

ISDN PRI



11.1 Overview

ISDN PRI is an interface between a user and a digital telephony network capable of delivering many types of services. The interface utilizes a set of communication protocols, including a message set used to request services. The user in the case of PRI is typically a PBX or some other switching equipment and the network is the central office (CO).

PRI can be implemented on either a T-1 or an E-1 carrier. In both cases, the full bandwidth of the bearer or B-channels is available for the transmission of voice and/or data. Signaling for the entire span is accomplished using a standard packet protocol on a single, common channel, called the D-channel. Therefore, PRI is often generically referred to as CCS, which stands for Common Channel Signaling.

PRI Carriers Compared		
	T-1	E-1
Total Channels	24 numbered 1-24	32 numbered 0-31
B-Channels	23	30
Total Bandwidth	1.544 Mbps	2.048 Mbps
User Data Rate	1.536 Mbps	1.920 Mbps
Framing Method		dedicated channel time slot 0
Signaling	D-channel time slot 24	D-channel time slot 16



This chapter covers installation, configuration, and troubleshooting for both versions of the Plexus ISDN PRI peripheral card. The chapter includes the following sections:

Features and Advantages	A brief discussion of the main features and advantages of ISDN PRI.
Hardware Description	A description of the hardware, including connectors, LEDs, and the applicable specifications.
Installation	Instructions on installing the ISDN PRI card and connecting it to the carrier.
Configuration	Instructions on configuring the card and detailed explanations of the configurable parameters.
Troubleshooting	Instructions on interpreting the real-time status indicators available in Plexus Administrator.
Glossary	A glossary of terms. Look here for detailed information about concepts you may encounter when ordering, installing, or configuring your ISDN PRI.

11.2 Features and Advantages

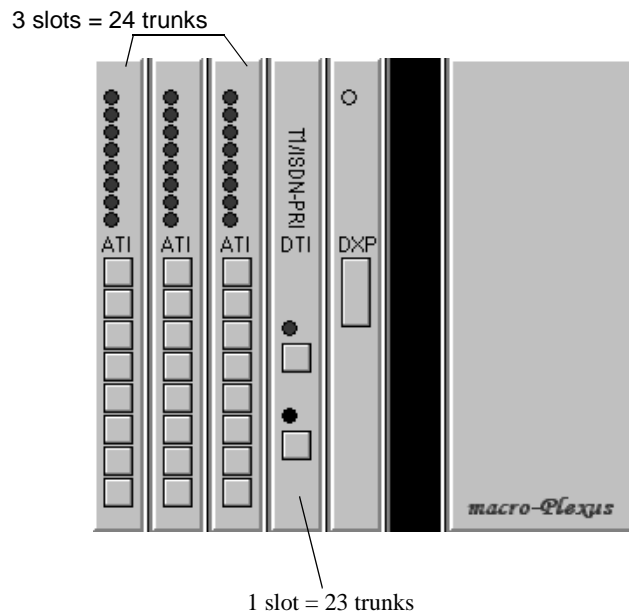
The primary incentive for using ISDN PRI, rather than analog POTs, is cost reduction. In many markets, an ISDN PRI is cheaper than the equivalent number of POTs lines.

Another advantage of ISDN PRI is that it allows users to make more efficient use of switch resources. Slots 8 and 10 in the Plexus cabinet are designed to accommodate up to sixty channels each; equivalent to two E-1 PRI spans. Therefore, sixty trunks can be made available to a system using a single slot in the cabinet. By comparison, 8 slots would be needed to make this many trunks available using analog, 8-port CO cards.



Note

If a T-1 or E-1 card is used in slot 10, slot 8 can only be filled by another T-1 or E-1 or by an Inter-Unit Link Interface card (ILI). Placing a T-1 or E-1 card in slot 8 produces no similar limitations.



ISDN PRI makes more efficient use of the available card slots.



Note

In the case of T-1, one slot could provide up to 23 trunks to the system. Three slots would be needed using analog, 8-port CO cards. An E-1 could up to 30 trunks to the system. Four slots would be needed using analog, 8-port CO cards.



While the incentives for using PRI for voice transmission are mostly economic, there are also call routing, billing, and other supplemental features that may prove valuable in some applications.

Calling Number Delivery and Called Party Number information are sent and received via message packets on the D-channel. This information can be used to automatically route calls to specific users or user groups on the system, bypassing the auto-attendant. For example, you can route all callers that dial one (or more) of your assigned directory numbers to the sales group and those that dial a different number(s) to the tech support group.

Calls made on a PRI can be tagged by the Plexus system with an ID known as the Outbound Caller-ID Tag. Each user on the system can have their own ID. If the IDs correspond to legitimate directory numbers for the PRI they may be sent as the Caller ID information¹. The Outbound Caller-ID tag can also be used for call reporting. Many providers record the outbound Caller ID data and present it on their billing statements. This allows customers to track their expenses on a user-basis.

For information regarding support for supplemental services, check our web page at <http://www.bbstelecom.com>.

1. Check with your provider.

11.3 Hardware Description

The ISDN PRI peripheral cards are available with support for one full or fractional span.

The ISDN PRI peripheral card in conjunction with the Plexus system provides all necessary signaling to the central office, distributes ISDN services to other devices that are attached to the system, and performs all protocol conversion functions for any attached analog devices. The ISDN PRI card therefore qualifies as NT2, or Network Termination Type 2, equipment.

All of the resources necessary to connect directly to a PRI network interface are provided on the card. No additional equipment is necessary.

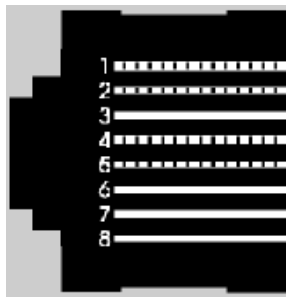


Note

Unlike an ISDN BRI, a PRI is not typically connected to an end-user's terminal equipment, such as a phone or modem. Rather, PRI is used as a trunk to connect customer's switching equipment (i.e., PBX or other NT2 equipment) to the central office.

11.3.1 Connectors

The ISDN PRI cards include a 8-pin connector wired to the RJ48X standard (EIA TIA 568B compatible). The pin out of the connectors is as follows:

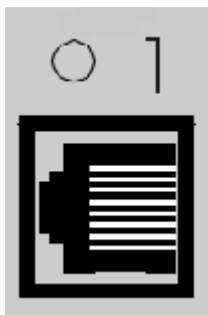


RJ48X connector

RJ48X Connector Pin Out	
Pin	Signal
1	Rx Tip
2	Rx Ring
4	Tx Ring
5	Tx Tip

11.3.2 LEDs

A red LED is provided for each span. Three different states provide status information as follows:



Connector and LED

Flash Cycle (in seconds)	Status
Flash: 1/4 ON, 1/4 OFF	Functioning, but not receiving or misconfigured (i.e., no frame alignment).
Flash: 1 ON, 1 OFF	OK
Off	Not functioning
Flash: 2 ON, 2 OFF	Not functioning - wrong software version on card

11.3.3 Specifications

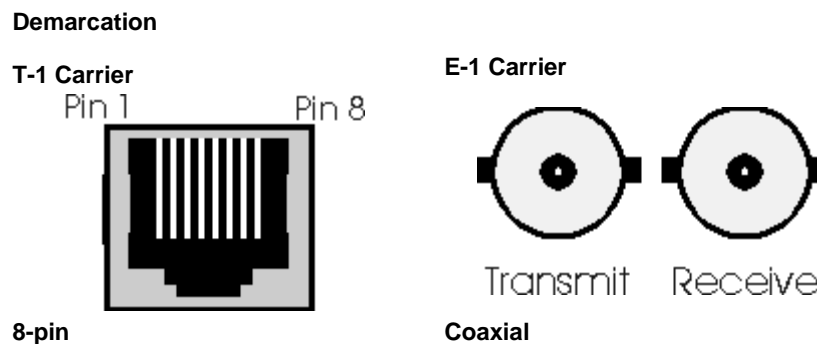
ITU-T I.431

ITU-T G.703 and G.704

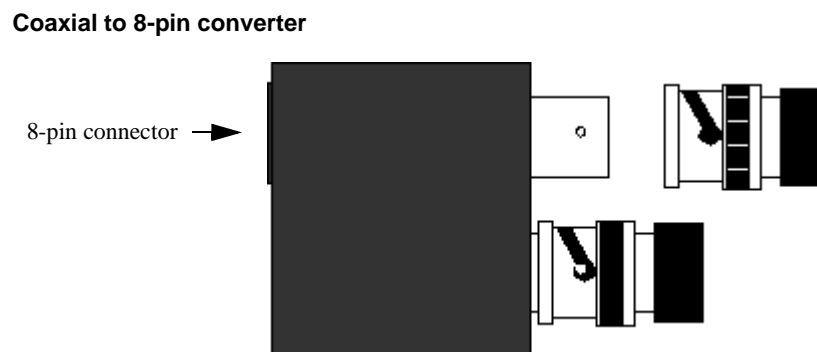
ITU-T Q.930 (I.450) and Q.931 (I.451)

11.4 Installation

The installation of an ISDN PRI is the responsibility of the provider. After the customer places an order, the provider sends out technicians to bring the necessary cabling into the customer premises and terminate it near the PBX. The location where the PRI is terminated is called the network interface or the demarcation point. The connection available at the demarcation point may be a single 8-pin connector or two coaxial connectors; one for transmit and one for receive. The customer is responsible for the connection between the demarcation point and the PRI peripheral card.



A device provided with the E-1 version of the card converts the coaxial demarcation into an 8-pin connector with the correct four wires terminated.



Note

The two coaxial connectors on the converter device are labeled "Tx" for transmit and "Rx" for receive.



11.4.1 Inserting the card

- 1 Power off the system.
- 2 Carefully remove the card from the packaging.



Note

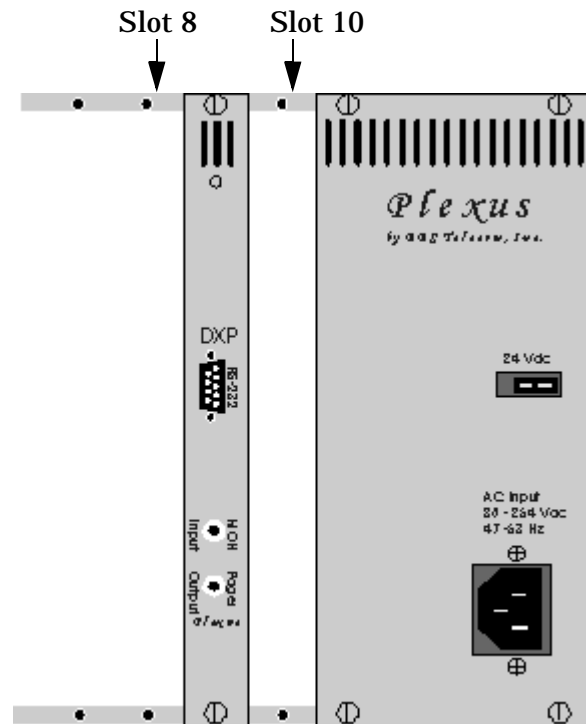
The cards are sensitive to static electricity and should be handled by the edges only. Never touch the components on a card.

- 3 Place the edges of the card inside the top and bottom card guides of either slot 8 or slot 10.



Note

If a T-1 or E-1 is installed in slot 10, slot 8 may only contain another T-1 or E-1 or an Inter-Unit Link Interface (ILI) card. If the T-1 or E-1 is installed in slot 8, no similar limitations exist.



ISDN PRI cards can only be inserted into slot 8 or slot 10. These slots support a larger number of channels than other slots in the system cabinet.

- 4 Gently slide the card in until it completely seats into the backplane. There will likely be an increase in pressure and a slight noise as the card is seated.

11.4.2 Making the connection



Tip

For straight through runs of less than 10 feet, a standard 10 BASE T cable can be used. The pin out discussed in the “Connectors” section (1 + 2 on one twisted pair and 4 + 5 on another), should be used for longer runs.

Using a cable that conforms to the following wiring diagram, connect the card to the demarcation point (or the converter device, if applicable). Either RJ-11 or RJ-45 plugs can be used.

Straight Through	
1	1
2	2
4	4
5	5

- 1 Insert one end of the cable into one of the connectors on the card.
- 2 Insert the other end into the connector installed by the provider (i.e., the demarcation point) or into the converter device as illustrated below.

Inserting cable into converter device



Note

If you move the Plexus system further away from the demarcation point than it was at the time of installation, you may need to adjust the line build-out setting. See page 16.

11.4.3 Activating service

As soon as the ISDN PRI card is connected to the demarcation point, you are ready to activate service. When you contact the provider to do this, make sure that you take notes. There are several configurable parameters on a PRI and it is extremely important that you and the provider select all the same options. If the same options are not implemented on both ends, the PRI will not function properly.

In some cases, the options selected are up to the customer. Therefore, you may want to review the glossary in “Glossary” - section 11.7 before activating service. This will allow you to make informed decisions and select the options that are best suited for your customer’s application.

The following checklist highlights several of the configurable parameters you should discuss with the provider. You may want to circle the options selected for future reference.

Parameter	Options	
	T-1	E-1
Line Code	B8ZS AMI	HDB3 AMI
CRC-4 Frame Align	N/A	Yes No
Terminal-Endpoint ID '0' is acceptable?	Yes No, use _____	Yes No, use _____
Switch Variant	US National ISDN-2 AT&T 4ESS AT&T 5ESS Nortel DMS-100	ETSI NET5 Australia TS014.1
Line Build-Out	Ask installers for code.	N/A
Main Directory Number		
Other Directory/DID Numbers		
Channel selection direction for inbound calls	Ascending (recommended) Descending	Ascending (recommended) Descending



Parameter	Options	
Dialing Method	En-bloc (recommended) Overlap	En-bloc (recommended) Overlap
Calling Number Delivery	Yes No	Yes No

11.5 Configuration

Configuration is necessary in order to set the various configurable parameters of the card so that it may properly communicate with the carrier. The parameters must be correctly configured in order to utilize the PRI.

Configuration is accomplished using the Plexus Administrator software utility. After launching the software and completing the peripheral card layout [see the Software Configuration section of the Plexus System Manual], you can begin configuring the card, as follows:

- 1 Click on the applicable port on the image of the card.
- 2 Click on each tab and address each parameter in the order that they are presented.

Below, you will find an explanation of each parameter, the available options, and an indication of the default setting. As you set the parameters, refer back to the checklist to determine which settings were selected.

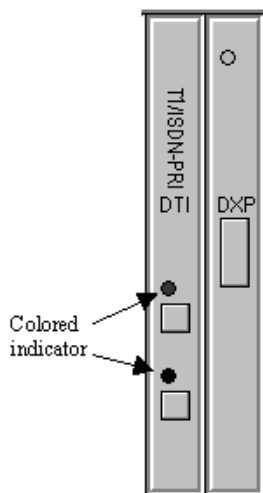


Note

It is extremely important that the same options be implemented on both ends of the ISDN PRI.

11.5.1 The ISDN PRI Peripheral Card

Before clicking on the port on the image of the card, you will notice that the port has a colored indicator. Each color of the indicator represents a different state for the T-1 / E-1 span.



Red – No channels have been mapped to trunks.
Green – At least 1 channel has been mapped to a trunk and all mapped channels are enabled.
Yellow – At least 1 channel that has been mapped to a trunk has been disabled.
Black – The span is not active / available



Note

The Plexus Administrator software will show two spans on each T-1 / E-1 peripheral card. The second span will always show not active / available. Ensure that all programming be completed on the top span in the Plexus Administrator software. The second span shown is for future release of two span T-1 / E-1 peripheral cards.

11.5.2 General

The general tab includes system ID information and most of the carrier-specific configurable parameters. Selections are made by clicking on the appropriate radio button or pull-down menu option. The Terminal-Endpoint ID can be adjusted, within the allowable range, using the arrow keys on your keyboard or by clicking on the appropriate arrow image.



T-1 Carrier

E-1 Carrier

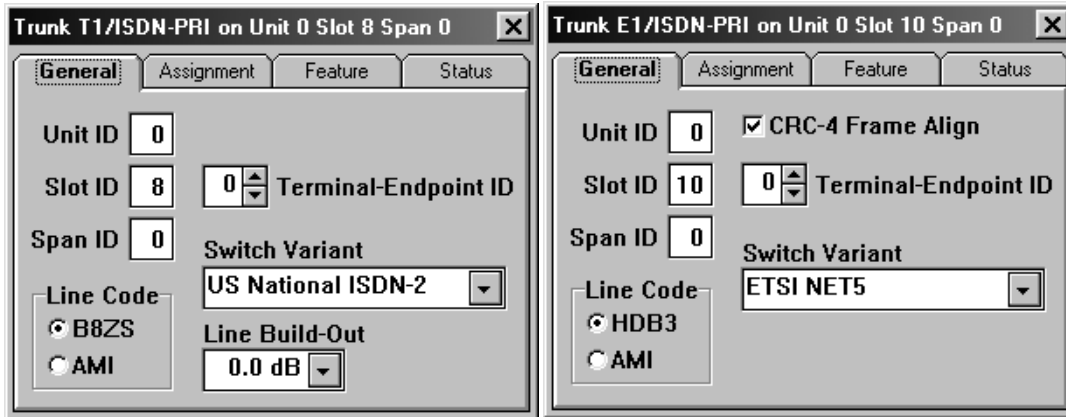


Table 11 - 1 ISDN PRI: General

Unit ID	T1	E1
Logical identifier for the system being configured. Unless there is more than one system, as in a linked environment, this ID will be 0.	Automatically Assigned	Automatically Assigned
Slot ID		
Logical identifier for the slot in which the card is inserted.	Automatically Assigned	Automatically Assigned
Span ID		
Logical identifier for the span being configured.	Automatically Assigned	Automatically Assigned
Line Code (Glossary page 26)		
Method of manipulating the bit pattern to maintain synchronization between the central office and the card.	B8ZS* AMI	HDB3* AMI
CRC-4 Frame Align		
Instructs the card to send cyclic redundancy check (checksum) information to the central office.		Disabled* Enabled



Table 11 - 1 ISDN PRI: General

Terminal-Endpoint ID (TEI) (Glossary page 27)		
Device identifier for the PRI.	0* Range: 0-63	0* Range: 0-63
Switch Variant		
The ISDN PRI protocol supported by the central office switch.	US National ISDN-2* AT&T 4ESS AT&T 5ESS Nortel DMS-100	ETSI NET5* Australia TS014.1
Line Build-Out (Glossary page 26)		
The amount of line build-out (LBO) necessary to attenuate signals transmitted from the card so that they are properly received and handled by receiving equipment.		0.0 dB* -7.5 dB -15.0 dB -22.5 dB

* = default settings

11.5.3 Assignment: Channel Association

The assignment: channel association tab includes checkboxes for enabling and disabling channels and pull-down menus for assigning trunks to channels.



Tip

To quickly assign a range of trunks to the enabled B-channels, right-click anywhere in the third column and select AutoAssign. To quickly enable / disable channels, right-click anywhere in the second column and choose Auto Assign to keep only assigned channels enabled, enable ALL channels, or disable ALL channels.

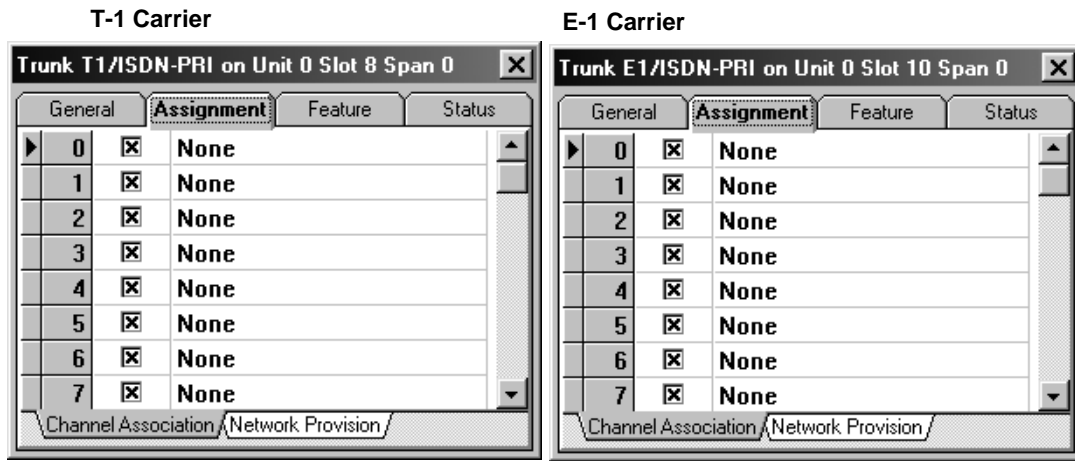


Table 11 - 2 ISDN PRI: Assignment: Channel Association

Channel ID	T-1	E-1
Logical IDs for available B-channels. These IDs are not meant to correspond to actual time slot IDs in the framing pattern.	0 - 22, 22*	0 - 29, 29*
Checkbox		
Enables/disables the corresponding B-channel.	Enabled* Disabled	Enabled* Disabled
Trunk Assignment (See "Channel Selection Order" and "Key Telephone Call Appearance" in the Glossary)		
The pull-down menu is used to logically assign a trunk to each channel. This assignment only establishes the direction in which incoming calls are dynamically assigned to trunks. There is no physical relationship between a trunk and a channel.	None* Trunk ID	None* Trunk ID

* = default settings

11.5.4 Assignment: Network Provision

The assignment: network provision tab provides an input box to enter the main directory number associated with your PRI and a pull-down menu that allows you to select the order in which channels are utilized for outbound calls. The directory number should be obtained from your provider when you activate service.

The main directory number is also referred to as "Billing Telephone Number (BTN)" and "Telephone Line Identification (TLI)."

T-1 Carrier

E-1 Carrier

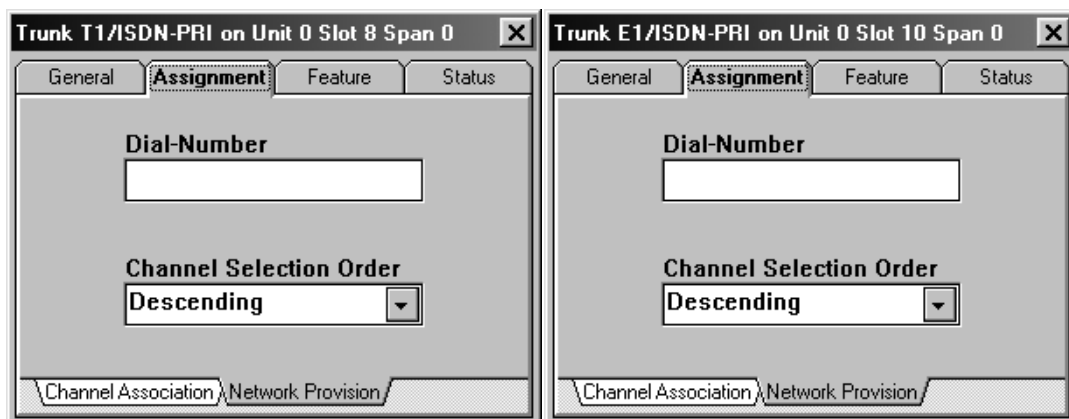


Table 11 - 3

Dial-Number (Glossary page 22)	T-1	E-1
The main directory number for the PRI This number is presented to the network on outbound calls in the absence of an Outbound Caller-ID tag.	up to 20 digits	up to 20 digits
Channel Selection Order (Glossary page 22. See also "Key Telephone Call Appearance" in the Glossary)		
The direction in which the B-channels are used for outbound calls.	Descending* Ascending	Descending* Ascending

* = default settings

11.5.5 Feature

The feature tab includes a programmable timing parameter and a checkbox to enable/disable en-bloc dialing.

T-1 Carrier

E-1 Carrier

Table 11 - 4 ISDN PRI: Feature

Dial Timeout	T-1	E-1
The period of time that must elapse before the system assumes that the user is finished dialing.	6 sec* Range: 0-255 sec	6 sec* Range: 0-255 sec
En-Bloc Dialing Enabled (Glossary page 23)		
Enables/disables en-bloc dialing. En-bloc dialing is the recommended dialing method on an ISDN PRI.	Enabled* Disabled	Enabled* Disabled

* = default settings

11.5.6 Call Routing

In order to use Calling Number Delivery and Called Party Number information to route calls, you must first establish a relationship between each calling number/called party number and the user, user group, or other system entity to which you want the call routed. These relationships are defined on the system's route map. See System Parameters: Route Map in the Software Configuration section of the Plexus System Manual.



If you obtain a large enough block of directory numbers from the provider, a unique number can be assigned to each user on the system. Using the Called Party Number information received on the D-channel and a DNIS assignment on the system's route map, calls can then be directly routed to users based on the number dialed, as on a DID trunk. If the user's assigned directory number corresponds with their Outbound Caller-ID tag, return calls can be placed to the user based on the Caller ID.



Note

Check with your provider about getting additional directory numbers. Typically, directory numbers are available in blocks.

11.5.7 Outbound Caller-ID tag

An Outbound Caller-ID tag should be defined for each user that will be placing calls on the PRI [see User: Feature in the Software Configuration section of the Plexus System Manual]. If the Outbound Caller-ID tags correspond to legitimate directory numbers, the number is typically forwarded on outbound calls as the Caller ID¹. If the Outbound Caller-ID tags are not directory numbers, they can still be used to track calls on a user-basis as many providers record the Outbound Caller ID data and present it on their billing statements.

1. Check with your provider.

11.6 Status Monitoring

Plexus Administrator provides an interface which can be used to monitor the real-time status of your installed and configured PRI.

To monitor your PRI, proceed as follows:

- 1 Launch Plexus Administrator.
- 2 Open the appropriate configuration file.
- 3 Select **Open** from the Link menu.
- 4 Click on either port on the image of the ISDN PRI card.
- 5 Click on the **Status** tab.

11.6.1 Status

The status tab includes a status indicator for each installed span.

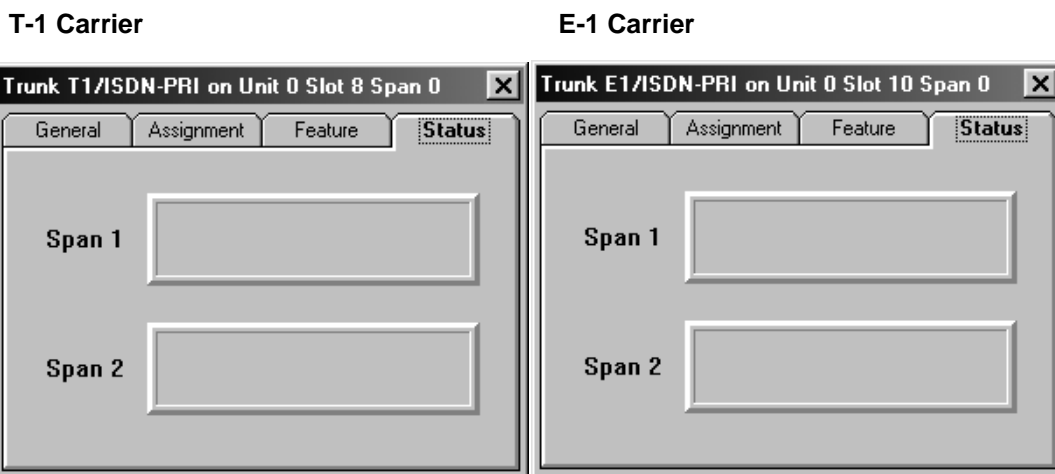


Table 11 - 5 ISDN PRI: Status

Span #	T-1 / E-1
Indicates the state of the signal on the corresponding span and the number of channels currently in use. Different colors indicate different states.	Green = good signal Red = no signal



11.7 Glossary

11.7.1 Called Party Number

Also known as DNIS; the number that the caller dialed.

11.7.2 Calling Number Delivery

Also known as ANI and Caller ID; the caller's phone number.

11.7.3 Channel Selection Order

The Channel Selection Order has to do with the direction the channels are used for outbound calls. Channels can be used in an ascending direction or in a descending direction. For each outbound call, the PRI card requests the next available channel in the selected direction. For example, on a T-1 carrier, if descending is selected and channels 22 and 23 are in use, the Plexus will request channel 21. Note that the central office can grant or deny the channel request.

To avoid glare, opposite directions should be selected for inbound and outbound calls. When you activate your PRI, your provider may allow you to choose the direction channels are selected for inbound calls. Inbound calls typically select channels in an ascending direction.

11.7.4 Clear

Indicates that only user data is on these channels; no bits are robbed or stuffed for signaling or framing.

11.7.5 Dial-Number

The Dial-Number is the main directory number associated with the PRI and the number presented to the network on outbound calls for Caller ID purposes. Calls made by users with an assigned Outbound Caller-ID tag that corresponds to a legitimate directory will present their tag instead of the Dial-Number.

The **main directory number** is also referred to as "Billing Telephone Number (BTN)" and "Telephone Line Identification (TLI)."

11.7.6 DNIS

Dialed Number Identification Service; the number that the caller called.

11.7.7 En-Bloc vs. Overlap

En-bloc and overlap are methods of sending the dialed digits to the central office on an outbound call. The en-bloc method sends the complete number in a single setup message. Dialed numbers are essentially buffered until dialing is complete; similar to dialing a number on a cell phone and then pressing send. The overlap method sends the number in separate messages, one digit at a time. En-bloc is the universally required method on an ISDN PRI. Overlap on PRI will only work in special, customized applications.



Note

Users can indicate that they are done dialing by pressing #. The system will immediately send the en-bloc message (i.e., the dialed number) when it detects the #, otherwise the message is not sent until the dial timeout expires.

11.7.8 Fractional T-1/E-1

A span with less than the full number of channels enabled.

11.7.9 Glare

Collisions resulting from an attempt to seize a channel on which an inbound call is being received.

11.7.10 HDB-3 and B8ZS compared

The primary difference between HDB-3 used on E-1 and B8ZS used on T-1 are the number of consecutive zeros they allow. HDB-3 replaces 4 consecutive zeros with a bipolar violation (successive pulses with the same polarity). B8ZS replaces a string of 8 zeros with a pre-defined bit pattern.

11.7.11 ISDN

Integrated Services Digital Network

11.7.12 Key Telephone Call Appearance

The following configuration is recommended in order to maximize call appearance on key telephones connected to the system.

- Select **Descending** for the Channel Selection Order.
- Create a single trunk group for all of the trunks assigned to the PRI.



- Assign the trunks to the trunk group in ascending order.
- Request that your provider implement ascending channel selection for inbound calls.

This configuration causes both inbound and outbound calls to be assigned to the trunks in an ascending direction. Each new call is assigned to the first available trunk in ascending order. Therefore, even with a limited number of DTS keys, the majority of calls will have an associated call appearance.

The following narratives and diagrams illustrate the benefits of the recommended configuration.

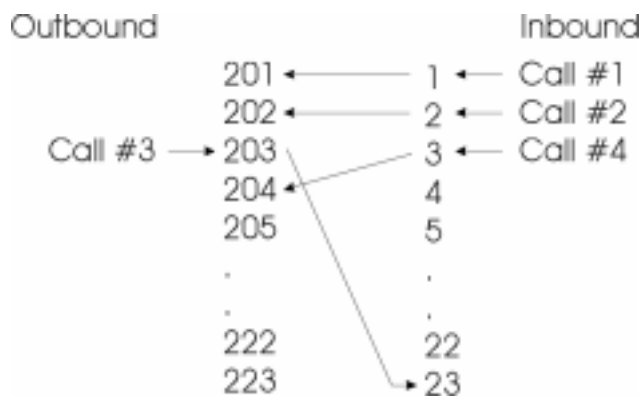


Table 11 - 6 Frame 1

- 1 Inbound call comes in on channel 1 and is assigned to trunk 201.
- 2 Inbound call comes in on channel 2 and is assigned to trunk 202.
- 3 Outbound call is placed. Trunk 203 is assigned to the call and the Plexus system requests and ultimately seizes channel 23.
- 4 Inbound call comes in on channel 3 and is assigned to trunk 204. Trunk 204 is the first available trunk, not necessarily the trunk that we assigned to the channel.



Note

There is no physical relationship between the trunks and the channels (see "Trunk Assignment page 17).

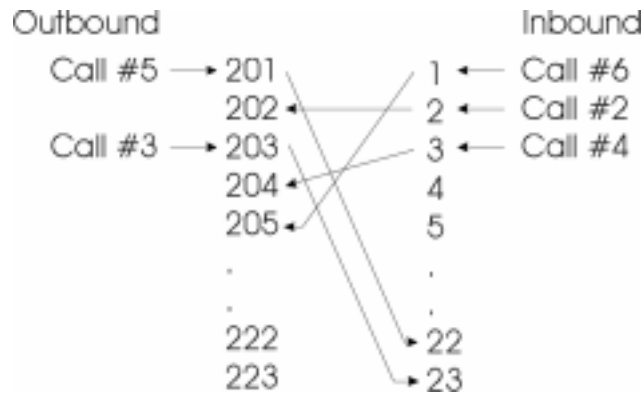


Table 11 - 7 Frame 2

- 5 Call #1 completes.
- 6 Outbound call is placed. Trunk 201 (the first available trunk) is assigned to the call and the Plexus system requests and ultimately seizes channel 22 (the first available channel in the descending direction).
- 7 Inbound call comes in on channel 1 and is assigned to trunk 205. Once again, trunk 205 is the first available trunk, not necessarily the trunk that we assigned to the channel.



11.7.13 Line Build-Out

A Line Build-Out (LBO) attenuates the signal transmitted by the PRI card (T-1 carrier only). LBO simulates cable loss to ensure that network equipment can properly receive and handle the transmitted signal. There are various equations used to determine the LBO value that is needed to properly attenuate a signal. Fortunately, your provider's installation personnel are responsible for informing you as to which LBO code applies at your installation. This information is used to determine the option you select in Plexus Administrator, as follows:

Code	Setting	w/ additional cable loss of 7.5 - 13.0 dB	w/ additional cable loss of 15.0 - 20.5 dB
A	0.0 dB	0.0 dB	0.0 dB
B	-7.5 dB	0.0 dB	0.0 dB
C	-15.0 dB	-7.5 dB	0.0 dB

Additional cable loss is achieved by moving the Plexus system further from the demarcation point. Unless the system needs to be relocated, it is recommended that you go with the advised code and retain the current position of the system. Otherwise, you will need to measure cable loss and determine whether you need to modify the LBO setting.



Note

The -22.5 dB setting is typically not used and is reserved for special applications.

11.7.14 Line Code

The line code has to do with how the binary data is coded. The line code options were developed in response to different challenges identified in receiving and synchronizing on the data bit pattern. AMI (alternate mark inversion) manipulates the data by reversing the polarity of successive 1's or marks. This helps the receiving equipment to maintain a zero voltage reference point.

B8ZS (binary 8-zeros suppression) and HDB3 (High Density Bipolar 3-zeroes), both developed subsequent to AMI, deal with “ones density” - the frequency of 1’s in the data bit pattern. Ones density is important because PRI devices synchronize by tracking the 1’s. A long string of 0’s increases the likelihood that a device will be unable to maintain synchronization. While today’s equipment is better able to deal with a long string of 0’s, B8ZS and HDB3 are still viewed as improved line code alternatives and are therefore recommended.

The most important consideration when selecting the line code option is that the same option be used on both ends. Therefore, make sure that you and the provider agree on the selected option.

11.7.15 POTs:

Plain Old Telephone lines.

11.7.16 PRI

Primary Rate Interface

11.7.17 Span

A group of channels or time slots.

11.7.18 Terminal-Endpoint ID

The Terminal-Endpoint ID (TEI) is a logical identifier that must be set for each device connected to an ISDN line. The central office uses the ID to identify the different devices so that it can maintain the necessary number of logical links on the D-channel.

The Plexus ISDN PRI card is "Nonautomatic TEI assignment user equipment" which means that a TEI must be manually programmed. TEIs 0-63 are allocated to this class of equipment.

Since PRIs are typically used as trunks connected to a single PBX, a ‘0’ setting is usually acceptable. Note, however, that a manually programmed TEI must be verified and accepted by the central office prior to its use. Therefore, you should discuss the TEI value with your provider when you activate service.



Note

TEI settings are more important in the case of BRI, where up to 8 devices can be connected to a single ISDN. However, most BRI equipment is "Automatic TEI assignment user equipment," which means it is capable of requesting an automatic TEI assignment from the central office.

