circuit and the LDM data PAD. Three models of the LDI exist. Two are four-port cards, and one is an eight-port card, as Table 4-53 indicates.

Some of the functions and features of the LDI are:

- Four or eight ports for interfacing to the data equipment
- Sampling of EIA lead status for the LDM to monitor
- Serial-to-parallel conversion of user data
- Support for DTE or DCE operation

Table 4-53 LDI Physical Interfaces

Card	Interface	Ports	Connector
LDI 4	EIA/TIA-232C/D (V.24)	4 ports	DB15 Subminiature, female
LDI 8	EIA/TIA-232C/D (V.24)	8 ports	DB15 Subminiature, female

The LDI can operate either as a DCE or DTE. Selection is made by using a Cisco DTE or DCE adapter cable between the port connector and the cable from the user device. This cable is terminated with a standard DB25 on the customer end. Each port is configured separately.

Three EIA control leads are brought out to the rear connectors, three when used as a DCE and three for DTE. Table 4-54 lists these leads.

Table 4-54 EIA Control Leads

Leads for DCE	Leads for DTE
RTS	CTS
DSR	DTR
DCD	RL

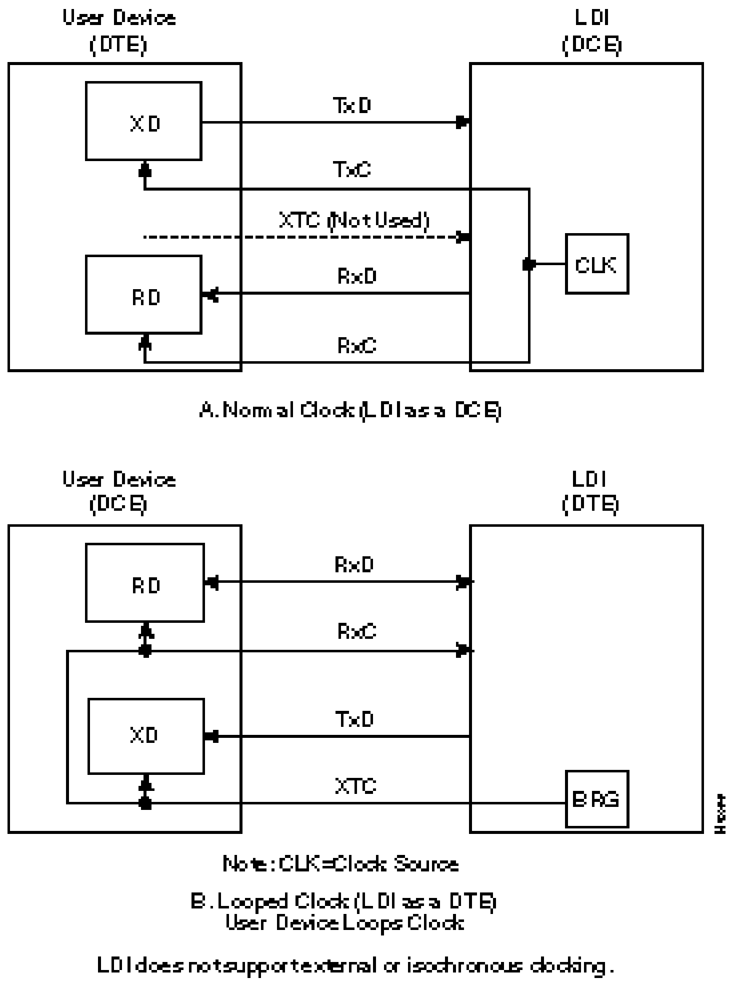
The RL lead allows the use of a previously unused DTE EIA output lead. You can use remote loopback (RL) to enable a far-end modem loopback. Local loopback (LL) is not provided as an output on the LDI. If local loopback is required, use the DTR lead by wiring it to the connector pin for local loopback.

The LDI supports two clocking modes: *normal* and *looped* (see Figure 4-58). The normal mode is used when the LDI port is configured as a DCE. Looped clock is only used when the LDI port is configured as a DTE. The user device must take the external transmit clock and loop it back to the RxC for clocking in the receive-data. In both cases, the LDI is the source of clock timing. Table 4-55 shows the accuracy and worst case jitter that can be expected from an end-to-end circuit using LDIs at each end.

Table 4-55 LDI Clocking Accuracy and Jitter Performance

Bit Rate	Accuracy	Worst-Case Jitter
1200	.06	.03
2400	.12	.06
4800	.24	.12
9600	.48	.23
14,400	.72	.35
19,200	.96	.47

Figure 4-58 LDI Clocking Modes



Optional Peripherals

At least one node in a network has a StrataView Plus terminal, a control terminal, or a dial-in modem connected to it. Any control terminal connected in the network can configure, manage, monitor, and diagnose the entire network. In addition, at least one node in a network may have a connected printer for error and event reports.

The control terminal and printer connect to two EIA/TIA-232 serial ports. These ports are the Control Terminal and Auxiliary Port on the SCM faceplate. These serial ports support all standard asynchronous data rates from 1200 to 19,200 baud. The default rate is 9600 baud. Data rates and the type of equipment connected to the ports are software-configurable.

Cisco recommends that at least one IGX in the network connects to a direct-dial modem so that TAC personnel can perform remote diagnostic tests. (Contact the TAC through Customer Engineering.) A direct-dial modem connects to the backplane at the Control Terminal port. In addition, an auto-dial modem can be connected to the AUX port connector on the SCM at any node in the network so that remote error messages and alarms can be sent to the Cisco TAC.

An external clock source can be connected to the SCM card using the external clock adapter cable. The external clock device can be either 1.544 MHz or 2.048 MHz EIA/TIA-422 square wave signals depending on the primary application of the IGX (T1 or E1). Selection is made through software.

The clock stability should be at least as good as a Stratum 3 clock source. The *Cisco IGX 8400 Series Installation* manual lists the terminals, printers, modems, and clock sources that have been tested and approved for use with an IGX switch.

System Specifications

This appendix contains system specifications for all models and communications types for the node.

General IGX 8410 Switch Specifications

This section provides general system information on the IGX 8410 node.

System Capacity:	1 shelf with 8 card slots. Has 2 dedicated front slots for NPMs. Has 2 dedicated back slots for SCMs (1 slot with blank plate). Up to 48 physical lines for UNI or NNI. Up to 32 physical lines for trunks.
Enclosure Size:	IGX 8410 Standalone/Rackmount: Height: 25 ins. (63.5 cm) standalone; 24.5 ins. (62.3 cm), rack Width: 19.9 ins. (50.5 cm), standalone; 19 ins. (48.3 cm.), rack Depth: 26.5 ins. (67.3 cm), standalone and rack-mount
Shipping Weight:	270 pounds (122.7 kilograms)
Clearance Requirement:	Min. clearance: 30 inches front; nominal 30 ins. rear; 12 ins. side.
Power Input Voltage:	AC system: Normal operating range is 100–240 VAC, 47 to 63 Hz. The (under and over-voltage limits are 90–264 VAC). DC system: –42 to –56 VDC. Each AC supply can provide up to 400 watts to the card shelves. Space is available for 4 power supplies.
Input AC Power Connector:	IEC 16 Amp input connector. 6 different power cords are available to comply with the standards of individual countries. Power cords are 6 feet (about 2 meters) long. See appendix titled Cabling Summary in the *Cisco IGX 8400 Series Installation* guide for details.
Current Requirements:	Configuration-dependent: use Network Design Tool for exact requirements. For planning purposes, use the following:
• AC System	10 Amps maximum for 110 VAC, 5 A for 220 VAC.
• DC System	20 Amps maximum at –48 VDC; 25 Amps at –42 VDC (worst case).

DC Input Connections:	3-wire pluggable terminal block with screw terminal connectors.
Operating Environment:	0° to 40° C (32° to 104° F) normal operation (50° C up to 72 hours). Maximum 85% relative humidity.
Shock:	Withstands 10 G, 10 ms. at 1/2 sine wave.
Vibration:	Withstands 1/4 G, 20–500 Hz.
Heat Transfer to Room:	IGX 8410: 2720 BTUs max.

General IGX 8420/8430 Switch Specifications

System Capacity:	1 or 2 shelves, each with 16 card slots. Requires 1 or 2 dedicated front slot(s) for NPMs. Requires 1 dedicated back slot for SCM. Up to 64 physical lines for UNI or NNI. Up to 32 physical lines trunks.
Enclosure Size:	IGX 8420 Standalone/Rackmount: HT: 32.25 ins. (82 cm.), standalone; 31.75 ins. (80.7 cm.), rack WD: 19.9 inches (50.5 cm), standalone; 19 inches (48.3 cm.), rack DP: 26.75 inches (68 cm), standalone; 26 inches (66 cm.), rack IGX 8430 Standalone/Rackmount: HT: 55.5 inches (141 cm.), standalone, 55 inches (139.7 cm) rack WD: 19.9 inches (50.5 cm), standalone; 19 inches (48.3 cm.), rack DP: 26.75 inches (68 cm), standalone; 26 inches (66 cm.), rack
Shipping Weight:	600 pounds (270 kilograms) for a fully loaded IGX 8430 enclosure. 400 pounds (180 kilograms) for a fully loaded IGX 8420 enclosure.
Clearance Requirement:	Min. 30 inches front and rear; nominal 12-inch side clearance.
Power Input Voltage:	AC system: Normal operating range is 200–240 VAC, 47 to 63 Hz. The under and over-voltage range is 180–264 VAC. DC system: –42 to –56 VDC. Each AC supply can provide up to 875 watts to a card shelf. Cabinet has space for 6 AC power supplies.
Current Requirements:	Configuration-dependent: use Network Design Tool for exact requirements. For planning purposes, use the following:
• AC System	IGX 8420/8430 node: 12 Amps at a nominal voltage of 200 VAC. At the under-voltage limit of 180 VAC, the current draw is a maximum of 16 Amps.
• DC System	IGX 8420 node: 24 Amps max. per circuit at –42 VDC (worst case) IGX 8430 node: 44 Amps at nominal –48 VDC; 50 Amps at –42 VDC maximum per circuit at –42 VDC.

Input AC Power Connector:	AC Power Distribution unit is the same for all cabinets: IEC 16 Amp input connector. Six different power cords available, depending on country of destination. See appendix titled "Cabling Summary," In the *Cisco IGX 8400 Series Installation* manual
DC Input Connections:	DC power is the same for all IGX 8420/8430 cabinets shipped. DC: 3-screw pluggable terminal connectors.
Operating Environment:	0° to 40° C (32° F to 104° F) normal operation (50° C or 122° F up to 72 hours). Maximum 85% relative humidity.
Shock:	Withstands 10 G, 10 ms. at 1/2 sine wave.
Vibration:	Withstands 1/4 G, 20–500 Hz.
Heat Transfer to Room:	IGX 8420 node: 4300 BTUs max, AC-powered system. 3600 BTUs in a DC-powered unit. IGX 8430 node: 8600 BTUs max, AC-powered system. 6800 BTUs in a DC-powered unit.

Voice Circuit Support

Voice Channel Interface:	24-channel T1 (D4 format). 24-channel T1-ESF. 30-channel framed CEPT E1.
Voice Compression:	32/24/16 Kbps ADPCM on the CVM 32/24/16 Kbps ADPCM 16 Kbps or 8 Kbps LDCELP (UVM only) Voice Activity Detection (VAD) compression
Compression Algorithm:	ITU-T G.721, G.723, G.726. Cisco 32 Kbps ADPCM Cisco LDCELP
PCM Encoding Types:	Accommodates µ-Law or A-Law encoding, End-to-end conversion available.
Channel Gain Control:	–8 dB to +6 dB.
Signaling Modes:	T1: Robbed bit or CCS (ISDN). E1 and J1: Channel Associative Signaling (CAS) or Common Channel Signaling (CCS).
Signaling Conditioning:	Various make-busy and forced-idle routines during circuit alarm, configurable on a per-channel basis.
Quantizing Distortion Added:	2.5 Quantizing Distortion Units (QDU)s with 32 Kbps ADPCM over 1 hop plus 0.7 QDUs with Digital Loss PAD (µ-law or A-Law).
Nominal Transmission Loss:	0 dB at 1 Khz.

Data Channel Support

Sync. Data Interfaces:	EIA/TIA-232C/D, EIA/TIA-449/422, V.24, X.21, and V.35 with IGX switch as DCE or DTE.
High-Speed Data Rates (HDM):	2.4 Kbps to 1.344 Mbps.
Low-Speed Data Rates:	2.4 to 19.2 Kbps per LDM port.
Ports per card:	LDI: 4 or 8. SDI: 4.
Control Leads Supported:	SDI: Per interface standards. SDI: Up to 7 in each direction for fast EIA. LDI: 3 in each direction for DCE and DTE for each port.
Control Lead Sync w/Data:	Control leads are sampled every 50 ms. A change normally follows data within 100 to 1000 msec. Fast EIA lead is within 1 byte.
Data Clocking:	Synchronous and isochronous clocking. Normal, looped, and split clock configurations.
Pleisochronous Clock Range:	± 2 percent of nominal data rate.

OC-3 (STM1) on UXM

Line Rate:	155.52 Mbps	
Line Code:	NRZ	
Signal Level:	Max	Min
MMF TX	–8 dBm	–15 dBm
MMF RX	–8 dBm	–28 dBm
SMF TX	0 dBm	–5 dBM
SMF RX	–10 dBm	–34 dBm
Framing Format:	STS-3c, STM1	
Port Interface:	LMI, ILMI	
ATM Cell Rate:	353,208 cells/sec.	
Jitter:	< 0.01 UI p-p, < 0.1 UI rms	
ATM Layer Protocol:	LMI, ILMI	
Port Alarm Processing:	LOS, LOF, LOP, Path AIS, Path Yellow	
Line Errors Counted:	Section BIP8, Line BIP24, Line FEBE, Path BIP8, Path FEBE	
Connector:	MMF SC SMF SC-PC	
Maximum Cable Lengths:	MMF ~ 2 KM KM SMF IR ~20	
Indicators:	Card status Port status	

T1 Interface on Frame Relay Interface (FRI) Back Card

Line Rate:	1.544 Mbps, ± 50 bps (± 200 bps VCO lock range).
Line Code:	Bipolar AMI or B8ZS.
Framing Formats:	Fractional T1, adjacent or alternating channels. Minimum of four DS0 channels required.
Signal Level:	DSX-1 compatible.
Line Impedance:	Terminated=100 Ohms nominal. Bridged=1 KOhm.
Pulse Amplitude	Individual pulse amplitude 2.4 V–3.6 V (making a total base-to-peak amplitude of 6 V ± 0.6V)
Minimum Pulse Density:	Zero code suppression, either LSB, MSB or B8ZS.
Frame Format:	D4 and Extended Superframe (ESF).
VF Signaling:	Robbed bit D4 with A and B bits.
Max. Line Lengths:	Up to 533 feet with equalizers using ABAM cable.
Jitter Transfer:	Meets AT&T PUB 62411 specifications.
Jitter Tolerance:	Meets ANSI standards and AT&T PUB 62411 specifications.
Connector:	DB 15 female.

T1 Interface on UFI-8T1

The following applies to each individual T1 line on the UFI-8T1:

Line Rate:	1.544 Mbps, ± 50 bps (± 200 bps VCO lock range).
Line Framing:	ESF per AT&T TR 54016.
Frame Relay Interface:	Meets ANSI T1.618, two-octet header.
Frame Relay Interface Rates:	Either 56 Kbps or n x 64 Kbps, where 1<=*n*<=24. Sum of all *n*<=24.
Number of Frame Relay Interfaces:	1–24 occupied channels where 1<= *n*<= 24, and the sum of all *n*<=24.
Synchronization:	Transmitter can be either loop-timed to receiver or synchronized to shelf (*normal mode*).
Line Code:	Bipolar AMI or B8ZS.
Framing Formats:	Fractional T1, contiguous DS0s/timeslots. Minimum of four DS0 channels required.
Signal Level:	DSX-1 compatible.
Line Impedance:	Terminated=100 Ohms nominal. Bridged=1 KOhm.
Pulse Amplitude:	Individual pulse amplitude 2.4 V–3.6 V (making a total base-to-peak amplitude of 6 V ± 0.6V).
Minimum Pulse Density:	Zero code suppression, either LSB, MSB or B8ZS.
VF Signaling:	Robbed bit D4 with A and B bits.
Max. Line Lengths:	Up to 533 feet with equalizers using ABAM cable.
Input Jitter Tolerance:	Meets AT&T PUB 62411 specifications.
Output Jitter Tolerance:	Meets AT&T PUB 62411 specifications using normal mode synchronization.
Connector:	DB 15 female.

E1 Interface on BC-E1

Line Rate:	2.048 Mbps, ± 50 ppm (± 200 bps VCO lock range)
Line Code:	Bipolar AMI or HDB3
Line Impedance:	120 Ohms (balanced) or 75 Ohms (balanced or unbalanced)
Minimum Pulse Density:	Zero code suppression via HDB3 coding
Frame Format:	Unframed, 32-channel (G.703). Framed: 30 or 31-channel CEPT multiframe per ITU-T G.704.
VF Signaling:	CAS or CCS
Max. Line Lengths:	100 meters. The E1 output complies with G.703, so cabling must not exceed –6dB/1000 feet at 1024 kHz (applies to 75 Ohm coax or 120 Ohm twisted pair up to 350 meters or 1000 feet). Cisco supplies cable with a maximum attenuation of 7 dB /1000 ft., but the maximum cable length for this E1 interface is 100 meters.
Jitter:	Transmit output jitter, receive jitter tolerance, and jitter gain meet G.823.
Electrical Interface:	Complies with G.703 Specification.
Connector:	DB 15 female or BNC.

E1 Interface for UFI-8E1

The following applies to each individual E1 line on the UFI-8E1:

Line Interface Connector:	DB15 (120 Ohms), BNC (75 Ohms)
Line Rate:	2.048 Mbps, ±50 bps (±200 bps VCO lock range).
Frame Relay Interface:	Meets ANSI T1.618, two-octet header.
Number of Frame Relay Interfaces:	1–31 occupied channels where 1 <= n <= 31, and the sum of all n <= 31
Frame Relay Interface Rate:	Either 56 Kbps or n x 64 Kbps, where 1 <= n <= 31. Sum of all n <= 31.
Line Code:	Bipolar AMI or HDB3.
Line Impedance:	120 ohms (balanced) or 75 ohms, balanced or unbalanced.
Minimum Pulse Density:	Zero code suppression via HDB3 coding.
Frame Format:	Unframed, 32-channel (G.703). Framed: 30 or 31-channel CEPT multiframe per ITU-T G.704.
VF Signaling:	CAS or CCS.
Max. Line Lengths:	E1 output complies with G.703, so cabling must not exceed -6dB/1000 feet at 1024 kHz (applies to 75 ohm coax or 120 ohm twisted pair up to 350 meters or 1000 feet).
Input Jitter Tolerance:	Meets G.823.
Output Jitter Tolerance:	Meets G.823.
Electrical Interface:	Complies with G.703 Specification.
Connector:	Back card has either all DB15 female or all BNC connectors.

E2 Interface on BTM

Required Hardware:	AIT front card in an IPX node, BTM front card in an IGX node. The back card is the AIT-E2
Line Rate:	8.448 Mbps
Line Coding:	HDB3.
Cell Delineation:	HEC
Physical Medium;	Coaxial
Line Length:	50 feet maximum; 6 feet nominal
Connector:	BNC, 75 Ohms.
Synchronization:	Master/slave (NOTE: loop timing to IPX or IGX node is allowed.)
Interfaces per card:	One
Applicable Standards:	E2 specification and G.703.

HSSI Interface on BTM

Required Hardware:	AIT front card on the IPX or BTM front card on the IGX node. The back card is the AIT-HSSI.
Line Rate:	Pre-setable and programmable for the range 4–50.84 Mbps: increments depend on the attached DSU.
Line Coding:	NRZ.
Cell Delineation:	PLCP
Physical Medium:	Multi-conductor, 25 twisted pairs in a ribbon cable, 110 Ohms.
Line Length:	50 feet maximum; 6 feet nominal
Connector:	50-pin, 50 mil SCSI type.
Synchronization:	None—accepts DSU clocks
Interfaces per card:	Single port.
Applicable Standards:	High Speed Serial Interface specification, March, 1990
	I.432, G.804.

T3 Interface on BC-UAI-1T3

Line Rate:	44.736 Mbps ± 20 ppm, asynchronous.
Line Code:	B3ZS.
Clock Source Mode:	Internal (Asynchronous).
Signal Level:	DSX-3.
Framing Formats:	M13 mode, C-bit parity.
Alarms Processed:	AIS. LOS. Remote Alarm Indication. Loss Of Framing.
Line Errors Counted:	BPV. Parity Bit Errors.
Receiver Input Impedance:	Terminated=75 ohms.
Transmission Modes:	Point-to-Point ~~or Drop and Insert~~.
Jitter:	Meets ACCUNET T45 specification (Pub 54014).
Connector:	75 ohm BNC.
Max. Line Lengths:	450 ft. (137 m.) to DSX-3 using 75 Ohm coaxial cable.
Indicators:	RED Alarm. YELLOW Alarm. LOS. AIS.

E3 Interface BC-UAI-1E3

Line Rate:	34.368 Mbps ± 20 ppm, asynchronous.
Line Code:	HDB3.
Clock Source Mode:	Internal (Asynchronous).
Signal Level:	ITU-T G.703
Framing Formats:	ITU-T G.804, G.832,
Alarms Processed:	AIS. LOS. Remote Alarm Indication. Loss Of Framing.
Line Errors Counted:	BPV. Parity Bit Errors.
Receiver Input Impedance:	75 ohms unbalanced.
Transmission Modes:	Point-to-Point. ~~or Drop and Insert.~~
Jitter:	per ITU-T G.823.
Connector:	75 ohm BNC.
Maximum Line Lengths:	137 meters (450 ft.) using specified cable.
Indicators:	RED Alarm. YELLOW Alarm. LOS. AIS.

J1 Interface on the BC-UVI-2J1EC

Line Rate:	2.048 Mbps, ± 50 ppm (± 200 bps VCO lock range)
Line Code:	Bipolar CMI
Line Impedance:	120 Ohms (balanced)
Frame Format:	Per JJ-20.11
VF Signaling:	CAS or CCS
Max. Line Lengths:	100 meters. Cisco supplies cable with a maximum attenuation of 7 dB /1000 ft., but the maximum cable length recommended for this J1 interface is 100 meters.
Jitter:	Transmit output jitter, receive jitter tolerance, and jitter gain meet G.823.
Electrical Interface:	Complies with G.703 Specification.
Connector:	Two DB 15, female.

J1 Interface on the BC-J1

Line Rate:	2.048 Mbps, ± 50 ppm (± 200 bps VCO lock range)
Line Code:	Bipolar CMI
Line Impedance:	120 Ohms (balanced) or 75 Ohms (balanced or unbalanced)
Frame Format:	Per JJ-20.11
VF Signaling:	CAS or CCS
Max. Line Lengths:	100 meters. Cisco supplies cable with a maximum attenuation of 7 dB /1000 ft., but the maximum cable length recommended for this J1 interface is 100 meters.
Jitter:	Transmit output jitter, receive jitter tolerance, and jitter gain meet G.823.
Electrical Interface:	Complies with G.703 Specification.
Connector:	DB 15 female or BNC.

Frame Relay Interface for the FRM Front Card

Type of Service:	Permanent Virtual Circuit (PVC).
Data Interface:	Per ITU-T I.122 and ANSI T1/S1 Standards.
Data Transfer Protocol:	LAP-D frame level core functions.
Input Data Format:	High Level Data Link (HDLC) protocol.
Input Data Frame Length:	Up to 4096 bytes.
Frame Integrity Check:	Frame Check Sequence and CRC check of data frame. If CRC fails, data frame is discarded at receiving node.
Input Data Rate:	56 Kbps–2.048 Mbps. The maximum rate is available with only one of four ports on the back card active).
Ports per Card:	4 Model D 31 Model E
PVCs per Port:	252 per FRM card, distributed in any combination.
Port Electrical Interface:	ITU-T V.35. IGX node and X.21 can be DCE or DTE for direction of control leads and timing on Model D and E using E1 or T1.
Data Clocking:	Normal or looped.
Virtual Circuit Identifier:	Data Link Connection Identifier (DLCI).
Control Protocol:	Local Management Interface with XON/XOFF type flow control. The IGX node sets FECN and BECN bits in frame relay frame.
Bundled Connections:	252 virtual circuits per card 1024 virtual circuits per node.
Billing Time Accuracy:	Upon request from a user-device, the IGX node provides GMT from any node accurate to within 1 second.

ATM Interface

Type of Service:	Permanent Virtual Circuit (PVC)
Interface Types:	User-to-Network (UNI) and Network-to-Network (NNI) per ITU I.361 and I.363
Data Rates:	T1, E1, T3, E3, OC3 (STM1)
ATM Layer:	Physical Layer Convergence Protocol per AT&T publication TA-TSY-00772 and 000773 for T3; ITU I-361 with HEC for E3
Cell Rate:	96,000 cells/sec. for T3, 80,000 cells/sec. for E3
Adaptation Layer:	AAL5
Number of PVCs per card:	255
VPI Addressing Range:	0–255
VCI Addressing Range:	0–65535
Traffic Queues:	CBR, VBR, and ABR
Management Protocol:	Layer Management Interface (LMI) and Interim Layer Management Interface (ILMI)

Network Synchronization

External Clock Sources:	The IGX switch synchronizes to the nearest, highest-stratm clock available. Any T1, E1, T3, E3, OC3 (STM1) line, trunk, or optional external clock input can serve a clock source.
Internal to Node Source:	T1: 1.544 MHz, ± 10 ppm. (Stratum 4). E1: 2.048 MHz, ± 10 ppm (Stratum 4).
Clocking Hierarchy:	Dynamic primary, secondary, and tertiary clocking.

Network Management Control

Network Control Terminal:	StrataView Plus workstation and Cisco software required for graphical display of network status, statistics gathering and display, and automatic downloading of software.
Control Terminal:	DEC VT100, WYSE 85, Televideo 970 or equivalent terminal for basic system configuring and alarm monitoring.
Remote Alarm Reporting:	Auto-dial modem connects to one of two control ports on each IGX node for automatic reporting of network alarms.
Remote Diagnostics:	Auto-answer modem connects to one of two control ports on each IGX node for remote diagnostic access by Cisco TAC or other authorized personnel.

Network Control Ports:	Two ports per node, (one EIA/TIA 232C interface and one Ethernet LAN port).
Alarm Notification:	Status of all trunks and nodes in network distributed to and stored by each individual node. Reported to StrataView Plus workstation at connecting node.
External Alarms:	Meets Bellcore Compatibility Bulletin #143 and AT&T Technical Reference PUB 43801 DS1 (T1) facility alarm requirements when equipped with DTI group.
Indicators and Controls:	Active and Fail lights on all cards and power supplies.

Numerics

A

B

C

D

T

U

V

W

X

Y

Z