T-1 / E-1 CAS

10

10.1 Overview

Channel Associated Signaling (CAS) is a generic name for a signaling method used on T-1 and E-1 carriers. While there are clear differences in the signaling methods used on the two carriers, they do both provide signaling information on a per-channel basis.

T-1 uses Robbed Bit Signaling (RBS). This method utilizes all 24 channels for voice, data, and signaling. Signaling between the central office and the customer equipment is accomplished through a combination of in-band DTMF/MF tones and bit robbing. Depending on the framing format being used (D4 or ESF), the least significant bits of certain frames are robbed and used for signaling. Framing is accomplished by inserting framing bits between each frame.

E-1 provides 30 "clear" channels for voice and data. The two remaining channels are reserved for framing and signaling. Despite the appearance of a common signaling channel, E-1 still qualifies as CAS because the signaling channel sends channel associated signaling bits.

CAS Carriers Compared		
	T-1	**E-1**
Total Channels	24	32
Usable Channels	24	30
Total Bandwidth	1.544 Mbps	2.048 Mbps
User Data Rate	1.536 Mbps	1.920 Mbps
Framing Method	in-band framing bits	dedicated channel (time slot 0)
Signaling	in-band DTMF/ tones and bit robbing	in-band MFC/DTMF tones and dedicated channel (time slot 16) for supervision bit signaling

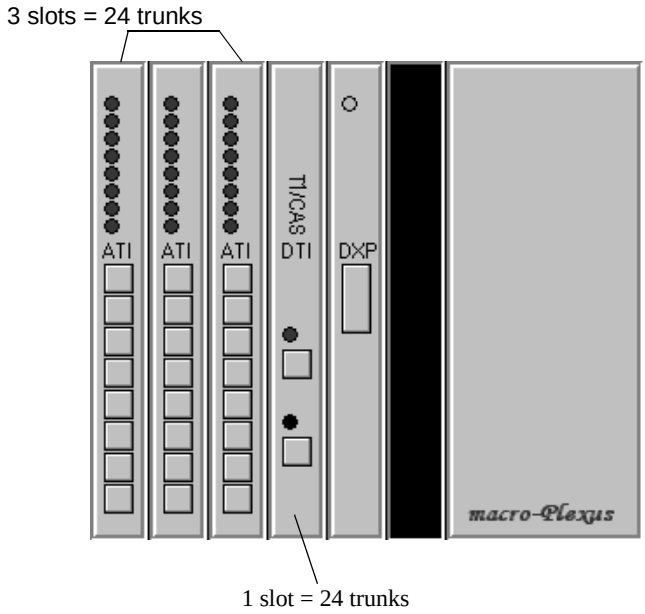
This chapter covers installation, configuration, and troubleshooting for both the T-1 and the E-1 digital trunk interfaces. The chapter includes the following sections:

Features and Advantages	A brief discussion of the main features and advantages of T-1 and E-1.
Hardware Description	A description of the hardware, including connectors, LEDs, and the applicable specifications.
Installation	Instructions on installing the 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 and using the diagnostics available in Plexus Administrator.
Glossary of Common Terms	Definitions of many of the terms used in this chapter. Look here for detailed information about concepts you may encounter when ordering, installing, or configuring your T-1 or E-1 carrier.

10.2 Features and Advantages

The primary incentive for using T-1 or E-1, rather than analog POTs, is cost reduction. In many markets, these digital carriers are less expensive than the equivalent number of POTs lines.

Another advantage of T-1 and E-1 is that they allow users to make more efficient use of switch resources. Slots 8 and 10 in the Plexus system cabinet are designed to accommodate up to thirty channels each, to a total of sixty channels. Therefore, thirty trunks can be made available to a system using a single slot in the cabinet. By comparison, 4 slots would be needed to make this many trunks available using analog, 8-port CO cards.



T-1 makes more efficient use of the available card slots.

Note
In the case of T-1, one slot could provide up to 24 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 T-1 or E-1 for voice transmission are mostly economic, there are also call routing and billing features that may prove valuable in some applications.

ANI and DNIS are often available on T-1 and E-1 carriers. The information provided by these services 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.

Note
ANI and DNIS information is sent in-band (on the voice channels) on T-1 and E-1 carriers. MFC signaling is used on E-1 and DTMF tones are used on T-1. The format of the DTMF string sent on a T-1 is *ANI*DNIS*.

Calls made on an E-1 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 E-1 they may be sent as the Caller ID information[1]. 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.

1. Check with your provider.

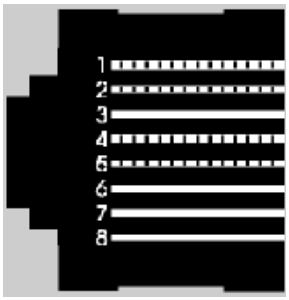
10.3 Hardware Description

The T-1 and E-1 peripheral cards are available with support for one full or fractional span.

All of the resources necessary to connect directly to the network interface are provided on the cards. For example, the CSU/DSU is fully-integrated on the T-1 card. The use of additional equipment, such as an external CSU or channel bank is not required and could complicate system setup.

10.3.1 Connectors

The T-1 and E-1 peripheral cards include up to two 8-pin connectors wired to the RJ48X standard (EIA TIA 568B compatible). The pin out of the connectors is as follows:

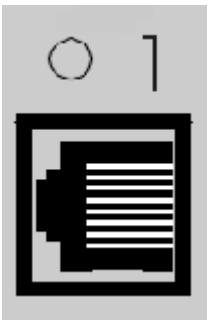


RJ48X connector

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

10.3.2 LEDs

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



Connector and LED

Flash Cycle (in seconds)	Status
1/4 ON, 1/4 OFF	Functioning, but not receiving or misconfigured (i.e., no frame alignment)
1 ON, 1 OFF	OK
2 ON, 2 OFF	In loopback mode (see “Line LB” and “Payload LB” on page 25) Only applies to T-1.
2 X 1/4 ON, 1/4 OFF, 1 X 1/4 ON, 3/4 OFF (3 rapid flashes, pause)	Not properly communicating with the digital switch processor (DXP). This can happen if the loaded XOS version is not compatible with digital trunks
OFF	Not functioning

10.3.3 Specifications

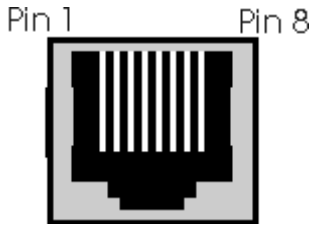
ITU-T I.431
ITU-T G.703 and G.704
ITU-T Q.930 (I.450) and Q.931 (I.451)

10.4 Installation

Carrier installation 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 carrier is terminated is called the network interface or 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 card.

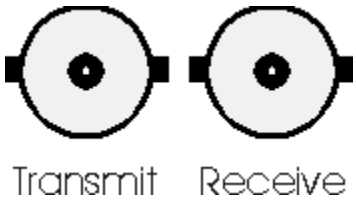
Demarcation

T-1 Carrier



8-pin

E-1 Carrier



Coaxial

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

Coaxial to 8-pin converter

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

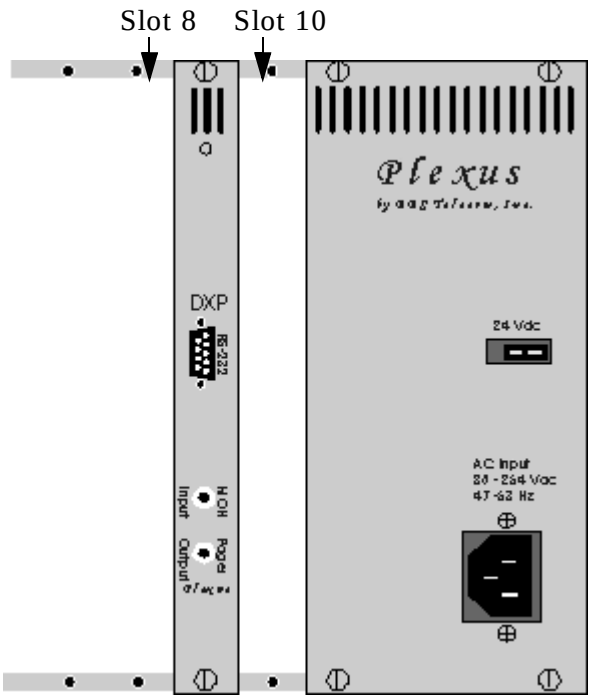
10.4.1 Inserting the card

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.



T-1 and E-1 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.

10.4.2 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.

Card-to-Network Interface Straight Through	
1	1
2	2
4	4
5	5

Card-to-Card (Tie-Line Application) Crossover	
1	5
2	4
4	2
5	1

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.

10.4.3 Activating service

As soon as the 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 both T-1 and E-1 carriers 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 carrier will not function properly.

In some cases, the options selected are up to the customer. Therefore, you may want to review the glossary beginning on page 27 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
DID Size	1-10 digits	1- 10 digits
Framing Format	ESF D4	N/A
CRC-4 Frame Align	N/A	Yes No
Circuit Signaling	E&M - Wink Start E&M - Delay Start E&M - Immediate Start Loop Start Ground Start	N/A
Signal Type	N/A	MFC DTMF The E-1 card only supports R2 signaling. R1 is not supported.
Register Signaling	N/A	Brazilian Signaling ITU Generic Korean Signaling TELMEX Signaling Other[a]
MFC Timing	N/A	Max ON = Min Cycle =
Line Build-Out	Ask installers for code.	N/A
Flash Period	milliseconds	milliseconds
DTMF Timing	On = Off =	On = Off =

Parameter	Options	
Main Directory Number		
Other Directory/DID Numbers		
ANI	Yes No	Yes No
DNIS	Yes No	Yes No
Raw-DID enabled	Yes No	N/A

a.Contact BBS Telecom for assistance in developing a register signaling profile. Exact specifications from the carrier will be required

10.5 Configuration

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

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 T-1/E-1 card, as follows:

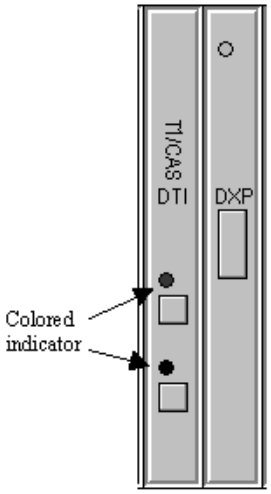
1. Click on the port on the image of the card.
2. Click on each tab and address each parameter in the order that they are presented.

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 T-1 / E-1.

10.5.1 The T-1 / E-1 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.



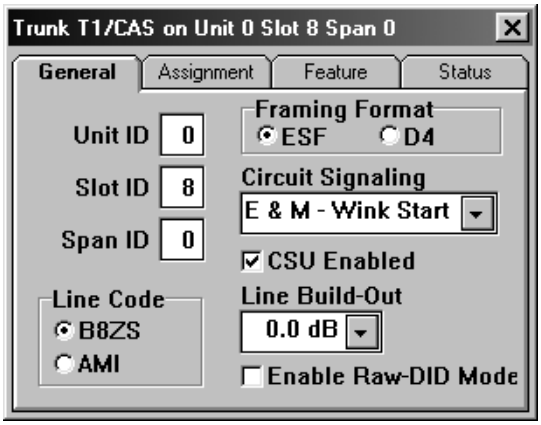
Red – No channels have been mapped to trunks.
Green – At least 1 channel has been mapped to a trunk and all mapped channels are enabled.
Yellow – At least 1 channel that has been mapped to a trunk has been disabled.
Black – The span is not active / available

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.

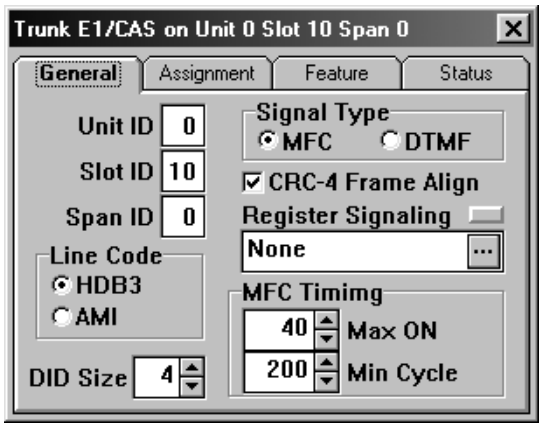
10.5.2 General

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. Values can be increased or decreased, 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



This version of the General window will appear when "Enable Raw-DID Mode is selected.

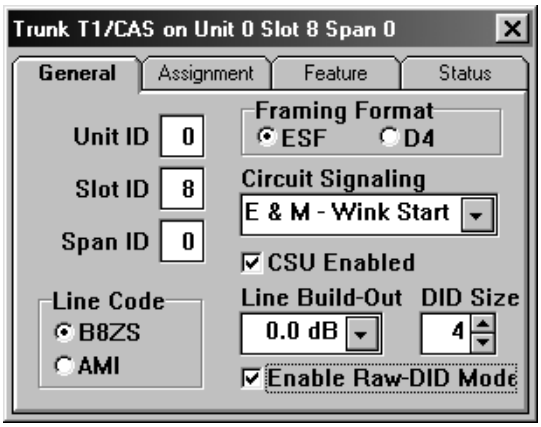


Table 10 - 1 T-1/E-1 CAS: General

Unit ID	T-1	E-1
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

Table 10 - 1 T-1/E-1 CAS: General

Span ID		
Logical identifier for the span being configured.	Automatically Assigned	Automatically Assigned
Line Code (Glossary page 31)		
Method of manipulating the bit pattern to maintain synchronization between the central office and the card.	B8ZS* AMI	HDB3* AMI
DID Size (Glossary page 27)		
The number of digits of the dialed number that the central office will send with a call.	4* Range: 1-10	4* Range: 1-10
Framing Format (Glossary page 29)		
Method of organizing the bit pattern so that the receiving end can identify the channel (time slot) from which the data was sampled.	ESF* D4	N.A.
Signal Type (Glossary page 32)		
The type of in-band signaling. MFC is the standard in-band signaling used on E-1 card-to-network interface applications. The selected option applies to all channels on the span.	N.A.	MFC* DTMF
CRC-4 Frame Align		
Instructs the card to send cyclic redundancy check (checksum) information to the central office.	N.A.	Disabled* Enabled
Circuit Signaling (Glossary page 27)		
The type of line interface to emulate. The selected option applies to all channels on the span.	E & M - Wink Start* E & M - Delay Start E & M - Immediate Start Loop Start Ground Start	N.A.

Table 10 - 1 T-1/E-1 CAS: General

Register Signaling (See "Signal Type" on page 32.)		
The MFC signaling profile that will be used. New profiles can be generated by double-clicking on any of the selections and modifying the category/tone relationship.	N.A.	None* Brazilian Signaling ITU Generic Korean Signaling TELMEX Signaling
CSU Enabled		
Defines if the card is acting as the CSU or if there is an external CSU.	Enabled* Disabled	N.A.
Line Build-Out (Glossary page 30)		
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	N.A.
MFC Timing - Max ON (See "Signal Type" on page 32.)		
The maximum allowed duration for MFC signals sent on the E-1 carrier. A certain duration may be mandated by the provider.	N.A.	40 sec* Range: 1-255 sec
MFC Timing - Min Cycle (See "Signal Type" on page 32.)		
The minimum allowed duration for a forward/backward MFC cycle. A certain duration may be mandated by the provider.	N.A.	200 msec* Range: 1-1000 msec
Enable Raw-DID Mode		
Enables the T-1 to act as a tie line between two systems or to accept digits in a non-standard form from the service provider. ***NOTE***: ANI and DNIS digits should sent in the format *ANI*DNIS*. If your provider is only sending DID with no ANI or *s (or any set of raw digits), select this mode. If this mode is enabled, ANI/DNIS capture is unavailable.	Enable Disable*	N.A.

* = default setting

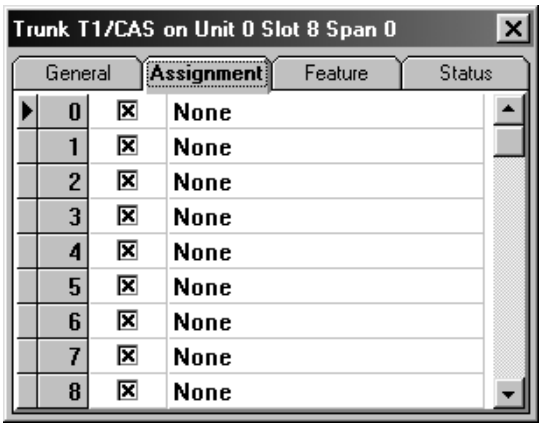
10.5.3 Assignment

The assignment: channel association tab includes checkboxes for enabling and disabling channels and pull-down menus for assigning trunks to channels. Channels are enabled and disabled based on the number of channels provided with the span.

Tip

To quickly assign a range of trunks to the enabled 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.

T-1 Carrier



E-1 Carrier

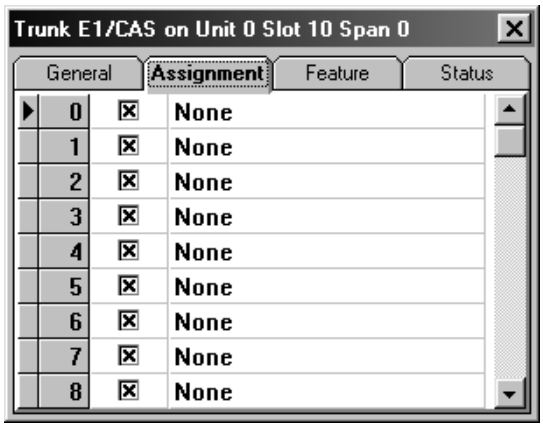


Table 10 - 2 T-1/E-1 CAS: Assignment

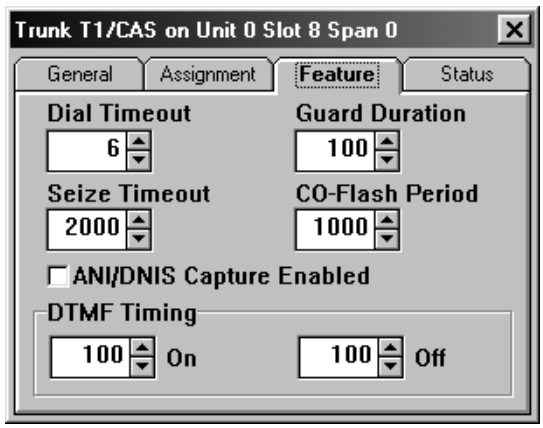
Channel ID	T-1	E-1
Channel identifier.	0 - 23, 23*	0 - 29, 29*
Checkbox		
Enables/disables the corresponding channel. All channels should be enabled for full spans. A subset of the channels is enabled for fractional spans.	Enabled* Disabled	Enabled* Disabled
Trunk Assignment Pull-Down		
The pull-down menu is used to assign a trunk to each channel. A 1-to-1 relationship must exist between trunks and channels.	None* Trunk ID	None* Trunk ID

* = default setting

10.5.4 Feature

The feature tab includes a checkbox to enable ANI and DNIS capture and several programmable timing parameters. The timing parameters 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

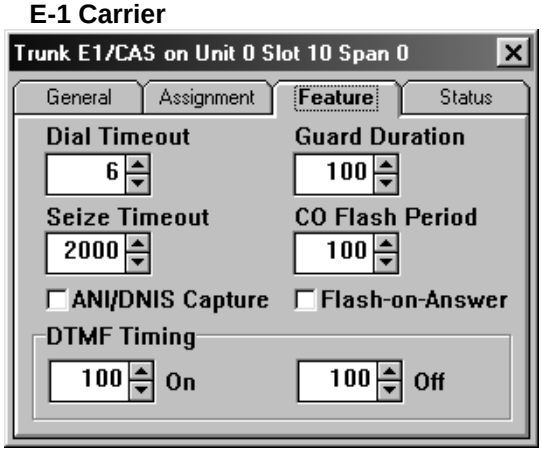


Table 10 - 3 T-1/E-1 CAS: Feature

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
Guard Duration		
The period of time that a channel is unavailable for placing an outbound call upon completion of a previous call. The guard duration prevents call collisions.	100 msec* Range: 0-65535 msec	100 msec* Range: 0-65535 msec
Seize Timeout		
The period of time that the system will wait when attempting to seize a channel to make an outbound call.	200 msec* Range: 50-2000 msec	200 msec* Range: 50-2000 msec

Table 10 - 3 T-1/E-1 CAS: Feature

CO Flash Period		
The on-hook duration that the central office interprets as a flash signal. This timing parameter varies from one central office to another.	1000 msec* Range: 50-2000 msec	100 msec* Range: 50-2000 msec
ANI/DNIS Capture Enabled		
Instructs the card to look for ANI and DNIS information on incoming calls. If you are receiving ANI and/or DNIS on your T-1, this parameter should be enabled. ***NOTE:*** The ANI/DNIS digits should be sent in the standard format *ANI*DNIS*. If ANI or DNIS is not available, the digits should be sent as **DNIS* or *ANI**, respectively. If Enable Raw-DID Mode is enabled, this selection will be unavailable.	Disabled* Enabled	Disabled* Enabled
Flash-on-Answer		
Used to "flash" the CO on seizing an inbound call. This is used to signal the CO to reject certain types of calls (e.g., collect calls).	N.A.	Disabled* Enabled
DTMF Timing		
The duration of a regenerated DTMF digit (On) and the interdigit period (Off) when dialing a string.	100 msec* 50-255 msec	100 msec* 50-255 msec

* = default setting

10.5.5 Call Routing

In order to use ANI and DNIS information to route calls, you must first establish a relationship between each 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 DNIS information and an 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 [E-1 only].

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

10.5.6 Outbound Caller-ID tag

An Outbound Caller-ID tag should be defined for each user that will be placing calls on an E-1 [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 ID[1]. 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.

10.6 Status Monitoring & Troubleshooting

Plexus Administrator provides an interface which can be used to monitor the real-time status of your installed and configured carriers. In the case of T-1, real-time diagnostics are provided to assist in troubleshooting.

To monitor your carrier, 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 card.
5. Click on the **Status** tab.

10.6.1 Status

The status tab includes a status indicator for each installed span. In the case of T-1, several indicators provide real-time diagnostic information about the state of both the received and the transmitted signal.

T-1 Carrier

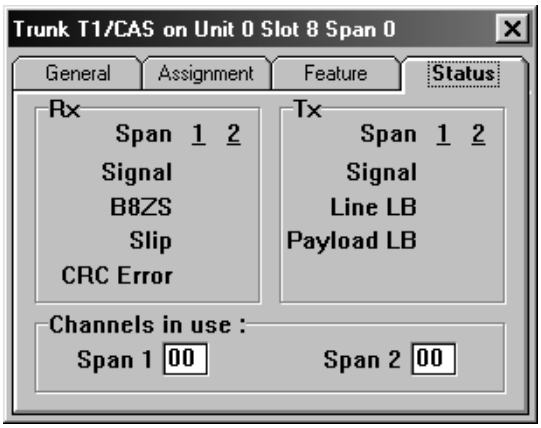


Table 10 - 4 T-1 CAS: Status - Receive (Rx)

Signal	
Indicates the state of the received signal on the corresponding span. Different colors indicate different states.	**Green** = properly framed signal, no alarm conditions. **Yellow** = properly framed signal, alarm condition. Alarm conditions can occur for several reasons, such as a loss of signal defect or during maintenance. **Blue** = unframed. During maintenance, an unframed signal may be received. **Red** = no signal.
B8ZS	
Indicates that a B8ZS bit pattern was detected on the corresponding span. If you are using AMI line code, no indication should ever be displayed. If an indication is received in such a case, you should check to make sure that the carrier is, in fact, using AMI.	**Red** = B8ZS bit pattern detected.
Slip	
Indicates that a received frame was either replicated or deleted. This can occur when there is a difference between the timing of a synchronous receiving terminal and the received signal.	**Red** = Slip error detected.
CRC Error	
Indicates that a received cyclic redundancy checksum (CRC) is not identical to the corresponding locally-calculated checksum. CRC Errors are only detected when using the ESF framing format.	**Red** = CRC error detected.

Table 10 - 5 T-1 CAS: Status - Transmit (Tx)

Signal	
Indicates the state of the received signal on the corresponding span. Different colors indicate different states.	**Green** = properly framed signal, no alarm conditions. **Yellow** = properly framed signal, alarm condition. **Blue** = unframed.
Line LB	
Indicates that the corresponding span is currently in line loopback mode. The provider initiates a loopback to perform diagnostic testing on a T-1 carrier. A line loopback results in a full 1.544 Mbit/s loopback of the signal received at the card.	**Red** = line loopback in progress.
Payload LB	
Indicates that the corresponding span is currently in payload loopback mode. A payload loopback results in a 1.536 Mbit/s loopback of the signal received at the card, maintaining bit-sequence integrity. Payload loopbacks can only be performed on a T-1 using the ESF framing format.	**Red** = payload loopback in progress.
# Channels in use	
This shows the number of channels currently in use on the T-1. This can be used to monitor system call load or when doing system maintenance.	0-23

E-1 Carrier

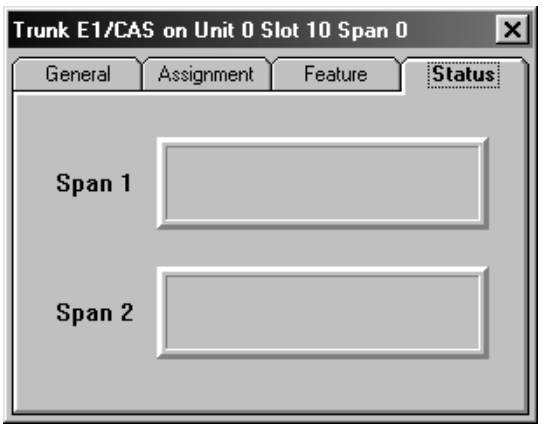


Table 10 - 6 E-1 CAS: Status

Span #	
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

10.7 Glossary

10.7.1 ANI

Automatic Number Identification; the caller's phone number (per directory listing)

10.7.2 Circuit Signaling

Circuit signaling refers to the type of line interface that the T-1 will emulate. The Plexus T-1 card is capable of emulating the following line interfaces:

- E&M – Wink Start
- E&M – Delay Start
- E&M – Immediate Start
- Loop Start
- Ground Start

The type of circuit signaling you select depends on the signaling information required by your application.

10.7.3 Clear

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

10.7.4 DID

See DNIS.

10.7.5 DID Size

The DID Size indicates the number of digits of the dialed number that the central office will send on an incoming call. For example, if the dialed number was 328-9500 and the DID Size was 4, the central office would send 9500 (i.e., the numbers at the end of the string).

The delivery of the dialed number information is also known as Dialed Number Identification Service (DNIS). On an E-1, this information is sent using the forward/backward methodology of MFC signaling. In the example above, the receiving end would indicate that it had all the numbers that it needed after receiving the second "0." At this point, it would request that the central office send any caller ID information.

When activating service, make sure to ask your provider what DID Size is applicable on your T-1 / E-1 carrier.

10.7.6 DNIS

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

10.7.7 E&M

The E&M interfaces are the simplest and most commonly used on T-1 carriers. E&M can communicate only two states, on-hook and off-hook, between the transmitting and receiving ends.

The differences between the three supported E&M interfaces has to do with channel seizure. Wink start requires a "wink" from the receiving end to acknowledge seizure before any further signals can be sent from the transmitting device. Delay start requires a wink followed by a fixed delay before the transmitting device can proceed. The delay gives the receiving device time for set up. Immediate start requires neither a wink nor a delay. The transmitting device can immediately send signals such as DTMF upon channel seizure. Immediate start is not frequently used because of the lack of handshaking signals which can cause signaling to be lost and a higher incidence of mis-routed calls.

The signaling on all of the supported E&M interfaces is symmetrical between the transmitting and receiving ends. E&M interfaces give clear answer/ disconnect supervision.

Note
Plexus tie-line applications must use one of the supported E&M interfaces. Loop start and ground start are only supported for T-1 card-to-network interface applications.

10.7.8 Fractional T-1/E-1

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

10.7.9 Framing Format

All of the bits transmitted on a T-1 carrier are meaningless unless the equipment at the receiving end knows how they are organized. Framing is what supplies organization to the bits. The Plexus T-1 card supports two common framing formats, superframe (D4) and extended superframe (ESF).

A frame contains an 8-bit sample from each of the time slots or channels, plus a single framing bit (193 bits in total). The framing bit allows the receiving equipment to identify the beginning of a frame.

The D4 format groups frames into blocks of 12. These blocks are called superframes. The framing bits in each superframe repeat a defined sequence that the receiving equipment uses to locate the framing bit. Signaling is accomplished by 'robbing' the least significant bit in the 6th and 12th frame (hence the name, Robbed Bit Signaling) from each channel in the superframe. By robbing two bits from each channel, four different states may be represented: 00 (on hook), 01, 11 (off hook), and 10.

The extended superframe (ESF) format improves upon the D4 format in several ways. First, it doubles the number of frames in the superframe from 12 to 24. This enables two more bits (in frames 18 and 24) to be used for signaling thereby expanding the states that may be represented. Second, ESF only uses every fourth framing bit for synchronization (6-bit framing pattern). This leaves 6,000 bit/s for new functions, primarily diagnostics and statistics. 2,000 of these bits are used for continuous error checking and the remaining 4,000 are used by the network for performing loopbacks and measuring various statistics.

In applications where only voice is being transmitted, D4 is adequate. For applications involving the transfer of large amounts of modulated data (i.e., using modems), ESF is the better choice. As is the case with line code, the most important consideration is that the framing format be the same on both ends. Therefore, make sure that you and your provider agree on the selected option.

10.7.10 Glare

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

10.7.11 Ground Start

The ground start option, like the loop start option, is not symmetrical. The network side of a ground start T-1 carrier can signal loop current feed, open loop current, and ringing. The card side can signal on-hook, off-hook, and service request. Disconnect supervision is available with ground start signaling and protection from glare is provided. ANI and DNIS are not available.

10.7.12 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.

10.7.13 In-band vs. supervision bit

In-band signaling occurs on the 30 voice channels. Supervision bit signaling is the signaling that takes place on time slot 16.

Note
The Plexus E-1 card only supports R2 signaling. R1 is not supported.

10.7.14 Line Build-Out

A Line Build-Out (LBO) attenuates the signal transmitted by the card (T-1 carrier only). LBO simulates cable loss to ensure that network equipment can properly receive and handle the transmitted signal. There are all sorts of 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.

10.7.15 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 T-1 and E-1 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.

10.7.16 Loop Start

The loop start option emulates the line interface found on a typical analog POTs line. Loop start signaling is not symmetrical with regard to the states communicated between transmitting and receiving ends. The network side of a loop start T-1 carrier can signal loop current feed and ringing. The card side can signal on-hook and off-hook. Disconnect Supervision, ANI, and DNIS are not available with loop start signaling and glare is not inhibited.

10.7.17 MFC Signaling

MFC signaling uses a standard set of tones to communicate between the E-1 card and the central office. Different countries and providers assign different messages to the tones. Therefore, it may be necessary to map the different messages to the tones and create a profile. Several pre-defined mappings are provided.

MFC signaling uses a forward (from the sending side) /backward (from the receiving side) methodology.

10.7.18 POTs

Plain Old Telephone Lines

10.7.19 Signal Type

The signal type option on an E-1 carrier refers to the in-band signaling on an E-1 carrier and is analogous to the circuit signaling option on a T-1. The choices are Multi-Frequency Compelled (MFC) or Dual Tone Multi-Frequency (DTMF). MFC is the required method for E-1 card-to-network interface applications in most countries. DTMF is used in some countries, but is more commonly used for tie-line applications.

10.7.20 Span

A group of channels or time slots.

10.7.21 Wink

A rapid off-hook, on-hook combination.