How To | Configure E1 links

Introduction

E1 is the European digital transmission format standard, traditionally used for inter-PBX traffic, where a large number of calls warrant a leased line between two corporate PBXs. Higher data bandwidth demands and reducing telecommunications charges have made 2Mbps circuits an affordable option for many smaller organisations.

What information will you find in this document?

This document provides information on:

What product and software version does this information apply to?

The information provided here applies to:

- AR390 and AR395 routers.
- AR020 E1/T1/PRA port interface card (PIC).

Overview of E1

E1 versus T1

E1 is the European standard which carries data at a rate of 2048 kpbs.

T1 is the United States standard, and is also used in Canada and Japan, and carries data at a rate of 1544 kbps.

The AT-AR390 router supports unstructured E1 and structured E1 in point-to-point mode. Unstructured and structured E1 are described in the section below.

The AT-AR395 router supports unstructured E1 and structured E1 in both point-to-point and point-to-multi-point mode. The router also supports Primary Rate Access ISDN.

The AR020 E1/T1/PRA PIC supports unstructured E1 and structured E1 in both point-to-point and point-to-multi-point mode. The card also supports Primary Rate Access ISDN and T1.

Unstructured versus structured E1

You can purchase E1 lines from a telecommunications company in either of two forms, unstructured or structured E1. There are various terminologies for the same type of line or circuit, whether structured or unstructured. These are listed in the following table.

Unstructured E1	Structured E1
Unstructured G.703	Structured G.703/G.704
Unchannelised E1	Channelised E1
Unchannelised G.703	Channelised G.703/G.704
Clear Channel G.703	G.703/G.704 TDM
2048 kbps E1	Time Division Multiplexed E1
Full 2 Mbps E1	

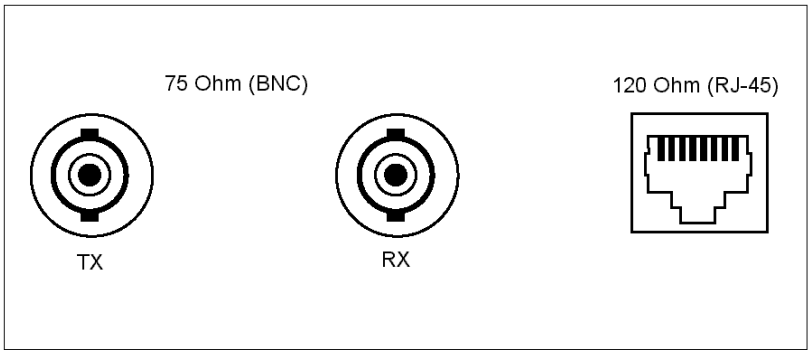
Since most lines have been used for voice applications, it was necessary to break an unstructured line into 64kbps channels, since 64kbps is the basis of all voice telecommunications.

2048kbps can thus be broken into thirty-two 64kbps channels, however the structuring requires the use of the first time slot or Time Slot 0 (TS0) to 'keep time', leaving time slots 1-31 available for communications. This process is called Time Division Multiplexing (TDM) or G.704 framing.

Unstructured, structured and Primary Rate ISDN use the same physical interface, known as G.703. This is presented on either a 120 or 75 Ohm interface. It is easy to convert between the two using a G.703 balun.

120 Ohm is becoming the standard throughout most of the world, although 75 Ohm is still popular in the UK and Holland.

75 Ohm G.703 is terminated on a pair of BNC connectors, while 120 Ohm G.703 is terminated in an RJ-45 plug



Further differences between unstructured and structured E1 are described below.

Line clocking

In unstructured E1 circuits, one of the devices must generate the clock for synchronisation, the other must receive the clock from the line. If this is not set correctly, data communications may still occur but be unstable due to frame slippage.

In structured E1, the clocking is always received from the telecommunications network so the equipment at each end of the circuit must be set to receive the clock from the line.

Cyclic redundancy checksum (CRC)

In unstructured E1, no provision is made for CRC multi-framing, so this should be turned off in the software.

In structured E1, CRC provides a means of determining and reporting line failures to both the network and terminal equipment. It is necessary to check with your telecommunications provider the correct setting for CRC-4. If CRC is not set correctly, the equipment may assume that CRC synchronisation has been lost and attempt to resynchronise, disturbing data flow and possibly giving symptoms of temporary line failure. The available options for the terminal equipment are either:

Off	No CRC
Checking	Enables CRC-4
Reporting	Enables CRC-4 and reports to the remote terminal equipment

An error threshold is set to allow a certain number of frames with CRC errors per second without forcing resynchronisation. In most countries, the ITU-T recommended standard of 914 error frames per second is acceptable without forcing resynchronisation.

Line Encoding

In E1 applications using the PPP protocol, HDB3 line encoding is used.

Configuring the E1 layer

Method 1 - Unstructured E1

System Configuration

1. Set the system name, territory, contact and location on each router

It is important to set the territory since the defaults for items such as the acceptable CRC-4 error threshold are automatically changed to values appropriate for the territory the router is operating in.

```
set system territory=europe
set system name="gateway4.mydomain.org"
set system location="rack 14, comms room"
set system contact=routeradmin@mydomain.org
```

2. Set the local time on the routers

This is useful when troubleshooting and checking the router's log.

```
show time
set time=10:55:00
set date=03-jun-2000
```

E1/PRI Interface Settings

1. Confirm the current state of the E1/PRI interface

```
show pri=0 state
```

```
State for PRI instance 0:

Interface type .......... E1
ISDN interface type ..... TE
HDLC controller type .... SCC
Mode ..................... ISDN
ISDN slots .............. 1-31
State ................... Local inbound fault
Clock source ............ line
Termination impedance ... 120 ohms
CRC-4 mode .............. reporting
CRC-4 error threshold ... 915
Idle character .......... 255
Interframe flags/slot ... 1
```

Interface type

Ensure that the interface type reports E1 rather than T1 and that there are 1-31 available TDM slots. If the interface reports T1 and only 1-23 TDM slots are available then you will need to change a jumper on the AR020 PIC in the router, as the AR390 and AR395 routers support E1 only. You can find details of the E1/T1 jumper settings in the PIC hardware reference manual, which is available from your Allied Telesyn reseller or distributor.

ISDN interface type

Ensure this reads TE for Terminal Equipment. NT mode is only used for Primary Rate ISDN back-to-back testing using a crossover cable. If this reads NT then again, you will need to change a jumper on the AR020 PIC in the router.

Termination Impedance

On the AR390 and AR395 routers, the termination impedance is selectable using a toggle switch on the back of the unit. On the AR020 E1/T1 PICs, an external balun is required for connection to a 75 Ohm circuit, thus will always read 120 Ohms.

2. Set the mode

Set the interface to operate in what is referred to as TDM mode, although it is acknowledged that an unstructured E1 link is not technically a TDM. To set the mode to TDM, use the command:

```
set pri=0 mode=tdm
```

3. Set the clock source

One of the devices on the unstructured E1 circuit will need to provide a clock source internally rather than take the clocking from the line, so if an AR router is required to provide the clock then use the command:

```
set pri=0 clock=internal
```

4. Set the CRC-4 mode

On unstructured links the CRC-4 mode should be set to off. You can set this using the command:

```
set pri=0 crc=off
```

The state of the E1/PRI Interface should then look something like this:

```
State for PRI instance 0:

Interface type .......... E1
ISDN interface type ..... TE
HDLC controller type .... SCC
Mode ..................... TDM
TDM slots ............... 1-31
State ................... Operation
Clock source ............ internal
Termination impedance ... 120 ohms
CRC-4 mode .............. off
CRC-4 error threshold ... 915
Idle character .......... 255
Interframe flags/slot ... 1
```

Only the clock source should vary between two sites.

Note that in unstructured TDM mode, slot 0 is used for data transmission.

5. Confirm the configuration of the E1/PRI interface

To confirm the E1/PRI interface configuration, use the command:

```
show config dynamic=pri
```

```
Manager gateway4.mydomain.org> sho con dyn=pri

#
# PRI configuration
#
set pri=0 mode=tdm
set pri=0 cl=int
set pri=0 crc=off
```

TDM layer configuration

1. Create an Unstructured TDM over the E1/PRI interface

Choose any name for the TDM group. In this case "foo" is used.

```
create tdm group=foo interface=pri0 unstructured
```

You can view the settings of the TDM using the command:

```
show tdm group=foo
```

```
Interface
  Group Name        User       Speed       Slots
-------------------------------------------------------------------
pri0
  foo               Yes        2048K       unstructured
-------------------------------------------------------------------
```

You can view the configuration of the TDM using the command;

```
show config dynamic=tdm
```

```
#
# TDM configuration
#
create tdm group=foo interface=pri0 unstructured
```

Method 2 - Structured E1

System Configuration

1. Set the system name, territory, contact and location on each router

It is important to set the territory since the defaults for items such as the acceptable CRC-4 error threshold are automatically changed to values appropriate for the territory the router is operating in.

```
set system territory=europe
set system name="gateway4.mydomain.org"
set system location="rack 14, comms room"
set system contact=routeradmin@mydomain.org
```

2. Set the local time on the routers

This is useful when troubleshooting and checking the router's log:

```
show time
set time=10:55:00
set date=03-jun-2000
```

E1/PRI Interface Settings

1. Confirm the current state of the E1/PRI interface

```
show pri=0 state
```

```
State for PRI instance 0:

Interface type .......... E1
ISDN interface type ..... TE
HDLC controller type .... SCC
Mode ..................... ISDN
ISDN slots ............... 1-31
State .................... Local inbound fault
Clock source ............. line
Termination impedance ... 120 ohms
CRC-4 mode ............... reporting
CRC-4 error threshold ... 915
Idle character .......... 255
Interframe flags/slot ... 1
```

Interface Type

Ensure that the Interface Type reports E1 rather than T1 and that there are 1-31 available TDM slots. If the Interface reports T1 and only 1-23 TDM slots are available then you will need to change a jumper on the AR020 PIC in the router, as the AR390 and AR395 routers support E1 only. You can find details of the E1/T1 jumper settings in the PIC hardware reference manual, which is available from your Allied Telesyn reseller or distributor.

ISDN interface type

Ensure this reads TE for Terminal Equipment. NT mode is only used for Primary Rate ISDN back-to-back testing using a crossover cable. If this reads NT then a jumper will require changing on the card. You can find details of the E1/T1 jumper settings in the PIC hardware reference manual, which is available from your Allied Telesyn reseller or distributor.

2. Set the interface to operate in TDM mode

```
set pri=0 mode=tdm
```

3. Set the clock source

Since the clocking is provided by the CSU/DSU or modem, the router should be set to take the clock from the line.

```
set pri=0 clock=line
```

Termination Impedance

On the AR390 and AR395 routers, the termination impedance is selectable using a toggle switch on the back of the unit. On the AR020 E1/T1PIC an external balun is required for connection to a 75 Ohm circuit, and thus will always read 120 Ohms.

4. Set the CRC-4 mode

After confirming with your carrier as to whether the structured E1 network supports CRC-4 multi-framing, configure the unit for either 'off' or 'reporting', using the command:

```
set pri=0 crc=[off|reporting]
```

Reporting monitors CRC-4 errors on the links and also informs the remote router of any errors, providing more detailed analysis of network problems. For a more detailed description of Remote Alarm indications refer to the **show pri state** command in the ISDN chapter of your AR Router reference manual.

The state of the E1/PRI Interface should look something like this:

```
State for PRI instance 0:

Interface type .......... E1
ISDN interface type ..... TE
HDLC controller type .... SCC
Mode ..................... TDM
TDM slots ............... 1-31
State ................... Operation
Clock source ............ line
Termination impedance ... 120 ohms
CRC-4 mode .............. reporting
CRC-4 error threshold ... 915
Idle character .......... 255
Interframe flags/slot ... 1
```

5. Set the CRC-4 error threshold

Ensure the CRC-4 error threshold is set to about 915, the ITU-T recommended standard for the number of acceptable CRC-4 errors per second before CRC-4 and frame resynchronisation is attempted. Use the command:

```
set pri=0 error_threshold=915
```

6. Confirm the configuration of the E1/PRI interface

To confirm the configuration of the E1/PRI interface, use the command:

```
show config dynamic=pri
```

```
#
# PRI configuration
#
set pri=0 mode=tdm
set pri=0 cl=int
set pri=0 crc=reporting
set pri=0 error_threshold=915
```

TDM layer configuration

1. Create a structured TDM over the E1/PRI interface

Choose any name for the TDM group. In this case "foo" is used.

```
create tdm group=foo interface=pri0 slots=1-31
```

Note: *In structured mode, Time Slot 0 is unavailable for data, since it is used for the G.704 framing.*

2. Show the TDM settings

You can view the settings of the TDM with

```
show tdm group=foo
```

```
Interface
  Group Name        User       Speed       Slots
-----------------------------------------------------------------
pri0
  foo               Yes        2048K       1-31
-----------------------------------------------------------------
```

You can view the configuration of the TDM with

```
show config dynamic=tdm
```

```
#
# TDM configuration
#
create tdm group=foo interface=pri0 slots=1-31
```

Configuring the data link layer protocol

1. Configure a data-link layer protocol over the structured TDM

In this case Point-to-Point protocol is used.

```
create ppp=0 over=tdm-foo
```

2. Ensure the Link Control Protocol has opened correctly

Enter the command:

```
show ppp=0
```

```
Name       Enabled  ifIndex  Over             CP           State
-------------------------------------------------------------------
ppp0       YES      03       tdm-foo          LCP          OPENED
-------------------------------------------------------------------
```

If you are connecting to a CISCO router, ensure that the Cisco router is set for PPP encapsulation rather than the proprietary HDLC encapsulation.

CISCO routers only support the ECHO method of Link Quality Reporting, so to ensure compatibility,

```
set ppp=0 over=tdm-foo echo=on lqr=off
```

CISCO routers also send out proprietary Router Discovery Protocol packets. These packets are often larger than standard packets and are treated as 'Unknown Packet types' by the AR router. Ensure this is function is turned **off** on the CISCO router to avoid unknown packets reaching the AR router.

Configuring the Network Layer Protocol

1. Configure a network layer protocol over the Point-to-Point-Protocol interface

In this case we have used IP.

```
enable ip
add ip interface=ppp0 ip=192.168.1.1 mask=255.255.255.252
```

2. Configure the network layer protocol over the remote router

```
enable ip
add ip interface=ppp0 ip=192.168.1.2 mask=255.255.255.252
```

It is possible to configure PPP links with Unnumbered IP, where 0.0.0.0 is specified instead of an IP address in the above commands. This simplifies network administration, but can make network troubleshooting a more complex process.

3. Configure TCP/IP over the Ethernet interface

```
add ip int=eth0 ip=172.16.1.1 mask=255.255.255.0
```

4. Configure TCP/IP on the remote router

```
add ip int=eth0 ip=172.16.2.1 mask=255.255.255.0
```

5. Enable routing over the link

This could be either a static or a dynamic (RIP or OSPF) route. In this case a static route is configured

```
add ip route=172.16.2.0 mask=255.255.255.0 int=ppp0
   next=192.168.1.2
```

Enable routing over the remote router

```
add ip route=172.16.1.0 mask=255.255.255.0 int=ppp0
   next=192.168.1.1
```

6. Test the link

It should now be possible to test the link from a host on the LAN to a host on the remote LAN using PING or perhaps an FTP file transfer. In this case the LANs are not yet configured, so the PING application on the AR router is used instead. It is important to ensure the source address of the ping is set to the Ethernet interface rather than the PPP interface, since this will give the same response as if it were a device on the LAN.

Enter the command:

```
ping 172.16.2.1 sipaddess=172.16.1.1 number=50 length=64
   pattern=12345678
```

The pattern parameter means the pings are stuffed with non-zero data, reducing the chances of the CSU/DSU modems losing synchronisation on large packets.

Troubleshooting

If no IP traffic is able to get through, try and determine whether PPP is opening at both Link Control Protocol and IP Control Protocol with the command:

```
sho ppp=0
```

The routers log will often help diagnose the cause of PPP establishment failure. Use the command:

```
show log
```

or to display the log in reverse order, use the command:

```
show log reverse
```

If PPP is opening correctly but is dropping, look in the router's log and try and determine whether it is dropping in a consistent time pattern, i.e. every two minutes, or dependent on data.

```
show log reverse
```

A consistent failure suggests configuration of link quality reporting between routers. An inconsistent failure suggests either line failure or configuration of clocking between devices.

If the failure seems to be at line level, it is worth looking at the E1/PRI counters. Since the router has only just been configured, some of the counters may be misleading since they may have been incrementing before the interface was configured. Either restarting the router or resetting the counters and leaving the unit to run for five minutes will help determine problems more accurately.

Enter the command:

```
restart router
```

or

```
reset pri=0 counters
```

To look at the E1/PRI counters, use the command:

```
show pri=0 counter
```

This displays pages of counters which are not all relevant to an Unstructured E1 circuit (D Channels is only relevant on an interface configured for ISDN) so only interface counters can be viewed with the command:

```
show pri=0 counter=interface
```

Interface unknown protocols, or 'ifInUnknownProtos' are often other manufacturer's router discovery protocols.

Counters that relate to the structured channel (channel 0) can be viewed with

```
show pri=0 counter=pri
```

The state counters can be viewed with

```
show pri=0 state
```

Loss of signal counters occur when more than 32 contiguous zeros are received on an interface which is unlikely in normal data applications, although a large ping 'stuffed' with zeros or other non-realistic traffic can cause the CSU/DSU or modems to lose synchronisation.

Frame slips & HDB3 code violations are indicative of incorrect clock settings between devices. You should check the clock settings.

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