



Configuration Guide

PRI Signaling for DSX-1

This Configuration Guide explains how to properly set up a DSX-1 interface for Primary Rate ISDN (PRI) signaling on the Total Access 900(e) Series products. It helps users understand the purpose of a DSX-1 interface as well as locate the interface(s) on Total Access 900(e) products. The step-by-step instructions guide users through configuration of the DSX-1 interface via the Command Line Interface (CLI).

The Total Access 900(e) Series products are Integrated Access Devices (IADs) that combine data and voice into a single platform controlled by the ADTRAN Operating System (AOS). For detailed information regarding specific command syntax, refer to the *AOS Command Reference Guide* available on the *ADTRAN OS System Documentation* CD shipped with your unit or on line at www.adtran.com.

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Defining and Locating the DSX-1 Interface

The DSX-1 interface allows DS0s to be provided to a customer's voice terminating equipment such as a PBX or Key system. (See Figure 1.) The Total Access 900 Series products have a DSX-1 interface (labeled **DSX-1 T1 0/2**) on the back of the unit. The Total Access 900e Series products allow two simultaneous DSX-1 connections to customer equipment. These interfaces are also located on the back of the unit and are labeled **NET 3 T1 0/3** and **NET 4 T1 0/4**. A bracket below the two interfaces identifies them as able to support Primary Rate ISDN/Communicating Application Specification (PRI/CAS).

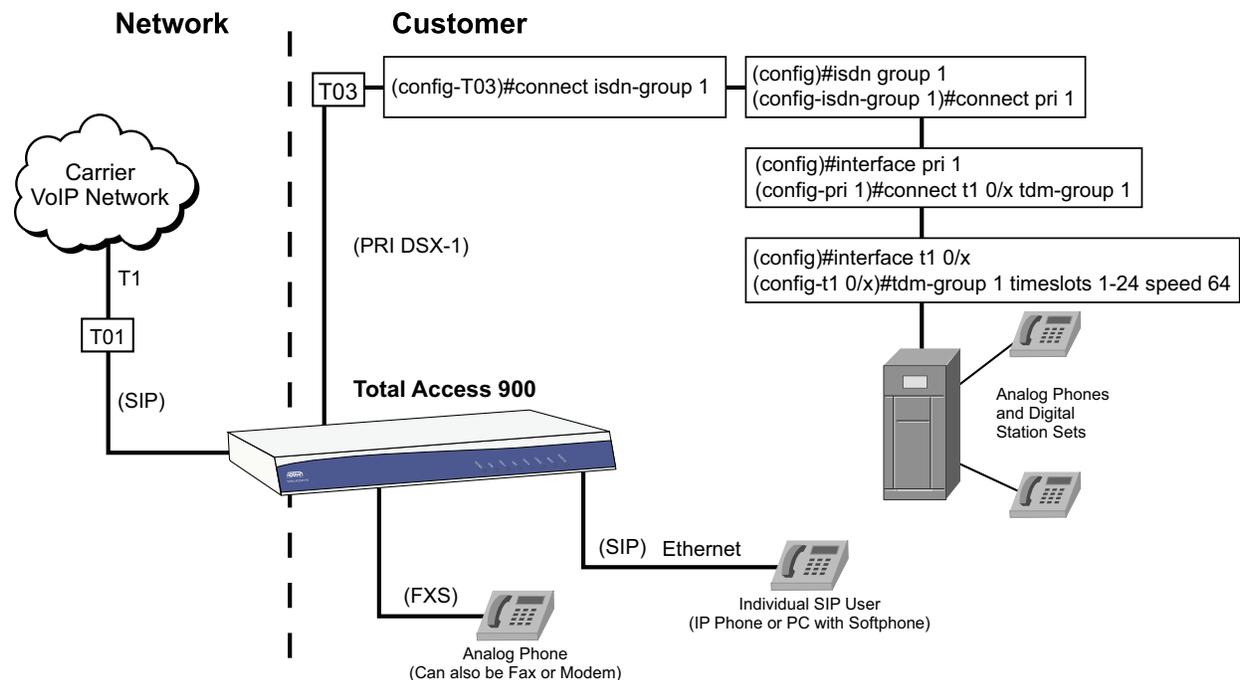


Figure 1. Typical Setup



Throughout this guide, references to DSX-1 configuration on the Total Access 900e Series refer to the connection from the unit to a PBX or key system (which is typically a crossed over short-haul DSX-1). Keep in mind that the T1 0/3 and T1 0/4 interfaces on the Total Access 900e Series products are true long-haul T1 ports; thus the wire pairs are not crossed over. The two interfaces are capable of supporting data, RBS, or PRI signaling. Line build out can be adjusted, if necessary.

Configuring the DSX-1 Interface



The commands and context in this guide pertain specifically to configuration of the DSX-1 interface for PRI signaling on the Total Access 900(e) Series products.

The PRI DSX-1 interface configuration is defined by a series of cross-connects that begin with the physical interface and end with an ISDN group. The following steps guide you through this process, noting important points and caveats along the way.

Configuring a Single PRI DSX-1 Interface

Follow the steps below to configure a single DSX-1 interface:

1. Configure the physical DSX-1 interface. Since the T1 carries the PRI signal, it is logical to set up the physical DSX-1 interface first.

```
(config)#interface t1 <slot/port>
```

<slot/port> specifies the slot/port of the T1 interface. Slots are numbered 0 to 0 (slot 0 is the integrated System Controller slot), and ports are numbered 1 to n.

The slot/port for the DSX-1 on a Total Access 900 is **0/2**.

The slot/port for the DSX-1 on a Total Access 900e is **0/3** and/or **0/4**.



The Total Access 900 Series products have one DSX-1 interface, while the Total Access 900e Series products have two possible DSX-1 interfaces.

2. Create a TDM group that will specify contiguous channels on the T1. These channels will be active and carry voice traffic across the DSX-1.

```
(config-t1 0/x)#tdm-group <number> timeslots <value> speed [56 | 64]
```

<number> Identifies the created TDM group. Valid range is 1 to 255.

timeslots <value> Specifies the channels to be used in the TDM group. Valid range is 1 to 24. The timeslot value can be entered as a single number representing one of the 24 T1 channel timeslots or as a contiguous group of channels. (For example, **1-10** specifies the first 10 channels of the T1.)

speed [56 | 64] Optional. Specifies the individual DS0 rate on the T1 interface. The default speed is 64 kbps. Only the T1 + DSX-1 Network Interface Module supports the 56 kbps DS0 rate.



*Channel 24 must be included when specifying timeslots because it is the dedicated channel that carries the PRI signaling. Fractional PRI is allowed. (For example, **1-12, 24** specifies a fractional PRI using channels 1 through 12 and channel 24.)*

```
(config-t1 0/x)#no shutdown
```

(Activate the physical T1 interface.)

```
(config-t1 0/x)#exit
```

3. Confirm the T1 activated in Step 2 is up and there are no active alarms.

```
(config)#do show interface t1 <slot/port>
```

<slot/port> Enter the same slot and port numbers as the T1 interface you configured in Step 1.

The following output shows a T1 that is up and has no alarms:

```
t1 0/3 is UP
Receiver has no alarms
T1 coding is B8ZS, framing is ESF
FDL type is ANSI
Line build-out is 0dB
No remote loopbacks, No network loopbacks
Acceptance of remote loopback requests enabled
Tx Alarm Enable: rai
Last clearing of counters 22:42:03
  loss of frame: 0
  loss of signal: 0
  AIS alarm: 0
  Remote alarm: 0

DS0 Status: 123456789012345678901234
XXXXXXXXXXXXXXXXXXXX
Status Legend: '.' =DS0 is not allocated
               'X' =DS0 is allocated (nailed)

Signaling Bit Status: 123456789012345678901234
  RxA: 0000000100000000000010000
  RxB: 000000010001010000010000

  TxA: 00000000000000000000111000
  TxB: 0010010000000000001010100
      123456789012345678901234
```

Line Status: -- No Alarms --

```
5 minute input rate 8 bits/sec, 0 packets/sec
5 minute output rate 8 bits/sec, 0 packets/sec
Current Performance Statistics:
  0 Errored Seconds, 0 Bursty Errored Seconds
  0 Severely Errored Seconds, 0 Severely Errored Frame Seconds
  0 Unavailable Seconds, 0 Path Code Violations
  0 Line Code Violations, 0 Controlled Slip Seconds
  0 Line Errored Seconds, 0 Degraded Minutes
```

```
TDM group 1, line protocol is not set
Encapsulation is not set
```

If the output of the command indicates that the T1 is down and/or has alarms, perform the following steps:

- Check connections, utilizing loopback plugs as necessary.
- Ensure proper cabling. The Total Access 900 products have a true DSX port, and therefore a straight-through cable will most likely be needed. The Total Access 900e products have DS1 interfaces, thus requiring a crossover cable. The LBO on these interfaces can be adjusted to accommodate shorter distances.

4. Create a PRI interface and connect it to the physical T1 you specified in Step 2. Note that the PRI interface itself is logical. Within the PRI configuration menu, various PRI parameters can be specified as well as the number of digits transferred from the Total Access 900(e) to the customer's equipment.

```
(config)#interface pri <number>
```

<number> Specifies the PRI interface number. Range is 1 to 255.

```
(config-pri x)#connect t1 <slot/port> tdm-group <number>
```

<slot/port> Enter the same slot and port numbers as the T1 interface you configured in Step 1.

<number> The number you use here should match the number you assigned to the TDM group in Step 2.

```
(config-pri x)#no shutdown           (Activate the D-channel on the PRI.)
```



*The default role for the PRI interface is **network b-channel-restarts disable**, and the default switch type is **National ISDN II**. Refer to the **Additional Settings** section in this document for commands used to change these default settings.*

5. Verify that the calling-party number (the number provided from the PBX through the Total Access 900(e) to the SIP server) exactly matches the number that has been programmed into the SIP server. It is imperative that the proper calling-party number is provided to the SIP server for outbound calls from the PBX. If the calling-party number (FROM header) received from the PBX does not match the Uniform Resource Identifier (URI) configured on the SIP server, the server will reject the call. This rejection will result in inability to execute calls from the PBX through the SIP network.

The Total Access 900(e) can be programmed with a calling-party number that can be substituted always or if no caller ID is sent from the PBX.

```
(config-pri x)#calling-party number <number>
```

<number> This number should exactly match what has been programmed into the SIP server for the FROM header.

```
(config-pri x)#calling-party override [always | if-no-CID | none]
```

6. Modify the called-party number to match the format the PBX has been programmed to receive. The called-party number or Dialed Number Identification Service (DNIS) formatted by the SIP network may not meet the requirements of the PRI interface on the PBX. In this case, it may be necessary to append or remove an area code or prefix, append or remove a 1, etc. Any changes made to the originally dialed number (such as removing a leading 1 from the called-party number or DNIS) can be accomplished using the **did digits-transferred** or **match substitute** commands found on the voice trunk account.



*The most common scenario occurs when a PBX that has been programmed to receive 3- or 4-digit extension numbers is connected to a SIP network that sends 10- or 11-digit numbers. The example that follows demonstrates the use of two different commands to strip digits from an incoming number. However, the **match substitute** command can be used to add or change digits as well.*

DID Digits-transferred Command



Setting the <value> in the **did digits-transferred** command to anything but “all” will cause all PRI setup messages to be tagged as “private.” Some PBXs reject calls tagged as “private.” If this situation occurs, the **match substitute** command should be used instead.

```
(config-Txx)#did digits-transferred <value> prefix <number>
```

<value> Specifies the number of digits to be transferred. Range is 1 to 16 digits.

prefix <number> Optional. Specifies a sequence of digits to be prepended to the digits that will be transmitted. For example, if seven digits will be transferred via DID, prefix the seven digits with 256. Thus 555-8000 would be prefixed with 256, transmitting out the string of digits 256-555-8000.

Example: A 10-digit call, 256-555-8000, is sent by the SIP network to a PBX that can only accept 4-digit calls. The **did digits-transferred** command can be used to transfer only the last four digits of the number to the PBX:

```
(config-Txx)#did digits-transferred 4
```

Match Substitute Command

Use the **match substitute** command to substitute a different number for the number originally received from the SIP network. If no match occurs (or no match statements have been entered), the originally received number will be propagated without being modified.

```
(config-Txx)#match <number> substitute <number>
```

match <number> Specifies the received number you are trying to match.

substitute <number> Specifies the number that will be sent in place of the number that was matched.



It is important to be specific when using this command. The match number must be the EXACT pattern received from the SIP invite. Use of all wildcards for the match number will not work because the most significant digits will likely be transferred (e.g., the number 256-555-8000 against an all wildcard entry (config-Txx)#**match xxx-xxx-xxxx substitute xxxx** will yield the number 2565 being sent to the PBX instead of the desired number of 8000).

Example: A 10-digit call, 256-555-8000, is sent by the SIP network to a PBX that can only accept 4-digit calls. The **match substitute** command can be used to strip the first six digits before sending the number to the PBX:

```
(config-Txx)#match 256-555-XXXX substitute XXXX
```

7. At this point, if everything has been set up properly, the D-channel on the PRI should be active. It is easy to verify an active D-channel with the following command:

```
(config-pri x)#do show interface pri <number>
```

<number> The number you use here should match the number of the PRI interface for which you would like to verify an active D-channel.

The following output shows an active D-channel on PRI interface 1:

```
pri 1 is UP
Switch protocol National ISDN 1
caller-id override none
caller-id presentation allowed
connect t1 0/2 tdm-group 1
digits transferred all prefix
role network b-channel-restarts disable
Channel status 123456789012345678901234
..... D
Status Legend:
- = Unallocated
. = Inactive
A = Active B-channel
B = Backup D-channel
D = Active D-channel
M = Maintenance
R = Restart
```

If the output of the command indicates that the D-channel is inactive, perform the following steps:

- Verify the PBX configuration for ISDN switch type. The Total Access 900(e) can be configured for the following switch types: NI-2, 4ESS, 5ESS, and DMS-100.
- Ensure the PBX role is configured for user.
- If all else fails, reset the PBX card.

The following command is used to verify that the PBX is responding to D-channel signaling:

```
#debug isdn L2-formatted
```

```
19:36:20 ISDN.L2_FMT PRI 1 =====
19:36:20 ISDN.L2_FMT PRI 1 Sent = Sapi:00 C/R:C Tei:00
19:36:20 ISDN.L2_FMT PRI 1 Ctl:SABME
19:36:20 ISDN.L2_FMT PRI 1 =====
19:36:20 ISDN.L2_FMT PRI 1 Recd = Sapi:00 C/R:C Tei:00
19:36:20 ISDN.L2_FMT PRI 1 Ctl:UA
1970.01.13 19:36:20 ISDN.EP PRI 1 D-channel is UP
```

The example output shows Layer 2 formatted messages that have been sent to and received from a PBX. Output that displays only the top portion (e.g., Ctl:SABME) means that the Total Access 900(e) product is not receiving L2 formatted messages, and the PBX is not responding.

8. Create an ISDN group. As soon as you have an active D-channel, Layer 3 control messages can begin. However, at this point in the configuration process, nothing defines where to route a call when it enters the Total Access 900(e). The ISDN group logically bridges the gap between a PRI interface and the switchboard within the Total Access 900(e).

```
(config)#isdn-group <number>
```

<number> Specifies ISDN group number. Range is 1 to 255.

Connect the ISDN group to the PRI interface:

```
(config-isdn-group-x)#connect pri <number>
```

<number> The number you use here should match the number you assigned to the PRI interface in Step 3.

```
(config-isdn-group-x)#do copy run start (Save your configuration.)
```



*If you intend to limit the number of channels used on the PRI (fractional PRI), you must do this when specifying the <timeslots> in the **tdm-group** command (refer to Step 2). The **min-channels** and **max-channels** options within the ISDN group menu are **NOT** associated with timeslot specification and should not be adjusted except under advisement of the ADTRAN technical support team.*

Example Configurations

The following example configurations show output generated by the **show running configuration** command in the AOS CLI. The examples are meant to provide users a reference to aid in configuration of the DSX-1 interface for PRI signaling.

Single PRI DSX-1 Interface on the Total Access 900

```
!  
interface t1 0/2  
  tdm-group 1 timeslots 1-24 speed 64  
  no shutdown  
!  
!  
interface pri 1  
  isdn name-delivery proceeding  
  calling-party override if-no-CID  
  calling-party number 2569638000  
  connect t1 0/2 tdm-group 1  
  no shutdown  
!  
!  
isdn-group 1  
  connect pri 1  
!  
!  
voice codec-list default  
  default  
  codec g729  
  codec g711ulaw  
!  
!  
voice trunk T01 type sip  
  description "to SIP server"  
  no reject-external  
  sip-server primary 10.1.4.5  
  registrar primary 10.1.4.5  
!  
!  
voice trunk T02 type isdn  
  description "to PBX"  
  no reject-external  
  connect isdn-group 1  
  match 256-963-XXXX substitute XXXX  
!  
!  
voice grouped-trunk SIP  
  description "outbound calls"  
  trunk T01  
  accept $ cost 0  
!  
voice grouped-trunk PRI  
  description "customer numbers"  
  trunk T02  
  accept 256-963-XXXX cost 0  
!  
!  
ip sip
```

Two PRI DSX-1 Interfaces on the Total Access 900e

Two PRI DSX-1 interfaces can be created on the Total Access 900e. Refer to the steps in *Configuring a Single PRI DSX-1 Interface* on page 3 to create the first PRI DSX-1 interface. After one PRI DSX-1 interface has been configured, repeat the process for the second PRI DSX-1 interface.



Be sure the T1 interface, TDM group, and PRI interface specified for the second PRI DSX-1 are different from those specified for the first PRI DSX-1.

```

!
interface t1 0/3
 tdm-group 1 timeslots 1-24 speed 64
 no shutdown
!
interface t1 0/4
 tdm-group 1 timeslots 1-24 speed 64
 no shutdown
!
!
interface pri 1
 isdn name-delivery proceeding
 calling-party override if-no-CID
 calling-party number 2569638000
 connect t1 0/3 tdm-group 1
 no shutdown
!
interface pri 2
 isdn name-delivery proceeding
 calling-party override if-no-CID
 calling-party number 2569638000
 connect t1 0/4 tdm-group 1
 no shutdown
!
!
isdn-group 1
 connect pri 1
!
isdn-group 2
 connect pri 2
!
!
voice codec-list default
 default
 codec g729
 codec g711ulaw
!
!
voice trunk T01 type sip
 description "to SIP server"
 no reject-external
 sip-server primary 10.1.4.5
 registrar primary 10.1.4.5
!
!

```

```
voice trunk T02 type isdn
description "to PBX 1"
no reject-external
connect isdn-group 1
match 256-963-XXXX substitute XXXX
!
voice trunk T03 type isdn
description "to PBX 2"
no reject-external
connect isdn-group 2
match 256-963-XXXX substitute XXXX
!
!
voice grouped-trunk SIP
description "outbound calls"
trunk T01
accept $ cost 0
!
voice grouped-trunk PRI
description "customer numbers"
trunk T02
trunk T03
accept 256-963-XXXX cost 0
!
!
ip sip
!
```

Additional Settings

Depending on your company's PBX and wide area network (WAN) environment, additional settings may need to be configured on the PRI and DSX-1 interfaces.

The following commands are issued from the PRI Interface Configuration mode:

Role

Use the **role** command to configure the interface protocol to use on the PRI. This setting controls the functional mode of the interface.

```
(config-pri x)#role [network | network b-channel-restarts disable | network b-channel-restarts enable | user]
```

network Sets the port to operate in network termination (NT) mode.

network b-channel-restarts disable Disables B-channel restarts. This is the default setting.

network b-channel-restarts enable Enables B-channel restarts.

user Sets the port to operate in terminal equipment (TE) mode.

ISDN Switch Type

Use the **isdn switch-type** command to configure the switch type assigned on the PRI circuit. The ISDN switch type will vary based on the PBX manufacturer and individual settings within the PBX. This setting must match the switch type used by the PBX.

```
(config-pri x)#isdn switch-type [4ess | 5ess | dms100 | ni2]
```

4ess Sets the ISDN switch type to ATT 4ESS.

5ess Sets the ISDN switch type to Lucent 5ESS.

dms100 Sets the ISDN switch type to Northern ISDN II.

ni2 Sets the ISDN switch type to National ISDN II. This is the default setting.

Name Delivery

Use the **isdn name-delivery** command to control the delivery of the name associated with the PRI. This command can be used to block the caller ID name on the PRI.

```
(config-pri x)#isdn name-delivery [none | proceeding | setup]
```

none Restricts the delivery of the calling party's name.

proceeding Delivers the calling party's name in the proceeding message.

setup Delivers the calling party's name in the setup message.

The following command is issued from the Voice Trunk Interface Configuration mode:

Modem Passthrough

Use the **modem-passthrough** command to switch to pass-through mode on fax or modem tone detection. This command allows modem and fax calls to maintain a connection without altering the signals with the voice improvement settings such as echo cancellation and voice activity detection (VAD).

```
(config-Txx)#modem-passthrough detection-time <value>
```

detection-time <value> Optional. Specifies the fax and/or modem detection time in seconds. Range is 0 to 8 seconds.

The following commands are issued from Global Configuration mode:

Timing Source

Timing is typically derived from the data T1 delivered by the service provider. Therefore, PRI PBXs are generally set to derive timing from the T1 provided to the Total Access 900(e). The Total Access 900(e) should be configured to recover clocking from the T1 interface connected to the service provider.



When timing is derived from a data T1, ensure that the PRI PBX is set to receive timing, not provide it.

Data may be delivered to customers via Ethernet in some applications. This circumstance will require timing to be derived from a PRI delivered to the PBX or internal to the Total Access 900(e).

Use the **timing-source** command to configure the timing source used for reference timing.

```
(config)#timing-source [internal | t1 <interface id>]
```

internal Configures the unit to provide timing using the internal 1.544 MHz clock generator.

t1 <interface id> Configures the unit to recover clocking from the specified T1 or DSX-1 interface.

ISDN Number Template

Use the **isdn-number-template** command to create an entry in the ISDN number type template. The template is used when encoding the called party and calling party information elements for inbound and outbound ISDN calls.

```
(config)#isdn-number-template <template id> prefix <number> [abbreviated | international | national | network-specific | subscriber | unknown] <pattern>
```

<template id> Specifies a numeric identifier for the template entry. Valid range is 1 to 255.

prefix <number> Specifies the expected prefix for the call type. Prefixes can be left blank (using double quotation marks “ ”) or consist of unlimited length strings of 0s and 1s. For example, for international calls made from within the United States, a prefix of 011 is expected.

abbreviated Specifies using the Type-of-Number octet Abbreviated (bits 110).

abbreviated is used mainly in private ISDN network applications, and the implementation is network-dependent.

international Specifies using the Type-of-Number octet International (bits 001).

international is used for calls destined outside the national calling area. International calls have the international direct dialing prefix removed. For example, consider an international call of 011-N\$, where the international direct dialing prefix is 011 and the N\$ represents the digits necessary for routing the call at the destination. When the Called Party IE is created for this call, the prefix is stripped and the N\$ digits are placed in the Number Digits field.

national Specifies using the Type-of-Number octet National (bits 010).

national is used for calls destined for inside the national calling area (i.e., does not cross into an international LATA). National calls have the direct dialing prefix removed. For example, consider a national call with a direct dialing prefix of 1 and Nxx-Nxx-xxxx to represent the ten-digit number necessary for routing the call. When the Called Party IE is created for this call, the prefix (1) is stripped and the Nxx-Nxx-xxxx digits are placed in the Number Digits field.

network-specific Specifies using the Type-of-Number octet Network-Specific (bits 011).

network-specific is used for calls that require special access to a private network that requires the use of a prefix that should be stripped once access to the network has been gained. Network-Specific calls have the dialing prefix removed. For example, a call to a private network with the prefix 700 consists of 700-N\$, where 700 is the dialing prefix and N\$ represents the digits necessary for routing the call at the destination. When the Called Party IE is created for this call, the prefix is stripped and the N\$ is placed in the Number Digits field.

subscriber Specifies using the Type-of-Number octet Subscriber (bits 100).

subscriber is used for local calls (not long-distance). Subscriber calls, by default, have the area code removed. For example, a subscriber call to 916-555-1212 would have the prefix 916 stripped and 555-1212 in the Number Digits field. For areas with mandatory ten-digit dialing, a blank prefix should be entered to ensure that all ten digits are passed to the Number Digits field.

unknown Specifies using the Type-of-Number octet Unknown (bits 000).

unknown is used when the number type is not known. Unknown numbers are assumed to have no prefix, and the entire dialed number is presented in the Number Digits field.

<pattern> Specifies a pattern for this template.

Valid Characters:

0-9 Match exact digit only.

X Match any single digit 0 through 9.

N Match any single digit 2 through 9.

M Match any single digit 1 through 8.

[] Match any digit in the list. For example: [1,4,6] matches 1, 4, and 6 only. [1-3, 5] matches 1, 2, 3, and 5.

Next Steps

This Configuration Guide provides information for users configuring a DSX-1 interface for PRI signaling on Total Access 900(e) Series products. The information in this guide is limited to setup of the PRI interface and the logical ISDN group. If the switchboard and dial plan within the Total Access 900(e) product have not been configured, refer to the *Switchboard and Dial Plan Configuration Guide* to continue setup of the product. The ISDN group created in Step 8 of this document must be logically connected to the switchboard within the Total Access 900(e) before calls can be successfully executed through the unit. The *Switchboard and Dial Plan Configuration Guide* demonstrates how to create voice trunks that will connect to the ISDN group. Also discussed is proper creation of accept number patterns that correspond to each DID/station/user.

DSX-1 Configuration Command Summary

	Command	Description
Step 1	(config)# interface t1 <slot/port>	Enter the configuration menu for the DSX-1 interface.
Step 2	(config-t1 0/x)# tdm-group <number> timeslots <value> speed [56 64]	Create a TDM group and specify the number of active channels on the DSX-1 interface.
	(config-t1 0/x)# no shutdown	Activate the DSX-1 interface.
	(config-t1 0/x)# exit	Exit the DSX-1 configuration menu.
Step 3	(config)# do show interface t1 <slot/port>	Confirm the DSX-1 interface has been activated and there are no active alarms.
Step 4	(config)# interface pri <number>	Create a PRI interface.
	(config-pri x)# connect t1 <slot/port> tdm-group <number>	Connect the PRI interface to the physical DSX-1 interface specified in Step 2.
	(config-pri x)# no shutdown	Activate the D-channel on the PRI.
Step 5	(config-pri x)# calling-party number <number>	Ensure that the calling-party number provided from the PBX to the SIP server exactly matches the URI on the SIP server.
	(config-pri x)# calling-party override [always if-no-CID none]	Specify the Total Access 900(e) to substitute calling-party number always, if no Caller ID is present, or never.
Step 6	(config-Txx)# did digits-transferred <value> prefix <number>	Modify the called-party number to ensure the format matches what the PBX has been programmed to receive.
	(or) (config-Txx)# match <number> substitute <number>	Alternative to the did digits-transferred command.
Step 7	(config-pri x)# do show interface pri <number>	Verify an active D-channel on the PRI.
	(Optional) # debug isdn L2-formatted	Verify the PBX is responding to D-channel signaling.
Step 8	(config)# isdn-group <number>	Create an ISDN group.
	(config-isdn-group-x)# connect pri <number>	Connect the ISDN group to the PRI interface created in Step 4.
	(config-isdn-group-x)# do copy run start	Save the configuration.