



IOT Interface Modules Configuration Guide, Cisco IOS XE 17 (Cisco ASR 900 Series)

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CHAPTER 1

Feature History

The following table lists the new and modified features supported in the IOT Serial Controller Configuration Guide in Cisco IOS XE 17 releases.

Feature	Description
Cisco IOS XE Cupertino 17.9.1	
Hitless Switching on C37.94 Interface Module	Hitless switching protection describes the ability to switch between the active and backup paths without losing packets when an active path fails. This feature ensures uninterrupted continuous service and maintains an extremely high-reliability rating.
Cisco IOS XE Bengaluru 17.4.1	
Support for A900-IMA6EM and A900-IMA4C3794 on A900-RSP3C-400-S and Cisco A900-RSP3C-200	This feature supports A900-IMA6EM and A900-IMA4C3794 interface modules on the Cisco A900-RSP3C-400, and on slot 4 on Cisco A900-RSP3C-200.



CHAPTER 2

E and M Signals over MPLS

This chapter provides information about peer-to-peer transport of receive and transmit (E and M) signals and voice data over MPLS on the Cisco ASR 903 Router.

Table 1: Feature History

Feature Name	Release Information	Feature Description
Support for A900-IMA6EM and A900-IMA4C3794 on A900-RSP3C-400-S and Cisco A900-RSP3C-200	Cisco IOS XE Bengaluru 17.4.1	This feature supports A900-IMA6EM and A900-IMA4C3794 interface modules on the Cisco A900-RSP3C-400, and on slot 4 on Cisco A900-RSP3C-200.

E and M signals and voice data over MPLS are supported on the RSP2 module of the Cisco ASR 902 and ASR 903 routers, on the Cisco A900-RSP3C-400, and only on slot 4 on Cisco A900-RSP3C-200.

- [E and M Signaling Overview, on page 3](#)
- [Restrictions, on page 4](#)
- [Information About Voice Port Configuration, on page 4](#)
- [How to Configure Analog Voice Ports, on page 8](#)
- [Configuration Examples for E and M, on page 11](#)
- [Verifying E & M Configuration, on page 11](#)
- [Additional References for Configuring E and M Signals , on page 13](#)

E and M Signaling Overview

E and M signaling defines a trunk circuit side and a signaling unit side for each connection similar to the data circuit-terminating equipment (DCE) and data terminal equipment (DTE) reference type. The analog E and M interface functions as the signaling unit side and it expects the other side to be a trunk circuit.



Note E and M controller indexes are populated in IfTable, the IfTable is defined in IF-MIB.

Restrictions

- E&M Interface Type IV is not supported on Cisco gateways.
- E&M modules only support CAS in-band signaling.
- E&M controller index in the IfTable does *not* provide the information of the following:
 - Maximum Transmit Unit (MTU)
 - Counters
- The ports 0, 1, 2, and 3 can be configured either in voice or Transmission Only (TO) mode. The combination of voice and TO mode for these set of ports is not supported.
- The ports 4 and 5 can be configured either in voice or TO mode. The combination of voice and TO mode for these set of ports is not supported.

Information About Voice Port Configuration

The following section provides an overview of voice port configuration.

Voice Port Configuration Overview

Voice ports are found at the intersections of packet-based networks and traditional telephony networks, and they facilitate the passing of voice and call signals between the two networks. Physically, voice ports connect a router or access server to a line from a circuit-switched telephony device in a PBX or the PSTN.

Basic software configuration for voice ports describes the type of connection being made and the type of signaling to take place over this connection. In addition to the commands for basic configuration, there are also commands that provide fine-tuning for voice quality, enable special features, and specify parameters to match those of proprietary PBXs.

Voice ports on routers and access servers emulate physical telephony switch connections so that voice calls and their associated signaling can be transferred intact between a packet network and a circuit-switched network or device. For a voice call to occur, certain information must be passed between the telephony devices at either end of the call. This information is referred to as signaling. The devices at both ends of the call segment must use the same type of signaling.

The devices in the packet network must be configured to convey signaling information in a way that the circuit-switched network can understand. The devices must also be able to understand signaling information received from the circuit-switched network.

Telephony Signaling Interfaces

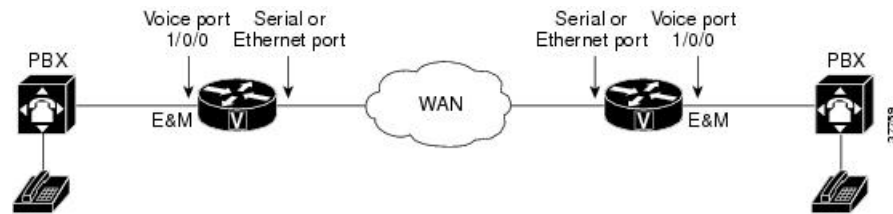
Voice ports on routers and access servers physically connect the router or access server to telephony devices such as telephones, fax machines, PBXs, and PSTN central office (CO) switches. These devices may use any of several types of signaling interfaces to generate information about on-hook status, ringing, and line seizure.

The router's voice-port hardware and software need to be configured to transmit and receive the same type of signaling being used by the device with which they are interfacing so that calls can be exchanged smoothly between the packet network and the circuit-switched network.

The signaling interface discussed in this document is receive and transmit (E&M), which is the type of analog interface. Some digital connections emulate E&M interfaces. It is important to know which signaling method the telephony side of the connection is using, and to match the router configuration and voice interface hardware to that signaling method.

In the following example, two PBXs are connected across a WAN by E&M interfaces. This illustrates the path over a WAN between two geographically separated offices in the same company.

Figure 1: E and M Signaling Interfaces



E and M Interfaces

Trunk circuits connect telephone switches to one another; they do not connect end-user equipment to the network. The most common form of analog trunk circuit is the E&M interface, which uses special signaling paths that are separate from the trunk's audio path to convey information about the calls. The signaling paths are known as the *E-lead* and the *M-lead*. The name *E&M* is thought to derive from the phrase *Ear and Mouth* or *rEceive and transMit* although it could also come from *Earth and Magnet*. The history of these names dates back to the days of telegraphy, when the CO side had a key that grounded the E circuit, and the other side had a sounder with an electromagnet attached to a battery. Descriptions such as *Ear* and *Mouth* were adopted to help field personnel determine the direction of a signal in a wire. E&M connections from routers to telephone switches or to PBXs are preferable to FXS/FXO connections because E&M provides better answer and disconnect supervision.

Like a serial port, an E&M interface has a data terminal equipment/data communications equipment (DTE/DCE) type of reference. In telecommunications, the *trunking* side is similar to the DCE, and is usually associated with CO functionality. The router acts as this side of the interface. The other side is referred to as the *signaling* side, like a DTE, and is usually a device such as a PBX. Five distinct physical configurations for the signaling part of the interface (Types I-V) use different methods to signal on-hook/off-hook status, as shown in the table below. Cisco voice implementation supports E&M Types I, II, III, and V.

Table 2: EandM Wiring and Signaling Methods

E&M Type	E-Lead Configuration	M-Lead Configuration	Signal Battery Lead Configuration	Signal Ground Lead Configuration
I	Output, relay to ground	Input, referenced to ground	--	--
II	Output, relay to SG	Input, referenced to ground	Feed for M, connected to -48V	Return for E, galvanically isolated from ground

E&M Type	E-Lead Configuration	M-Lead Configuration	Signal Battery Lead Configuration	Signal Ground Lead Configuration
III	Output, relay to ground	Input, referenced to ground	Connected to -48V	Connected to ground
V	Output, relay to ground	Input, referenced to -48V	--	--

The physical E&M interface is an RJ-48 connector that connects to PBX trunk lines, which are classified as either two-wire or four-wire. This refers to whether the audio path is full duplex on one pair of wires (two-wire) or on two pair of wires (four-wire). A connection may be called a four-wire E&M circuit although it actually has six to eight physical wires. It is an analog connection although an analog E&M circuit may be emulated on a digital line.

PBXs built by different manufacturers can indicate on-hook/off-hook status and telephone line seizure on the E&M interface by using any of the following three types of access signaling:

- Immediate-start is the simplest method of E&M access signaling. The calling side seizes the line by going off-hook on its E-lead and sends address information as dual-tone multifrequency (DTMF) digits following a short, fixed-length pause.
- Wink-start is the most commonly used method for E&M access signaling, and is the default for E&M voice ports. Wink-start was developed to minimize glare, a condition found in immediate-start E&M, in which both ends attempt to seize a trunk at the same time. In wink-start, the calling side seizes the line by going off-hook on its E-lead, then waits for a short temporary off-hook pulse, or "wink," from the other end on its M-lead before sending address information. The switch interprets the pulse as an indication to proceed and then sends the dialed digits as DTMF or dialed pulses.
- In delay-dial signaling, the calling station seizes the line by going off-hook on its E-lead. After a timed interval, the calling side looks at the status of the called side. If the called side is on-hook, the calling side starts sending information as DTMF digits; otherwise, the calling side waits until the called side goes on-hook and then starts sending address information.

E and M Interface Transmission Only

In Transmission Only (TO) mode configuration, CESoP is configured without CAS support to transport voice data using T1/E1CESoP PW. Field Programmable Gate Arrays (FPGA) configures the port to Transmission Only and port is always on off-hook mode.

In this mode, signaling is not expected to provide through router.

E and M Signaling

Start dial supervision is the line protocol that defines how the equipment seizes the E&M trunk and passes the address signaling information such as dual tone multifrequency (DTMF) digits. There are three main techniques used for E&M start dial signaling:

- Immediate Start—This is the most basic protocol. In this technique, the originating switch goes off-hook, waits for a finite period of time (for example, 200 ms), then sends the dial digits to the far end.
- Wink Start—Wink is the most commonly used protocol. In this technique, the originating switch goes off-hook, waits for a temporary off-hook pulse from the other end (which is interpreted as an indication to proceed), then sends the dial digits.

- Delay Dial—In this technique, the originating side goes off-hook and waits for about 200 ms, then checks to see if the far end is on-hook. If the far end is on-hook, it then outputs dial digits. If the far end is off-hook, it waits until it goes on-hook, then outputs dial digits.

Codec Complexity for Analog Voice Ports

The term *codec* stands for *coder-decoder*. A codec is a particular method of transforming analog voice into a digital bit stream (and vice versa) and also refers to the type of compression used. Several different codecs have been developed to perform these functions, and each one is known by the number of the International Telecommunication Union-Telecommunication Standardization Sector (ITU-T) standard in which it is defined. The various codecs use different algorithms to encode analog voice into digital bit-streams and have different bit rates, frame sizes, and coding delays associated with them. The codecs also differ in the type of perceived voice quality they achieve.

Select the same type of codec as the one that is used at the other end of the call. For instance, if a call was coded with a G.711 codec, it must be decoded with a G.711 codec.

Circuit Emulation Service Overview

Circuit Emulation (CEM) is a technology that provides a protocol-independent transport over IP Networks. It enables proprietary or legacy applications to be carried transparently to the destination, similar to a leased line.

The Cisco ASR 903 Series Router E & M IM supports pseudowire types that utilize CEM transport, Circuit Emulation Service over Packet-Switched Network in T1 and E1 modes to transport Analog Signals and Voice traffic over MPLS.

The voice port interfaces that connect the router or access server to E & M lines pass voice data and signaling between the packet network and the Analog-circuit-switched network.

For more information about the Circuit Emulation Service over Packet-Switched Network on Cisco ASR 903 Series Router, see Chapter 16 Configuring Pseudowire.

CAS Overview

Channel Associated Signaling (CAS) is also referred to as Robbed Bit Signaling. In this type of signaling, the least significant bit of information in a T1 signal is "robbed" from the channels that carry voice and is used to transmit framing and clocking information. This is sometimes called "in-band" signaling. CAS is a method of signaling each traffic channel rather than having a dedicated signaling channel (like ISDN). In other words, the signaling for a particular traffic circuit is permanently associated with that circuit. The most common forms of CAS signaling are loop-start, ground-start, Equal Access North American (EANA), and E&M. In addition to receiving and placing calls, CAS signaling also processes the receipt of Dialed Number Identification Service (DNIS) and Automatic Number Identification (ANI) information, which is used to support authentication and other functions.

Each T1 channel carries a sequence of frames. These frames consist of 192 bits and an additional bit designated as the framing bit, for a total of 193 bits per frame. Super Frame (SF) groups twelve of these 193-bit frames together and designates the framing bits of the even-numbered frames as signaling bits. CAS looks specifically at every sixth frame for the time slot's or channel's associated signaling information. These bits are commonly referred to as A- and B-bits. Extended Super Frame (ESF), due to grouping the frames in sets of twenty-four,

has four signaling bits per channel or time slot. These occur in frames 6, 12, 18, and 24 and are called the A-, B-, C-, and D-bits respectively.

The biggest disadvantage of CAS signaling is its use of user bandwidth in order to perform signaling functions.

Ear and Mouth Type Transmission Only

The Ear and Mouth (ENM) TO mode configuration supports CESoP without CAS configuration to transport data using T1 or E1 CESoP pseudowire. The CESoP is configured without signaling.

How to Configure Analog Voice Ports

Configuring CEM Group and Parameters on Analog E and M Voice Ports

Perform this task to configure cem group and basic parameters:

Procedure

Step 1 **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **configure terminal**

Example:

```
Router# configure terminal
```

Enters global configuration mode.

Step 3 **controller voice-port slot / subslot / port**

Example:

```
voice-port slot/subslot/port
```

Example:

```
Router(config)# controller voice-port 1/0/0
```

Enters voice-port configuration mode.

Note The **show voice port summary** command enters into the controller for further parameter configuration.

Step 4 **cem-group group-number timeslots timeslot**

Example:

```
Router(config-controller)# cem-group 0 timeslots 1
```

Configures cem-group with group number 0 in CESoP with speed (DS0).

Note The group number is always 0. The timeslot is always 1.

Step 5 **compand-type** *a-law* | *u-law*

Example:

```
Router(config-controller)# compand-type u-law|a-law
```

Specifies the PCM encoding configuration for voice port.

- The default for E1 is **a-law**.
- The default for T1 is **u-law**.

Step 6 **signal** *wink-start* | *immediate-start* | *delay-dial*

Example:

```
Router(config-controller)# signal immediate-start
```

Specifies the options of signaling type configuration.

- The default signaling type is **wink-start**.

Step 7 **type** **1** | **2** | **3** | **5** | **TO**

Example:

```
Router(config-controller)# type 2
```

Specifies the type of E&M interface to which this voice port is connecting in TO mode. See Table 2 in the "Voice Port Configuration Overview" chapter for an explanation of E&M types.

- The default is **1**.

In type TO, CEoP is configured without CAS type.

Step 8 **operation** *2-wire* | *4-wire*

Example:

```
Router(config-controller)# operation 4-wire
```

Specifies the number of wires used for voice transmission at this interface (the audio path only, not the signaling path).

- The default is **2-wire**.

Step 9 **impedance** **600r** | **complex1** | **complex2** | **complex3**

Example:

```
Router(config-controller)# impedance complex1
```

Specifies the impedance depending upon the operation selected.

- Note** The options for operations are:
- Option for operation 4-wire: 600r
 - Option for operation 2-wire: 600r, complex1, complex2, complex3

The default impedance is **600r**.

Step 10 **exit**

Example:

```
Router(config-controller)# exit
```

Exits controller configuration mode and returns to privileged EXEC mode.

Configuring CEM Group with Cross Connect

The following section describes how to configure a CEM group on the Cisco ASR 903 Series Router.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	interface cem slot/bay lport Example: Router(config)# int cem slot/bay/port	To specify the slot number, bay number or port number to be configured.
Step 4	cem number Example: Router(config-if)# cem 0	CEM number is always 0.
Step 5	xconnect router-id vcid encapsulation mpls Example: Router(config-if)# xconnect 10.1.1.1 40 encapsulation mpls	To configure xconnect with other end using router-ID, VCID and encapsulation as MPLS.

	Command or Action	Purpose
Step 6	exit Example: Router(config-if)# exit	Exits configuration mode and returns to privileged EXEC mode.

Configuration Examples for E and M

This section provides examples for configuring E&M over MPLS

Example: Configuring E&M Controller

The following example shows how to configure voice port interface.

```
Router> enable
Router# configure terminal
Router(config)# controller voice-port 0/1/4
Router(config-controller)# cem-group 0 timeslots 1
Router(config-controller)# compand a-law
Router(config-controller)# signal immediate
Router(config-controller)# type 5
Router(config-controller)# operation 4-wire
Router(config-controller)# exit
```

Example: Configuring Xconnect

The following example shows how to configure xconnect.

```
Router> enable
Router# configure terminal
Router(config)# interface CEM0/1/0
Router(config-if)# cem 0
Router(config-if-cem)# xconnect 10.1.1.1 1 encapsulation mpls
Router(config-if-cem-xconn)# end
```

Verifying E & M Configuration

The following show commands you can use to verify the E and M configuration.

- **show controllers voice-port**: This command shows how to configure voice port interface.

```
Router# show controllers voice-port 0/3/0

voice-port 0/3/0 - (A900-IMA6EM) is up
Encapsulation : None
Type          : Type I
Operation     : 2-Wire
Signalling    : wink-start
Companding    : u-law
```

- **show interface cem**: This command shows how to configure CEM.

```

Router# show interface CEM0/3/0

CEM0/3/0 is up, line protocol is up
  Hardware is Circuit Emulation Interface
  MTU 1500 bytes, BW 64 Kbit/sec, DLY 0 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation CEM, loopback not set
  Keepalive not supported
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/0 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    0 packets input, 0 bytes, 0 no buffer
    Received 0 broadcasts (0 IP multicasts)
    0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    0 packets output, 0 bytes, 0 underruns
    0 output errors, 0 collisions, 0 interface resets
    0 unknown protocol drops
    0 output buffer failures, 0 output buffers swapped out

```

- **show cem circuit:** This command shows how to configure CEM circuit.

```

Router# show cem circuit 0

CEM0/3/0, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Controller state: up, T1/E1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 8 (In use: 0)
Payload Size: 32
Framing: Framed (DS0 channels: 1)
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts:      0                Dropped:          0
Egress Pkts:       0                Dropped:          0

CEM Counter Details
Input Errors:      0                Output Errors:     0
Pkts Missing:     0                Pkts Reordered:   0
Misorder Drops:   0                JitterBuf Underrun: 0
Error Sec:        0                Severly Errored Sec: 0
Unavailable Sec:  0                Failure Counts:    0
Pkts Malformed:  0                JitterBuf Overrun: 0

```

- **show xconnect all:** This command shows the output of xconnect command.

```

Router# show xconnect all

Legend:   XC ST=Xconnect State  S1=Segment1 State  S2=Segment2 State
          UP=Up                 DN=Down             AD=Admin Down      IA=Inactive
          SB=Standby            HS=Hot Standby     RV=Recovering      NH=No Hardware

XC ST  Segment 1                               S1 Segment 2                               S2
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
UP pri  ac CE0/3/0:0 (CESoPSN Basic)          UP mpls 10.1.1.1:1                             UP
UP pri  ac CE0/3/1:0 (CESoPSN Basic)          UP mpls 10.1.1.1:2                             UP
UP pri  ac CE0/3/2:0 (CESoPSN Basic)          UP mpls 10.1.1.1:3                             UP

```



```

UP pri ac CE0/3/3:0 (CESoPSN Basic) UP mpls 10.1.1.1:4 UP
UP pri ac CE0/3/4:0 (CESoPSN Basic) UP mpls 10.1.1.1:5 UP
UP pri ac CE0/3/5:0 (CESoPSN Basic) UP mpls 10.1.1.1:6 UP

```

- **show ip int brief:** This command shows the usability status of interfaces configured for IP.

```

Router# show ip int brief
Interface IP-Address OK? Method Status Protocol
GigabitEthernet0/4/0 209.165.200.225 YES NVRAM up up
GigabitEthernet0/209.165.201.1 YES NVRAM up up
CEM0/3/0 unassigned YES unset up up
CEM0/3/1 unassigned YES unset up up
CEM0/3/2 unassigned YES unset up up
CEM0/3/3 unassigned YES unset up up
CEM0/3/4 unassigned YES unset up up
CEM0/3/5 unassigned YES unset up up

```

Additional References for Configuring E and M Signals

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases

Standards and RFCs

Standard/RFC	Title
—	<i>There are no standards and RFCs for this feature.</i>

MIBs

MIB	MIBs Link
IF-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<p>http://www.cisco.com/cisco/web/support/index.html</p>



CHAPTER 3

Configuring Serial Interface (X.21/V.35/RS-530/RS-449)

This chapter provides information about the serial interface using cable type x.21/v.35/rs-530/RS-449. The serial interface transports the respective x.21/v.35/rs-530/RS-449 traffic over a MPLS network. The Cisco ASR 903 Series Router supports the pseudowire that utilizes the Circuit Emulation Service over Packet-Switched Network in E1 mode to transport x.21/v.35/rs-530/RS-449 traffic.



Note Effective from Cisco IOS XE Bangalore Release 17.4.1, serial interface using cable type x.21 is supported on the Cisco A900-RSP3C-400, and only on slot 4 on A900-RSP3C-200.

- [Information About Serial Interface \(X.21/V.35/RS-530/RS-449\)](#), on page 15
- [How to Configure Serial Interface \(X.21/V.35/RS-530/RS-449\)](#), on page 16

Information About Serial Interface (X.21/V.35/RS-530/RS-449)

The following sections provide information about configuring serial interface (x.21/v.35/rs-530/RS-449) feature on the Cisco ASR 903 Series Router.

Overview of Configuring X.21/V.35/RS-530/RS-449

CESoPSN encapsulates structured signals as pseudowires over packet switched networks (PSNs). Emulation of signals saves PSN bandwidth and supports distributed cross-connect applications. It also enhances resilience of CE devices due to the effects of loss of packets in the PSN.

CESoPSN identifies framing and sends the payload. The number of TDM frames to be used within the CESoP is a factor of the serial data size. For Nx64 kbps serial line, the number of timeslots in a given TDM frame are inferred based on the line speed.

Circuit Emulation Overview

Circuit Emulation (CEM) is a technology that provides a protocol-independent transport over IP Networks. It enables proprietary or legacy applications to be carried transparently to the destination, similar to a leased line.

CEM provides a bridge between a time-division multiplexing (TDM) network and MPLS network. The router encapsulates the TDM data in the MPLS packets and sends the data over a CEM pseudowire to the remote provider edge (PE) router. Thus, CEM functions as a physical communication link across the packet network.

CEM dejitter buffer value can be configured to accommodate any delays in the MPLS network. Service policy can be applied to the CEM interface, only exp bit re-marking is supported in default class.

Configuring CEM Restriction

Not all combinations of payload size and dejitter buffer size are supported. If you apply an incompatible payload size or dejitter buffer size configuration, the router rejects it and reverts to the previous configuration.

Benefits

- The pseudowire utilizes Circuit Emulation Service over Packet-Switched Network (CESoPSN -RFC5086) in E1 mode to transport the x.21/v.35/rs-530/RS-449 traffic over MPLS network.
- Migration from legacy network to MPLS network supports hitless traffic switch from active RSP to standby RSP.
- It supports the serial data speed that are multiples of 64kbps. The maximum limit of speed can be 2048kbps.

Prerequisites

- Serial IM SPA must be installed.
- PEs must be reachable over MPLS network.
- Sync-E must be configured between pseudowire peers.

Restrictions

- Specific combinations of payload size and dejitter buffer size are supported. If incompatible values are applied, the router reverts to the previous configuration.
- Supported speeds are 64kbps, 128kbps, 256kbps, 512kbps, 1024kbps, and 2048kbps.
- Serial IM does *not* support to configure pseudowire between local and remote PE with different speeds on sync (x.21/v.35/rs-530/RS-449) ports.
- The transit of traffic over a MPLS core is supported only on the Cisco ASR 900 RSP2 module.
- The transit of traffic is *not* supported from port 0 to 7. It is supported only from port 8 to 13.

How to Configure Serial Interface (X.21/V.35/RS-530/RS-449)

The following sections provide information about how to configure serial interface (x.21/v.35/rs-530/RS-449) on the Cisco ASR 903 Series Router.

Configuring Serial Interface (X.21/V.35/RS-530/RS-449)

Before you Begin

Before you configure x.21/v.35/rs-530/RS-449 on Cisco ASR 903 Series Router, check for the following:

- MPLS LDP neighbor relation must be established between the PE devices.
- The Ethernet interfaces on the provider edge routers towards the core must be configured with SyncE.

Follow these steps to configure x.21/v.35/rs-530/RS-449 on the Cisco ASR 903 Series Router:

```
enable
configure terminal
Controller serial 0/5/8
clock rate 64000
cem-group 0
exit
interface CEM0/5/8
cem 0
xconnect 10.10.10.2 305 encapsulation mpls
exit
end
```

Or,

```
enable
configure terminal
Controller serial 0/5/8
clock-rate 64000
cem-group 0
exit
interface CEM0/5/8
cem 0
xconnect 10.10.10.2 305 encapsulation mpls
exit
end
```

Verifying the Serial Interface (X.21/V.35/RS-530/RS-449) Configuration

You can use the **show controllers serial** command to verify the serial interface (x.21/v.35/rs-530/RS-449) configuration.

- The following is the sample output to verify that the controller is configured using X.21 cable type.

```
Router# show controllers serial0/5/8

CEM0/5/8 - (Circuit Emulation Interface) is up
Physical Layer : SYNC
Encapsulation : CEM
mtu 1500, max_buffer_size 1524, max_pak_size 1524 enc 84
Cable type: X.21 DCE
loopback: Off, crc: 16, invert_data: Off
nrzi: Off, idle char: Flag
dce_terminal_timing_enable: Off ignore_dtr: Off
serial_clockrate: 128000bps, serial_clock_index: 17

DCD=up DSR=up DTR=up RTS=up CTS=up
```

- The following is the sample output to verify that the controller is configured using V.35 cable type.

```
Router# show controllers serial0/5/8

CEM0/5/8 - (Circuit Emulation Interface) is up
Physical Layer : SYNC
Encapsulation  : CEM
mtu 1500, max_buffer_size 1524, max_pak_size 1524 enc 84
Cable type: V.35 DCE
loopback: Off,  crc: 16, invert_data: Off
nrzi: Off, idle char: Flag
dce_terminal_timing_enable: Off ignore_dtr: Off
serial_clockrate: 128000bps, serial_clock_index: 17

        DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

- The following is the sample output to verify that the controller is configured using RS-530 cable type.

```
Router# show controllers serial0/5/8

CEM0/5/8 - (Circuit Emulation Interface) is up
Physical Layer : SYNC
Encapsulation  : CEM
mtu 1500, max_buffer_size 1524, max_pak_size 1524 enc 84
Cable type: RS-530 DCE
loopback: Off,  crc: 16, invert_data: Off
nrzi: Off, idle char: Flag
dce_terminal_timing_enable: Off ignore_dtr: Off
serial_clockrate: 128000bps, serial_clock_index: 17

        DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

- The following is the sample output to verify that the controller is configured using RS-449 cable type.

```
Router# show controllers serial0/5/8

CEM0/5/8 - (Circuit Emulation Interface) is up
Physical Layer : SYNC
Encapsulation  : CEM
mtu 1500, max_buffer_size 1524, max_pak_size 1524 enc 84
Cable type: RS-449 DCE
loopback: Off,  crc: 16, invert_data: Off
nrzi: Off, idle char: Flag
dce_terminal_timing_enable: Off ignore_dtr: Off
serial_clockrate: 128000bps, serial_clock_index: 17

        DCD=up  DSR=up  DTR=up  RTS=up  CTS=up
```

- Use the **show int cem 0/5/8** command to verify that the CEM is configured.

```
Router# show int cem0/5/8

Building configuration...
Current configuration : 97 bytes
!
interface CEM0/5/8
  no ip address
  cem 0
  xconnect 10.10.10.10 100 encapsulation mpls
!
end
```

- Use the **show xconnect all** command to verify that the cross connection between controllers is configured.

```
Router# show xconnect all
```

```
Legend:   XC ST=Xconnect State  S1=Segment1 State  S2=Segment2 State
          UP=Up                 DN=Down             AD=Admin Down      IA=Inactive
          SB=Standby           HS=Hot Standby     RV=Recovering      NH=No Hardware
```

```
XC ST Segment 1                               S1 Segment 2                               S2
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
UP pri ac CE0/5/8:0 (CESoPSN Basic)          UP mp1s 10.10.10.10:100                     UP
```

Setting Payload-Size and Dejitteer-Buffer

After the configuration of CEM circuit and xconnect, configure the appropriate values for payload-size and dejitter buffer in the CEM. Below table provides the ideal values payload-size and dejitter buffer for different clock rates.

Clock Rate	Payload Size	Dejitteer Buffer
64000	32	9
128000	64	16
	64	20
	64	32
	128	20
	256	20
512000	128	20
	128	5
	64	5
	256	20
	640	20
1024000	64	8
	64	5
	128	5
	128	8
	256	8

Clock Rate	Payload Size	Dejitter Buffer
2048000	128	8
	128	5
	256	5
	256	8
	640	8
	1280	8

Configuring Payload Size and Dejitter Buffer

Before you configure payload size and dejitter buffer on CEM, ensure the CEM and xconnect are configured.

```
enable
configure terminal
interface cem 0/5/8
cem 0
payload-size 64
dejitter-buffer 20
end
```



Note

- Use **no payload-size** command to set the default values for payload-size.
- Use **no dejitter-buffer** command to set the default values for dejitter-buffer for a given clock rate.

Verifying the Payload Size and Dejitter Buffer Configuration

You can use the following commands to verify your pseudowire configuration:

Use **show interface cem** command to verify the CEM configuration.

```
Router# show interface cem 0/5/8
Building configuration...
Current configuration : 136 bytes
!
interface CEM0/5/8
no ip address
cem 0
  payload-size 64
  dejitter-buffer 20
  xconnect 10.10.2.2 204 encapsulation mpls
!
end
```




CHAPTER 4

Configuring 4-Port C37.94 Interface Module

The IEEE C37.94 standard defines the communication of protection relays with communication equipment inside a substation using optical fibers.

The IEEE defines the C37.94 standard as $N * 64$ kbps optical fiber interface to provide transparent communications between tele-protection relays and multiplexers equipments. The C37.94 standard describes the interconnection details for the variable N , (where $N = 1, 2 \dots 12$), which describes a multiple of 64 kilobit per second connections at which the communication link is to operate.

The C37.94 interface module supports four ports from port number 0 to 3.

The 4-Port C37.94 interface module is supported on the RSP2 module of the Cisco ASR 902 and ASR 903 routers.



Note Effective from Cisco IOS XE Bangalore Release 17.4.1, 4-Port C37.94 interface module is supported on the Cisco A900-RSP3C-400, and only on slot 4 on A900-RSP3C-200.



Note Effective from Cisco IOS XE Bangalore Release 17.6.1, 14-port serial interface module (A900-IMASER14A/S) is supported on the following:

- Any slots on ASR900 with RSP2-128
 - Any slots on ASR900 with A900-RSP3C-400-S
 - Only on slot 4 on RSP3C-200-S with ASR903
 - Only on slots 3, 4 and 5 on RSP2-64 with ASR903
 - Only on slots 3, 4, 7, 8, 11 and 12 on A900-RSP3C-400-W with ASR907
-

- [Information About C37.94 Interface Module, on page 22](#)
- [How to Configure C37.94 Interface Module, on page 23](#)
- [Hitless Switching on C37.94 Interface Module, on page 26](#)
- [Troubleshooting, on page 28](#)
- [Additional References , on page 30](#)

Information About C37.94 Interface Module

This following section provides information about configuring C37.94 interface module on the Cisco ASR 903 Series Router.

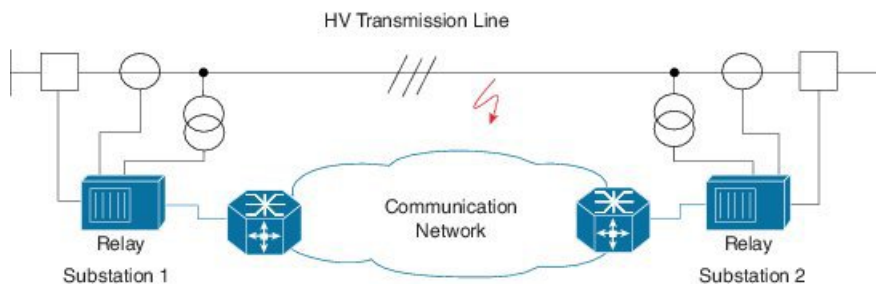
Smart Grid Tele-Protection Support

The C37.94 interface module supports smart grid tele-protection.

Smart Grid refers to the electricity delivery system from the point of generation to the point of consumption using analog or digital information and the communication technology for gathering and acting on the information.

Tele-protection refers to the mechanism to quickly switch on alternative routes using tele-protection equipment when a malfunction occurs. The switchover is to improve the performance of the electric grid.

Figure 2: Smart Grid Tele-protection



Overview of C37.94 Frame

The IEEE standard defines a data frame format for C37.94 interface module. The frame format is designed to allow the passage of information in packet format from the multiplexer to the tele-protection equipment and from the tele-protection equipment to the multiplexer equipment.

Features of 4-Port C37.94 Interface Module

The features of 4-Port C37.94 Interface Module are:

- Supports 4 independent C37.94 interfaces
- Provides low latency connection over pseudowires
- Supports allocation of timeslot. Timeslot ranges from 1 to 12
- Supports Online Insertion and Removal (OIR)
- Supports traffic switch from active to standby
- Provides quick switchover to alternative route at the time of a route failure
- Populates the C37.94 controller indexes in IfTable; the IfTable is defined in IF-MIB

Prerequisites

- Provider Edges (PEs) must be reachable over MPLS network
- Sync-E must be configured between pseudowire peers

Restrictions

- The channelization of N * 64 kbps channels of C37.94 interface is *not* supported
- The bandwidth of N * 64 kbps (N ranges from 1 to 12) is supported
- Pseudowire configuration between local and remote PE with different time slots is *not* supported
- Pseudowire configuration is supported only when C37.94 interface is configured on both PE nodes
- C37.94 controller index in IfTable does *not* provide the following information:
 - Maximum Transmit Unit (MTU)
 - Counters

Benefits

- Provides low latency connection to C37.94 interfaces
- Supports multiple interface modules on single chassis
- Tele-protection relay checks a failure and thus provides reliable, robust and safe electric grid
- Provides quick switchover to an alternative route of any route failure
- Prevents damage to the network and power outages

How to Configure C37.94 Interface Module

Configuring CEM Class

Before you configure CEM class, configure payload size and dejitter buffer values on CEM.

```
enable
configure terminal
class cem mycemclass
payload-size 64
dejitter-buffer 20
idle-pattern 0x55
end
```



-
- Note**
- The default payload size varies with the number of time slots selected.
 - Payload size can be configured to achieve lower bandwidth.
-

Configuring CEM

Before you configure CEM group cross-connect, configure the C37.94 controller.

```
enable
configure terminal
controller c3794 0/0/0
cem-group 0 timeslots 1
interface CEM0/0/0
no ip address
cem 0
dejitter-buffer 2
modifytimeslots 6
cem class mycemclass
xconnect 10.10.10.10 200 encapsulation mpls
exit
```



-
- Note** The controller is auto-configured when the interface module is inserted.
-

Low bandwidth applications can be configured, as required. You can configure the exact number of timeslots required.

The **modifytimeslots** command must be configured after configuring the **cem-group timeslots** command.

When you configure **cem-group 0 timeslots x** command and then configure **modifytimeslots y** command, the total number of timeslots that get configured in the system would be x+y.

For example, when you configure **cem-group 0 timeslots 1** command and then configure **modifytimeslots 6** command, the total number of timeslots that get configured in the system would be 1+6 = 7 timeslots.

A maximum of 12 timeslots can be configured. So, if you configure **cem-group 0 timeslots 12** command and then try to configure more timeslots using the **modifytimeslots y** command, the configuration will not be successful and an error is displayed.

Verifying C37.94 Interface Module Configurations

You use the following **show** commands to verify the configuration of 4-Port C37.94 interface module:

- Use the **show running-config** command to view the configurations.

```
Router# show running-config | sec 0/0/0

controller C3794 0/0/0
  cem-group 0 timeslots 12
interface CEM0/0/0
no ip address
cem 0
```

```
xconnect 10.10.10.10 200 encapsulation mpls
```

- Use the **show xconnect** command to verify the configuration of cross connect between the controllers.

```
Router# show xconnect all
```

```
Legend:   XC ST=Xconnect State  S1=Segment1 State  S2=Segment2 State
          UP=Up                DN=Down            AD=Admin Down      IA=Inactive
          SB=Standby          HS=Hot Standby    RV=Recovering     NH=No Hardware

XC ST  Segment 1                               S1 Segment 2                               S2
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
UP pri ac CE0/0/0:0 (CESoPSN Basic)          UP mpls 10.10.10.10 200                               UP
```

- Use the **show cem circuit** command to verify the CEM configurations.

```
Router# show cem circuit detail
```

```
CEM0/0/0, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Controller state: up, T1/E1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 5 (In use: 0)
Payload Size: 96
Framing: Framed (DS0 channels: 1-12)
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts:   26669                Dropped:           0
Egress Pkts:   26669                Dropped:           0

CEM Counter Details
Input Errors:   0                    Output Errors:     0
Pkts Missing:  0                    Pkts Reordered:   0
Misorder Drops: 0                    JitterBuf Underrun: 0
Error Sec:     0                    Severly Errored Sec: 0
Unavailable Sec: 0                    Failure Counts:    0
Pkts Malformed: 0                    JitterBuf Overrun: 0
```

- Use the **show controllers** command to verify the controller configurations.

```
Router# show controllers c3794 0/0/0
```

```
C3794 0/0/0 - (A900-IMA4C3794) is up
Configured Channels: 1
Peer Channels       : 1
Alarm               : Nil
Sending Y-Alarm to Peer Device : No
Receiving Y-Alarm from Peer Device : No
Transceiver Rx Optical Power :-15 db
```

Associated Commands

Commands	URL
cem-group	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2440628600
xconnect	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t2.html#wp8578094790
loopback	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-11.html#wp1033903426

Hitless Switching on C37.94 Interface Module

Table 3: Feature History

Feature Name	Release Information	Description
Hitless Switching on C37.94 Interface Module	Cisco IOS XE Cupertino 17.9.1	Hitless switching protection describes the ability to switch between the active and backup paths without losing packets when an active path fails. This feature ensures uninterrupted continuous service and maintains an extremely high-reliability rating.

Hitless switching protection describes the ability to switch between the active and backup paths without losing packets when an active path fails. Hitless switching is supported only on the A900-IMA4C3794 interface module with Flex LSP configuration. Pseudowire segment protection is provided by the Packet Switched Network (PSN) layer with a fast-reroute (FRR) backup or an end-to-end backup LSP. These mechanisms can restore the PSN connectivity rapidly during an active path failure.

However, the traffic convergence to protect path may take some time, depending upon the following factors:

- Time taken to detect link or node failure in the active path.
- Switch the traffic to backup path.
- Reprogramming the head end to avoid the faulty path.

You need to enable hitless switching on active path to protect path which carries the PW traffic.

You must configure Flex Label Switched Paths as Active-Active LSPs, so that more than one LSP paths are programmed to carry the data traffic at all the time from end to end. The LSPs are made active by replicating the traffic to both active LSP paths at the ingress PE.

The receiving-end device can choose the packet based on arrival time and integrity of the packet. By maintaining active-active LSP paths, receiving-end device need not wait until the control plane detects failure and switch to the backup path. Hitless switching is achieved with active-active LSP paths on network failure seamlessly.

The egress PE processes the replicated packets based on the packet arrival time, thus eliminating the duplicate packets received on the high latency path. The receiver PE chooses on per-packet basis to forward the packets that arrived first, irrespective of the LSP paths it received the packet. The second packet (replicated packet) arrived on high latency path with same sequence number is then dropped by egress PE.

Hence, if a packet from one path gets delayed then packets from the other path is considered, thus making seamless transmission of packets to end devices. This transmission is seamless, even when there's a link or node failure in any of the nodes of an active path-1 as long as active path-2 is intact.

Enabling Hitless Switching SDM Template

You must enable hitless SDM template to enable hitless switching using the **enable_hitless_switching** command.

```
Router(config)#sdm prefer enable_hitless_switching
Hitless Switching Template configuration is modified. Save config and Reload[yes/no]:yes
Building configuration...

*May  5 12:49:52.551 IST: Changes to the Hitless Switching template preferences have been
stored[OK]
Proceeding with system reload...
Reload scheduled in 2 minutes by console
Reload reason: Hitless Switching template change
*May  5 12:50:05.383 IST: %SYS-5-SCHEDULED_RELOAD:
Reload requested for 12:52:04 IST Thu May 5 2022 at 12:50:04 IST Thu May 5 2022 by console.

Reload Reason: Hitless Switching template change
```

Disabling Hitless Switching SDM Template

You can disable hitless switching using the **disable_hitless_switching** command.

```
Router(config)#sdm prefer disable_hitless_switching
Hitless Switching Template configuration is modified Save config and Reload?[yes/no]: yes
Building configuration...

*May  5 12:17:16.800 IST: Changes to the Hitless Switching template preferences have been
stored[OK]
Proceeding with system reload...
Reload scheduled in 2 minutes by console
Reload reason: Hitless Switching template change
*May  5 12:17:58.194 IST: %SYS-5-SCHEDULED_RELOAD:
Reload requested for 12:19:57 IST Thu May 5 2022 at 12:17:57 IST Thu May 5 2022 by console.

Reload Reason: Hitless Switching template change.
Reload scheduled in 1 minute and 51 seconds by console
Reload reason: Hitless Switching template change
```

Limitations

- Hitless switching isn't supported on non co-routed (one in the forward direction and the other in reverse direction) flex LSP.
- Hitless switching is supported only on RSP3 module.
- During SSO on head or tail node, packet drops may occur.

- All the existing limitations of flex LSP are applicable.
- Hitless switching is supported only after you enable `sdm enable hitless template`.

Troubleshooting

You use the following to troubleshoot C37.94 controllers:

Alarms

The 4-Port C37.94 interface module supports the following alarms during failure:

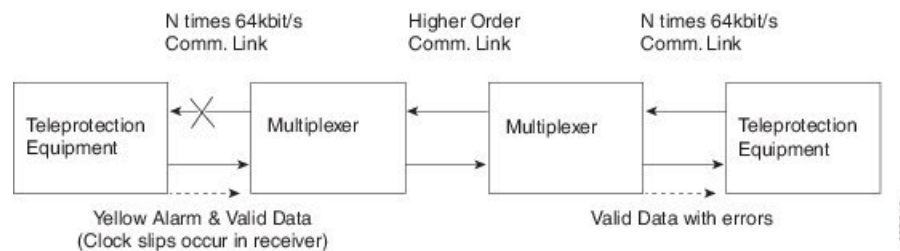
- Loss of Signal (LOS)
- Path Yellow Detection

Loss of Signal

The scenario when the receiver end receives two or more errors in eight consecutive framing patterns within 1 millisecond, the Loss of Signal (LOS) alarm is declared.

The receiver end should clear LOS after receiving eight consecutive correct framing patterns.

Figure 3: LOS at Optical Receive Port of Tele-protection Equipment



Failure Scenarios

- During the LOS condition at its optical receive port

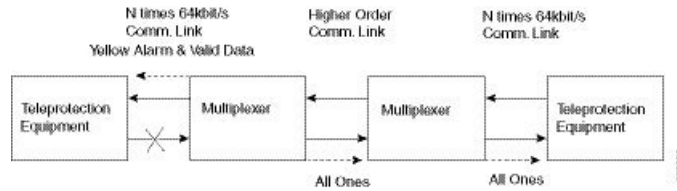
At Tele-protection Equipment

- Changes the “Yellow” bit in the transmitted optical output frames from “0” to “1”.

At Multiplexer Equipment

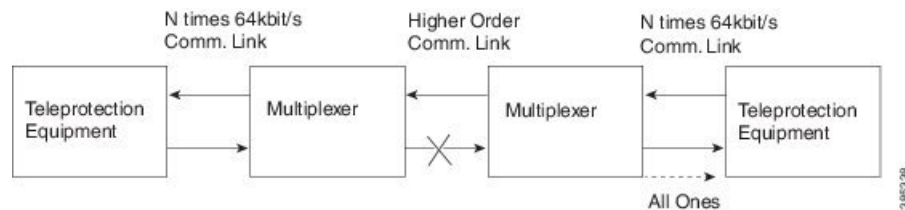
- Replaces the data bits over the higher order communications link with “All Ones,” which is commonly referred to as Alarm Indication Signal (AIS).
- Changes the “Yellow” bit in the transmitted optical output frames from “0” to “1”

Figure 4: LOS at Optical Receive Port of Multiplexer



- During the loss of the higher order communications link, the multiplexer should replace the data bits in the transmitted optical output frames with “All Ones.”

Figure 5: LOS at Far End Multiplexer



Path Yellow Detection

The scenario is declared as path yellow when three consecutive received frames have the “Yellow” bit = 1 and the received signal is OK (no LOS).

The receiver clears path yellow when three consecutive received frames have the “Yellow” bit = 0 or the received signal is bad (LOS).

Loopback on C37.94 Interfaces

Loopback Description

You can use the following loopbacks on the C37.94 interfaces.

Loopback	Description
loopback local line	Loops the incoming signal in the interface using the framer’s line loopback mode. The framer does not reclock or reframe the incoming data. All incoming data is received by the interface driver.
loopback local payload	Loops the incoming signal back in the interface using the payload loopback mode of the framer. The framer reclocks and reframes the incoming data before sending it back out to the network.
loopback network line	Sets the loopback toward the network before going through the framer (line).
loopback network payload	Sets the loopback toward the network after going through the framer (payload).

Configuring Loopback

Before You Begin

Before you configure loopback, you must configure the controller and the CEM.

To set a loopback local on the C37.94 interfaces, perform the following tasks in controller configuration mode:

```
enable
configure terminal
controller c3794 0/0/0
loopback local line
exit
```

To set a loopback network on the C37.94 interfaces, perform the following tasks in controller configuration mode:

```
enable
configure terminal
controller c3794 0/0/0
loopback network payload
exit
```



Note To remove a loopback, use the **no loopback** command.

Verifying the Loopback Configurations

You use the following **show** command to verify the loopback configuration of 4-Port C37.94 interface module:

- Use the **show controllers** command to view the configurations.

```
Router# show controllers c3794 0/0/0

C3794 0/0/0 - (A900-IMA4C3794) is up
Configured Channels: 12
Peer Channels       : 12
Alarm               : Nil
Sending Y-Alarm to Peer Device : No
Receiving Y-Alarm from Peer Device : No
Loopback            : local line
```

Additional References

Related Documents

Related Topic	Document Title
Cisco IOS commands	Cisco IOS Master Commands List, All Releases

Standards and RFCs

Standard/RFC	Title
—	<i>There are no standards and RFCs for this feature.</i>

MIBs

MIB	MIBs Link
IF-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	http://www.cisco.com/cisco/web/support/index.html

