

Errata

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HP References in this Application Note

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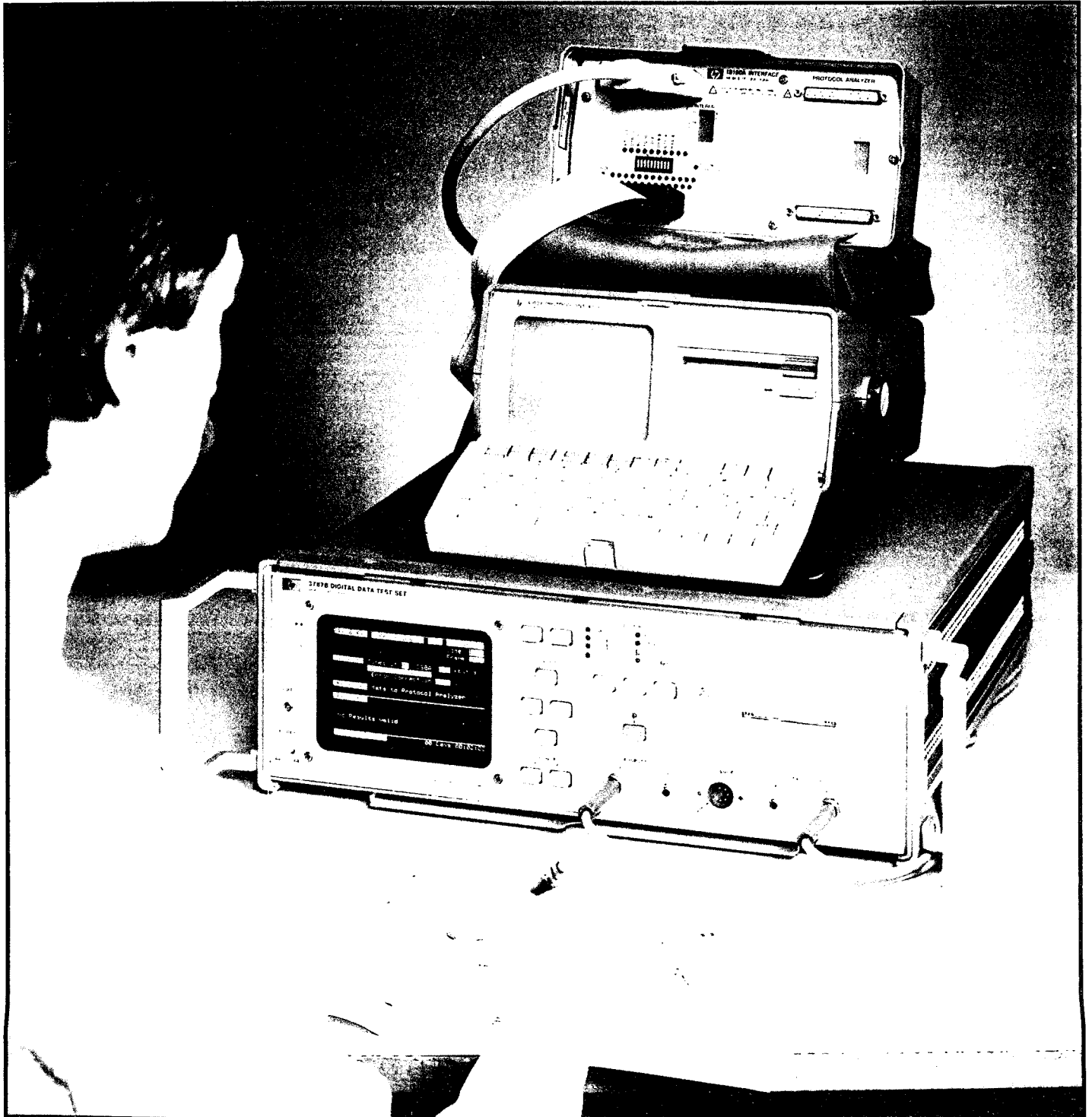
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Application Note 368

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Digital Communications

Complete BER and Protocol Testing
on an ISDN Primary Rate Interface



Introduction

Troubleshooting on a datacom network

Bit Error Rate (BER) is the traditional yardstick used to measure the performance of a digital transmission system. It gives an overall assessment of the physical elements of the system.

However, even when BER indicates no transmission errors, problems may still exist because of errors in the structure of the transmitted data. These problems can be tackled with a protocol analyzer.

A protocol analyzer normally connects to the end-user parts of the network (eg RS-232-C, V.35 interfaces etc), simulating terminals or computers. The BER tester (BERT) connects to the transmission parts of the system - multiplexers, cross-connects, fiber transmission terminals etc.

The HP 3787B Digital Data Test Set is a T1 BERT with a difference - it can extract customer channels from a T1 stream, and make measurements on individual data streams. It can also interface these embedded data streams to a protocol analyzer.

Now the power of protocol analysis can be extended to all parts of the network.

This application note deals with one specific case where protocol analysis is needed but there is no traditional interface point.

The specific case is the Integrated Services Digital Network (ISDN) primary rate interface. This is a T1 signal which is divided into 23B + 1D channel.

The general principles illustrated in the test examples given in this application note can of course be applied to many other situations eg sending/receiving message-oriented signals on the data link of an ESF formatted T1 signal or testing the protocol on a sub-rate (2.4 to 56 kbit/s) DDS channel etc.

An application on how to set the HP 3787B for sub-rate protocol analysis is given in the HP 3787B Operating Manual.

ISDN Primary Rate Interface (PRI) testing

The goal of ISDN is to provide a flexible voice and data service to end-users of the telephone system. The basic rate service will provide two 64 kbit/s channels to carry voice and/or data plus a 16 kbit/s control channel. These channels are referred to as 2B+D. For customers

who need a higher bandwidth service, the PRI service gives 23B+D.

Field trials of basic rate ISDN have been underway for some time, and AT&T currently offer a 23B+D PRI service even though the full ISDN service flexibility is not yet available.

ISDN in the network

The 23B+D PRI signal is carried in the network as a 1.544 Mbit/s T1 signal. Like any T1 signal, this contains 24 channels each running at 64 kbit/s. In PRI, these are assigned as 23 B-channels for voice or data plus one 64 kbit/s D-channel for signaling and control. In addition, there is the normal T1 overhead of framing bits, CRC code words, and a 4 kbit/s network data link.

The HP 3787B can access any of the B or D channels, as well as the framing bits, CRC and network data link.

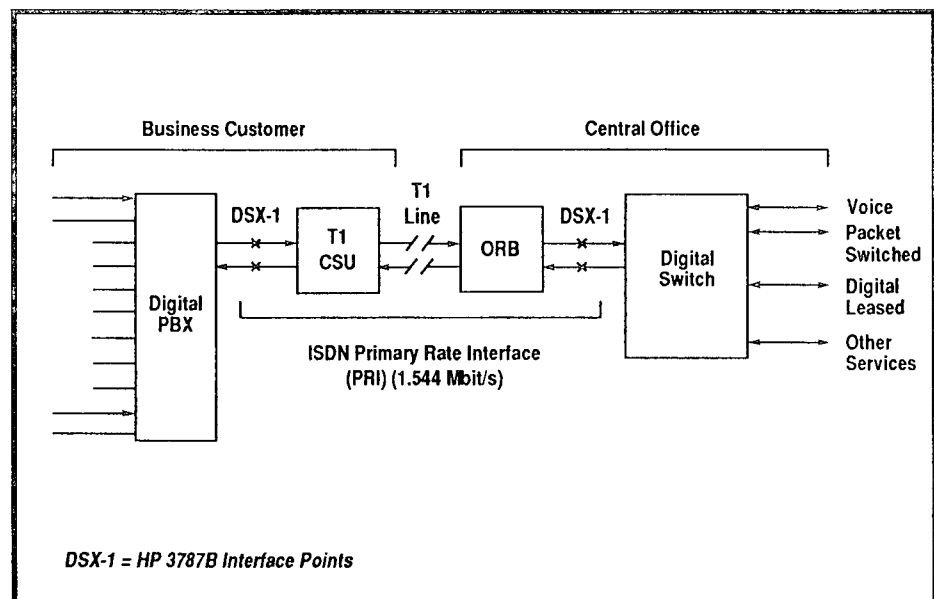


Figure 1 Typical ISDN PRI to digital PBX configuration

ISDN network test access points

Figure 1 shows how a business customer's telecom equipment might be interfaced to an ISDN. The business customer has a digital Private Branch eXchange (PBX) to provide voice and data channels to individual users.

This PBX is connected to the telephone operating companies' ISDN via a T1 line. A standard T1 Channel Service Unit (CSU) converts between line signals and a standard interface (DSX-1 cross-connect). In the central office, an Office Repeater Bay (ORB) provides a similar interface between the line signal and the standard cross-connect signal. The Digital Switch connects the customer channels to the ISDN services (eg voice, packet switched, digital leased, etc).

The HP 3787B can be connected to any of the DSX-1 points shown in Figure 1 to test the ISDN PRI. Any 'B' or 'D' channel can be accessed for error performance measurements using the HP 3787B, or protocol analysis using the HP 3787B with an external protocol analyzer connected.

Test philosophy

Testing can be split into three categories:

1. Installation testing before live traffic is connected.

A test signal is needed to simulate the T1 live traffic signal. This is usually a Pseudo Random Binary Sequence (PRBS) with the appropriate framing structure added. The HP 3787B can provide more thorough tests by generating a T1 test signal which contains a test pattern in any of the 64 kbit/s channels. This can be either a BER test pattern or, for example, the FOX message from a protocol analyzer. This T1 test signal is invaluable for half-channel tests across a T1 multiplexer.

Testing in the reverse direction is also easy, because the HP 3787B can extract the contents of any channel and either make BER measurements or pass the data to the protocol analyzer receiver.

Loopback control, and access to the framing pattern, CRC bits, and 4 kbit/s data link make for simple, comprehensive pre-service tests.

2. Monitoring live traffic to gather data for preventive maintenance or troubleshooting.

Once a link is up and running, performance can be checked by bridging onto live traffic. Checking the frame word, line code and CRC code gives data on overall performance. Using the protocol analyzer in a real-time or data capture mode, individual customer live traffic protocol problems can be quickly isolated.

3. Troubleshooting faulty individual circuits.

If a single customer channel is giving problems, then losing the complete T1 link is a a drastic and expensive option. The better alternative is to test only the faulty circuit.

This is possible in "Thru-mode" operation, where the T1 circuit is routed through the test set. Individual channels can then be removed from service and a test pattern inserted. Once again, this can be a BER or protocol test pattern.

Installation testing

Introduction

Before ISDN PRI live traffic is connected, the operation of an ISDN PBX or digital switch can be checked using a test signal which simulates the live traffic. The test signal is usually a PRBS with the appropriate framing structure added.

The HP 3787B can generate an ISDN PRI test signal which contains a test pattern in any of the 64 kbit/s channels. This can be either a PRBS test pattern or, for example, a CCS7 (Common Channel Signaling #7) simulation pattern from a protocol analyzer.

Testing in the reverse direction is also easy, because the HP 3787B can extract the contents of any channel and either make BER measurements or pass the data to the protocol analyzer receiver.

Installation testing example

In this example, we will demonstrate how the HP 3787B can be used with a protocol analyzer to generate and receive a FOX message at a 64 kbit/s rate in timeslot 24 (ie D-channel) of an ISDN PRI. Various types of 64 kbit/s protocol analyzer with an RS-232-C pod can be connected to the HP 3787B. This example uses the HP 4954A with an HP 18135A RS-232-C/V.24 Interface Pod.

The test example assumes that timeslot 24 is looped back by the digital switch or PBX, the ISDN signal is ESF framed and has B8ZS line coding. Other timeslots, channel rates, DS1 framing or line code can be selected if required.

Note: The procedure for setting up the HP 3787B can also be used when using the protocol analyzer for CCS7 simulation and analysis. For CCS7 testing we recommend the HP 4954A protocol analyzer with the HP 18355A application software.

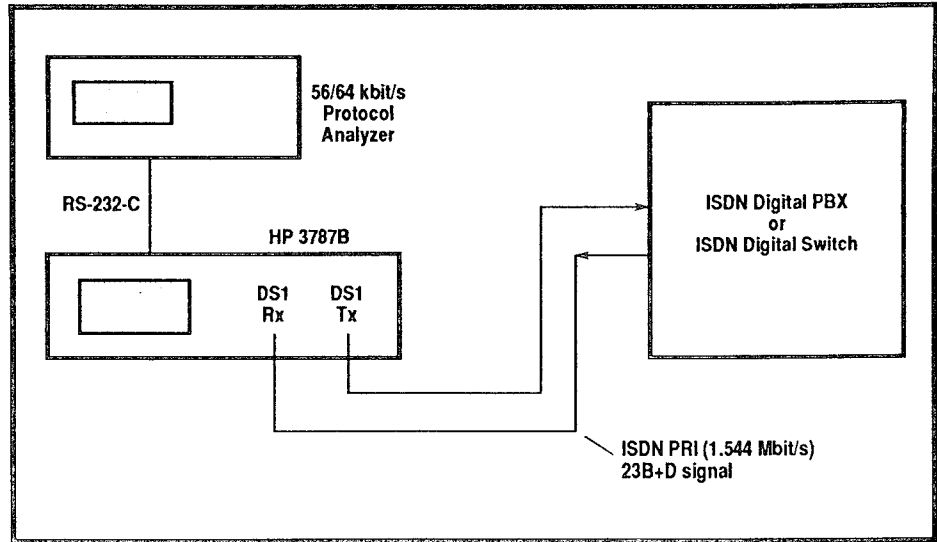


Figure 2 Installation test configuration

TRANSMITTER SETTINGS

TX & RX	Transmitting	DS1 Code	B8ZS	
		Frame	ESF	
		DS1 Clock	INT	
Select	Timeslot 24	Clear Channel		
Transmit	Data from Protocol Analyzer			

Set the DS1 signal to be compatible with the UUT signal.

Clear channel indicates 64 kbit/s operation. Other rates available include 56, 9.6, 4.8 and 2.4 kbit/s.

Set the clear channel (64 k) test pattern to be generated from the Protocol Analyzer.

RECEIVER SETTINGS

TX & RX	Receiving	DS1	Auto	
		Code	B8ZS	
		Frame	ESF	
Select	Timeslot 24	Clear Channel		
Receive	Data to Protocol Analyzer			
Monitor				
Received Word	XXXXXXXX			
Elapsed Time	00 Days 00:00:01			

Set the receiver settings to correspond with the HP 3787B transmitter settings.

Set the clear channel test pattern to be received by the Protocol Analyzer.

By setting to Monitor, the binary content of the selected timeslot is displayed. This is useful for determining if the channel is active or idle.

Procedure

1. Connect the HP 3787B to the unit under test as shown in Figure 2.
2. Connect the protocol analyzer to the HP 3787B rear panel PROTOCOL ANALYZER interface. With a short connecting cable (<10 metres), this RS-232-C interface will easily handle a 56/64 kbit/s signal.

3. Set up the HP 3787B Transmitting and Receiving displays as shown.

Note: If you are not familiar with the operation of the HP 3787B, we recommend that you to read through the "Getting Started" section of the HP 3787B Operating Manual or Operators Guide.

Setting up the protocol analyzer

Note: For CCS7 testing, the User's Guide included in the HP 18355A package gives instructions on how to drive the HP 4954A.

The following points should help you when setting up a protocol analyzer to operate on the HP 3787B rear panel PROTOCOL ANALYZER interface.

- The HP 3787B interfaces with synchronous networks and cannot be used as an interface for asynchronous protocols.
- The HP 3787B is the network access point, and so is a DCE. The protocol analyzer must therefore be configured as a DTE.
- The protocol analyzer Rx data and Tx data clocks are provided by the HP 3787B via the RS-232-C cable. This is selected by setting the protocol analyzer (DTE) clock source to DCE.

If you decide to use the protocol analyzer to run a BER test through the HP 3787B, setting the "bits/sec" field on the protocol analyzer's BER set-up page to "EXT" causes it to take its clock from the HP 3787B.

1. Select the "Setup Menu" on the protocol analyzer display as shown in Display 1.
2. Select "Exit Field" then "Exit" to enable the next display selection.
3. Select "Simulate Menu" and key in the FOX pattern as shown in Display 2.
4. Select "Exit Field" then "EXIT" to enable the next display selection.
5. Select "Run Menu" to show Display 3.
6. Select "Execute".

The transmit and receive data is displayed on alternate lines with the received data in inverse video. With the selected channel looped back by the digital switch or PBX, the transmit and receive data should be the same.

```

Protocol HDLC
Mode Sync
Data Code ASCII 8
Error Check CRC-CCITT
(character frame=8 bits)
Extended Address No

DTE Channel Primary
DCE Channel Primary

DTE Channel DCE
Clock Source DCE Channel DCE

Bits/Sec 64000

Pod Id RS-232-C (partial)

Extended Control No
    
```

Display 1

```

Device Emulating DTE
Transmission Mode is HDX
Interface Lead Control is User Defined

Block 1 :

Send | THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG c/r l/f GG |
and then
Goto Block 1
    
```

Display 2

```

Source of data Line Run mode Simulate
Operating mode Free Run
    
```

Display 3

Performance monitoring

Introduction

Once an ISDN PRI link is up and running, the performance can be checked by bridging on to a live traffic.

Checking the embedded information (ie frame word, line code and CRC bits) in a live traffic ISDN PRI, the HP 3787B gives data on the overall performance of the link. This data can be used to identify deteriorations in circuit performance before the service is seriously affected or problems which occur only at certain times of day or when certain live traffic is sent etc.

If the performance of the overall ISDN link is acceptable and a trouble report is still received from a single customer multiplexed within the link, then chances are that the problem is protocol based. Protocol-based problems can be identified using the HP 3787B with an externally connected protocol analyzer. The HP 3787B can demultiplex any customer channel to the protocol analyzer without affecting the customer's data.

Performance monitoring example

In this example, we will demonstrate how the HP 3787B can be used with a protocol analyzer to monitor a 56 kbit/s channel in timeslot 11 of a live traffic ISDN PRI signal.

The test example assumes that the problem channel is in timeslot 11, the DS1 signal is ESF framed and has B8ZS line coding (other timeslots, DS1 framing or line code can be selected if required). Data to be analyzed by the protocol analyzer must be generated from the unit under test (eg the ISDN digital PBX or ISDN network digital switch).

RECEIVER SETTINGS

TX & RX	Receiving	DS1	Bridged
			Code B8ZS
			Frame ESF
Select	Timeslot 11	DS0A	56 kbit/s
	Primary Channel		
Receive	Data to Protocol Analyzer		
Monitor			
Received Word	XXXXXXXX		
Elapsed Time	00 Days 00:00:01		

** If connecting the HP 3787B to a 20 dB monitor point, set the HP 3787B to 'DSX-MON' mode.

*If connecting straight on to a line, set the impedance to "Bridged".***

Set the receiver settings to correspond to the live traffic signal.

Set the timeslot and rate.

Set the data in timeslot 11 to be received by the Protocol Analyzer.

By setting to Monitor, the binary content of the selected timeslot is displayed. This is useful for determining if the channel is active or idle.

Procedure

Note: To avoid the risk of double terminating the line, do not connect the HP 3787B to live traffic until the receiver is set as shown in step 2.

1. Connect the protocol analyzer to the HP 3787B rear panel PROTOCOL ANALYZER interface. Please note that with a short connecting cable (<10 metres), this RS-232-C interface will easily handle a 56/64 kbit/s rate signal.
2. Set the HP 3787B Receiving display as shown.

Note: If you are not familiar with the operation of the HP 3787B, we recommended that you read through the "Getting Started" section of the HP 3787B Operating Manual or Operators Guide.

3. Connect the HP 3787B to the unit under test as shown in Figure 3.

4. Set up the protocol analyzer.

For information on connecting a protocol analyzer to the HP 3787B and setting the protocol analyzer, see "Setting up the protocol analyzer" on page 5.

As we are only monitoring the data, there is no need to set the protocol analyzer to send a pattern.

Timeslot 11 live traffic should now be displayed on the protocol analyzer.

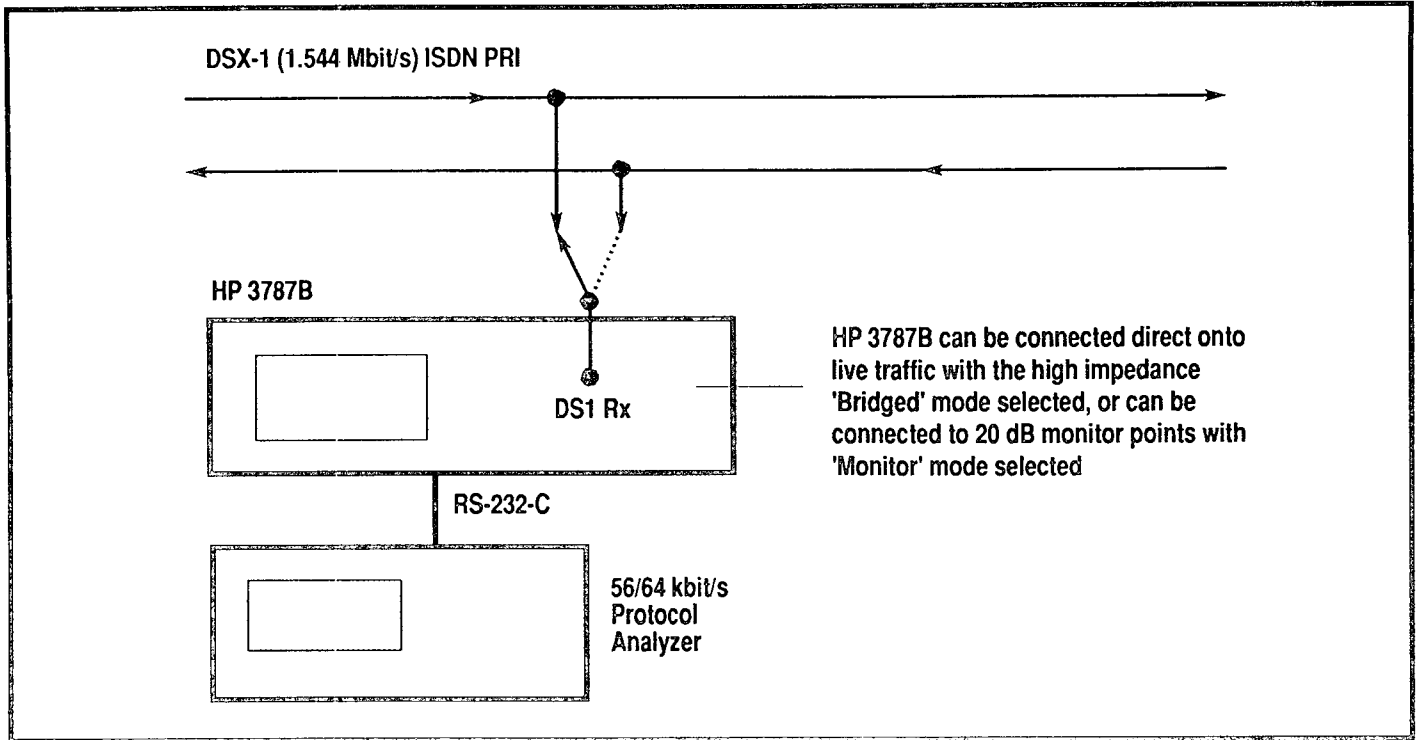


Figure 3 Performance monitoring test configuration

Thru-mode troubleshooting

Introduction

If a single customer channel is giving problems, then losing the complete ISDN PRI or T1 link is a drastic and expensive option. The better alternative is to test only the faulty circuit.

This is possible in "Thru-mode" operation, where the T1 circuit is routed through the test set. Individual channels can then be removed from service and a test

pattern inserted. This can be a BER or protocol test pattern.

This type of testing is normally performed with one HP 3787B connected to a Digital access and Cross-connect System (DCS). The BER or protocol test patterns from the HP 3787B are switched by the DCS to the problem circuit.

Where DCS are not employed, two HP 3787Bs are required to perform thru-mode testing on a full duplex T1 or ISDN PRI line.

Thru-mode troubleshooting example

In this example, we will demonstrate how two HP 3787Bs with one protocol analyzer can be used to perform full duplex testing on a single B-channel contained in timeslot 12 while the other channels contain live traffic.

The test example assumes that timeslot 12 is looped back by the Unit Under Test (UUT), the DS1 signal is ESF framed and has B8ZS line coding. (Other timeslots, rates, DS1 framing or line code can be selected if required.)

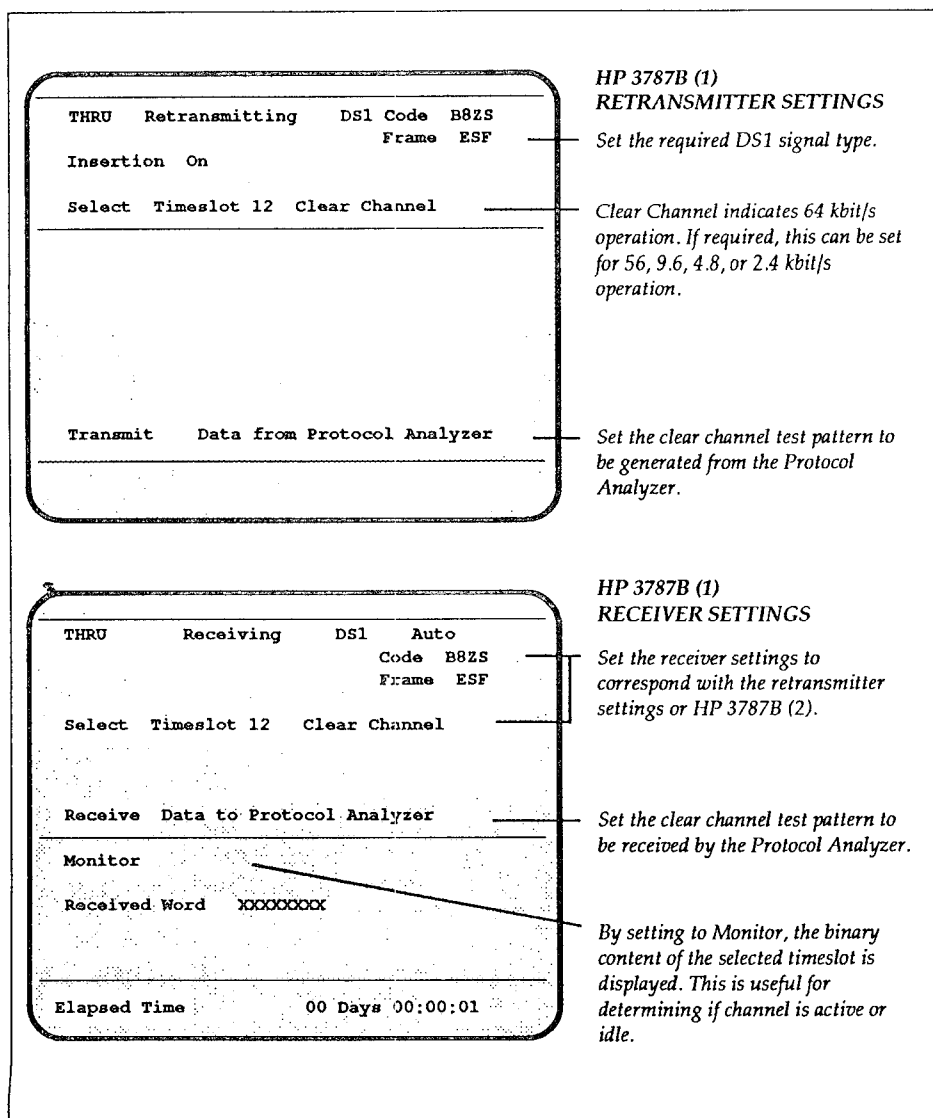
Procedure: Testing a far-end UUT B-channel using the HP 3787B and a protocol analyzer

Note: Connecting the two HP 3787Bs to live traffic will cause loss of signal for a short duration. To reduce signal loss time, we recommend that you set the two HP 3787Bs as shown in steps 1 and 2, before connecting up to live traffic.

1. Set up the HP 3787B (1) Retransmitting and Receiving displays as shown.

Note: If you are not familiar with the operation of the HP 3787B, we recommended that you read through the "Getting Started" section of the HP 3787B Operating Manual or Operators Guide.

2. Set up the HP 3787B (2) Retransmitting and Receiving displays as shown on page 9.



3. Connect the protocol analyzer to the two HP 3787Bs via a fabricated RS-232-C cable or, if using the HP 4952A, the HP 18179A break-out unit. (See Appendix for details of the RS-232-C fabricated cable and configuring the break-out unit.)
4. Connect the two HP 3787Bs to the unit under test as shown in Figure 4.
5. Set up the protocol analyzer.

For information on connecting a protocol analyzer to the HP 3787B and setting the protocol analyzer, see "Setting up the protocol analyzer" on page 5.

The transmit and receive data from the protocol analyzer is displayed on alternate lines with the receive data in inverse video. With the selected channel looped back, the transmit and receive data should be the same.

Note: To test a near-end UUT B-channel, change the RS-232-C cables from HP 3787B (1) to HP 3787B (2) (ie unplug the RS-232-C cable from HP 3787B (1) and insert into HP 3787B (2), and unplug RS-232-C cable from HP 3787B (2) and insert into HP 3787B (1)).

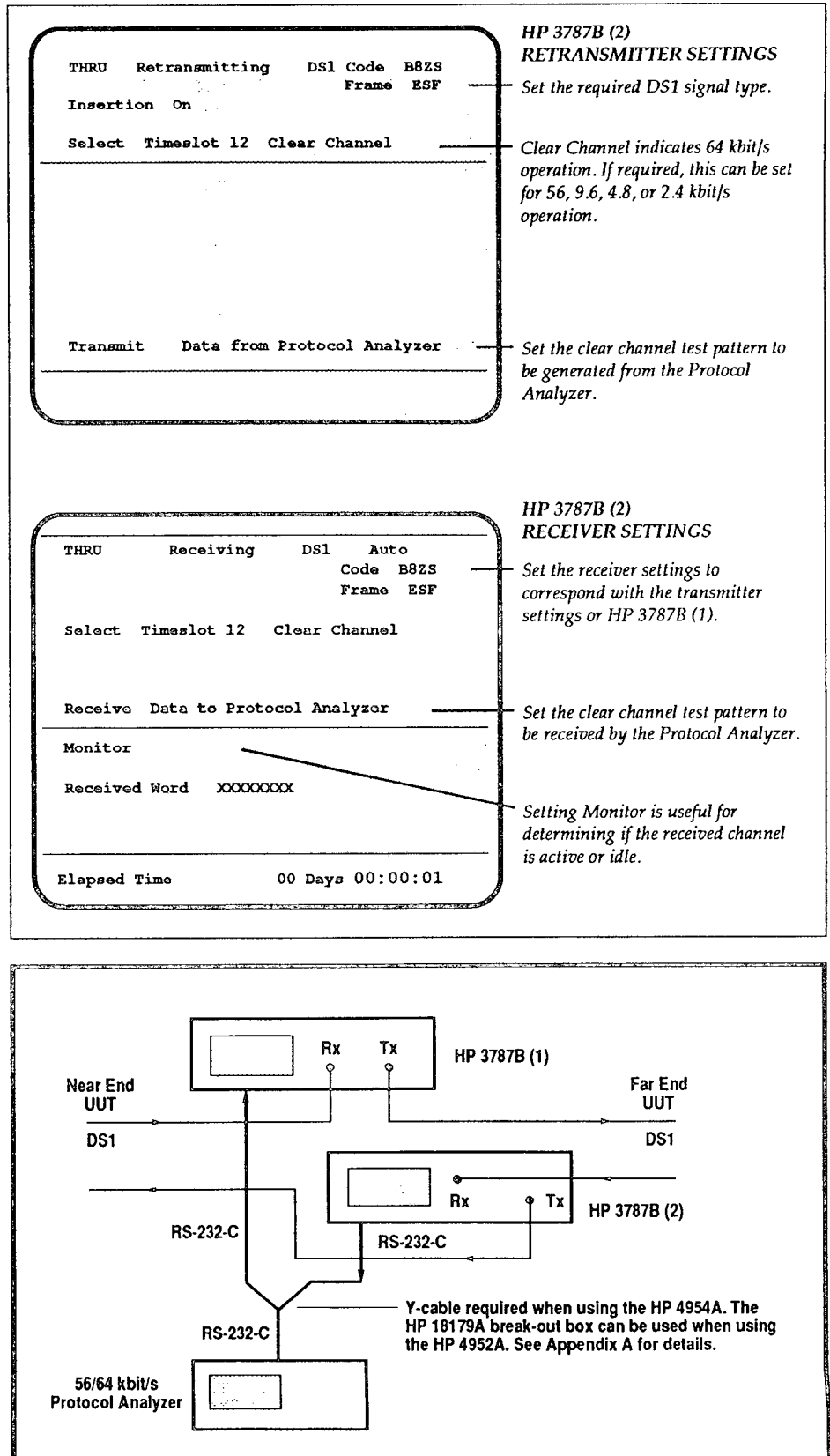


Figure 4 Thru-mode troubleshooting configuration

Summary

Most industry analysts predict a migration from T1 to ISDN PRI with a possible intermediate step involving some sort of T1/ISDN hybrid network. Whether you are involved in manufacturing, installing, commissioning or maintaining T1 systems, you need a test solution which you can use now and one which will not be made obsolete when you migrate to ISDN.

The HP 3787B will help you make this transition. It can test the error performance of complete ISDN PRI or T1 signals, or individual 'B', 'D' or DS0 channels, and, as outlined in this application note, it can also be used with a protocol analyzer to test user protocol including simulation and analysis of CCS7.

Other features include:

- In-service error analysis performed on CRCs, Frame Word and line code bipolar violations.
- Comprehensive T1 loopback code generation (in-band and 4 kbit/s datalink).
- T1 Jitter and Controlled Frame Slip measurements.
- Comprehensive DDS (2.4, 4.8, 9.6, 19.2, 56 kbit/s) loopback, signaling and measurement capability.
- DS1C (3.152 Mbit/s) interface and DS1 to DS1C multiplexing.
- Remote control interfaces (HP-IB and RS-232-C).

Appendix

Fabricating an RS-232-C Y-cable

This Appendix gives information on how to connect two HP 3787Bs via the rear panel PROTOCOL ANALYZER ports to one HP 4952A or 4954A Protocol Analyzer. This connection is required when using the HP 3787Bs and a protocol analyzer to perform simulation and analysis on full duplex T1 signals. See Figure 4 on page 9 for application details.

For applications with the HP 4952A, the HP 18179A break-out box can be used with the appropriate switch configuration and jumper links to provide the connection outlined in Figure A-1.

For applications with the HP 4954A, a special RS-232-C Y-cable must be fabricated.

Fabricated RS-232-C Y-cable for use with the HP 4954A

The RS-232-C Y-cable can be fabricated using 3 x DB25 male connectors and a length of 5-core cable.

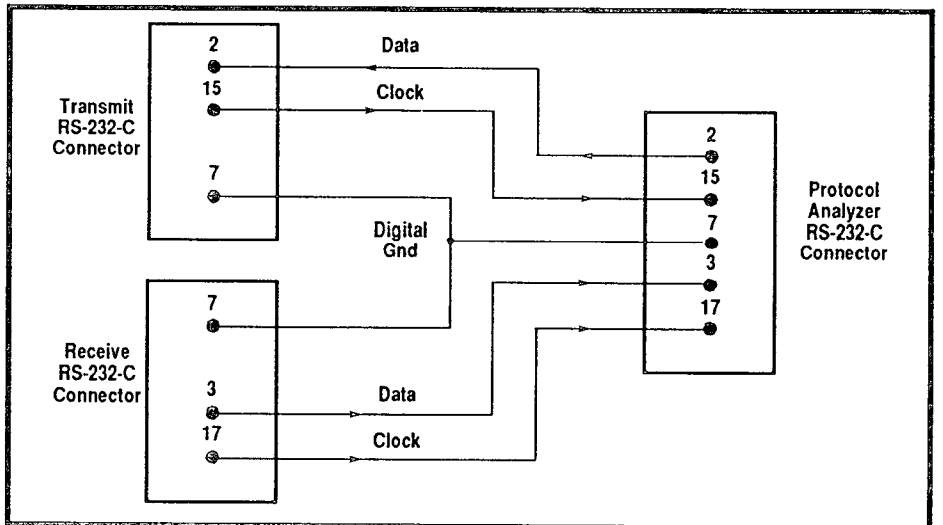
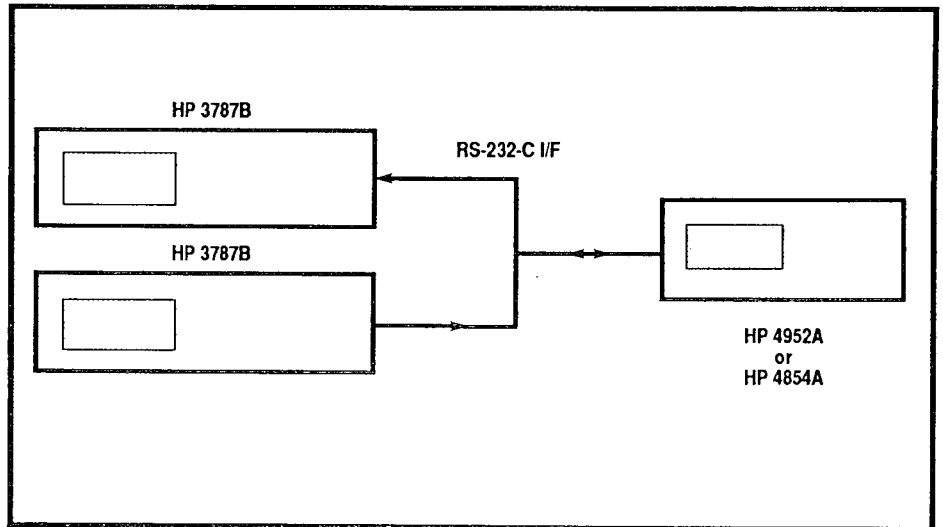


Figure A-1 Y-cable configuration

Protocol analyzer interface pin configuration

The pin designations for the rear panel connector are as shown in Figure A-2.

The HP 3787B supplies both the Tx and Rx clocks. The interface allows full duplex data transmission between the HP 3787B and the protocol analyzer.

Notes:

- The HP 3787B is shipped from the factory with Link 8 (LK8) out.
- The T STATUS bit is permanently set False (ie high level).
- The F STATUS bit is not used by the HP 3787B.

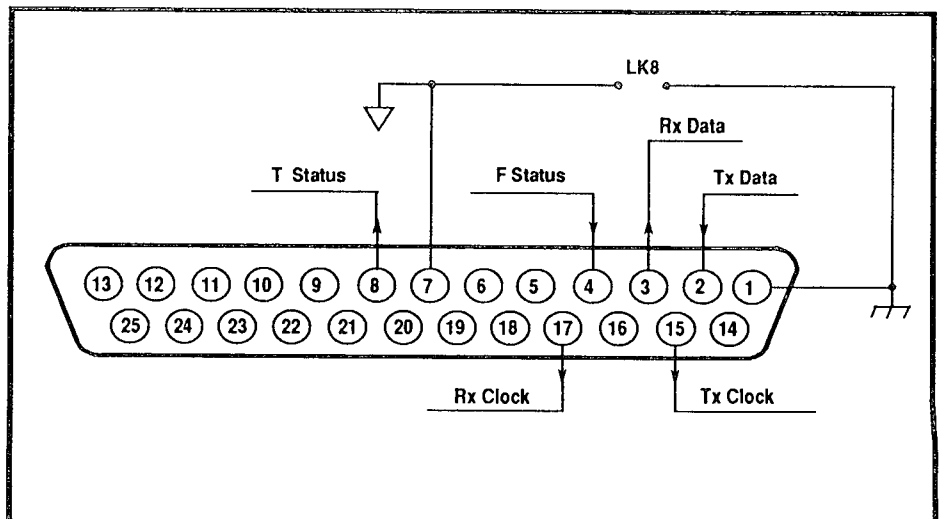


Figure A-2 Protocol analyzer connector pin configuration

Other channels available for protocol analysis

Although this application note deals with protocol analysis at 56/64 kbit/s rate, the HP 3787B can also perform drop and insert

error measurements and protocol analysis on the following channels and at the network interfaces listed in the following table.

**Table A-1 Channels accessed from the
PROTOCOL ANALYZER interface on the HP 3787B**

HP 3787B Network Interfaces	Mux/demux Channel to Protocol Analyzer Interface
DS0A/DS0B (64 kbit/s)	64, 56, 9.6, 4.8 and 2.4 kbit/s
DS1 (1.544 Mbit/s)	64, 56, 9.6, 4.8, 2.4 kbit/s plus the 4 kbit/s ESF data-link, the 4 kbit/s Fs channel and the T1DM framed 8 kbit/s R-channel.
DS1C (3.152 Mbit/s)	Channels are the same as for DS1, but at DS1C a demultiplexing-only capability is provided.

For more information, call your local HP sales office listed in your telephone directory or an HP regional office listed below for the location of your nearest sales office.

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Rockville, MD 20850
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