HEWLETT PACKARD

OPERATING MANUAL

HP 3787B

DIGITAL DATA TEST SET (Including Options 001 and 002)

SERIAL NUMBERS / SOFTWARE REVISIONS

This manual has been modified to apply to instruments with serial numbers prefixed 2939U and/or with software revision 2936.

For instruments with serial numbers prefixed 2703U and/or with software revision 2726, an unmodified manual is required.

For instruments with serial numbers prefixed 2814U and/or with software revision 2830, a manual modified with update package 03787-90001U0388 is required.

For additional important information about Serial numbers see INSTRUMENTS COVERED BY MANUAL in Section 7.

For additional information about software revisions, see FIRMWARE / SOFTWARE HISTORY at the start of Section 6.

Manual Part Number: 03787-90001
Microfiche Part Number: 03787-90026
Printed: September 1987

WARNING

READ THE FOLLOWING NOTES BEFORE INSTALLING OR SERVICING ANY INSTRUMENT.

1. IF THIS INSTRUMENT IS TO BE ENERGISED VIA AN AUTO-TRANSFORMER MAKE SURE THAT THE COMMON TERMINAL OF THE AUTO-TRANSFORMER IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SOURCE.

2. THE INSTRUMENT MUST ONLY BE USED WITH THE MAINS CABLE PROVIDED. IF THIS IS NOT SUITABLE, CONTACT YOUR NEAREST HP SERVICE OFFICE. THE MAINS PLUG SHALL ONLY BE INSERTED IN A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD (POWER CABLE) WITHOUT A PROTECTIVE CONDUCTOR (GROUNDING).

3. BEFORE SWITCHING ON THIS INSTRUMENT:

   (a) Make sure the instrument input voltage selector is set to the voltage of the power source.

   (b) Ensure that all devices connected to this instrument are connected to the protective (earth) ground.

   (c) Ensure that the line power (mains) plug is connected to a three-conductor line power outlet that has a protective (earth) ground. (Grounding one conductor of a two-conductor outlet is not sufficient).

   (d) Check correct type and rating of the instrument fuse(s).

Setting the Instrument to the Default State

The instrument automatically starts up in the state it was in when it was last switched off. To start from a known state you may recall a fixed setup stored in the instruments memory.

Use the CURSOR [↑] and [↓] keys to move the flashing cursor to:

Stored Panels & Keyboard Lock . . . 2

then press the [PAGE/INDEX] key.

The "Stored Panels and Keyboard Lock" page is now displayed.

```
Keyboard is  Unlocked   Beeper is  Off

Panel
  0  Factory Default Panel
  1
  2
  3
  4
  5
  6
  7
  8
  9

Stored Panels  Protected
Press EXEC to  Recall from Panel 0
Last Panel configuration recalled : 0
```

Use the CURSOR keys to move the cursor to "Press EXEC to Recall from Panel _" and use the CHANGE keys to select 0.

Press the [EXEC] key to recall panel 0. Panel 0 is a fixed state permanently stored in the instrument - later you will see how to store your own selections in panels 1 to 9.

Press the [PAGE/INDEX] key to return to the "INDEX" page.

Use the CURSOR keys to move the cursor to:

Normal Operation . . . 1

Press [PAGE/INDEX] again to display the "Normal Operation" Receiving page.

Note that since measurement results are held until a new measurement is started the result of the previous measurement may be displayed at this stage. The result will be reset to 0 when you start your measurement.

```
_TX & RX   Receiving   DS1   Auto
                             Code   AMI
                             Frame  SF

 Select  DS1



 Pattern   20 Stage PRBS 14-0 Limit  On
 Results

  DS1     Logic  Error Count             0



 Elapsed Time               00 Days 00:00:00
```

- SF framing is also known as D4 or multiframe format
- Result of previous measurement may be displayed here.
- Elapsed time of previous measurement may be displayed here.

Making a DS1 Measurement and Adding Single Errors

In the first trial run the transmitter is set to add single errors and the receiver to make logic (binary) error measurements at DS1. The transmitter and receiver are then looped to make a back-to-back measurement.

Selecting the Measurement

The measurement is selected by selecting the results required. As the default state is a logic error count measurement at DS1, you have already selected what you want by recalling panel 0. All you need to do is set a suitable gating interval and the type of error to be added.

REMEMBER:

CURSOR keys ------Move the cursor in the direction of the arrow on the key.

CHANGE keys ------Change the parameter indicated by the cursor.

Set the display from top left to bottom right.

Checking Receiver Input Voltage Levels

Before making measurements at a DS1 cross-connect the receiver input levels may be checked to confirm that the levels are within the recommended limits:

DSX-1 ± 2.4V to ± 3.6V
DSX-1C ± 2.8V to ± 4.5V

Move the cursor to Results and use the NEXT key to change the display to RX Level. The positive and negative peak voltages at the receiver input are displayed simultaneously but are updated alternately.

```
TX & RX    Receiving     DS1    Auto
                                Code   AMI
                                Frame T1DM

Select  Timeslot 11  DS0B   2.4 kbit/s
        Customer 02
        Primary Channel

Pattern   2047 Bit PRBS
          Continuous
_RX Level

Positive peak :  +3.00 Volts

Negative peak :  -3.00 Volts

Gating    Interval    00 Days 00:10:00
```

Updated alternately.

Storing and Recalling Measurement Set-ups

This trial run shows you how to use the "stored panels". These stored panels are preset instrument setups which are retained in the instruments memory, even after the power has been removed. One of the panels is fixed, the other 9 are selectable. In this trial run you store the current setup, recall the fixed setup (to reconfigure the instrument) and then recall the one you stored.

Storing a Panel

Use the PAGE/INDEX key to display the index and use the CURSOR keys to move the cursor to

Stored Panels & Keyboard Lock. . . 2

Press the PAGE/INDEX key again to access the Stored Panels display. Use the CURSOR and CHANGE keys to set the display as shown below:

```
Keyboard is Unlocked   Beeper is Off

Panel
  0  Factory Default Panel
  1
  2
  3
  4
  5
  6
  7
  8
  9

Stored Panels Not Protected
Press EXEC to  Save into  Panel 1
Last Panel configuration recalled : 0
```

- Current setup will be stored as Panel 1.

Press EXEC to store the last selected setup in "Stored Panel 1". This will be the setup (both Transmit and Receive) which you used for the DDS measurement.

The Not Protected display will automatically change to Protected. If in future, you wish to overwrite your stored panel you must first change this field from Protected to Not Protected.

Recalling the Fixed Stored Panel

Now use the CURSOR and CHANGE keys to select Recall from Panel 0.

Remember this is the factory default setting.

```
Keyboard is  Unlocked    Beeper is  Off

Panel
  0  Factory Default Panel
  1
  2
  3
  4
  5
  6
  7
  8
  9

Stored Panels  Protected
Press EXEC to  Recall from Panel 0
Last Panel configuration recalled : 0
```

To access the selected panel press the EXEC key.

Press the PAGE/INDEX key again to return to the "INDEX" page and use the CURSOR keys to move the cursor to

Normal Operation. . . 1

Use the PAGE/INDEX key to display the "Normal Operation" page.

The instrument setup is now the one used for the DS1 trial run at the start of this exercise. This is permanently held in stored panel 0.

Recalling the Panel You Stored

Use the PAGE/INDEX key to display the "INDEX" and use the CURSOR keys to move the cursor to

Stored Panels & Keyboard Lock. . . 2

Press the PAGE/INDEX key again to obtain the Stored Panels display. Use the CURSOR and CHANGE keys to set the display as shown below:

```
Keyboard is Unlocked    Beeper is Off

Panel
  0  Factory Default Panel
  1
  2
  3
  4
  5
  6
  7
  8
  9

Stored Panels  Protected
Press EXEC to  Recall from Panel 1
Last Panel configuration recalled : 0
```

Now press EXEC to recall the panel you stored in Stored Panel 1.

Press the PAGE/INDEX key again to return to the "INDEX" page and use the CURSOR keys to move the cursor to

Normal Operation. . . 1

Use the PAGE/INDEX key to display the "Normal Operation" page.

The instrument setup is now the one used for the DDS measurement and stored at the beginning of this trial run.

The Insertion field appears whenever a multiplexing function is selected. This must be set to On to enable any selected insertion. This field may be an exception from the rule for setting the display from top left to bottom right. You may wish to set the complete display before switching insertion on. Any subsequent configuration change automatically causes this field to revert to Off

```
THRU   Retransmitting  DS1  Code   AMI
                            Frame  ESF

Insertion  On
           |
           Off
```

You can add logic and frame errors to the retransmission. You can also introduce BPV's or run an APS test.

Stored Panels and Keyboard Lock

The Stored Panels and Keyboard Lock display is obtained by selecting INDEX Page 2.

Keyboard Lock

When the keyboard is Locked EXEC and START/STOP are inoperative. The CHANGE keys will allow the current instrument state to be displayed but not changed.

```
Keyboard is  Unlocked   Beeper is  Off
                |                   |
             Locked                On
```

Stored Panel Protection

```
Keyboard is  Unlocked   Beeper is  Off

Panel
  0  Factory Default Panel
  1
  2
  3
  4
  5
  6
  7
  8
  9

Stored Panels   Protected
                    |
              Not Protected
```

When a panel is stored it is automatically Protected against overwriting. Not Protected must be selected before a new instrument setup can be stored.

Recalling a Stored Panel

To recall a Protected panel,select the number of the panel to be recalled and press EXEC.

```
Stored Panels  Protected
Press EXEC to  Recall from Panel 1
Last Panel configuration recalled : 0
```

The stored setup is recalled and the number of the recalled panel (n) is shown in "Last panel configuration recalled : n"

To recall a stored panel which is Not Protected, select Recall from, select the panel number, and press EXEC

```
 9

Stored Panels Not Protected
Press EXEC to  Recall from Panel 1
                    |            |
                Save into     0 to 9
```

Storing a Panel

The Stored Panels are normally Protected as a safeguard against overwriting. Before storing a new instrument setup in a panel it is first necessary to select Not Protected. When you press EXEC to Save a panel, the current setup is saved and the stored panels field resets to Protected.

```
 9

Stored Panels Not Protected
                    |
                Protected
```

Select Save into, the reference number of the panel, 1 to 9, and press EXEC to store the panel.

```
Stored Panels Not Protected
Press EXEC to  Save into  Panel 1
Last Panel configuration recalled : 0
```

Naming a Stored Panel

You can give each of the selectable stored panels a name of up to 32 characters. Alternatively, you can use the 32 characters to add an instruction or message on the "stored panels" display.

Move the cursor to the first character position of the inverse video display following the number of the panel to be named. Use NEXT and PREV to select the first character, <space>, A-Z, a-z or 0-9. Move the cursor and repeat this process for each character leaving spaces as required.

The name can be loaded remotely from a controller by using the NAM command followed with the name in the form of a string variable.

```
Keyboard is Unlocked   Beeper is Off

Panel
  0  Factory Default Panel
  1  DDS TEST with DS0B frame errors
  2
  3
  4  Connect printer and press START
  5
  6
  7
  8  Before overwriting call J SMITH
  9

Stored Panels  Protected
Press EXEC to  Recall from Panel 1
Last Panel configuration recalled : 0
```

Data Logging

The Data Logging display is obtained by selecting INDEX Page 3.

Full details of internal and external printing are given in Section 5.

Printer Selection

Printer selection depends on Remote Control display selections

Only the internal printer is available when the instrument is configured as an addressable device.

```
Logging On    Logging Device HP3787B

Set the HPIB mode on page 5 to Talk Only
to use an external HPIB printer.
```

The internal printer HP3787B or an external printer HP-IB can be selected when the instrument is configured as a Talk Only device.

```
Logging  On    Logging Device    HPIB
                                   |
                                HP3787B
```

Triggering Prints of Result A Type Errors

With Log During Gating set to On you can chose to have a printout for every second which has error(s) Error Seconds or every second in which the error ratio exceeds a selectable limit Error Ratio >. The information printed is the number of errors (of the type selected for Result A) in the second when the trigger condition occurred.

When a jitter measurement is selected (option 001 only), Hit Bit Ratio or Hit Seconds can be logged.

```
Logging  On    Logging Device    HPIB

Log During Gating  On
          Trigger  Error Ratio >  1.0E-2
                        |
                   Error Second

                   Hit Bit Ratio>  1.0E-2
                        |
                     Hit Second
```

Printing Selected Results

With the End of Gating Summary set to On you can chose to print at the end of each gating period Always, or at the end of gating periods in which the error ratio has exceeded a selectable limit Error Ratio >.

This may be used to obtain prints at timed intervals with with repetitive gating.

```
Logging  On    Logging Device    HPIB

Log During Gating  On
          Trigger  Error Ratio >  1.0E-2

End of Gating Summary  On
                When  Error Ratio >  1.0E-2
                           |
                        Always
```

FIRMWARE/SOFTWARE HISTORY

You can check the software version of your instrument manually or remotely.
Manually by selecting INDEX display: INSTRUMENT ID 6
Remotely by using the "FRN?" command.

Programs written for earlier (lower numbered) software versions of the HP 3787B can be used for later (higher numbered) software versions except where the following conditions apply.
Programs written for version 2726 will run on version 2830, see condition 1.
Programs written for version 2726 will run on version 2839, see conditions 1 and 2.
Programs written for version 2830 will run on versions 2839 to 2936, see condition 2.
Programs written for version 2839 will run on versions 2919 to 2936
Programs written for version 2919 will run on version 2936

Condition 1 Except where they depend on the Tx DS1C digroups being unframed or the default state of alarm mask register 2 being 7.

Condition 2 Except where they depend on the default state of the DDS line and multiplexer rates being 2.4 kbit/s or the Dataport error correction defaulting to OFF when deselecting and reselecting DS0A.

Programs written for later (higher numbered) versions, AND which make use of the additional features in the later version, will not run on instruments with earlier (lower numbered) software versions.

The following table lists the functions which are affected by software changes and explains the differences. The version at which the change occurred is marked with an asterisk (*).

VERSION			FUNCTION	DIFFERENCE
2726	2808	2839		
R0R	R0R	RR0*	Rx DS0A/B data rate	19.2kbit/s included
T1F	T1F*	T1F	T1 Framing	Applies to DS1C Digroups as well as DS1
TAM	TAM*	TAM	Tx DS0A Interface	Bipolar now an alternative to DSX
TDT	TDT*	TDT	Tx data type	PROTOCOL available for 56kbit/s DDS and 64kbit/s clear channel. Provision for ESF datalink message added
		TEC*	BCH Error Encoding	Additional facility with 19.2kbit/s. DS0A
	TMC*	TMC	ESF Datalink Message	ESF Datalink Message has Selectable Content
	TMT*	TMT	ESF Datalink Message Type Setting	Enables Setting of Message/Idle
TNU	TNU*	TNU	Tandem Number	Valid for Alternating DS0DP Loopback
T0R	T0R	TR0*	Tx DS0A/B Data Rate	19.2kbit/s, included
TSC	TSC*	TSC	Tx DDS Code	Additional Bit Selectable

Additional Changes for Software Versions 2919 and 2936

Version 2919
Mnemonic: CSL
Function: DDS latching loopback/MJU operation sequence length.
Description: Standard/Extended selection introduced.

Version 2936
Mnemonic: NAM
Function: Name stored panel.
Description: Stored panel name/comment facility introduced.

VERSION			FUNCTION	DIFFERENCE
2726	2830	2839		
AL1?	AL1?*	AL1?	Alarm status enquiry	Bit 1 (2) changed from SL1 (indicating signal loss and excess zeros) to XS0 (excess zeros only). See AM2 and AL2? for signal loss.
AL2?	AL2?*	AL2?	Alarm status enquiry	Bit 3 (8) added for signal loss Bit 4 (16) and bit 5 (32) added for positive and negative frame slips.
AM1	AM1*	AM1	Alarm Mask Setting	Bit 1 changed to XS0 as for AL1?
AM2	AM2*	AM2	Alarm Mask Setting	Bits 3, 4, and 5 added as for AL2?
ANR?	ANR?*	ANR?	Analysis Result Enquiry	4 Additional Results
ATY	ATY*	ATY	Analysis Type Setting	4 New Measurement Types
EAT	EAT*	EAT*	Tx Error Add Setting	2830 - Logic Errors Available in THRU Mode 2839 - 19.2 Encoding Errors Available
		EER*	19.2 kbit/s Encoding Errors Setting	ON/OFF setting for added 19.2 kbit/s BCH Encoding Errors
	FSL?*	FSL?	Frame Slip Result Enquiry	Additional Measurement
GTY	GTY*	GTY	Gating Type	Short 5M and 15M Included
LBT	LB0*	LB0	DS0 Loopback Setting	Additional DS0 Loopbacks Available
LBT	LB1*	LB1	DS1 Loopback Setting	Additional DS1 Inband and Datalink Loopbacks
	LHB?*	LHB?	Hub ID enquiry.	Applies to added MJU loopback.
LEC	LES*	LES	Log End of Gating Summary	Frame Slips Added
MDS	MDS*	MDS	Measurement Display Select	Frame Slips Added
RCD	RCD	RCD*	Rx Pattern Type	DDS Return Codes now Automatic
RDT	RDT*	RDT	Rx Data Type	PROTOCOL Available for 56kbit/s DDS and 64kbit/s Clear Channel

Miscellaneous Parameters (DATA LOGGING)

Function	Mnemonic Code	Description
		EXAMPLE :- To obtain a summary of Selected Measurement Results, all Alarm Duration results and Frame Slips on the Internal Printer at the end of each Gating period when the Error Rate exceeds 1 in 10 million send : **OUTPUT 707;"LOG ON;LDV HP 3787B; LEG RATIO;LET 7; LES "1,0,2,1"**
LOG DURING GATING	**"LDG n"** n = OFF or Ø n = ERR_SEC or HIT_SEC or 1 n = RATIO or 2 "LDG?"	No Logging during Gating When an Error Second or a Hit Second (Opt 001 only) occurs. When the Error Ratio or Hit Ratio (Opt 001 only) exceeds threshold.(See LDT) Returns state of LDG ie Ø to 2. Note :-It is possible to have Logging During Gating and Logging at End of Gating both selected.
ERROR RATIO THRESHOLD FOR LOGGING DURING GATING	"LDT n" "LDT?"	n = 2 to 7 representing an Error Ratio of 1.ØE-2 to 1.ØE-7. Returns state of LDT ie 2 to 7.
LOG ON DEMAND	"LOD"	This message mimics the "PRINT' key in Local Mode and will cause the currently selected set of results to be Logged on the Internal Printer even if LOGGING is disabled (LOG OFF). One of the following will be logged :- Measurement Results, Analysis Results, Alarm Duration Results, Monitor Word Result or Input Voltage Result. LOD provides the only remote method of Logging the Monitor Word and Input Voltage Results.

Miscellaneous Parameters (STORED PANELS & BEEPER)

Function	Mnemonic Code	Description
SAVE PANEL	"SAV n" n = 1 to 9	Corresponds to non volatile Memory locations. The current instrument settings are stored in the designated Memory location. This is only possible if Write Protection is OFF ie "PRP Ø". The state of Request Service (RQS), Alarm Mask Registers 1 & 2 (AM1,AM2) and User Defined Pattern (TRP) are not Saved by this Message, nor recalled by the Recall Panel Message (RCL).
PROTECT PANEL	"PRP n" n = OFF or Ø n = ON or 1 "PRP ?"	 Write Protection Off. SAV valid Write Protection On. SAV invalid Returns state of PRP ie Ø or 1.
RECALL PANEL	"RCL n" n = Ø to 9	Corresponds to non volatile Memory locations. Location Ø holds the instrument DEFAULT settings and cannot be used when saving settings. The instrument settings stored in the designated Memory location are recalled and the instrument configured according to those settings.
NAME PANEL	"NAM n'cc...cc'" n = 1 to 9	Inserts a name for panel "n" on the Stored Panels display. The string cc...cc may be 1 to 32 characters long and must be contained within quotation marks ("cc...cc").
	"NAM? n"	Returns the name of the stored panel "n" as a string of 34 characters comprising 32 characters of data and 2 characters for quote marks.
AUDIO CONTROL	"AUD n" n = OFF or Ø n = ON or 1 "AUD ?"	 Only sounds on User Error Sounds on User & Bit Errors, & Alarm Returns state of AUD ie Ø or 1.

Table E-1. Remote Control Messages (continued)

MJU Loopback Identification	"LHB?"	6-46A	N/A
Log On Demand	"LOD"	6-49	N/A
Logging ON/OFF	"LOG n" n = OFF or 0 n = ON or 1 "LOG?"	6-48	OFF
Output Latching Loopback Mapcode	"MAP?"	6-47	N/A
RX Measurement Source A	"MAS n" n = SEC_CHAN or 1 n = CUST or 2 n = SUBRATE or 3 "MAS?"	6-36	N/A
Measurement Source B	"MBS n" n = OFF or 0 n = SEC_CHAN or 1 n = CUST or 2 n = SUBRATE or 3 n = TIMESLOT or 4 n = DS0 or 5 n = DS0A or 6 n = PSDC or 7 n = DATALINK or 8 n = DIGROUP or 9 n = DS1 or 10 n = DS1C or 11 n = R_CHAN or 12 "MBS?"	6-38	OFF
Measurement Display	"MDS n" n = RESULTS or 1 n = ALARMS or 2 n = BIT_MON or 3 n = INP_LEV or 4 n = ANALYSIS or 5 n = SLIPS or 6 "MDS?"	6-51	RESULTS
TX Multipoint Junction Unit Operations	"MJU n" n = SELECT or 1 n = TEST or 2 n = END_TEST or 3 n = BLOCK or 4 n = UNBLOCK or 5 n = RELEASE or 6 "MJU?"	6-20	N/A

Table E-1. Remote Control Messages (continued)

Instrument Mode	"MOD n" n = TX&RX or 1 n = THRU or 2 MOD?	6-16, 6-30	TX&RX
Output Monitor Word Result	"MON?"	6-46A	N/A
RX Measurement Type A	"MTA n" n = LOGIC or 1 n = BPV or CODE or 2 n = FRAMING or 3 n = ESF_CRC or 4 n = JITTER or 5 "MTA?"	6-36	LOGIC
RX Measurement Type B	"MTB n" n = LOGIC or 1 n = BPV or CODE or 2 n = FRAMING or 3 n = ESF_CRC or 4 n = JITTER or 5 "MTB?"	6-38	LOGIC
Name Stored Panel	"NAM n ′cc....cc′" n = 1 to 9 "NAM? n"	6-50	N/A
Option Query (Common Capability)	"OPT?"	6-53	N/A
Protect Panel	"PRP n" n = OFF or Ø n = ON or 1 "PRP?"	6-50	ON
RX DS1/DS1C Coding	"R1C n" n = AMI or 1 n = B8ZS or 2 "R1C?"	6-30	AMI
RX DS1/Digroup Framing	"R1F n" n = OFF or Ø n = T1DM or 1 n = SF or D4 or 2 n = FT or 3 n = ESF or FE or 4 "R1F?"	6-31	SF

OPERATING MANUAL UPDATE PACKAGE 2

Use the following information to check the software version of your HP 3787B Digital Data Test Set and to determine if your operating manual needs to be updated.
Use the update packages to replace the correspondingly numbered pages in your manual. Additional pages have a suffix letter eg Pages 6-1, 6-2 and 6-2A, 6-2B replace Pages 6-1, 6-2.
This package (03787-90001U0988) applies only to manuals which have already been updated with package 03787-90001U0388.

SOFTWARE VERSION CHECK
You can check the software version of your instrument by selecting INDEX display :
INSTRUMENT ID. 6

SOFTWARE VERSION 2726
Instruments with software version 2726 require Operating Manuals with HP Part Number 03787-90001.

SOFTWARE VERSION 2830
Instruments with software version 2830 require Operating Manuals with HP Part Number 03787-90001 updated with the OPERATING MANUAL UPDATE PACKAGE, HP Part Number 03787-90001U0388

SOFTWARE VERSION 2839
Instruments with software version 2839 require Operating Manuals with HP Part Number 03787-90001 updated with two packages **IN THE CORRECT ORDER.**
FIRSTLY update with the OPERATING MANUAL UPDATE PACKAGE, HP Part Number 03787-90001U0388.
THEN update with this package OPERATING MANUAL UPDATE PACKAGE 2, HP Part Number 03787-90001U0988.

The additional features with this software version are as follows :

- 19.2 kbit/s DDS sub rates available.
- 19.2 kbit/s DS1/DS0A and DS0A BCH encoding available.
- 19.2 kbit/s BCH encoding error add available.
- MJU latching loopback available with point-to-point operation.
- Automatic return of MJU and latching loopback return codes.
- Default to "last selected" dataport error correction state.
- Power on default of DDS rate changed to 9600 bit/s.

HEWLETT PACKARD

OPERATING MANUAL

HP 3787B

DIGITAL DATA TEST SET (Including Options 001 and 002)

SERIAL NUMBERS / SOFTWARE REVISIONS

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Manual Part Number: 03787-90001
Microfiche Part Number: 03787-90026

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3. BEFORE SWITCHING ON THIS INSTRUMENT:

   (a) Make sure the instrument input voltage selector is set to the voltage of the power source.

   (b) Ensure that all devices connected to this instrument are connected to the protective (earth) ground.

   (c) Ensure that the line power (mains) plug is connected to a three-conductor line power outlet that has a protective (earth) ground. (Grounding one conductor of a two-conductor outlet is not sufficient).

   (d) Check correct type and rating of the instrument fuse(s).

DSX-1 to DSX-0A Test, Sample Receiving Display

```
TX & RX   Receiving   DS0A Terminated
                   56 kbit/s Service
DS0 Clocks  Front

 Select   Primary Channel

 Pattern   2047 Bit PRBS
           Continuous
 Results

  DS0A     Logic  Error Count         0

 Gating    Interval    00 Days 00:15:00
```

- Set the receive interface.
- Select the test Pattern.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

Press the START/STOP key.

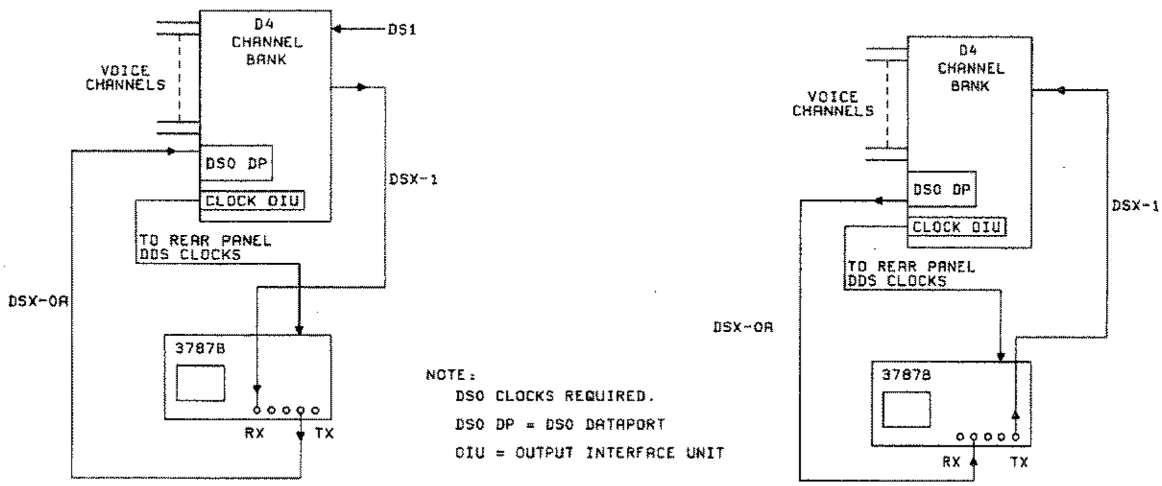
Remember that you can display Alarm Durations, Analysis and the Received Word (Monitor) by changing the Results field.

Dataport Testing

The HP 3787B allows you to measure the performance of Dataport cards installed in channel banks. This can be done from DS0A to DS0A or DS1 to DS1 by looping the channel bank. Alternatively by using the multiplexing/demultiplexing capability of the HP 3787B you can make half-channel measurements (i.e. DS0A to DS1 and DS1 to DS0A).

Measurement Configuration

The D4 channel bank clock source must be set to "LOOPED".



Example: Test a DS0 Dataport (DS0 DP) card in a D4 channel bank using the half-channel method. The 9.6 kbit/s rate has been chosen for this example.

Error Correction Testing

Some dataport cards have a selectable error-correction capability in the DS1 to DS0A direction. The HP 3787B can generate errored data to test this at all subrates. With the HP 3787B transmitter set to produce 3 errored bytes in every 5 bytes (3 in 5) the Dataport error correction will fail to remove the inserted errors and the HP 3787B DS0 receiver should see the added errors. With 2-in-5 selected the Dataport error correction should remove all the inserted errors and the HP 3787B DS0 receiver should see no added errors.

```
TX & RX   Transmitting   DS1 Code   AMI
                             Frame   SF
Insertion On            DS1 Clock Looped

Select  Timeslot 01   DS0A   9.6 kbit/s

Point-to-Point

Loopback  Off

Test   Primary Channel


Pattern   2047 Bit PRBS
Dataport Test    3 in 5
```

19.2 kbit/s Error Correction

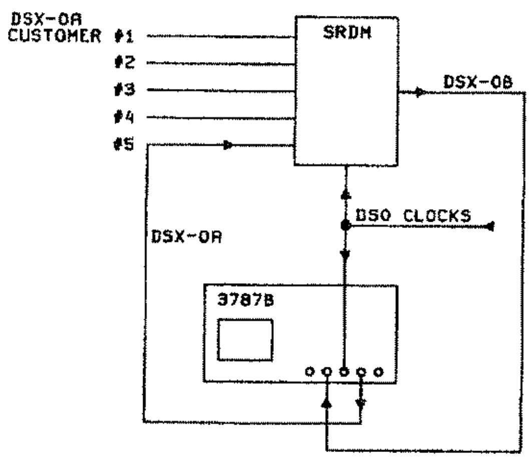
For 19.2 kbit/s DS0A circuits a different form of error correction is used. Access to the error corrected signal in the network is only (normally) available via the HP 3787B's "drop and insert" capability. The HP 3787B allows testing of this error correction scheme by introducing errors after coding (at the Transmitter) which the receiver will remove. Hence even when "encoding error add" is enabled there should not be any logic errors counted at the receiver. This corresponds to the 2-in-5 case for subrates; there is no case corresponding to the 3-in-5 dataport error add function.

Sub-Rate Data Multiplexer (SRDM) Testing

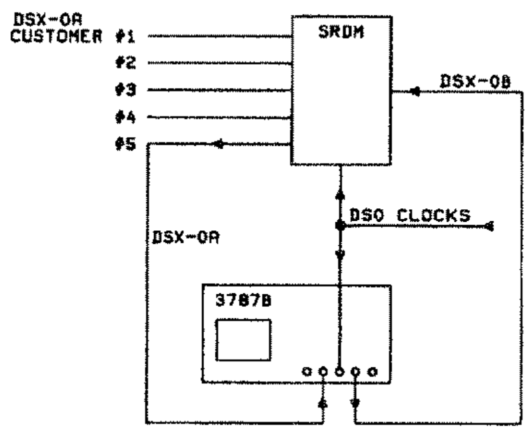
Application

You can run tests on SRDMs from DSX-0A to DSX-0B, and from DSX-0B to DSX-0A, at all DDS subrates.

Measurement Configuration



DSX-0A to DSX-0B



DSX-0B to DSX-0A

Example: DSX-0A to DSX-0B

In this example the SRDM is configured to multiplex five 9.6 kbit/s customers into a DS0B signal.

NOTE

SRDMs are sometimes loaded with customers at service rates lower than the capacity of the multiplexer, eg a 2.4 kbit/s customer into a 9.6 kbit/s multiplexer. The HP 3787B can generate and test such signals.

SRDM DSX-0B to DSX-0A, Sample Receiving Display

```
TX & RX   Receiving   DS0A Terminated
                   9.6 kbit/s Service
DS0 Clocks  Front

 Select   Primary Channel
          (Error Correction  Off )

Pattern   2047 Bit PRBS
          Continuous
Results

  DS0A     Logic  Error Count          0
_

Gating    Interval     00 Days 00:15:00
```

- Set the receive interface.
- Remember to select the same test Pattern as on the Transmitting display.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

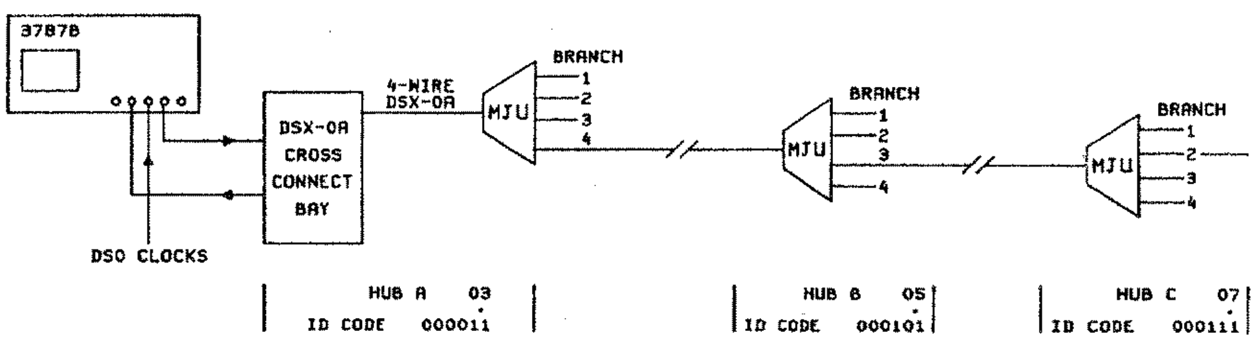
Press the (START/STOP) key.

MJU Branch Selection and Testing

Application

You can select, test, block, unblock and release all branches of a DDS Multi-point Circuit. You can loop-back a selected branch or an MJU. Testing is normally performed downstream from a DSX-0A cross-connect bay by routing each Multi-point Junction Unit in turn. Using the drop and insert capabilities of the HP 3787B, you can also access the circuit at T1.

Measurement Configuration



Example: Select HUB C branch 2 from the HUB A DSX-0A cross connect bay, perform a loopback, make a measurement and release the loopback.

Select Branch

The first operation is to establish the route through the system to the chosen branch. You do this by setting the transmit display for the branch of the first MJU, in this example branch 4, and pressing the EXEC key. When the branch has been selected, the Hub A ID code is returned and is displayed in the "Present" field. You then repeat the operation for branch 3 out of Hub B and branch 2 out of Hub C. This sequence is shown on the following Transmitting displays:

NOTE

The receive display must be set to a DDS Pattern (PRBS or word) for the transmitter to display the HUB-ID's.

Branch Selection, Sample Displays

```
TX & RX  Transmitting DS0A  Bipolar
                   9.6 kbit/s Service
DS0 Clocks Front
```

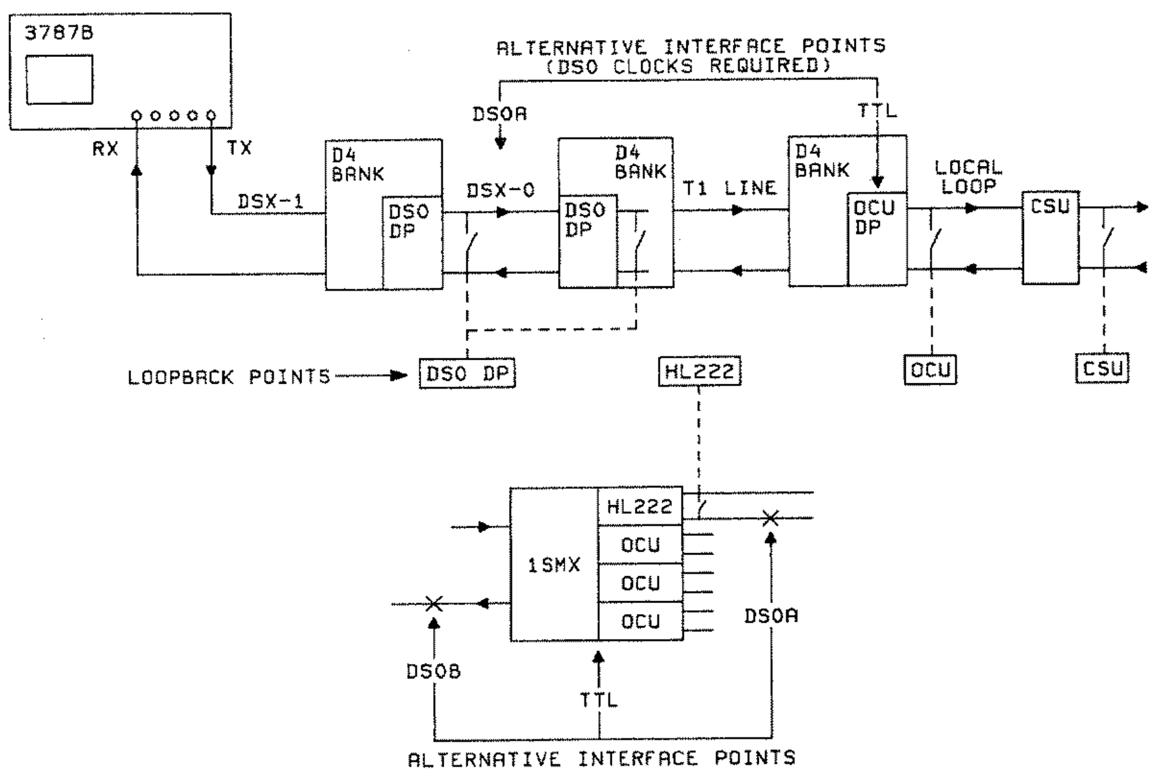
- Set the transmit interface.

DDS Latching Loopbacks

Application

You can set a latching loopback in the DDS system at any of the points shown in the measurement configuration below or at an MJU, make a measurement and release the loopback.

Measurement Configuration



Example: Access at a DSX-1 cross-connect and loopback the second DS0DP Dataport. Make logic error measurements on a 2.4 kbit/s customer circuit and release the loopback.

The HP 3787B can also access at DS0A and DS0B cross-connects and at DS0A logic access points. With DS0 access DDS clocks must be supplied.

If you wish the loopback to be acknowledged select the Receiving display and set the Pattern to a DDS PRBS or word. This ensures that MAP codes returned from a successful loopback will be displayed on the Transmitting display.

Latching Loopback, Sample Receiving Display

```
TX & RX    Receiving    DS1    Auto
                        Code    AMI
                        Frame  T1DM

Select  Timeslot 01   DSOB   2.4 kbit/s
        Customer 01
        Primary Channel

Pattern  2047 Bit PRBS
          Continuous
Results

Customer   Logic  Error Count         0



Gating    Interval   00 Days 00:05:00
```

- Set the receive interface.
- Select the timeslot parameters and customer number
- Select the test pattern. A DDS PRBS or word provides the Mapcode on the Transmitting display.
- Select the measurement.
- Set the measurement Gating Interval.

On the Transmitting display select the point at which you wish to loopback the circuit, in this case the second DS0DP unit. Press EXEC to actuate the loopback.

Latching Loopback, Sample Transmitting Display

```
TX & RX   Transmitting   DS1 Code   AMI
                            Frame  T1DM
Insertion On             DS1 Clock Looped

Select  Timeslot 01   DSOB   2.4 kbit/s
        Customer 01

Point-to-Point

Loopback  Latching  DSODP  MAPX
Tandem Number of Unit 2
Test   Primary Channel

Press EXEC to Actuate Loopback

Pattern   2047 Bit PRBS
 No Error Add
```

- Set the transmit interface.
- Select the timeslot parameters and customer number.
- Select Loopback.
- Select the test Pattern.
- Press EXEC to loop-up.

If you have selected a DDS Pattern (PRBS or word) on the Receiving page a successful loopback attempt will result in the display of "MAP0 (DS1)" indicating a lineside DS0DP loopback has been achieved.

For the various types of latching loopbacks MAP codes are returned as follows:

DS0DP (dropside), i.e. DS0 side OCU HL222	MAP1 (X110110X)
DS0DP (lineside), i.e. DS1 side CSU (channel)	MAP0 (X001001X)

If an attempt is unsuccessful or if the Receiving display has not been set for acknowledgment (to a DDS PRBS or word), the display will remain as MAPX.

Make the Measurement

Press the START/STOP key

Releasing the Loopback

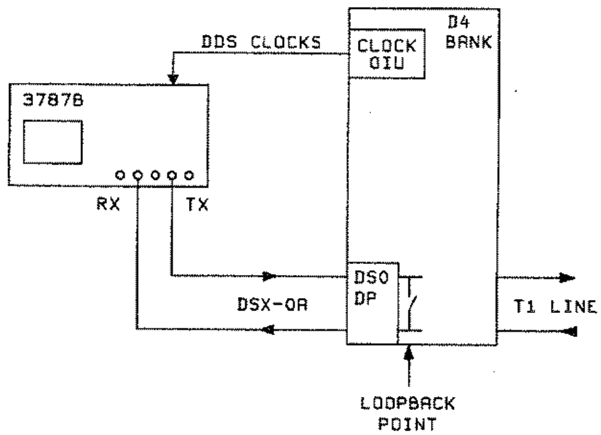
When you have completed your measurement release the loopback by selecting the Transmitting display and pressing the EXEC key. (Ensure "to Release Loopback" is displayed before you press EXEC).

DDS Secondary Channel Testing

Application

You can access and test DDS secondary channel, either end-to-end or by using latching loopbacks. The HP 3787B can access the network at the DSX-0A, DSX-0B or DSX-1 cross-connects or at DS0A logic access points.

Measurement Configuration



Example: Interface at the DSX-0A cross-connect on a 2.4 kbit/s point-to-point circuit. Loopback the first Dataport and measure secondary channel logic errors.

Secondary Channel Test, Sample Transmitting Display

```
TX & RX   Transmitting  DS0A   Bipolar
                2.4 kbit/s Service
DS0 Clocks  Front



Point-to-Point

Loopback  Latching  DS0DP  MAPX
Tandem Number of Unit  1
Test  _Secondary Channel

Press EXEC to Actuate Loopback

Pattern   511 Bit PRBS
 No Error Add
```

- Set the transmit interface.
- Select the Loopback.
- Select Secondary Channel.
- Select the test Pattern.

Press EXEC to loop-up.

For information on Latching Loopback acknowledgment see Page 2-28.

56 kbit/s Switched Timeslots

With ESF framing the A, B, C and D signaling bits may be set in the selected timeslot.

With SF framing the A and B signaling bits may be set in the selected timeslot.

```
TX & RX  Transmitting   DS1 Code    AMI
                           Frame    ESF
Insertion On           DS1 Clock    Int

Select  Timeslot 01  56 kbit/s Switched

Signaling Bits   Set   A  B  C  D
                       0  1  0  1
```

Select the desired test pattern. One of the test patterns is a short settable word and another is a long preprogrammable word (up to 256 bytes) which is programmed remotely.

```
 Pattern   Settable Word 1 0 1 0 1 0 1 S
                  |
           Preprogrammed
                  |
           2047 Bit PRBS
                  |
           511 Bit PRBS
                  |
           All Ones Word
```

Select the desired error-add type.

```
  No Error Add
        |
 Logic Error Add       Single
        |
  Byte Error Add
```

Setting Up the Transmitter (DS0B, DS0A & DS0)

The following pages contain the information required to transmit at 64 kbit/s cross-connects.

Transmit Interface Selection

Select the required cross-connect - DS0B, DS0A or DS0. For transmitting at DS1 see Page 3-4 or DS1C see Page 3-2.

```
TX & RX   Transmitting   DS1 Code    AMI
                          |
                         DS0B
                          |
                         DS0A
                          |
                         DS0
                          |
                         DS1C
```

Transmitting at DS0B

Select the desired DS0B rate. For all rates, except 56 kbit/s, the DS0B signal is a multicustomer format as generated by an SRDM. The 56 kbit/s DS0B signal carries a single customer.

When emulating the output of an SRDM where the customer rate is less than the SRDM rate, then the SRDM rate should be selected.

```
TX & RX   Transmitting   DS0B
                     2.4 kbit/s Service
                      |
                     4.8
                      |
                     9.6
                      |
                    19.2
                      |
                     56
```

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

```
TX & RX   Transmitting   DS0B
                     2.4 kbit/s Service
DS0 Clocks   Front
              |
             Rear
```

Select the customer slot to be stimulated. The range of customer numbers depend on the service rate selected.

2.4 kbit/s	1 to 20
4.8 kbit/s	1 to 10
9.6 kbit/s	1 to 5
19.2 kbit/s	1 or 2

```
TX & RX   Transmitting   DS0B
                     2.4 kbit/s Service
DS0 Clocks   Front


Transmit Customer   01
```

The DS0B customer rate field is displayed when the 4.8 or 9.6 kbit/s service rate is selected. In these two cases it is sometimes necessary to load some slots in the DS0B signal with lower rate customers. See the note on Page 2-14. Select the customer rate in the field shown.

```
 TX & RX   Transmitting  DS0B
                          9.6 kbit/s Service
DS0 Clocks  Front


Transmit Customer 01   2.4 kbit/s
                        |
                       4.8
                        |
                       9.6
```

For details on DDS transmission features, see Page 3-12.

Transmitting at DS0A

The network can be stimulated at Logic access points or at DSX (Bipolar).

```
 TX & RX   Transmitting  DS0A Logic Near
                                   |
                               Logic Far
                                   |
                                Bipolar
```

Select the DDS customer service rate.

```
 TX & RX   Transmitting  DS0A Logic Near
                         2.4 kbit/s Service
                          |
                         4.8
                          |
                         9.6
                          |
                        19.2
                          |
                          56
```

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

```
 TX & RX   Transmitting  DS0A Logic Near
                         2.4 kbit/s Service
DS0 Clocks  Front
              |
             Rear
```

For details on DDS transmission features, see Page 3-12.

The 19.2 kbit/s transmission has provision for forward error correction encoding (BCH).

```
 TX & RX   Transmitting  DS0A Logic Near
                        19.2 kbit/s Service
DS0 Clocks  Front  Encoding  On
                             |
                            Off
```

Transmitting at DS0

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

```
TX & RX  Transmitting  DS0
                       Clear Channel
DS0 Clocks  Front
              |
            Rear
```

The set of test patterns include a short settable word and a long preprogrammed word (up to 256 bytes) which is programmed remotely.

```
 Pattern    2047 Bit PRBS
                |
            511 Bit PRBS
                |
           All Ones Word
                |
           Settable Word 1 0 1 0 1 0 1 0
                |
           Preprogrammed
```

DS0 Clear Channel can be tested with data from a Protocol Analyzer via the HP 3787B rear panel PROTOCOL ANALYZER port.

```
Transmit Data from Protocol Analyzer
```

With error-add, selected errors can be added singly.

```
 Pattern    2047 Bit PRBS
   No Error Add
         |
 Logic Error Add       Single
         |
 Byte Error Add
```

DDS Transmission Facilities (DS0A/DS0B)

The following DDS features apply also when the HP 3787B is interfaced to the network at the DS0A and DS1 cross-connects.

```
TX & RX  Transmitting  DS0B
                    _56 kbit/s Service
DS0 Clocks  Front
```

You can test point-to-point circuits or multipoint circuits. The test capability is the same in both.

```
 Point-to-Point
       |
   Multipoint
```

Point-to-Point Circuits

Select the type of loopback required.

With alternating loopbacks only primary channels are tested.

```
Point-to-Point

Loopback Off
          |
         Alternating
          |
         Latching
```

Select the type of alternating loopback required.

```
Point-to-Point

Loopback Alternating   DSU
                        |
                      Channel
                        |
                       OCU
                        |
                      Repeater
                        |
                       HL96NY
                        |
                      Dataport
```

With OCU loopback, specify whether an intermediate HL96NY unit is present.

```
Loopback Alternating _ OCU
HL96NY present No
```

With Channel loopback at the 56 kbit/s service rate, specify the intermediate repeaters (0, 1 or 2).

```
Loopback Alternating _Channel
Intermediate repeaters 1
```

With Repeater loopback (56 kbit/s only), specify the repeater number (1 or 2).

```
Loopback Alternating _Repeater
Repeater Number 2
```

With Dataport loopback the tandem number may be selected in the range 1 to 8.

```
Loopback Alternating _Dataport
Tandem Number of Unit 2
```

With all latching loopbacks, both primary and secondary channels may be tested.

Select the type of latching loopback required.

```
Point-to-Point

Loopback Latching DSODP MAPX
                   |
                  OCU
                   |
                 Channel
                   |
                  HL222
                   |
                  MJU  HUB-ID XX
```

With DS0DP loopback the tandem number may be selected in the range 1 to 8.

```
Loopback  Latching  _DS0DP  MAPX
Tandem Number of Unit 2
```

The actuate message is displayed whenever alternating or latching loopback is selected. With any loopback selected, the actuate or release message can be selected at any time.

```
Press EXEC to Actuate Loopback
```

```
Press EXEC to Release Loopback
```

Multipoint Circuits

When a multipoint circuit is first selected the next step is branch selection. During branch selection the branch number of each MJU is in the range 1 to 4 since each MJU has 4 output branches.

```
  Multipoint              Select Branch  4
                                |
                            Test Branch
                                |
                             End Test
                                |
                           Block Branch
                                |
                          Unblock Branch
                                |
                            Release All
```

After a sequence of branch selection to select a single leaf branch, testing of this branch can be done exactly as on a point-to-point circuit. This is initiated by pressing the EXEC key.

```
  Multipoint              Select Branch  3

                      (Last branch selected X)

                            Present HUB-ID XX
                           Previous HUB-ID XX

Press EXEC to select branch
```

With multipoint circuits you can loopback an MJU.

```
  Multipoint              Test Branch

Loopback  Latching  _MJU   HUB-ID XX
```

You can select primary or secondary channel.

```
  Multipoint              Test Branch

Loopback  Off

Test   Primary Channel
              |
       Secondary Channel
```

Data

As well as transmitting standard test patterns and DDS codes the HP 3787B can insert data from a protocol analyzer into 64 kbit/s Clear Channel, 56 kbit/s DDS and sub-rate timeslots.

```
Pattern   2047 Bit PRBS
   |
  Code
   |
Transmit  Data from Protocol Analyzer
```

The set of test patterns includes a short settable word and a long preprogrammed word (up to 256 bytes) which is programmed remotely.

With the preprogrammed word all bits are settable except bit #1 at the sub-rates (sub-rate frame pattern bit position).

```
Pattern   2047 Bit PRBS
          511 Bit PRBS
          All Ones Word
          Settable Word S 0 1 0 1 1 0 1
          Preprogrammed
```

The code being transmitted is displayed as the "Current Code". You can select the "next" code to be transmitted and then change the transmission by pressing EXEC.

In addition to the standard codes a settable code is provided.

With settable word only the "data bits" can be set. With settable code, the control/status bit (bit 8) is also settable.

The examples on this page are for the sub-rate case with DS0B access.

```
Code            CMI          S1111110
              OCU L/B
             CHAN L/B
              DSU L/B
                TIP
                LBE
                FEV
                TA
                MA
                UMC
               BLOCK
                RLS
                ASC
               TEST
                OOS
          Settable Code S 0 1 0 1 0 1 0
          Current Code : S1111110 (CMI)
```

Error Add

With error-add, selected errors can be added singly using the SINGLE ERROR key.

* Depends on measurement set-up.

```
  No Error Add
       |
  Logic Error Add      Single
       |
* Sub Frame Err Add
       |
  Byte Error Add
       |
  Dataport Test       3 in 5
       |
* Encoding Err Add     On
```

Setting Up the Receiver (DS1/DS1C)

The following pages contain the information required to receive at a DS1 or DS1C cross-connect.

Receive Interface Selection

Select the required cross-connect - DS1 or DS1C. For receiving at a DS0B, DS0A or DS0 cross-connect, see Page 3-20.

```
TX & RX   Receiving   DS1   Auto
                       |
                      DS0B
                       |
                      DS0A
                       |
                      DS0
                       |
                      DS1C
```

Receiving at DS1C

If the HP 3787B is connected to an unprotected access, select Bridged; otherwise select Auto. If you wish to have an indication of the correct signal level when terminating or when connected to a protected monitor point, select the particular signal expected.

```
TX & RX   Receiving   DS1C   Bridged
                               |
                              Auto
                               |
                              DSX
                               |
                            DSX-MON
                               |
                             DS-LO
                               |
                           DS-LO-MON
```

Select the required code

```
TX & RX   Receiving   DS1C   Auto
               Code   AMI    Frame  On
                       |
                      B8ZS
```

Receiving at DS0B

DS0B signals can be accessed at monitor points. Alternatively, the HP 3787B can terminate a DSX-0B signal.

```
TX & RX   Receiving   DS0B Terminated
                                |
                             Monitor
```

Select the desired DS0B rate. For all rates, except 56 kbit/s, the DS0B signal is a multicustomer format as generated by an SRDM. A 56 kbit/s DS0B signal carries a single customer.

When receiving a DS0B signal in which the customer service rate is less than the SRDM rate, then the SRDM rate should be selected.

```
TX & RX   Receiving   DS0B Terminated
                     2.4 kbit/s Service
                      |
                     4.8
                      |
                     9.6
                      |
                    19.2
                      |
                     56
```

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

```
TX & RX   Receiving   DS0B Terminated
                     2.4 kbit/s Service
DS0 Clocks  Front
              |
            Rear
```

Select the customer slot to be measured. The range of customer numbers depends on the service rate selected.

2.4 kbit/s	1 to 20
4.8 kbit/s	1 to 10
9.6 kbit/s	1 to 5
19.2 kbit/s	1 or 2

```
TX & RX   Receiving   DS0B Terminated
                     2.4 kbit/s Service
DS0 Clocks  Front


 Select   Customer 20
```

The DS0B customer rate field is displayed when the 4.8 or 9.6 kbit/s service rate is selected. In these cases some customer slots in the DS0B signal may contain lower rate traffic. Select the customer rate in this field.

For details of the DDS receiver features available, see Page 3-23.

```
TX & RX   Receiving   DS0B Terminated
                     9.6 kbit/s Service
DS0 Clocks  Front


 Select   Customer 05  2.4 kbit/s
                        |
                       4.8
                        |
                       9.6
```

Receiving at DS0A

DS0A signals can be accessed at monitor points. Alternatively, the HP 3787B can terminate a DSX-0A signal. Some equipments allow logic access to DS0A signals - the HP 3787B can access near and far logic signals.

```
TX & RX   Receiving   DS0A Terminated
                             |
                          Monitor
                             |
                         Logic Near
                             |
                         Logic Far
```

Select the required DS0A customer service rate.

```
TX & RX   Receiving   DS0A Terminated
                 2.4 kbit/s Service
                  |
                 4.8
                  |
                 9.6
                  |
                19.2
                  |
                  56
```

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

For details of the DDS receiver features available, see Page 3-23.

```
TX & RX   Receiving   DS0A Terminated
                 2.4 kbit/s Service
DS0 Clocks  Front
              |
            Rear
```

Receiving at DS0

Clear Channel signals can be accessed at monitor points. Alternatively, the HP 3787B can terminate a DSX signal.

```
TX & RX   Receiving   DS0  Terminated
                             |
                          Monitor
```

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

```
TX & RX   Receiving   DS0  Terminated
                      Clear Channel
DS0 Clocks  Front
              |
            Rear
```

The test patterns available are as shown.

```
Pattern   2047 Bit PRBS
             |
          511 Bit PRBS
             |
          All Ones Word
             |
          Settable Word 1 0 1 0 1 0 1 0
```

DDS Receiving Facilities (DS0A/DS0B)

Either the primary or secondary channel may be measured. This applies to all customer rates and at all interfaces.

```
TX & RX   Receiving   DS1   Auto
                            Code   AMI
                            Frame  ESF

Select  Timeslot 12  DS0A  2.4 kbit/s
         Primary Channel
               |
        Secondary Channel
```

Sub-rate error correction is applicable where a DS1 signal timeslot contains a sub-rate DS0A signal or where the HP 3787B input signal us a sub-rate DS0A signal.

```
TX & RX   Receiving   DS1   Auto
                            Code   AMI
                            Frame  ESF

Select  Timeslot 12  DS0A  2.4 kbit/s
         Primary Channel
        (Error Correction  Off )
                            |
                            On
```

For test pattern measurement the choice is as shown. With these patterns selected on the receiving display confirmation of either Latching loopback or MJU operations is automatic. Confirmation will be displayed on the transmit subpage from which these operations are controlled.

```
Pattern   2047 Bit PRBS
             |
          511 Bit PRBS
             |
          All Ones Word
             |
          Settable Word 1 0 1 0 1 1 0 1
```

With settable word only the data bits can be set. The two PRBS patterns are used when testing using alternating loopbacks. When receiving from an alternating loopback select from Alternating Loopback.

```
Pattern  2047 Bit PRBS
         Continuous
             |
         from Alternating Loopback
```

As well as measuring the standard test patterns the HP 3787B can also extract data from 64 kbit/s Clear Channel, 56 kbit/s DS0A/DS0B, a sub-rate timeslot or 4kbit/s / 8kbit/s framing channels for protocol analysis.

```
Receive  Data to Protocol Analyzer
```

Results

In addition to displaying BER Results the HP 3787B can display Alarm Durations, (byte) Monitor, RX Level, Analysis results, and Frame Slips.

```
Results
  |
Alarm Durations
  |
Monitor
  |
RX Level
  |
Analysis
  |
Slips
```

Set the Parity and Stop Bits to suit the controller

```
Source  RS232  Status:Local  Error:   0

Connection   Modem      Duplex  Full

    Enq/Ack  On        Xon/Xoff   Off

        DTR  Off

      Speed   300

(7 Bit Data) Parity  0's   Stop Bits  1
                      |               |
                     1's              2
                      |
                     Odd
                      |
                     Even
```

Instrument Identification

The Instrument Identification display is obtained by selecting INDEX Page 6.

The Instrument Identification (ID) display specifies the software status of the instrument. This information may be required for instrument service.

```
              Instrument ID

             ROM - REV & CRC


Software Version :   28XX

Options fitted   :   DS1 Jitter Meas
```

User Confidence Tests

The User Confidence Test display is obtained by selecting INDEX Page 7.

Full details of the Power on Self Tests and User Confidence Tests are given in the HP3787 Service Manual, Section 8.3 Built-in Service Facilities

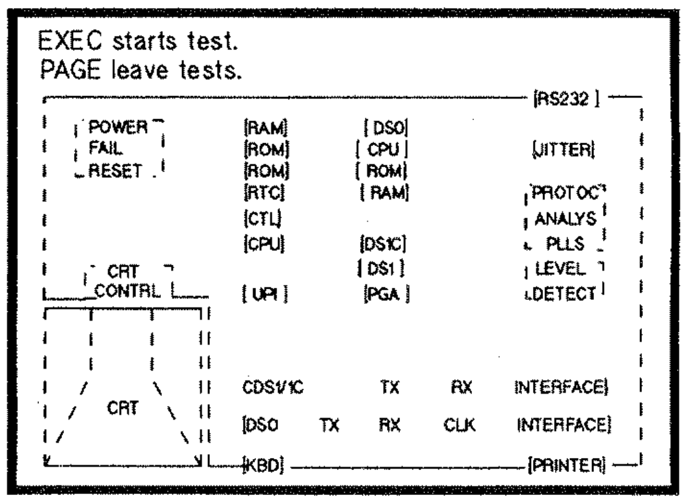
The User Confidence Tests provide a high confidence level that the instrument operates to specification and also provides service information for fault location.

The only external equipment required for these tests is a DS0 clock source for the DS0 interface test and an RS232 test connector for the RS232 Self Test.

The User Confidence Tests can be performed individually and repeatedly cycled or all tests can be performed in sequence. Instructions for performing these tests are given on the display.

```
          USER CONFIDENCE SELF TESTS

To select all tests press the "EXEC" key

To select a specific test press    "NEXT"

Ensure that there is nothing connected
to the DSX-1/1C and DSX-0 transmit and
receive front panel interfaces.

Front panel DS0 clocks are required for
the DS0 interface test.

The loopback test connector is required
for the RS232 port test.
```

If you press EXEC you get a graphic display of the self tests being performed.



FIRMWARE/SOFTWARE HISTORY

You can check the software version of your instrument manually or remotely.
Manually by selecting INDEX display: INSTRUMENT ID 6
Remotely by using the "FRN?" command.

Programs written for earlier (lower numbered) software versions of the HP 3787B can be used for later (higher numbered) software versions except where the following conditions apply.
Programs written for version 2726 will run on version 2830, see condition 1.
Programs written for version 2726 will run on version 2839, see conditions 1 and 2.
Programs written for version 2830 will run on version 2839, see condition 2.

Condition 1 Except where they depend on the Tx DS1C digroups being unframed or the default state of alarm mask register 2 being 7.

Condition 2 Except where they depend on the default state of the DDS line and multiplexer rates being 2.4 kbit/s or the Dataport error correction defaulting to OFF when deselecting and reselecting DS0A.

Programs written for later (higher numbered) versions, AND which make use of the additional features in the later version, will not run on instruments with earlier (lower numbered) software versions.

The following table lists the functions which are affected by software changes and explains the differences. The version at which the change occurred is marked with an asterisk (*).

VERSION			FUNCTION	DIFFERENCE
2726	2830	2839		
AL1?	AL1?*	AL1?	Alarm status enquiry	Bit 1 (2) changed from SL1 (indicating signal loss and excess zeros) to XS0 (excess zeros only). See AM2 and AL2? for signal loss.
AL2?	AL2?*	AL2?	Alarm status enquiry	Bit 3 (8) added for signal loss Bit 4 (16) and bit 5 (32) added for positive and negative frame slips.
AM1	AM1*	AM1	Alarm Mask Setting	Bit 1 changed to XS0 as for AL1?
AM2	AM2*	AM2	Alarm Mask Setting	Bits 3, 4, and 5 added as for AL2?
ANR?	ANR?*	ANR?	Analysis Result Enquiry	4 Additional Results
ATY	ATY*	ATY	Analysis Type Setting	4 New Measurement Types
EAT	EAT*	EAT*	Tx Error Add Setting	2830 - Logic Errors Available in THRU Mode 2839 - 19.2 Encoding Errors Available
		EER*	19.2 kbit/s Encoding Errors Setting	ON/OFF setting for added 19.2 kbit/s BCH Encoding Errors
	FSL?*	FSL?	Frame Slip Result Enquiry	Additional Measurement
GTY	GTY*	GTY	Gating Type	Short 5M and 15M Included
LBT	LB0*	LB0	DS0 Loopback Setting	Additional DS0 Loopbacks Available
LBT	LB1*	LB1	DS1 Loopback Setting	Additional DS1 Inband and Datalink Loopbacks
	LHB?*	LHB?	Hub ID enquiry.	Applies to added MJU loopback.
LEC	LES*	LES	Log End of Gating Summary	Frame Slips Added
MDS	MDS*	MDS	Measurement Display Select	Frame Slips Added
RCD	RCD	RCD*	Rx Pattern Type	DDS Return Codes now Automatic
RDT	RDT*	RDT	Rx Data Type	PROTOCOL Available for 56kbit/s DDS and 64kbit/s Clear Channel

VERSION			FUNCTION	DIFFERENCE
2726	2808	2839		
R0R	R0R	RR0*	Rx DS0A/B data rate	19.2kbit/s included
T1F	T1F*	T1F	T1 Framing	Applies to DS1C Digroups as well as DS1
TAM	TAM*	TAM	Tx DS0A Interface	Bipolar now an alternative to DSX
TDT	TDT*	TDT	Tx data type	PROTOCOL available for 56kbit/s DDS and 64kbit/s clear channel. Provision for ESF datalink message added
		TEC*	BCH Error Encoding	Additional facility with 19.2kbit/s. DS0A
	TMC*	TMC	ESF Datalink Message	ESF Datalink Message has Selectable Content
	TMT*	TMT	ESF Datalink Message Type Setting	Enables Setting of Message/Idle
TNU	TNU*	TNU	Tandem Number	Valid for Alternating DS0DP Loopback
T0R	T0R	TR0*	Tx DS0A/B Data Rate	19.2kbit/s, included
TSC	TSC*	TSC	Tx DDS Code	Additional Bit Selectable

Setting Calendar (DATE & TIME)

Function	Mnemonic Code	Description
DATE	"DAT y,m,d" y = 1987 to 2050 m = 1 to 12 d = 1 to 31	Sets the Date portion of the Calendar. y = Year, m = Month, d = Day
	"DAT?"	Returns state of DAT ie ´y,m,d´.
TIME	"TIM h,m,s" h = 0 to 23 m = 0 to 59 s = 0 to 59	Sets the Time portion of the Calendar. h = Hours, m = Minutes, s = Seconds
	"TIM?"	Returns Hours, Minutes, Seconds Example:- To set the Calendar to 1143 on 3rd July 1987 send: **OUTPUT 707;"TIM 11,43,0; DAT 1987,7,3"** Example:- To read the calendar send: **OUTPUT 707;"TIM?;DAT?"** **ENTER 707;Hms$,Ymd$** **PRINT Hms$,Ymd$**

Setting TX Parameters (INTERFACE LEVEL)

Function	Mnemonic Code	Description
INSTRUMENT MODE	"MOD n"	
	n = TX&RX or 1	Independent TX & RX mode
	n = THRU or 2	Transmit Received Signal
	"MOD?"	Returns state of MOD ie 1 or 2
DS0 CLOCK SOURCE (DS0/DS0A/DS0B)	"DCS n"	
	n = FRONT or 1	Connect DS0 Clock to Front Panel
	n = REAR or 2	Connect DS0 Clock to Rear Panel
	"DCS?"	Returns state of DCS ie 1 or 2.
INTERFACE LEVEL	"TIN n"	
	n = DS1C or 1	(See TCD,TCF,TCL)
	n = DS1 or 2	(See TCD,T1F,TCL)
	n = DS0B or 3	(See DCS,TRØ)
	n = DS0A or 4	(See DCS,TRØ,TAM)
	n = DS0 or 5	(See DCS)
	"TIN?"	Returns state of TIN ie 1 to 5.
		Selection of Interface Level determines the Level at the TX output. Selection of Interface Level also incurs further selections eg DS1 incurs selection of Coding (TCD); Framing (T1F); Clock (TCL).
DS1/DS1C CODING	"TCD n"	
	n = AMI or 1	Alternate Mark Inversion
	n = B8ZS or 2	Binary 8 Zeros Substitution
	"TCD?"	Returns state of TCD ie 1 or 2
DS1C FRAMING	"TCF n"	DS1C Interface Level only
	n = OFF or Ø	Transmit Unframed DS1C
	n = ON or 1	Transmit Framed DS1C
	"TCF?"	Returns TCF state ie Ø or 1.
DS1/DS1C DIGROUP FRAMING	"T1F n"	DS1 or DS1C Interface Level only
	n = OFF or Ø	No Framing
	n = T1DM or 1	T1 Data Multiplexer
	n = SF or D4 or 2	Superframe
	n = FT or 3	Ft only
	n = ESF or FE or 4	Extended Superframe
	"T1F?"	Returns state of T1F ie Ø to 4.

Setting TX Parameters (INTERFACE LEVEL)

Function	Mnemonic Code	Description
DS1 CLOCK	"TCL n"	
	n = INTERNAL or 1	Internal DS1 Clock source
	n = EXTERNAL or 2	External DS1 Clock source
	n = LOOPED or 3	RX Clock Looped to TX
	"TCL?"	Returns state of TCL ie 1 to 3.
		If the Instrument Mode (MOD) selected is *THRU* then the clock is always notionally *LOOPED* ie the TX Clock is derived from the RX Clock. If the instrument Mode selected is *TX&RX* the *LOOPED* Clock is derived from the DS1 RX. The *LOOPED* selection is therefore only valid if the Instrument Mode is *TX&RX* and the RX Interface Level (RIN) is *DS1*.
MULTIPLEXER RATE DS0A/DS0B	"TRØ 1"	2.4 kbits
	"TRØ 2"	4.8 kbits
	"TRØ 3"	9.6 kbits
	"TRØ 4"	19.2 kbits
	"TRØ 5"	56 kbits
	"TRØ?"	Returns state of TRØ ie 1 to 5.
DS0A INTERFACE MODE	"TAM n	
	n = BIPOLAR or 1	DSX cross-connect. Non TTL
	n = LOGIC_NEAR or 2	Logic Near Interface (Tip)
	n = LOGIC_FAR or 3	Logic Far Interface (Ring)
	"TAM?"	Returns state of TAM ie 1 to 3.
		If TAM and IAT (RX DS0A Termination) are both set to Logic then a change from NEAR to FAR or FAR to NEAR in either will cause the other to change automatically.
		EXAMPLE :- Require to Transmit at an Interface Level of DS1 with B8ZS Coding T1DM Framing and an External Clock in the TX&RX Mode :
		OUTPUT 707;"MOD TX&RX;TIN DS1; TCD B8ZS;T1F T1DM;TCL EXTERNAL"

Setting TX Parameters **(SELECT LEVEL)**

Function	Mnemonic Code	Description
SELECT LEVEL	"TSL n"	Only valid if TX Interface Level is DS1
	n = DS1 or 1	DS1
	n = DS0B or 2	(See TCU,TRØ,TCR,TTS,INS)
	n = DS0A or 3	(See TRØ,TTS,INS)
	n = PSDC or 4	SF or ESF Framing only(See TTS,INS)
	n = DS0 or 5	Not valid T1DM Framing(See TTS,INS)
	n = DATALINK or 6	ESF Framing only(SeeINS)
	n = FS_CHAN or 7	Ft Framing only(See INS)
	n = R_CHAN or 8	T1DM Framing only(See INS)
	"TSL?"	Returns state of TSL ie 1 to 8.
		This Message is only valid if the Interface Level (TIN) is DS1. Selection of Select Level may incur further selections eg Select level DS0B incurs selection of Customer Number (TCU); Data Rate (TRØ); Customer Rate (TCR); Timeslot Insertion (INS); Timeslot Number (TTS).
ESF DATALINK MESSAGE TYPE	"TMT n"	Only valid if TSL is DATALINK
	n = IDLE or 1	Idle code transmitted
	n = WORD or 2	16 bit message (See TMC)
	"TMT?"	Returns state of TMT ie 1 or 2.
ESF DATALINK MESSAGE CONTENT	"TMC '0bbbbbb0'"	Content of 16 bit message is
		0dddddd011111111
		d = Data bit 0 or 1
	"TMC?"	Returns state of TMC ie '0bbbbbb0'
CUSTOMER NUMBER DS0B	"TCU n"	n depends upon Data Rate set by TRØ.
		TRØ = 2.4 kbits n = 1 to 2Ø
		TRØ = 4.8 kbits n = 1 to 1Ø
		TRØ = 9.6 kbits n = 1 to 5
		TRØ =19.2 kbits n = 1 or 2
	"TCU?"	TRØ =56 kbits n = 1
		Returns state of TCU ie 1 to 2Ø.
MULTIPLEXER RATE DS0A/DS0B	"TRØ 1"	(2.4 kbits)
	"TRØ 2"	(4.8 kbits)
	"TRØ 3"	(9.6 kbits)
	"TRØ 4"	(19.2 kbits)
	"TRØ 5"	(56 kbits)
	"TRØ?"	Returns state of TRØ ie 1 to 5.

Setting TX Parameters (SELECT LEVEL)

Function	Mnemonic Code	Description
CUSTOMER RATE DS0B	"TCR 1" "TCR 2" "TCR 3" "TCR?"	2.4 kbits (Insert Rate) 4.8 kbits (Insert Rate) 9.6 kbits (Insert Rate) Returns state of TCR ie 1 to 3. TCR must be < or = to TRØ. If TRØ is 19.2 or 56 kbits then TCR and TCR? are illegal.
TIMESLOT NUMBER	"TTS n" n = 1 to 24 "TTS?"	Designates DS1 Timeslot into which Data is inserted. If DS1 Framing(T1F) is T1DM then selection of Timeslot 24 is illegal. Returns TTS state ie 1 to 24.
TIMESLOT INSERTION	"INS n" n = OFF or Ø n = ON or 1 "INS?"	No Insertion into Timeslot Transmit Data into Timeslot Returns state of INS ie Ø or 1. In *TX&RX* mode, Insertion is always ON. In *THRU* mode INS is only valid if Interface Level is DS1 and Select Level is other than DS1. EXAMPLE :- Wish to insert a 2047 bit PRBS test pattern into the 2.4 kbits Primary Channel of Customer #5 of a 9.6 kbits DS0B. The DS0B is contained within Timeslot 15 of the DS1 signal, which has D4 Framing and AMI Coding. The access is at the DS1 level : **OUTPUT 707;"MOD TX&RX;TIN DS1; TCD AMI;T1F D4;TCL INTERNAL; TSL DS0B;TCU 5;TRØ 3;TCR 1;TTS 15; DLT SINGLE;TDC PRIMARY;TDT PATTERN;TRD PRBS_2047"**

Setting TX Parameters (DDS LINK TYPE)

Function	Mnemonic Code	Description
DDS LINK TYPE	"DLT n" n = SINGLE or 1 n = MULTI or 2 "DLT?"	DS0A & DS0B only Point to Point(See TDC) Multi-point(See TDC,SBR,MJU) Returns state of DLT ie 1 or 2. This Message is only valid when Interface Level (TIN) or Select Level (TSL) is DS0A or DS0B.
DDS CHANNEL TYPE	"TDC n" n = PRIMARY or 1 n = SECONDARY or 2 "TDC?"	Not valid for Alt. Loopback(See LBØ) DDS Primary Channel DDS Secondary Channel Returns state of TDC ie 1 or 2.
SELECT BRANCH	"SBR n" n = 1 to 4 "SBR?"	Determines which MJU Branch will be affected by next MJU message. Returns state of SBR ie 1 to 4.
MULTI-POINT JUNCTION UNIT OPERATIONS	"MJU n" n = SELECT or 1 n = TEST or 2 n = END_TEST or 3 n = BLOCK or 4 n = UNBLOCK or 5 n = RELEASE or 6 "MJU?"	Select a Branch Test Selected Path Restore Normal Operation Block a Branch Unblock a Branch Unblock All Branches Returns state of MJU ie 1 to 6. EXAMPLE :- Wish to Transmit a 511 bit PRBS into Branch 4 of a Multi-Point Junction Unit :- **OUTPUT 707;"MOD TX&RX;TIN DS1; TCD B8ZS;T1F ESF;TCL INTERNAL;TSL DS0B;TCU 4;TRØ 3;TCR 1;TTS 9; DLT MULTI;TDC PRIMARY;SBR 4;MJU SELECT;MJU TEST;LBØ NONE;TDT PATTERN;TRD PRBS_511;EAT OFF"**

Setting TX Parameters (LOOPBACK)

Function	Mnemonic Code	Description
DS1 LOOPBACK TYPE	"LB1 n"	
	n = NONE or 0	No Loopback
	n = IN_LINE or 1	In-band line loopback
	n = IN_NETWORK or 2	In-band network loopback
	n = DL_LINE or 3	ESF Datalink line loopback
	n = DL_NETWORK or 4	ESF Datalink network loopback
	n = DL_PAYLOAD or 5	ESF Datalink payload loopback
	"LB1?"	Returns state of LB1 ie 0 to 5
		Only valid when TIN and TSL are DS1 and ALT is OFF.
		ESF Datalink loopbacks (3 to 5) need TIF to be ESF.
DS0 LOOPBACK TYPE	"LB0 n"	Valid at DS0A and DS0B
	n = NONE or 0	No Loopback
	n = ALT_DSU or 1	Alternating DSU L/B
	n = ALT_CHAN or 2	Alternating Channel L/B
	n = ALT_OCU or 3	Alternating OCU L/B
	n = ALT_RPT or 4	Alternating Repeater L/B
	n = ALT_HL96 or 5	Alternating HL96 L/B
	n = ALT_DATAPORT or 6	Alternating DS0 Dataport L/B
	n = LAT_DS0DP or 7	Latching DS0 Dataport L/B
	n = LAT_OCU or 8	Latching OCU L/B
	n = LAT_CSU or 9	Latching CSU L/B
	n = LAT_HL222 or 10	Latching HL222 L/B
	n = LAT_MJU or 11	Latching MJU L/B see LHB? for HUB-ID
	"LB0?"	Returns state of LB0 ie 0 to 11
		ALT_RPT Loopback is only valid at 56kbit/s DS0A or DS0B.
ACTUATE LOOPBACK	"ALB"	For this Message to be valid a Loopback of some type must have been selected and the Gating stopped. If the Instrument is Gating the Message will be ignored and Error -250 will be generated.

Setting TX Parameters (LOOPBACK)

Function	Mnemonic Code	Description
RELEASE LOOPBACK	"RLB"	For this Message to be valid a Loopback of some type must have been selected and actuated and the Gating stopped. If the Instrument is Gating the Message will be ignored and Error -25Ø will be generated.
REPEATER NUMBER	"TRN n" n = 1 or 2 "TRN?"	Sets the Repeater Number for a 56 kbits Alternating Repeater Loopback. Returns state of TRN ie 1 or 2.
HL96NY PRESENCE	"HLP n" n = No or Ø n = YES or 1 "HLP?"	Only valid if an Alternating OCU Loopback is selected. HL96NY Card absent HL96NY Card Present Returns state of HLP ie Ø or 1.
TANDEM NUMBER	"TNU n" n = 1 to 8 "TNU?"	Only valid if a latching DS0DP or alternating dataport loopback has been selected. Returns state of TNU ie 1 to 8.
NUMBER OF INTERMEDIATE REPEATERS	"TIR n" n = Ø to 2 "TIR?"	Only valid if a 56 kbit Alternating Channel Loopback is selected. Returns state of TIR ie Ø to 2.

Setting TX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
DATA TYPE	"TDT n"	
	n = PATTERN or 1	(See TRD,TSW,TRP)
	n = CODE or 2	DDS Special Codes. DDS Primary Channel only.(See TRC,TSC,TXC,STC)
	n = PROTOCOL or 3	Data from Protocol Analyzer. Valid for all DDS primary and secondary channels (including 56kbit/s), ESF 4kbit/s Datalink, FS_Chan and R_Chan.
	n = MESSAGE or 4	ESF Datalink only (See TMT, TMC)
	"TDT?"	Returns state of TDT ie 1 to 4.
		If an Alternating Loopback is selected then TDT must be Pattern.
		If Code is to be transmitted into a channel which has a Latched Loopback, the Loopback must be established before selecting CODE otherwise Error -252 occurs.
PATTERN TYPE	"TRD n"	
	n = PRBS_20 or 1	2Ø Stage PRBS(See TZL)
	n = ALL_ONES or 2	All Ones Word
	n = SETTABLE or 3	Settable Word(See TSW)
	n = PRBS_2047 or 4	2Ø47 Bit PRBS
	n = PRBS_511 or 5	511 Bit PRBS
	n = PREPROG or 6	User defined Pattern(See TRP)
	"TRD?"	Returns state of TRD ie 1 to 6.
		The Pattern Type validity depends on Select Level & DDS Channel Type :-
		PRBS_2Ø - Only valid at DS1&DS1C. *ALL_ONES* - Not valid for DDS Secondary Channel or Alt. Loopback *SETTABLE* - NOT valid for Datalink; FS_Chan; R_Chan;DDS Secondary Channel or Alternating Loopback. *PRBS_2Ø47; PRBS_511* - NOT valid for DS1 or DS1C. *PREPROG* - Valid for DS0B; DS0A; DDS Primary Channel; DS0 & PSDC.
14 ZERO LIMIT	"TZL n"	PRBS_20 only.
	n = OFF or Ø	No 14 Zero Limit
	n = ON or 1	PRBS_20 14 Zero Limited
	"TZL?"	Returns state of TZL ie Ø or 1.

Setting TX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
SETTABLE WORD	"TSW 'bbbbbbbb'"	The content of the 8 bit (b) Word depends upon the Interface or Select Level selected:- DS1/DS1C 'dddddddd' 64 kbits Clr. Chan. 'dddddddd' 56 kbits DDS 'ddddddd1' 56 kbits PSDC 'ddddddds' DS0B <56 kbits 'fdddddd1' DS0A <56 kbits '1dddddd1' d = Data bit Ø or 1 s = Signaling bit f = subrate Frame bit
	"TSW?"	Returns state of TSW ie 'bbbbbbbb'.
USER DEFINED PATTERN LOAD	"TRP #H"	This Message allows the user to define a Preprogrammed Pattern . The user can enter any number of Bytes of data in the range 1 to 256, in Block format (IEEE Standard 728 #H). A Byte consists of two Hexadecimal Characters ie two of (0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F). The selectable content (d) of the bytes depends on the interface or "select level" selected: 64 kbits Clr. Chan. 'dddddddd' 56 kbits DDS 'dddddddd' 56 kbits PSDC 'ddddddds' DS0B/DS0A <56 kbits 'fddddddd' In all cases the user enters an 8 bit Byte (2 HEX. Characters). The HP3787B overwrites bit 8 (s) in PSDC and bit 1 (f) in DS0A/B < 56k bit/s. When all bytes have been transmitted the TX starts again at the beginning of the Pattern. Example :-To define a Pattern of 0011001011110000 (32F0H) send : **OUTPUT 707;"TDT PATTERN; TRD PREPROG;TRP #H32FØ"**
	"TRP?"	Returns the currently loaded user defined Pattern in #H Block format.

Setting TX Parameters **(DATA TYPE)**

Function	Mnemonic Code	Description
DDS CODE	"TRC n"	Only valid if DDS Primary Channel and TX Data Type is Pattern.
	n = CMI or 1	Control Mode Idle
	n = OCU_LB or 2	OCU Loopback
	n = CHAN_LB or 3	Channel Loopback
	n = DSU_LB or 4	DSU Loopback
	n = TIP or 5	Transition In Progress
	n = LBE or 6	Loopback Enable
	n = FEV or 7	Far End Voice
	n = TA or 8	Test Alert
	n = MA or 9	MJU Alert
	n = UMC or 10	Unassigned Mux Channel
	n = BLOCK or 11	MJU Block
	n = RLS or 12	MJU Release
	n = ASC or 13	Abnormal Station Condition
	n = TEST or 14	Test
	n = OOS or 15	Out Of Sync (Mux)
	n = SETTABLE or 16	User Settable Code(See TSC)
	"TRC?"	Returns state of TRC ie 1 to 16.
START DDS CODE	"TXC"	When the DDS Code has been selected the HP 3787B sends an "ALL 1's" PATTERN This Message starts the transmission of the selected Code.
STOP DDS CODE	"STC"	This message stops transmission of the selected Code and the HP 3787B reverts to transmitting an "ALL 1's" PATTERN. The following Messages also perform this function :- Change of TX Interface Level(TIN) Change of TX Multiplexer Rate(TRØ) Change of DDS Link Type(DLT) Change of TX Timeslot No.(TTS) Change of TX Customer No.(TCU) Change of TX Customer Rate(TCR) Change of TX Data Type(TDT) Change of TX DDS Channel Type(TDC) Change of TX DDS Code(TRC) Change of TX DDS Settable Code(TSC)

Setting TX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
DDS SETTABLE CODE	"TSC ´bbbbbbbb´"	The content of the 8 bit (b) Code depends upon the DDS Rate selected :- 56 kbits DDS "dddddddd" DS0B <56 kbits "fddddddd" DS0A <56 kbits "1ddddddd" d = Data bit Ø or 1 f = subrate Frame bit
	"TSC?"	Returns state of TSC ie ´bbbbbbbb´. Example :- Transmit a Settable DDS Code of all 0´s at a DS0A rate of 2.4 kbits. Interface is at DS1 with D4 Framing and B8ZS Coding and the DS0A is contained in Timeslot 2 **OUTPUT 707;"MOD TX&RX;TIN DS1; TCD AMI;T1F D4;TCL INTERNAL;TSL DS0A;TTS 2;TRØ 1;DLT SINGLE;TDC PRIMARY;TDT CODE;TRC SETTABLE; TSC ´1ØØØØØØ1´"**
SIGNALING MODE	"TSM n" n = SET or 1 n = RETRANSMIT or 2 "TSM?"	Set Signaling bits. (See SIG) TX received Signaling bits Returns state of TSM ie 1 or 2. *Retransmit* is only valid in *THRU* mode when receiving PSDC and wishing to retransmit into the same Timeslot.
SIGNALING BITS	"SIG ´xxyy´"	This message is only valid when Select Level is 56 kbits *PSDC* or 4 kbits *DATALINK* (See TSL) and when DS1 Framing is *SF* or *ESF* (See T1F). If DS1 Framing is *SF*, only two bits are valid ie xx, however spaces must be substituted for yy ie "xx ". If DS1 Framing is *ESF*, four bits are valid ie xxyy. x value = Ø or 1. y value = Ø or 1.
	"SIG?"	Returns state of SIG ie ´xx ´ or ´xxyy´.
BCH ENCODING (19.2 kbits DDS)	"TEC n" n = OFF or Ø n = ON or 1	Selects BCH encoding for 19.2 kbits DS0A
	"TEC?"	Returns state of TEC ie Ø or 1.

Setting TX Parameters (ERROR ADD)

Function	Mnemonic Code	Description
ERROR ADD TYPE	"EAT n"	Not valid if TDT is PROTOCOL or CODE or TDT is PATTERN & TRD is PREPROG
	n = OFF or Ø	No Errors Added
	n = LOGIC or 1	Pattern Only(See EAD,SEA,EAR)
	n = BPV or CODE or 2	DS1/DS1C(See EAD,SEA,EAR)
	n = FRAME or 3	Framed DS1/DS1C(See EAD,SEA)
	n = SUBFRAME or 4	DS0B <19.2 kbits(See EAD,SEA)
	n = ESF_CRC or 5	DS1 with ESF Framing(See EAD, SEA,CAR)
	n = DATAPORT or 6	DS0A <19.2 kbits(See DER)
	n = BYTE or 7	DS0,DS0A,DS0B(See EAD,SEA)
	n = APS or 8	DS1/DS1C Automatic Protection Switch Test(See APR,APM)
	n = ENCODING or 9	DS0A 19.2 kbits with encoding on.
	"EAT?"	Returns state of EAT ie Ø to 9.
ERROR ADD METHOD	"EAD n"	Not valid when EAT is OFF or APS (See SEA)
	n = SINGLE or 1 n = RATE or 2	Not valid when EAT is FRAME, SUBFRAME, DATAPORT, BYTE, APS, ENCODING (See EAR,C
	"EAD?"	Returns state of EAD ie 1 or 2.
SINGLE ERROR ADD	"SEA"	Adds a single Error if EAD 1 (single) is selected and EAT is other than Ø.
ERROR ADD RATE (LOGIC, BPV/CODE)	"EAR n" n = 1.ØE-8 to 9.ØE-3	Sets the Error Ratio for LOGIC or BPV/CODE Errors. The Mantissa must be Ø.
	"EAR?"	Returns state of EAR ie 1.ØE-8 to 9.ØE-3. EXAMPLE :- To Add Logic Errors at a rate of 1 in 1000 send : **OUTPUT 707;"EAT LOGIC;EAD RATE; EAR 1.ØE-3"**
ERROR ADD RATE (ESF_CRC ERRORS)	"CAR n" n = 1.ØE-8 to 3.ØE-4	Sets the Error Ratio for ESF_CRC errors. The Mantissa must be Ø. Is only valid when a DS1 signal with ESF Framing is being transmitted. The error rate set is the equivalent bit error rate, not the actual CRC error rate.
	"CAR?"	Returns state of CAR ie 1.ØE-8 to 3.ØE-4.

Setting TX Parameters (ERROR ADD)

Function	Mnemonic Code	Description
ERROR ADD RATE DATAPORT	"DER n" n = OFF or Ø n = LOW or 1 n = HIGH or 2 "DER?"	Only valid at DS0A <19.2kbits No Bytes Errored 2 in 5 Bytes Errored 3 in 5 Bytes Errored Returns state of DER ie Ø to 2. EXAMPLE :- To Add Dataport Errors of 3 in 5 Bytes Errored send : **OUTPUT 707;"EAT DATAPORT; DER HIGH"**
BCH ENCODING ERROR ADD (DS0A 19.2 kbits only)	"EER n" n = OFF or Ø n = ON or 1 "EER?"	Error add type (EAT) must be ENCODING Returns state of EER ie Ø or 1.
APS ERROR RATE (DS1 & DS1C only)	"APR r1,r2,r3,r4" r1 = 1.ØE-8 to 9.ØE-3 r2 = 1.ØE-8 to 9.ØE-3 r3 = 1.ØE-8 to 9.Øe-3 r4 = 1.ØE-8 to 9.Øe-3 "APR?"	The Mantissa must be Ø. Sets Error Rate for *NO TRANSFER* Sets Error Rate for *TRANSFER* Sets Error Rate for *NO RESTORE* Sets Error Rate for *RESTORE* Returns state of APR ie 'r1,r2,r3,r4'.
APS TEST MODE (DS1 & DS1C only)	"APM n" n = START or 1 n = NO_TRANSFER or 2 n = TRANSFER or 3 n = NO_RESTORE or 4 n = RESTORE or 5 "APM?"	 Rate always Ø errors Rate defined by APR r1 Rate defined by APR r2 Rate defined by APR r3 Rate defined by APR r4 Returns state of APM ie 1 to 5. EXAMPLE :- To Define typical Error Rates for DDS Automatic Protection Switches send : **OUTPUT 707;"EAT APS;APR 3.ØE-7, 1.ØE-6, 3.ØE-7, 2.ØE-8"** The individual rates can then be transmitted by use of the appropriate APM message.

Setting TX Parameters (ALARMS)

Function	Mnemonic Code	Description
ALARM TYPE DS1/DS1C	"ALT n"	
	n = OFF or Ø	No Alarms
	n = YELLOW or 1	Only valid when transmitting Framed DS1 with Select Level DS1.
	n = X_BIT or 2	Only valid when transmitting Framed DS1C.
	n = AIS or 3	Only valid when transmitting DS1 or DS1C with Select Level DS1.
	"ALT?"	Returns state of ALT ie Ø to 3.

Setting RX Parameters (INTERFACE LEVEL)

Function	Mnemonic Code	Description
INSTRUMENT MODE	"MOD n"	
	n = TX&RX or 1	Independent TX & RX mode
	n = THRU or 2	Through mode
	"MOD?"	Returns state of MOD ie 1 or 2.
DS0 CLOCK SOURCE (DS0/DS0A/DS0B)	"DCS n"	
	n = FRONT or 1	Connect DS0 Clock to Front Panel
	n = REAR or 2	Connect DS0 Clock to Rear Panel
	"DCS?"	Returns state of DCS ie 1 or 2.
INTERFACE LEVEL	"RIN n"	
	n = DS1C or 1	(See I1L,R1C,RCF,R1F)
	n = DS1 or 2	(See I1L,R1C,R1F)
	n = DS0B or 3	(See DCS,IBT,RRØ)
	n = DS0A or 4	(See DCS,IAT,RRØ)
	n = DS0 or 5	(See DCS,IØT)
	"RIN?"	Returns state of RIN ie 1 to 5.
		Selection of Interface Level should match Level at RX input. Selection of Interface Level also incurs further selections eg DS1C incurs selection of Input Level Range (I1L); Coding (R1C); DS1C Framing (RCF). Additionally if "RCF ON" is selected this incurs selection of Digroup Framing (R1F).
INPUT LEVEL RANGE (DS1/DS1C)	"I1L n"	
	n = AUTO or 1	Automatic
	n = DSX or 2	DS cross-connect
	n = DSX_MON or 3	DS cross-connect Monitor
	n = DS_LO or 4	DS Lo
	n = DS_LO_MON or 5	DS Lo Monitor
	n = BRIDGED or 6	Bridging Mode
	"I1L?"	Returns state of I1L ie 1 to 6.
DS1/DS1C CODING	"R1C n"	
	n = AMI or 1	Alternate Mark Inversion
	n = B8ZS or 2	Binary 8 Zeros Substitution
	"R1C?"	Returns state of R1C ie 1 or 2.
DS1C FRAMING	"RCF n"	Only valid if RX Interface Level is DS1C
	n = OFF or Ø	Unframed DS1C
	n = ON or 1	Framed DS1C(See R1F)
	"RCF?"	Returns state of RCF ie Ø or 1.

Setting RX Parameters (INTERFACE LEVEL)

Function	Mnemonic Code	Description
DS1/DS1C-DIGROUP FRAMING	"R1F n"	Only valid if RX Interface Level is DS1 or DS1C with Framing On.
	n = OFF or Ø	No Framing
	n = T1DM or 1	T1 Data Multiplexer
	n = SF or D4 or 2	Superframe
	n = FT or 3	Ft only
	n = ESF or FE or 4	Extended Superframe
	"R1F?"	Returns state of R1F ie Ø to 4.
		EXAMPLE :- The signal at the RX Input is a Framed DS1C from the DS Cross-connect (DSX) with B8ZS Coding. The Digroups have T1DM Framing :
		OUTPUT 707;"RIN DS1C;I1L DSX; R1C B8ZS;RCF ON;R1F T1DM"
DS0B TERMINATION	"IBT n"	
	n = TERMINATED or 1	Terminated
	n = MONITOR or 2	Monitor
	"IBT?"	Returns state of IBT ie 1 or 2.
DS0A TERMINATION	"IAT n"	
	n = TERMINATED or 1	Terminated
	n = MONITOR or 2	Monitor
	n = LOGIC_NEAR or 3	Logic Near(Tip)
	n = LOGIC_FAR or 4	Logic Far(Ring)
	"IAT?"	Returns state of IAT ie 1 to 4.
		If IAT and TAM (TX DS0A Interface Mode) are both set to Logic, then a change from NEAR to FAR or FAR to NEAR in either the TX or RX will cause the other to change automatically.
DS0 TERMINATION	"IØT n"	
	n = TERMINATED or 1	Terminated
	n = MONITOR or 2	Monitor
	"IØT?"	Returns state of IØT ie 1 or 2.
MULTIPLEXER RATE DS0A/DS0B	"RRØ 1"	(2.4 kbits)
	"RRØ 2"	(4.8 kbits)
	"RRØ 3"	(9.6 kbits)
	"RRØ 4"	(19.2 kbits)
	"RRØ 5"	(56 kbits)
	"RRØ?"	Returns state of RRØ ie 1 to 5.

Setting RX Parameters (MEASUREMENT SELECT)

Function	Mnemonic Code	Description
MEASUREMENT SELECT	"RMS n"	Only valid if the RX Interface Level (RIN) is DS1 or DS1C.
	n = OFF or Ø	Valid in THRU mode only
	n = DS1C or 1	DS1C only
	n = DIGROUP or 2	Framed DS1C only(See RDN)
	n = DS1 or 3	DS1 only
	n = DS0B or 4	(See RCU,RRØ,RCR,RTS,RDC,RDN)
	n = DS0A or 5	(See RRØ,RDC,DEC,RDN)
	n = PSDC or 6	SF & ESF Framing only(See RTS,RPI,RDN)
	n = DS0 or 7	Not T1DM Framing(See RTS,RDN)
	n = DATALINK or 8	ESF Framing only(See RDN)
	n = FS_CHAN or 9	Ft Framing only(See RDN)
	n = R_CHAN or 1Ø	T1DM Framing only(See RDN)
	"RMS?"	Returns state of RMS ie Ø to 1Ø.
		The Measurement Select must be equal to or less than the Interface Level eg if Interface Level is DS1 then Measurement Select of DS1C or Digroup are not allowed but all others are, providing Framing requirements are met. Selection of Measurement Select may incur further selections eg DS0A incurs selection of Data Rate (RRØ); Timeslot Number (RTS); DDS Channel Type (RDC); Dataport Error Correction (DEC).
DIGROUP NUMBER	"RDN n"	Only valid if RX Interface Level is DS1C
	n = 1	Digroup 1
	n = 2	Digroup 2
	"RDN?"	Returns state of RDN ie 1or 2.
MULTIPLEXER RATE DS0A/DS0B	"RRØ 1"	(2.4 kbits)
	"RRØ 2"	(4.8 kbits)
	"RRØ 3"	(9.6 kbits)
	"RRØ 4"	(19.2 kbits)
	"RRØ 5"	(56 kbits)
	"RRØ?"	Returns state of RRØ ie 1 to 5.
TIMESLOT NUMBER	"RTS n"	Designates DS1 Timeslot from which DS0 Data is extracted. Is only valid if RMS is DS0B, DS0A, PSDC or DS0. If T1DM Framing is selected (ie "R1F 1") then selection of Timeslot 24 is not allowed.
	n = 1 to 24	
	"RTS?"	Returns state of RTS ie 1 to 24.

Setting RX Parameters (MEASUREMENT SELECT)

Function	Mnemonic Code	Description
CUSTOMER NUMBER DS0B	"RCU n"	n depends upon Data Rate set by RRØ:- RRØ = 2.4 kbits - n = 1 to 2Ø RRØ = 4.8 kbits - n = 1 to 1Ø RRØ = 9.6 kbits - n = 1 to 5 RRØ =19.2 kbits - n = 1 or 2 RRØ =56 kbits - n = 1
	"RCU?"	Returns state of RCU ie 1 to 2Ø.
CUSTOMER RATE DS0B	"RCR 1" "RCR 2" "RCR 3" "RCR?"	(2.4 kbits) (4.8 kbits) (9.6 kbits) Returns state of RCR ie 1 to 3. RCR must be < or = to RRØ. If RRØ is 19.2 or 56 kbits then RCR is illegal.
DDS CHANNEL TYPE (DS0A/DS0B)	"RDC n"	Only valid if RX Interface Level or Measurement Select is DS0A or DS0B.
	n = PRIMARY or 1	DDS Primary Channel
	n = SECONDARY or 2	DDS Secondary Channel
	"RDC?"	Returns state of RDC ie 1 or 2.
DATAPORT ERROR CORRECTION	"DEC n"	Only valid at DS0A < 19.2kbits. Not valid if Framing is T1DM.
	n = OFF or Ø	No Error Correction
	n = ON or 1	Perform Error Correction
	"DEC?"	Returns state of DEC ie Ø or 1.
PATTERN INVERSION (PSDC ONLY)	"RPI n"	Only valid when RX Measurement Select is PSDC.
	n = OFF or Ø	Normal Pattern expected
	n = ON or 1	Inverted Pattern expected
	"RPI?"	Returns state of RPI ie Ø or 1. EXAMPLE :- The signal at the RX Input is a Framed DS1C from the DS Cross-connect with B8ZS Coding. The Digroups have T1DM Framing. Wish to test the Primary Channel of Customer #2 within a 9.6 DS0B. The DS0B is contained within Timeslot 20 of Digroup 2 : **OUTPUT 707;"RIN DS1C;I1L DSX; R1C B8ZS;RCF ON;R1F T1DM; RMS DS0B;RDN 2;RTS 2Ø;RRØ 3; RCU 2;RCR 1;RDC PRIMARY"**

Setting RX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
DATA TYPE	"RDT n"	
	n = PATTERN or 1	(See RCD)
	n = PROTOCOL or 2	RX Data is passed to Protocol Analyzer. Protocol is only valid for DDS Primary Channel <19.2 kbits; DDS Secondary Channel;Datalink; FS_Chan & R_Chan.
	"RDT?"	Returns state of RDT ie 1 or 2.
PATTERN TYPE	"RCD n"	
	n = PRBS_20 or 1	20 Stage PRBS(See RZL)
	n = ALL_ONES or 2	All Ones Word
	n = SETTABLE or 3	Settable Word(See RSW)
	n = PRBS_2047 or 4	2047 Bit PRBS
	n = PRBS_511 or 5	511 Bit PRBS
	n = TRAFFIC or 6	RX Traffic
	"RCD?"	Returns state of RCD ie 1 to 6. The Pattern Type available depends upon the Measurement Select and DDS Channel Type:- *PRBS_20* - Only available at Digroup; DS1; DS1C *ALL_ONES* - Not available for DDS Secondary Channel *SETTABLE* - Not available at Datalink; R_Chan; FS_Chan; DDS Secondary Channel. *PRBS_2047; PRBS_511* - NOT available at DS1; Digroup; DS1C *TRAFFIC* - Only available at Digroup; DS1; DS1C.
14 ZERO LIMIT	"RZL n"	PRBS_20 only
	n = OFF or 0	No 14 Zero Limit
	n = ON or 1	PRBS_20, 14 Zero limited
	"RZL?"	Returns state of RZL ie 0 or 1.
LOOPBACK DATA	"RLD n"	Only valid for DS0B and DS0A, DDS Primary Channel with PRBS_2047 or PRBS_511
	n = NO_LOOP or 0	Data Only
	n = LOOP or 1	Data Alternated with Loopback Code
	"RLD?"	Returns state of RLD ie 0 or 1.

Setting RX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
SETTABLE WORD	"RSW 'bbbbbbbb'"	The content of the 8 bit (b) Word depends upon the Interface Level or Measurement Select, selection :- DS1/DS1C "dddddddd" 64 kbits Clr. Chan. "dddddddd" 56 kbits DDS "ddddddd1" 56 kbits PSDC "ddddddds" DS0B <56 kbits "fdddddd1" DS0A <56 kbits "1dddddd1" d = Data bit Ø or 1 s = Signaling bit f = subrate Frame bit
	"RSW?"	Returns state of RSW ie "bbbbbbbb"

Setting RX Parameters (MEASUREMENT TYPE)

Function	Mnemonic Code	Description
MEASUREMENT SOURCE A	"MAS n"	Only valid if Data Rate is <56 kbits
	n = SEC_CHAN or 1	Valid DS0B Secondary Channel only
	n = CUST or 2	Valid DS0B Primary Channel only
	n = SUBRATE or 3	Valid DS0B < 19.2 kbit/s only
	"MAS?"	Returns state of MAS ie 1 to 3.
MEASUREMENT TYPE A	"MTA n"	
	n = LOGIC or 1	Only valid if RDT is PATTERN and RCD is not CODES or TRAFFIC.
	n = BPV or CODE or 2	Valid DS1C & DS1 only
	n =FRAMING or 3	Valid Framed DS1C, DS1, DS0B < 19.2 kbit/s
	n = ESF_CRC or 4	Only valid DS1 or Digroup, with ESF Framing.
	n = JITTER or 5	Only valid at DS1 with Jitter Option (See JFL,JFT)
	"MTA?"	Returns state of MTA ie 1 to 5.
		Measurement Source & Type A are automatically selected by Measurement Select except in the case of DS0B. If DS0B is selected in conjunction with a Primary DDS Channel then a choice of Customer (Logic), all rates, or Subrate (Frame), rates < 19.2 kbits, is necessary. If DS0B is selected in conjunction with a Secondary DDS Channel then a choice of Sec_Chan (Logic), all rates, or Subrate (Frame), rates < 19.2kbits, is necessary. Setting RDT to PROTOCOL makes all results invalid except Subrate Frame when DS0B is < 19.2kbits. The correlation between Measurement Select, Measurement Source A & Measurement Type A is :-

Meas Select	Meas Source A	Meas Type A
DS1C	DS1C	Frame Code/BPV
Digroup	Digroup	Frame Logic
DS1	DS1	Frame Logic Code/BPV Jitter

Setting RX Parameters **(MEASUREMENT TYPE)**

Function	Mnemonic Code	Description
		DS0B with (Primary Channel) — Customer Subrate — Logic Frame DS0B with (Sec. Chan) — Sec_Chan Subrate — Logic Frame DS0A with (Primary Channel) — DS0A — Logic DS0A with (Secondary Channel) — Sec_Chan — Logic PSDC — PSDC — Logic DS0 Clear Channel — Timeslot — Logic Datalink — Datalink — Logic Fs_Chan — Datalink — Logic R_Chan — R_Chan — Logic If Framing is ESF and Measurement Select is Digroup then Digroup Frame is replaced by Digroup CRC. If Framing is ESF and Measurement Select is DS1 then DS1 CRC is available in addition to DS1 Frame. When there is effectively no Measurement Select, due to choice of Interface Level, Measurement Source A is selected according to the Interface Level :- **Interface Level** — **Meas Source A** — **Meas Type** DS1C (Unframed) — DS1C — Logic Code/BPV DS1 (Unframed) — DS1 — Logic Code/BPV

Setting RX Parameters (MEASUREMENT TYPE)

Function	Mnemonic Code	Description
		At Interface Levels of DS0B, DS0A & DS0 Measurement Source A and Measurement Type A are the same as those specified under Measurement Select DS0B, DS0A and DS0.
MEASUREMENT SOURCE B	"MBS n"	
	n = OFF or Ø	No Measurement
	n = SEC_CHAN or 1	Only valid if DS0B Secondary Channel and RDT is PATTERN.
	n = CUST or 2	Only valid if DS0B Primary Channel and RDT is PATTERN.
	n = SUBRATE or 3	Only valid if DS0B Primary Channel < 19.2 kbits.
	n = TIMESLOT or 4	Only valid if PSDC or DS0 extracted from DS1 or DS1C.
	n = DS0 or 5	Only valid if DS0 Interface Level.
	n = DS0A or 6	Only valid for DS0A.
	n = PSDC or 7	Only valid if Framing is SF or ESF.
	n = DATALINK or 8	Only valid for Datalink & FS_Chan.
	n = DIGROUP or 9	Only valid for DS1C Interface Level.
	n = DS1 or 1Ø	Only valid for DS1.
	n = DS1C or 11	Only valid for DS1C
	n = R_CHAN or 12	Only valid if Framing is T1DM.
	"MBS?"	Returns state of MBS ie Ø to 12.
MEASUREMENT TYPE B	"MTB n"	
	n = LOGIC or 1	Not valid if RCD is CODES or TRAFFIC.
	n = BPV or CODE or 2	Valid DS1C, DS1 only
	n = FRAMING or 3	Valid Framed DS1C, DS1, DS0B < 19.2 kbit/s
	n = ESF_CRC or 4	Only valid DS1, Digroup, with ESF Framing.
	n = JITTER or 5	Only valid at DS1 with Jitter Option (See JFL,JFT)
	"MTB?"	Returns state of MTB ie 1 to 5.
		Measurement Source B and Measurement Type B must be selected using the MBS and MTB messages. The Measurement Source and Type available are dependent on the Interface Level and Measurement Select. Measurement Source and Type B always allows the same Measurements as are available with Measurement Source and Type A. An additional list of Measurements are available due to the Interface Level selected :-

Setting RX Parameters **(MEASUREMENT TYPE)**

Function	Mnemonic Code	Description
		INTERFACE LEVEL DS1C **Meas Select** — **Meas B Availability** DS1C — As Measurement A Digroup — As Measurement A + DS1C Code/BPV, DS1C Frame DS0B,DS0A, PSDC,Clear Channel, Datalink, FS_Chan & R_Chan — As Measurement A + Digroup Frame, DS1C Frame, DS1C Code/BPV If Framing is ESF and Measurement Select is Digroup then Digroup CRC replaces Digroup Frame. If Framing is ESF and Measurement Select is DS0B, DS0A, PSDC, Clear Channel or Datalink then Digroup CRC & Digroup Frame are available. INTERFACE LEVEL DS1 **Meas Select** — **Meas B Availability** DS1 — As Measurement A DS0B,DS0A PSDC,Clear Channel, Datalink, FS_Chan & R_Chan — As Measurement A + DS1 Code/BPV, DS1 Frame, DS1 Jitter (OPT 001 only) If Framing is ESF then DS1 CRC is available when Measurement Select is DS1, DS0B, DS0A, PSDC, Clear Channel or Datalink. When there is effectively no Measurement Select ie DS1C Unframed, DS1 Unframed, DS0B Interface Level, DS0A Interface Level or DS0 Interface Level then Meas B availability is the same as for Meas A.

Setting RX Parameters (MEASUREMENT TYPE)

Function	Mnemonic Code	Description
JITTER FILTER (Option ØØ1 Only)	"JFL n"	
	n = LP or 1	Low Pass
	n = LP_HP1 or 2	Low Pass & High Pass 1
	n = LP_HP2 or 3	Low Pass & High Pass 2
	"JFL?"	Returns state of JFL ie 1 to 3.
JITTER FILTER THRESHOLD (Option ØØ1 Only)	"JFT n"	
	n = Ø.Ø5 to 1Ø.ØØ UI	Resolution Ø.Ø1 UI.
	"JFT?"	Returns state of JFT ie Ø.Ø5 to 1Ø.ØØ UI.
ANALYSIS SOURCE	"ANS n"	
	n = A or 1	Result A
	n = B or 2	Result B
	"ANS?"	Returns state of ANS ie 1 or 2.
		Analysis is only possible on one result during any Gating Period. If analysis of a second result is required a new Gating Period must be used. Analysis is not possible when only Jitter measurements are being performed.
ANALYSIS TYPE	"ATY n"	
	n = AVAIL or 1	% Availability
	n = UNAVAIL or 2	% Unavailability
	n = SEVERE_ES or 3	% Severe Error Seconds
	n = ERROR_SEC or 4	% Error Seconds
	n = MINUTES or 5	% Degraded Minutes
	n = CSES or 6	Consecutive severely errored seconds count
	n = SEVERE_CNT or 7	Severely errored seconds count
	n = ES_CNT or 8	Error seconds count
	n = MINS_CNT or 9	Degraded minutes count
	"ATY?"	Returns state of ATY ie 1 to 9.
ALARM DURATION TYPE	"ADT n"	
	n = PATTERN or 1	Pattern Loss
	n = SUBR_FRAME or 2	Subrate Frame Loss
	n = DS1_FRAME or 3	DS1 Frame Loss
	n = DIGR_FRAME or 4	Digroup Frame Loss
	n = DS1C_FRAME or 5	DS1C Frame Loss
	n = AIS_SECS or 6	AIS Seconds
	n = INST_POWER or 7	Instrument Power Loss
	n = SIGNAL or 8	Signal Loss
	"ADT?"	Returns state of ADT ie 1 to 8
		The Alarm Duration Type availability depends upon the selection of Interface Level and/or Measurement Select :-

Setting RX Parameters (MEASUREMENT TYPE)

Function	Mnemonic Code	Description
		INST_POWER : Always available. *AIS_SECS* : Available when Interface Level is DS1C or DS1. *DS1C_FRAME* : Framed DS1C *DS1_FRAME* : Framed DS1 *DIGR_FRAME* : Framed DS1C & Meas. Select other than DS1C *SUBR_FRAME* : Interface Level or Meas. Select, DS0B < 19.2 kbits. *SIGNAL* : Signal Loss can be DS1C; DS1; DS0B; DS0A and is directly related to the Interface Level. *PATTERN* : Pattern Loss is available at all Interface Levels and all Measurement Select if the RX Data Type is Pattern and the RX Pattern Type is other than Traffic or DDS Codes.

Setting RX Parameters (GATING)

Function	Mnemonic Code	Description
GATING TYPE	"GTY n"	
	n = MANUAL or 1	Manual Gating(See STR,STP)
	n = SINGLE or 2	Single Interval(See GPR,STR)
	n = REPEAT or 3	Repetitive Interval(See GPR,STR,STP)
	n= SHORT_1S or 4	1 Second Repeat(See STR,STP)
	n = SHORT_15S or 5	15 Second Repeat(See STR,STP)
	n = SHORT_5M or 6	5 Minute Repeat (See STR, STP)
	n = SHORT_15M or 7	15 Minute Repeat (See STR, STP)
	"GTY?"	Returns state of GTY ie 1 to 7.
GATING PERIOD	"GPR d,h,m,s"	Sets the measurement Gating Period. d = Days, h = Hours, m = Minutes, s = Seconds.
	d = 0 to 99	
	h = 0 to 23	
	m = 0 to 59	
	s = 0 to 59	
	"GPR?"	Returns state of GPR ie 'd,h,m,s'.
START GATING	"STR"	Clears all results and causes the instrument to start gating.
STOP GATING	"STP"	Causes the instrument to stop gating. The Results are updated.
		EXAMPLE :- To select and start Repetitive Gating of 1 Day, 23 Hours, 59 Minutes and 9 Second send :
		OUTPUT 707;"GTY REPEAT; GPR 01,23,59,09" **OUTPUT 707;"STR"**

Setting RX Parameters (ALARM MASK/STATUS)

Function	Mnemonic Code	Description
ALARM MASK REGISTER 1	"AM1 n"	Not included in Saved Panel.
	n = NONE or Ø	No AM1 type Alarms
	n = PAT or 1	Pattern Sync Loss
	n = XSØ or 2	DS1/DS1C Excess Zeros
	n = SLØ or 4	DS0A/DS0B Signal Loss
	n = CL1 or 8	DS1 External Clock Loss
	n = CLØ or 16	DS0 External Clock Loss
	n = FLC or 32	DS1C Frame Sync Loss
	n = MFA or 64	DS1 Multi-Frame Align Sync Loss
	n = FL1 or 128	DS1 Frame Sync Loss
	n = FLB or 256	DS0B Subframe Sync Loss
	n = AIS or 512	DS1 Alarm Indication Signal
	n = XBT or 1Ø24	X-Bit Alarm
	n = YAL or 2Ø48	Yellow Alarm
	n = ERR or 4Ø96	Errors/Hits
ALARM MASK REGISTER 2	"AM1?"	Returns the state of AM1 ie Ø to 8191
	"AM2 n"	Not included in Saved Panel
	n = NONE or Ø	No AM2 type Alarms
	n = SLH or 1	DS1/DS1C Signal Level High
	n = SLL or 2	DS1/DS1C Signal Level Low
	n = SLI or 4	DS1/DS1C Signal Level Imbalance
	n = SLZ or 8	Signal loss
	n = NFS or 16	Negative frame slip
	n = PFS or 32	Positive frame slip
	"AM2?"	Returns state of AM2 ie Ø to 63.
	If Multiple alarms are required the Message can be specified in 3 ways :- 1. A list of integers ie "AM1 1,8,64,512; AM2 4" 2. A list of mnemonics ie "AM1 PAT,CL1,MFA, AIS;AM2 SLI" 3. A single integer ie "AM1 585;AM2 4" (585 = 1+8+64+512)	NOTE :- All Front Panel Alarms are included in the Alarm Mask Registers. In addition the following "extra" Alarms are included :- Signal Loss (DS0), External Clock Loss (DS0), External Clock Loss (DS1), Multi-Frame Alignment Sync Loss (DS1), Signal Level High (DS1/DS1C), Signal Level Low (DS1/DS1C) and Signal Level Imbalance (DS1/DS1C). The Alarm Mask Registers are used to determine under what Alarm conditions the the instrument should issue an SRQ. To achieve an SRQ on Alarm :- 1. Set the Alarm Mask Registers to the required value (Ø to 8191 &/or Ø to 63). 2. Set Bit 9(AL1) &/or Bit 1Ø(AL2) in Status register A. (See Common Capabilities "STA" Message).

Setting RX Parameters (ALARM MASK/STATUS)

Function	Mnemonic Code	Description
		The instrument will then issue an SRQ whenever Bit 1 (ALC Bit) in the Status Byte (Status Register B) is set.
ALARM STATUS REGISTER 1 RESULT	"AL1?"	Returns the current status of Alarm Status Register 1 as an integer (Ø to 8191). Alarm Weighting is as follows :- *Ø* (No AM1 type Alarms) *1* (Pattern Sync Loss) *2* (DS1/DS1C Excess Zeros) *4* (DS0A/DS0B Signal Loss) *8* (DS1 External Clock Loss) *16* (DS0 External Clock Loss) *32* (DS1C Frame Sync Loss) *64* (DS1 Multi-Frame Align Sync Loss) *128* (DS1 Frame Sync Loss) *256* (DS0B Subframe Sync Loss) *512* (DS1/DS1C AIS) *1Ø24* (X-Bit Alarm) *2Ø48* (Yellow Alarm) *4Ø96* (Errors/Hits) The value is updated every 100mS regardless of Gating.
ALARM STATUS REGISTER 2 RESULT	"AL2?"	Returns the current status of Alarm Status Register 2 as an integer (Ø to 63). Alarm Weighting is as follows :- *Ø* (No AM2 type Alarms) *1* (DS1/DS1C Signal Level High) *2* (DS1/DS1C Signal Level Low) *4* (DS1/DS1C Signal Level Imbalance) *8* (Signal loss) *16* (Negative frame slip) *32* (Positive frame slip) The value is updated every Second regardless of Gating.

Setting RX Parameters (OUTPUT RESULTS)

Function	Mnemonic Code	Description
SIGNALING BITS RESULT	"SGR?"	Is only valid when Measurement selection is 56 kbits PSDC or 4 kbits Datalink and DS1/Digroup Framing is SF or ESF. If Framing is SF, 2 Signaling Bits with 2 trailing spaces("xx ") are returned. If Framing is ESF, 4 Signalling Bits ("xxyy") are returned. Returns Result in the form :- Validity Flag, "xxyy". x = Ø or 1, y = Ø or 1. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
ELAPSED TIME RESULT	"ELP?"	Returns the Elapsed Time since the start of Measurement period. Returns Result in the form :- Validity Flag, Days, Hours, Minutes, Seconds. Days = Ø to 99, Hours = Ø to 23, Minutes = Ø to 59 and Seconds = Ø to 59. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
MJU BRANCH SELECT CODE RESULT	"BSC?"	Returns the MJU Branch Select Code, which is a confirmation from an MJU following a Route Message (See TX Parameters (DDS LINK TYPE), where the MJU indicates which Branch has been selected. Returns Result in the form :- Validity Flag, n. n = 1 to 4. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
MJU HUB-ID RESULT	"HUB? n" n = PRESENT or 1 n = PREVIOUS or 2	Returns the identification (ID) number of the present or previous HUB. Returns ID number of the present HUB Returns ID number of the previous HUB Returns Result in the form :- Validity Flag, nn. nn = ØØ to 77(Octal). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
LATCHING LOOPBACK MAPCODE RESULT	"MAP?"	Only valid for DS0DP, OCU, CSU and HL222, DDS Latched Loopbacks (See LBØ). Reads the MAPCODE (Identity) of equipment that has been looped using a DDS Loopback. Returns Result in the form :- Validity Flag, n. n = Ø or 1. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).

Miscellaneous Parameters (DATA LOGGING)

Function	Mnemonic Code	Description
LOGGING ON/OFF	"LOG n"	
	n = OFF or Ø	(See LOD)
	n = ON or 1	(See LDV,LEG,LES,LET,LDG,LDT)
	"LOG ?"	Returns state of LOG ie Ø or 1.
LOGGING DEVICE	"LDV n"	
	n = HP 3787B or 1	Internal Printer
	n = HP-IB or 2	External Printer. Only via RS-232-C. Not allowed via HP-IB as HP 3787B would need to be in Talk Only.
	"LDV?"	Returns state of LDV ie 1 or 2.
LOG AT END OF GATING	"LEG n"	
	n = OFF or Ø	No Summary at end of Gating period
	n = ALWAYS or 1	Summary at end of every Gating period(See LES)
	n = RATIO or 2	Summary at end of Gating when Error/Hit Ratio exceeds threshold(See LES,LET)
	"LEG?"	Returns state of LEG ie Ø to 2.
CONTENTS OF END OF GATING SUMMARY	"LES a,b,c,d"	
	a = OFF or Ø	No Measurement Results
	a = SELECTED or 1	Only those Measurement Results selected on the RX Page
	a = ALL or 2	All Measurement Results
	b = OFF or Ø	No Analysis Results
	b = SELECTED or 1	Only those Analysis Results selected on the RX Page
	b = ALL or 2	All Analysis Results
	c = OFF or Ø	No Alarm Duration Results
	c = SELECTED or 1	Only those Alarm Duration Results selected on the RX Page
	c = ALL or 2	All Alarm Duration Results
	d = OFF or Ø	No Frame Slips Results
	d = ON or 1	All Frame Slips Results
	"LES?"	Returns state of LES ie 'a,b,c,d'.
ERROR RATIO THRESHOLD FOR END OF GATING SUMMARY	"LET n"	n = 2 to 7 representing an Error Ratio of 1.ØE-2 to 1.ØE-7.
	"LET?"	Returns the state of LET ie 2 to 7.

Alarm Registers

The HP 3787B has the capability to capture all events in the Alarm Status Registers and issue a Service Request. In order to issue an SRQ the Alarm Mask Register(s) must be set using the AM1 and/or AM2 Messages. In addition the, RQS Mask must be set to enable bit 9 (AL1) and/or bit 10 (AL2). The HP 3787B will then issue an SRQ when any Alarm specified by AM1 and/or AM2 changes state. Alarm Status Registers are not Latched ie they contain instantaneous values . Alarm Status Register 1 is updated every 100mS and Alarm Status Register 2 is updated every second. The Bit maps of the Mask and Status Registers are identical :-

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
0	0	0	ERR	YAL	XBT	AIS	FLB

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
FL1	MFA	FLC	CLO	CL1	SLO	XSO	PAT

Table 6-4. Alarm Status Register 1

Bit	Decimal Value	Description
12	4096	Error :- Set when an Error/Hit has occurred.
11	2048	Yellow ALarm :- Set when Yellow Alarm has occurred.
10	1024	X-Bit :- Set when X-bit Alarm has occurred.
9	512	AIS :- Set when AIS Alarm has occurred.
8	256	Frame Loss B :- Set when DS0B Subframe Sync Loss has occurred.
7	128	Frame Loss 1 :- Set when DS1 Frame Sync Loss has occurred.
6	64	MultiFrame Alignment :- Set when DS1 Multiframe Alignment Sync Loss has occurred.
5	32	Frame Loss C :- Set when DS1C Frame Sync Loss has occurred.
4	16	Clock Loss Ø :- Set when DS0 External Clock Loss has occurred.
3	8	Clock Loss 1 :- Set when DS1 External Clock Loss has occurred.
2	4	Signal Loss Ø :- Set when DS0A/DS0B Signal Loss has occurred.
1	2	Excess Zeros :- Set when DS1 or DS1C Consecutive zeros >14.
0	1	Pattern :- Set when Pattern Sync Loss has occurred.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	PFS	NFS	SLZ	SLI	SLL	SLH

Table 6-5. Alarm Status Register 2

Bit	Decimal Value	Description
5	32	PFS :- Set when a Positive Frame Slip has occurred.
4	16	NFS :- Set when a Negative Frame Slip has occurred.
3	8	Signal Level Zero :- Set when Signal is lost.
2	4	Signal Level Imbalance :- Set when Signal Level is imbalanced.
1	2	Signal Level Low :- Set when Signal Level is low.
0	1	Signal Level High :- Set when Signal Level is high.

Additional Registers

The READY and ERROR Registers are also available for interrogation in the HP 3787B.

Ready Register

The Ready Register indicates the readiness of the HP 3787B to accept or output Data and can be interrogated by using RDY?. By setting the RQS Mask bit 4 the HP 3787B will issue an SRQ when bit 3 of the Ready Register is set ie Data Ready for Output.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	DRO	0	0	RAC

Table 6-6. Ready Register

Bit	Decimal Value	Description
3	8	Data Ready for Output :- This Bit is set when a Message causes the HP 3787B to output Data and is cleared when the HP 3787B has finished outputting Data.
0	1	Ready to Accept new Command :- This Bit is set when the Parser has completed Parsing a Message and passed it on to the Executor. Cleared on the receipt of the next Message.

Status Reporting

The HP 3787B contains 6 Registers which can be interrogated. Status Registers A & B; Alarm Registers 1 & 2; Ready Register and Error Register.

To determine the current status of the HP 3787B you must interrogate the Primary Status Byte register (Status Register B). Three methods of of interrogation are available via the HP-IB, but only one method is available via the RS-232-C. Table 6-1 lists the three methods and their availability according to the remote interface selected :-

Table 6-1. Status Reporting

Methods Of Interrogation	HP-IB Interface	RS-232-C Interface
Poll using STB? (Common Capability Message)	YES	YES
Repeated Serial Poll (SPOLL)	YES	NO
Poll using a Service Request Interrupt routine.	YES	NO

Service Request Interrupt Routine

- Select the condition(s), under which you require the HP 3787B to Request Service by using the Common Capability Message RQS.
- Specify the action to be taken when the HP 3787B issues an Interrupt by using the controller dependent ENABLE INTR and ON INTR (Basic) statements.
- Acquire the Primary Status Byte using the SPOLL (Basic) statement.

NOTE

An example of a Service Request Interrupt routine occurs in the DS1 Loopback Application Program. (Lines 100, 320 and 2090 to 2140)

Poll Using STB?

- Select the condition(s), under which you require the HP 3787B to Request Service by using the RQS message.
- Enter a Waiting loop and acquire the Primary Status Byte using the STB? message.

Primary Status Byte

The Primary Status Byte returned in response to a serial poll or STB? is the contents of Status Register B :-

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
LOG	RQS	ERR	RDY	LCL	FPS	ALC	EOG

Table 6-2. Primary Status Byte

Bit	Decimal Value	Description
7	128	Logging has occurred :- This Bit is set when Data Logging occurs. Cleared by Device Clear, Selective Device Clear, RST, CLR and any Message that causes Results to be output
6	64	ReQuest Service :- This Bit is set if an SRQ is generated for any reason. Cleared by Device Clear, Selective Device Clear, SPOLL, RST, CLR and STB?.
5	32	Error has occurred :- This Bit is set when an Error occurs. Cleared by Device Clear, Selective Device Clear, RST, CLR and ERR?.
4	16	Ready :- This Bit is set when a Program Message causes the HP 3787B to output Data and is cleared when the HP 3787B has finished outputting Data.
3	8	Local :- This Bit is set when the Power has cycled. Cleared by Device Clear, Selective Device Clear, RST, CLR, STB? and STA?.
2	4	Front Panel Service :- This Bit is set when a front panel Key is pressed. Cleared by Device Clear, Selective Device Clear, RST, CLR and KEY?.
1	2	Alarm Change :- This Bit is set when an Alarm, which has been specified using an AM1/AM2 Program Message, (Alarm Mask Status) causes AL1 or AL2 in Status Register A to be set. Cleared by Device Clear, Selective Device Clear, RST, CLR and AL1? or AL2?.
0	1	End Of Gating :- This Bit is set when the HP 3787B reaches the end of its gating period, irrespective of the type of gating. Cleared by Device Clear, Selective Device Clear, RST, CLR, STR and any Message that causes Results to be output (RSA?, RSB?, RJA?, RJB?, ANR?, ALD?, RXL?, and FSL?).

SPECIFICATIONS

Except where otherwise stated, the following parameters are warranted performance specifications. Parameters described as "typical" or "nominal" are supplemental characteristics which provide a useful indication of typical, but non-warranted, performance characteristics.

INTRODUCTION

OPERATING MODES

When interfacing at DS1/DS1C levels, the HP 3787B can operate as a separate Transmitter and Receiver, or in Through (THRU) Mode. In THRU Mode, a DS1/DS1C signal applied to the RX Input is retransmitted from the TX Output. When interfacing at DS0 levels, the HP 3787B operates as a separate Transmitter and Receiver, sharing a common (externally-provided) clock source. Protocol analysis can be performed on channels accessed by the HP 3787B by connecting a protocol analyzer to a rear-panel port.

MEASUREMENT PRESETS

Nine completely independent instrument configurations can be stored in non-volatile memory for later recall. Memory location 0 contains a default instrument configuration. The HP-IB address is not held in the measurement presets.

KEYBOARD LOCK

This feature locks the EXEC and START/STOP keys. The CHANGE keys (PREV and NEXT) are also locked for functions which change the state of the instrument. They are not locked for VIEW functions.

USER CONFIDENCE TESTS

Seventeen independently selectable tests are provided to allow the user to check the functional operation of the instrument.

TRANSMITTER

DS1/DS1C TRANSMITTER

□ Clock Sources

Internal DS1/DS1C TX Clock
Frequency : 1.544 Mbit/s (DS1); 3.152 Mbit/s (DS1C).
Stability : < 25 ppm all causes including 5-year aging and ± 10 ppm temperature 0 to 50°C.

External DS1 TX Clock
Frequency : 1.544 MHz ± 130 ppm.
Sensitivity : Compatible with TTL level signals.
Connector : BNC (rear panel).
Impedance : 75 Ω unbalanced (nominal).
Termination : GND.
Note : This port accepts inputs only at a DS1 rate. When the TX Output is framed DS1C this input can be used to clock the constituent digroup generators.

Looped DS1 TX Clock
Function : DS1 TX timing is derived from a data signal applied to the DS1/DS1C RX Input. This source is also valid if the RX interface is selected to be DS0, provided a DS1 signal is also connected to the DS1/DS1C RX Input.

□ DS1/DS1C Interface

DS1/DS1C TX Line Code
AMI, B8ZS.

DS1/DS1C TX Output
Connector Type : WECO jack to accept WECO type 310 plug.
Impedance : 100 Ω balanced (nominal).

DS1/DS1C TX Level

DSX-1 (Refs : KS-22332, L-171907, T1X1-4/85-032);
DSX-1C.

Pulse Height :

DS1 : ± 3 V ± 600 mV (at the center of the pulse).
DS1C : ± 3.65 V ± 850 mV (at the center of the pulse).

Pulse Imbalance : Ratio of power in positive and negative pulses nominally 0 ± 0.5 dB.

Pulse Width : (Measured at half amplitude)

DS1 : 324 ± 30 ns.
DS1C : 159 ± 20 ns.

Rise and Decay Time :

DS1 : 50 ns ± 25 ns (10% to 90%).
DS1C : 37.5 ns ± 12.5 ns (20% to 80%).

Waveshape :

DS1 : Meets T1X1.4-85-032 (same as CCITT G.703).
DS1C : Meets T1X1.4-85-032 (not defined in CCITT G.703).

DS1/DS1C Additional TX Output

Signal : Identical to main output signal.
Connector : Rear-panel WECO, identical to front-panel port.

DS1/DS1C TX Signal Format

DS1 : Unframed
Framed Ft only, SF(D4), ESF(Fe), T1DM(DDS).
DS1C : Unframed
Framed.

DS0 TRANSMITTER

▫ Clock Sources

DS0 Clocks

For DDS testing, the DS0 transmitter must always be supplied with bit and byte clocks from the DDS system. These clocks can be connected to the front-panel 5-pin connector or to the rear-panel D-shell, the active source being selected via the CRT. The clocks are shared by the DS0 RX circuitry.

If the output format is clear channel these clocks must still be provided.

Frequency :

Bit Rate : 64 kbit/s (nominal).
Byte Rate : 8 kbit/s (nominal).

Indication : Error message on line 1 of screen if instrument fails to receive either bit or byte clock : "NO DS0 CLOCKS".

DS0 Complementary Clocks

Connector : 5-pin DIN male (front-panel).
Format : Separate bit and byte clocks. Both have complementary TTL inputs.
Levels :

Low Level : 0.0 to 0.8 V.
High Level : 2.0 to 5.5 V.

DS0 Channel Bank DDS Clocks

Connector : 9-pin D-shell (rear-panel).
Format : Separate bit and byte clocks, both TTL.
Levels :

Low Level : 0.0 to 0.8 V.
High Level : 2.0 to 5.5 V.

▫ DS0 Interface

DS0 Bipolar Output

Validity : All DS0.
Connector : WECO Bantam.
Impedance : 100 Ω ± 5%, balanced, DC-isolated at DS0 interface.
Transition Time : 0.5 µs maximum.
Transmitted Zero : < 0.7 V.
Transmitted One : 3.2 V peak ± 10%.
Pulse Width : 15 µs (nominal).
Pulse Shape : The ratio of the amplitudes of positive and negative pulses at the center of the pulse interval is in the range 0.95 to 1.05.

The ratio of the widths of positive and negative pulses at the nominal half-amplitude point is in the range 0.95 to 1.05.

(All measured when terminated with 100 Ω ± 5% resistive load.)

Drive Capability : This output will drive up to 1500 feet of 22 AWG balanced, twisted, shielded 100 Ω cable.

DDS Logic Output

Validity : DS0A.
Direction : Near; Far.

With DS0A interface selected for both TX and RX, the selection of Near or Far is commoned with the receiver.

Connector : WECO Bantam - Tip = Near; Ring = Far.
Output Levels :

TTL High : > 2.4 V (Logic 0).
TTL Low : < 0.4 V (Logic 1).

Drive Capability : Output sink current = 16 mA DC (nominal).

DS0 TX Format

DDS DS0A :

XDDDDDDC for sub-rate services (2.4, 4.8 or 9.6 kbit/s);
DDDDDDDC for 56 kbit/s service
where D is data.
C is control or status
X is don't care.
19.2 kbit/s is compatible with CB-INC-100.

DDS DS0B :

SDDDDDDC for sub-rate services (multi-customer) (2.4, 4.8 or 9.6 kbit/s);
DDDDDDDC for 56 kbit/s service
where D is data.
C is control or status.
S is sub-rate frame sequence.
19.2 kbit/s is compatible with CB-INC-100.

Clear Channel : DDDDDDDD where D is data.

TEST SIGNALS

□ DS1/DS1C TX Data

Patterns

PRBS : 2^{20}-1, (D20+D17+1=0), a 14-zero limit may be selected.

Word : 8-bit fully programmable.

DS1 In-Band Loopbacks : (Ref TA-TSY-000312. T1C1.2/87-001R3). Latching loopbacks activated and deactivated by the EXEC key. DS1 signals can be framed or unframed.

Network : Set-up, 8 second burst of "11000" repeated.
Clear-down, 8 second burst of "11100" repeated.

Line : Set-up, 8 second burst of "00001" repeated.
Clear-down, 8 second burst of "001" repeated.

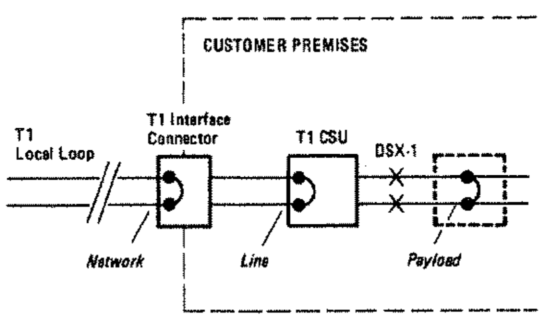
DS1 ESF Datalink Loopbacks : (Ref TR-TSY-000194). Latching loopbacks activated and deactivated by the EXEC key. Bit oriented message on the 4 kbit/s ESF datalink.

Network : Set-up, "00010010 11111111" repeated 10 times.
Clear-down, "00100100 11111111" repeated 10 times.

Line : Set-up, "00001110 11111111" repeated 10 times.
Clear-down, "00111000 11111111" repeated 10 times.

Payload : Set-up, "00010100 11111111" repeated 10 times.
Clear-down, "00110010 11111111" repeated 10 times.

Note: The rightmost bit is transmitted first.



DS1/DS1C TX Alarms

AIS : Valid with either DS1 or DS1C interface selected. The selection of AIS overrides any prior frame selection.

Yellow Alarm : Yellow alarm can be transmitted for all four DS1 frame formats. Yellow alarm is introduced in the various framing formats as follows :

SF, "Ft only" : Bit 2 of every timeslot zero.

T1DM : Bit 190 of every frame zero.

ESF : 4 kHz datalink carries repetitive 8 zeros/8 ones pattern.

X-Bit : With DS1C framed signals, the X-bit can be set to "0" (alarm) or "1".

□ DS1 Timeslot Insertion

Available in all DS1 framing modes, all other timeslots filled with a background 2^{20}-1 PRBS.

Timeslot Formats :

Multi-customer DDS (DS0B);
56 kbit/s single-customer DDS;
Dataport single-customer (except 56 kbit/s);
56 kbit/s circuit-switched (PSDC);
64 kbit/s clear channel.

For PSDC the format is DDDDDDDS, where D is data, S is signaling bit (frames 6, 12, etc). (S = 1 in other frames).
For the other formats refer to the DS0 TX Signal Format section. PSDC is available only with SF and ESF. Clear channel is NOT available with T1DM.

Insertion Level : Unless the timeslot is specified to contain DDS multi-customers, the insertion pertains to the complete (single-customer) timeslot.

If the timeslot is specified to be multi-customer DDS, then customer number must be further specified to permit insertion in a particular customer slot. In the TX & RX mode, other customer slots in the chosen timeslot are filled with DDS TEST code. In the THRU mode, they are retransmitted unmodified.

Insertion Data : The data applicable is as specified for the DS0 Transmitter.

With 56 kbit/s PSDC selected, the choice of test patterns is the same. As with clear channel and 56 kbit/s, DDS data received from a protocol analyzer cannot be inserted in a timeslot.

Errors may be added as described in the TX Error Addition section.

Signaling : When 56 kbit/s circuit-switched channels are inserted in a DS1 signal (TX & RX or THRU modes), the signaling bits of the selected channel can be set via the front panel.

SF : A, B bits.
ESF : A, B, C, D bits.

□ T1 Datalink

Types :

With ESF framing, data may be inserted in the 4 kbit/s datalink.
With "Ft only" framing, data may be inserted in the 4 kbit/s Fs link.
With T1DM framing, data may be inserted in the 8 kbit/s R-channel.
Insertion is available in both TX & RX and THRU modes.

Test Patterns :

511-bit PRBS
2047-bit PRBS
All-ones word

In addition, data may be transmitted as received over the rear-panel serial protocol analyzer interface.

DS0 TX Data

Patterns :

511-bit (2^9-1) PRBS. (D9+D5+1=0).

2047-bit (2^{11}-1) PRBS. (D11+D9+1=0).

All-ones word
8-bit word, fully programmable } Bits 1 and 8 restricted for DDS; bit 8 restricted for PSDC

Preprogrammed sequence : This can be any length from 1 byte to 256 bytes inclusive. The content can be programmed only remotely (HP-IB or RS-232-C). The following number of bits per byte are programmable :

- Clear channel - 8
- 56 kbit/s CSDC - 7
- 56 kbit/s DDS - 8 (data + status)
- Sub-rate DDS - 7 (data + status)

Note : The pattern choice is restricted in the following cases -

- DDS Alternating Loopbacks
- DDS Secondary Channel
- T1 Data Links

See appropriate section for details.

Protocol : Transmitted data is as received over the rear-panel serial link. It is not available with alternating loopbacks.

Background : When the interface is DDS multi-customer DS0B the other customer slots are filled with TEST code.

DDS Multi-Point Signaling Unit

When testing multi-point DDS circuits, any number of multi-point junction units (MJUs) in tandem may be routed to set up a path by sending control sequences from the HP 3787B. The returned MJU branch number and Hub Office Identification are displayed.

Once the path has been set up the branch may be tested, blocked or an existing block cleared.

Control Sequences : The following table describes the code sequences which are transmitted for the various MJU operations.

Operation	Select	Block	Unblock	Release
1 second TA	•			
20 bytes MA*	•			
20 bytes BRN*	•			
20 bytes UMC*	•			
1 second BLK		•		
1 second CMI		•	•	
1 second RLS				•

where :

TA	Test Alert	S1101100
MA	MJU Alert	S1110010
BRN	Branch Select	S0101XY1
UMC	Unassigned Mux	S0011000
BLK	Block	S0001010
CMI	Idle	S1111110
RLS	Release	S1111000

The branch selected is binary-coded into bits "XY" in the range 0 to 3. These are mapped from the branch range 1 to 4 (1 ➤ 0, 2 ➤ 1, etc).

Note : For the multiple byte transmissions marked by * in the table above, the number of bytes is the number transmitted at DS0A after iteration to 64 kbit/s.

Within a DS0B signal the numbers of MA, BRN and UMC bytes are respectively :

- 1 each for the 2.4 kbit/s case;
- 2 each for the 4.8 kbit/s case;
- 4 each for the 9.6 kbit/s case;
- 20 each for the 19.2 kbit/s case.

DDS Loopback

Alternating and latching loopbacks may be activated and released.

Alternating

Whenever the loopback is selected the HP 3787B transmits the selected test pattern alternated with the appropriate code.

There are six types of alternating loopback. The following table lists them and details the activation codes :

	D1	D2	D3	D4	D5	D6	D7	C8
DSU	0	0	1	0	1	1	0	0
Channel	0	0	1	0	1	0	0	0
OCU	0	0	1	0	1	0	1	0
56 kbit/s Repeater	0	0	1	0	1	0	0	0
HL96NY	0	0	1	0	1	0	1	0
DS0DP*	0	0	1	0	1	0	1	0

* The DS0DP alternating loopback is available only in some DS0DP cards. Please check that your DS0DP card has this capability before attempting a DS0DP alternating loopback.

Column D1 assignment is for 56 kbit/s operation. For sub-rate operation (2.4, 4.8, 9.6 and 19.2 kbit/s) from a DS0A interface the first bit is a one in all cases. For sub-rate channels when interfacing at DS0B this bit position contains one bit of the sub-rate framing sequence and is designated S.

While testing using alternating loopbacks, test pattern selection is restricted to :

- 511-bit PRBS (D9+D5+1=0).
- 2047-bit PRBS (D11+D9+1=0).
- Preprogrammed word.

DDS code transmission is not valid during an alternating loopback.

Latching

There are five types of latching loopback.

Control Sequences : The following table describes the code sequences which are transmitted to set up the various latching loopbacks. Note that the number of bytes specified applies to the DS0A interface, ie after iteration.

Operation	DS0DP	OCU	Chan	HL222	MJU
40 bytes TIP	•	•	•	•	
40 bytes TA					•
20 bytes MA					•
20 bytes MJU					•
40 bytes DS0DP	•				
40 bytes OCU		•			
40 bytes CSU			•		
40 bytes HL222				•	
120 bytes LBE	•	•	•	•	
20 bytes UMC					•
40 bytes DMI*	•				
120 bytes LBE*	•				
2 seconds FEV	•	•	•	•	
200 bytes LBE	•	•	•	•	

* This section is transmitted once for every intervening DS0DP unit up to a maximum of 7.

where :

TIP	Transition In Progress	00111010
TA	Test Alert	S1101100
MA	MJU Alert	S1110010
MJU	Loopback Identification	S1010001
DS0DP	Dataport LSC	00000101
OCU	Office Channel Unit LSC	01010101
CSU	Channel Unit LSC	00110001
HL222	HP222 LSC	01000111
LBE	Loopback Enable	01010110
UMC	Unassigned Mux Channel	S0011000
DMI	Data Mode Idle	11111111
FEV	Far-End Voice	01011010
(LSC =	Loopback Select Code	0XXXXXX1)

Assignment of the first bit is for 56 kbit/s. For sub-rate operation (2.4, 4.8, 9.6 and 19.2 kbit/s) from a DS0A interface the first bit is a one in all cases. For sub-rate channels when interfacing at DS0B this bit position contains one bit of the sub-rate framing sequence and is designated S.

Releasing a Latched Loopback

The DS0DP, OCU, Chan and HL222 latched loopbacks are released by sending 2 seconds of TIP bytes. The MJU loopback is released by sending 2 seconds of CMI bytes.

□ DDS Secondary Channel

Interleave Factor : DDS secondary channel is transmitted by modifying every 3rd control bit (bit 8).

Test Patterns :

511-bit PRBS

2047-bit PRBS

Note : These both contain the secondary channel training sequence of 6 consecutive zeros.

Protocol : As with primary DDS channels, data can be transmitted as received over the rear-panel serial link.

Note : A preamble of 6 consecutive zeros must be transmitted to initialize secondary channel reception. Transmission of twelve or more consecutive ones will cause the secondary channel receiver to drop out.

Loopback : Only latching loopbacks are used to test a secondary channel.

Primary Data : When a secondary channel is transmitted, the primary channel is filled with random data.

Note : When testing the primary channel, the secondary channel is idle.

□ Special DDS Codes

When any of these special codes are selected, the EXEC key is required to start the generation.

Predefined Codes :

	D1	D2	D3	D4	D5	D6	D7	C8
CMI	1	1	1	1	1	1	1	0
OCU L/B	0	0	1	0	1	0	1	0
CHANNEL L/B	0	0	1	0	1	0	0	0
DSU L/B	0	0	1	0	1	1	0	0
TIP	0	0	1	1	1	0	1	0
LBE	0	1	0	1	0	1	1	0
FEV	0	1	0	1	1	0	1	0
TA	0	1	1	0	1	1	0	0
MA	0	1	1	1	0	0	1	0
UMC	0	0	0	1	1	0	0	0
BLOCK	0	0	0	0	1	0	1	0
RLS	0	1	1	1	1	0	0	0
ASC	0	0	0	1	1	1	1	0
TEST	0	0	0	1	1	1	0	0
OOS	0	0	0	1	1	0	1	0

Column D1 assignment is for 56 kbit/s operation. For sub-rate operation (2.4, 4.8, 9.6 and 19.2 kbit/s) from a DS0A interface, the first bit is a one in all cases. For sub-rate channels when interfacing at DS0B, this bit position contains one bit of the sub-rate framing sequence and is designated S.

Settable Code

In addition to the above codes, any other code can be transmitted by selecting SETTABLE CODE.

For sub-rate operation (2.4, 4.8, 9.6 and 19.2 kbit/s) from a DS0A interface, the first bit is a one in all cases. For sub-rate channels when interfacing at DS0B, this bit position contains one bit of the sub-rate framing sequence and is designated S. All other bits are selectable.

ERROR ADDITION

▫ DS1/DS1C Error Add

Error Types

Binary (Logic) Errors : Any DS1/DS1C test pattern. Any DS1 datalink test pattern.

Bipolar Violation/Code Errors

Frame Errors : T1DM, F-bits and 24th timeslot.
SF, Ft bits and Fs bits.
ESF, Fe bits.
Ft only, Ft bits.

CRC Errors : ESF only.

Insertion

Single : SINGLE ERROR key allows insertion of single logic, BPV, Frame or ESF CRC errors.

Ratio :

Logic and BPV : $Mx10^{-N}$, where M = 1 to 9 and N = 3 to 8 variable in unit steps.

CRC : $1x10^{-0}$ to $4.6x10^{-5}$, selected by setting corresponding BER in the range $3x10^{-4}$ to $1x10^{-8}$.

DS1 Thru Mode : Logic errors are added in the range 9×10^{-3} to 1×10^{-8}.

Notes :

Frame errors can be added only singly.

Datalink errors (ESF and "Ft only") can be added only singly.

T1DM R-channel errors can be added only singly.

If output framed then logic error ratio is wrt data bits.

Logic error insertion does not cause bipolar violations, CRC or frame errors. Both 0 to 1 and 1 to 0 conversions are included without violating the 15-zero constraint in DS1 signals.

Bipolar violation insertion does not cause logic, CRC or frame errors.

CRC error insertion does not cause bit errors.

Automatic Protection Switch (APS) Test

Based on BPV insertion. Five states are sequenced using the NEXT key :

START
NO TRANSFER
TRANSFER
NO RESTORE
RESTORE

In the START state no bipolar violations are inserted. For each of the other states, BPV error ratios are independently selectable in the range $1x10^{-8}$ to $9x10^{-3}$. The states are sequenced using the NEXT key. Valid for both AMI and B8ZS. (Selected set common for DS1 and DS1C).

DS0 TX Error Add

Type : Logic bit, byte or sub-rate frame errors. Sub-rate frame errors apply only with sub-rate cases of DDS DS0B. They cannot be added with secondary channel selected. Logic bit or byte errors cannot be added when remote word or protocol analysis is selected.

Single : The SINGLE ERROR key allows insertion of single logic, byte or sub-rate frame errors. With logic selected, each successive press of the SINGLE ERROR key causes the insertion position to rotate through the set of valid data bit locations. (Ratio error add is provided for Dataport testing.)

Insertion Method : With the DDS formats, DS0A and DS0B bit errors are inserted only in the data bits, ie not in the status or sub-rate framing bits.

With DDS interleaved loopbacks, logic bit and byte errors are inserted only in the data bytes, NOT in the code bytes.

Dataport Test : For testing 2.4, 4.8 and 9.6 kbit/s Dataport error correction, every twentieth set of byte iterations can be errored in the following ways :

(1) 2 in every 5 bytes inverted (error correction should cope 100%).

(2) 3 in every 5 bytes inverted (error correction should fail 100%).

For testing 19.2 kbit/s error correction, 1 and 2 bit errors are added to the first data byte and its associated parity byte in the 5-byte frame. The receiving equipment should error correct all errors.

DS1/DS1C THRU MODE

Function : In this mode, a signal applied to the DS1/DS1C RX Input passes through the instrument and is retransmitted from the DS1/DS1C TX Output. When the interface is DS1, timeslots can be accessed for measurement as described in the Receiver DS1 Timeslot Extraction section, and data can be inserted in timeslots as described in the Transmitter DS1 Timeslot Insertion section. At DS1C interface points, the THRU mode offers only monitoring access.

Frame : In the THRU mode the retransmitted frame format is always the same as the received format.

Received frame bits are retransmitted unmodified. Hence frame errors are preserved. The only exception occurs with T1DM framing when the R-channel is being stimulated.

While the receiver is not aligned to the incoming frame the entire received signal is retransmitted unmodified. Hence both frame structure and data present in the received stream are preserved intact.

In DS1 operation where insertion is selected, the insertion commences after frame alignment has been achieved.

Code : In the THRU mode the retransmitted line code is always the same as the received line code.

The retransmitted line code is regenerated. Any received code errors are not retransmitted.

Delay : This depends on the line code as follows :

AMI : ~4 bits.
B8ZS : ~20 bits.

Protection : In the event of a failure of the instrument power source a fail-safe relay provides a metallic connection between the RX and TX ports to provide traffic continuity. Also in the THRU mode protection against traffic corruption is provided by an INSERT field which reverts to OFF on selection of ANY new insert configuration. During insertion only the data may be modified.

ESF CRC : When a DS1 signal with ESF framing is being retransmitted the CRC is recalculated (to take account of any timeslot insertions). However, for every received CRC error an error is inserted in the retransmitted stream to preserve end-to-end CRC-monitoring accuracy.

DDS with Secondary Channel : The insertion of DDS or Dataport primary channel data will corrupt any received secondary channel data pertaining to that customer.

Conversely, the insertion of DDS secondary channel data will corrupt any received primary channel data pertaining to that customer. The received primary channel data will be overwritten with random data.

RECEIVER

DS1/DS1C RECEIVER

DS1/DS1C Input Modes

Terminated/monitor.

Bridged.

DS1/DS1C RX Input

Connector Type : WECO jack to accept WECO type 310 plug.

Impedance :

Terminated : 100 Ω ± 5% balanced (nominal);

Monitor : 100 Ω ± 5% balanced (nominal);

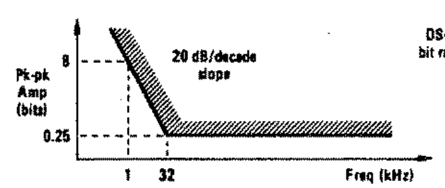
Bridged : 1 kΩ ± 5% balanced (nominal).

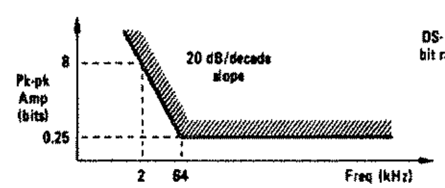
DS1/DS1C RX Rate

DS1 Rate : 1.544 Mbit/s ± 130 ppm.

DS1C Rate : 3.152 Mbit/s ± 30 ppm.

Jitter Tolerance : The input will operate without error in the presence of a signal with a jitter content within the nominal masks shown. These specifications apply for data with maximum zero runs of 14.





DS1/DS1C RX Level

Terminated/Monitor : 80 mV to 5.5 V peak.

Bridged : 800 mV peak (minimum).

Safe operating maximum 10 V peak.

DS1/DS1C Preselectable Levels

DS1 Levels :

DSX-1 : 3.0 V peak ± 600 mV, at pulse center.

DSX-MON : As for DSX-1 less 20 dB.

DS-LO : As for DSX-1 but with loss due to the equivalent of 655 feet (200 m) of ABAM cable.

DS-LO-MON : As for DS-LO less 20 dB.

DS1C Levels :

DSX-1C : 3.65 V peak ± 850 mV, at pulse center.

DSX-MON : As for DSX-1C less 20 dB.

DS-LO : As for DSX-1C but with loss due to the equivalent of 655 feet (200 m) of ABAM cable.

DS-LO-MON : As for DS-LO less 20 dB.

DS1/DS1C RX Level Measurement

The received DS1 or DS1C level can be displayed in peak volts. The positive and negative peaks are displayed simultaneously.

Display Format : X.XX V.

Accuracy : ± 10%

DSX : One LSB = 77 mV.

DS-LO : One LSB = 77 mV.

DSX-MON : One LSB = 39 mV.

DS-LO-MON : One LSB = 39 mV.

Bridged Mode : One LSB = 390 mV.

DS1/DS1C RX Line Code

AMI; B8ZS

Decoding Rules :

AMI : +1 ➤ 1 and -1 ➤ 1.

B8ZS : 0V10V1 ➤ 000000. +1 ➤ 1 and -1 ➤ 1 except in 0V10V1.

DS1/DS1C RX Framing

DS1 Format : SF (D4); Ft only; ESF (Fe); T1DM (DDS); unframed.

DS1C Format : Framed or unframed.

DS1/DS1C Frame Synchronization Criteria

DS1 (T1DM)

Reframe : 5 successive correct timeslot 24 bytes followed by 14 successive correct Ft bits followed by 6 successive correct Fs bits.

Frame Loss : 3 in any 12 successive frames containing errors in either the F bits or timeslot 24.

DS1 (SF)

Reframe : Ft bits - 14 successive error-free.

Frame Loss : Ft bits - 3 in any 7 errored.

Multiframe : Fs bits - 6 successive error-free.

Multiframe Loss : Fs bits - 2 in any 4 errored.

DS1 (ESF)

Reframe : Fe bits - 14 successive error-free.

Frame Loss : Fe bits - 3 in any 7 errored.

DS1 (Ft only)

Reframe : Ft bits - 14 successive error-free.

Frame Loss : Ft bits - 3 in any 7 errored.

DS1C Reframe :

F Bits : 8 error-free, then

M Bits : next "0 1 1 X" sequence error-free.

DS1C Frame Loss :

F Bits : 3 in error between successive M4 bits, or

M Bits : 3 errors in any 3 consecutive "0 1 1" sequences.

Multilevel : If the RX configuration requires synchronization at more than one level the sync processes occur sequentially with the above criteria.

ESF False-Framing Protection : When ESF framing is selected this feature is activated by selecting CRC measurements in result B. A message "FALSE-FRAMING PROTECTION ACTIVE" is displayed in the Results section of the CRT. With this feature active, the complete sync process is :

- 14 successive error-free Fe bits.
- One or more error-free CRC checks in the following decisecond.

DS1/DS1C RX Data

Patterns : PRBS 2^{20}-1, (D20+D17+1=0); a 14-zero limit may be selected.

8-bit word fully programmable.

All-ones word.

Note : If the input signal is DS1C framed, then this signal must be formed by stuffing, multiplexing and scrambling two DS1 digroups.

Traffic : The input signal may be live traffic for all but logic error measurements.

DS1/DS1C Pattern Synchronization Criteria

Sync Loss : Sync loss is deemed to have occurred if the error ratio exceeds ~1/6 as measured over a decisecond.

Sync Gain : Sync is regained after 40 error-free clock periods.

DS1 Timeslot Extraction

DS1 Timeslot Format :

Multi-customer DDS (DS0B).

56 kbit/s single-customer DDS.

Dataport single-customer (except 56 kbit/s).

56 kbit/s circuit-switched (PSDC).

64 kbit/s clear channel.

For 56 kbit/s circuit-switched operation the format is DDDDDDDS where

D is data

S is signaling bit (frames 6, 12 etc) (S = 1 in other frames)

For the other formats refer to the DS0 RX Format section.

Timeslot Data : When demultiplexing of the RX Input to channel or DDS customer level is selected, then the channel or customer data may be selected as for the DS0 Receiver.

With 56 kbit/s PSDC selected, the choice of test patterns is the same. As with clear channel and 56 kbit/s DDS, the data received is not available for protocol analysis.

Data inversion may be selected for the receipt of inverted data from a PSDC loopback. Note that in this case the signaling bits are not inverted.

DS0A Synchronization Criteria :

Sync Gain : Byte 1 = byte 5.

Sync Maintenance : 160 error-free byte comparisons before 20 with errors (byte comparison is byte 1 with byte 5).

Sync Loss : 20 errored byte comparisons before 160 which are error-free.

DS0B Synchronization Criteria : If the RX configuration requires demultiplexing at a lower level (ie DS0B to single-customer), the multi-customer frame sync criteria are as described in the DDS Sub-Rate Frame Synchronization Criteria section.

Error Correction : If the RX configuration requires demultiplexing to a 64 kbit/s channel carrying 2.4, 4.8, 9.6 or 19.2 kbit/s dataport service (DS0A), error correction can be selected. Note that error correction is not available for a 56 kbit/s dataport channel. Error correction for 2.4, 4.8 and 9.6 kbit/s is compatible with TA-TSY-000055. Error correction for 19.2 kbit/s is compatible with CB-INC-100.

DS0 RECEIVER

DS0 Bipolar Input

Validity : All DS0.

Modes : Terminated; monitor.

Connector : WECO Bantam.

Impedance :

Terminated : 100 Ω balanced (nominal), transformer-coupled.

Monitor : 2 kΩ balanced (nominal), transformer-coupled.

DS0 RX Level : DSX-0. The sampling threshold is set to sample DSX-0 at 1.2 V above or below zero level.

DDS Logic Input

Validity : DS0A.

Direction : Near; Far.

With the DS0A interface selected for both TX and RX, the selection of Near or Far is commoned with the transmitter.

Connector : WECO Bantam - Tip = Near, Ring = Far.

Impedance : 10 kΩ unbalanced (nominal).

Input Levels :

TTL High : > 2.0 V (Logic 0).

TTL Low : < 0.8 V (Logic 1).

DS0 RX Rate

64 kbit/s (nominal).

DS0 RX Clocks

Shared with DS0 TX Clocks - see section in Transmitter specification.

DS0 RX Format

DDS DS0A :

XDDDDDDC for sub-rate services (2.4, 4.8 or 9.6 kbit/s);

DDDDDDDC for 56 kbit/s service

where D is data.

C is control or status

X is don't care.

19.2 kbit/s is compatible with CB-INC-100

DDS DS0B :
SDDDDDDC for sub-rate services (multi-customer) (2.4, 4.8 or 9.6 kbit/s);
DDDDDDDC for 56 kbit/s service
where D is data,
C is control or status.
S is sub-rate frame sequence.
19.2 kbit/s is compatible with CB-INC-100.

Clear Channel : DDDDDDDD where D is data.

DS0 RX Data

Patterns :
511-bit (2^9-1) PRBS, (D9+D5+1=0).
2047-bit (2^{11}-1) PRBS, (D11+D9+1=0).
All-ones word
8-bit word, fully programmable
} Bits 1 and 8 restricted for DDS: bit 8 restricted for PSDC

Protocol Mode : Received data is output over the rear-panel serial datalink but no internal measurements (bit, frame, etc) are available. However, ALARM duration measurements and bit monitor functions are available simultaneously.

This feature is not available with alternating loopbacks.

Alternating Loopback : While testing using alternating loopbacks, test pattern selection is restricted to :
511-bit PRBS (D9+D5+1=0).
2047-bit PRBS (D11+D9+1=0);

For these test patterns a choice of "Continuous" or "From Alternating Loopback" is offered in the receiver. The latter must always be selected when receiving from an alternating DDS loopback.

It is not assumed that the test pattern bytes have maintained their byte identity through the loopback process.

DS0 Pattern Synchronization Criteria

Sync Loss : Sync loss is deemed to have occurred if the error ratio as measured over a decisecond exceeds ~1/5.

Sync Gain : Sync gain is deemed to have occurred if the error ratio as measured over a decisecond is less than ~1/5.

DDS Sub-Rate Frame Synchronization Criteria

Sync Gain : Searches for 20 consecutive correct frame bits in the following sequences according to the service rate :
01100 for 9.6 and 19.2 kbit/s.
0110010100 for 4.8 kbit/s.
01100101001110000100 for 2.4 kbit/s.

Sync Loss :
2.4, 4.8 and 9.6 kbit/s - 2 frame errors in any 6 frame bits.
19.2 kbit/s - 4 consecutive frames in which each has at least 1 frame bit in error.

DDS Secondary Channel

Interleave Factor : DDS secondary channel is implemented by modifying every 3rd control bit (bit 8).

Sync Gain : Locks to an initialization sequence of 6 consecutive zeros in the secondary channel.

Sync Loss : Loses sync on detecting 12 consecutive ones in the secondary channel. A search for a following initialization sequence commences automatically.

Test Patterns : 511-bit PRBS; 2047-bit PRBS.

Protocol : As with primary DDS channels, the received data can be transmitted over the rear-panel serial link.

ALARM INDICATORS (front panel)

These indicators are illuminated whenever the alarm condition exists. They are NOT hierarchical.

The indication remains for 500 ms beyond the duration of the alarm condition.

The following alarm conditions are indicated :
Signal Loss
DS1C Frame Loss
DS1 Frame Loss
DS0B Frame Loss
Errors/Hits Detected
Pattern Sync Loss
Yellow Alarm
AIS
X-Bit (set to zero)

ERROR DETECTION

DS1C

BPV/Code, Frame, Test Pattern bit errors.

Digroup : Frame errors :
T1DM : F bits and frame bits in timeslot 24.
SF : Ft and Fs.
ESF : Fe.
Ft only : Ft.
CRC errors (ESF only).
Test pattern bit errors.

Digroup Datalink : Test pattern bit errors (ESF, and "Ft only").

Digroup T1DM R-Channel : Test pattern bit errors.

DS1

BPV/Code, CRC (ESF only), Test Pattern bit errors.

Frame errors -
T1DM : F bits and frame bits in timeslot 24.
SF : Ft and Fs.
ESF : Fe.
Ft only : Ft.

Note : Code Error Rules
AMI : Each BPV = one error.
B8ZS : Each BPV not contained in 0V10V1 = one error.

DS1 Datalink

Test Pattern bit errors.

Datalink types :
ESF framing - 4 kbit/s datalink.
Ft only framing - 4 kbit/s link.
T1DM framing - 8 kbit/s.

DS1 Timeslot Extraction

Test Pattern bit errors.

DDS sub-rate frame errors (2.4, 4.8 and 9.6 kbit/s DS0B).

DS1 Timeslot Format :
Multi-customer DDS (DS0B).

56 kbit/s single-customer DDS (before error correction).
Dataport sub-rate single-customer (before or after error correction).
56 kbit/s circuit-switched (PSDC).
64 kbit/s clear channel.

For 56 kbit/s circuit-switched operation the format is DDDDDDDS where
D is data
S is signaling bit (frames 6, 12 etc) (S = 1 in other frames)

For the other formats refer to the DS0 RX Format section.

DS0

DS0B (DDS) : Sub-rate framing errors (except 19.2 kbit/s and 56 kbit/s). Customer level test pattern bit errors. Secondary channel test pattern bit errors.

DS0A (DDS) : Test pattern bit errors. Secondary channel test pattern bit errors.

Clear Channel : Test pattern bit errors.

ERROR PERFORMANCE MEASUREMENTS

□ Real-Time Clock

Fundamental Period : 1 decisecond (nominal).

Settability : ± 50 ppm at 25°C (nominal).

Stability : Crystal-controlled -0/+50 ppm including 5-year aging.

Display : Displays of time and date are presented on Page 4 of the CRT.

TIME Format : Time 14 hrs 31 mins 12 secs (example).

DATE Format : Date 24 January 1987 (example).

Both can be set at any time (time display resolution 1 second).

Battery Back-Up : The real-time clock and calendar remain operational during line power failures and when the instrument is switched off.

Elapsed Time

Function : The instrument can monitor the time which has elapsed since the start of a gating period. This facility is available in all GATING modes.

Display : In these modes the ELAPSED TIME display can be selected for display.

□ Gating Periods

Modes

Manual : Controlled by START/STOP key.

Interval : START key controls start of gating period. End of gating period normally controlled by the internal timer but this can be overridden by the START/STOP key.
Minimum Interval : 1 second.
Maximum Interval : 99 days 23 hrs 59 mins 59 secs.
Resolution : 1 second.

Repeat Interval : START/STOP key controls the start of the first gating period. End of gating periods normally controlled by the internal timer but this can be overridden by the START/STOP key. The START/STOP key ends the sequence of gating periods as well as terminating the current gating period.
Minimum Interval : 1 second.
Maximum Interval : 99 days 23 hrs 59 mins 59 secs.
Resolution : 1 second.

Short (repeats) : As for Repeat Interval but with a short period restricted to a choice of 1 second, 15 seconds, 5 minutes or 15 minutes.

Dead Time : In repeat modes there is NO dead time between gating periods.

Power Failure : In the event of a loss of line power to the instrument during a gating period, measurement results and settings are retained in non-volatile memory. When line power returns the instrument automatically continues gating from the point in the period reached at the time of interruption.

□ Measurement Results

Two error types can be accumulated simultaneously whenever two types of error can be present. These must be chosen prior to the start of a gating period. Two selected results, Result A and Result B, may be displayed simultaneously.

The form of display, eg Async EFS, can be chosen before, during or after a gating period.

Error Results

Error Count :

Display Format : 7-digit display for < 10,000,000 errors; 2-digit mantissa, 2-digit exponent display for ≥ 10,000,000 errors.

For CRC error counts, an incorrect CRC checksum is counted as one error.

Error Ratio :

Display Format : 2-digit mantissa, 2-digit exponent display.
For CRC error ratio results, the number of clocks is used as the base. For all other ratio results, the number of bits sampled is used as a base.

Error Seconds : Both synchronous and asynchronous.

Error-Free Seconds : Asynchronous.

% Error-Free Seconds : The number of error-free seconds expressed as a percentage of the number of seconds in the gating period.

Display Format : XX.XXXX% or 100.00%.

Validity : Valid for all gating modes and error types.

Display Update

Single Modes : Non-exponent format displays update every 100 ms to show the cumulative result.

Exponent format displays update every second to show the cumulative result.

Repeat Modes : The displays update only at the end of each gating period. Consequently no results are displayed during the first gating period.

Result Hold : After a single gating period or set of gating periods (repetitive) the final result is held until a new gating period is initiated. If the configuration is modified in the meantime the previous result remains until the new gating period is initiated.

Error Analysis

These measurements are based on CCITT Recommendation G.821. Analysis is available for all error sources and gating modes.

% Availability : The number of available seconds during a gating period expressed as a percentage of the number of elapsed seconds.

Availability is as defined in CCITT Rec. G.821. A system becomes "available" when the error ratio measured in 1 second intervals is better than 1×10^{-3} for 10 or more consecutive seconds, ie minimum available period is 10 seconds.

A system becomes "unavailable" when the error ratio measured in 1 second intervals is greater than 1×10^{-3} for 10 or more consecutive seconds.

For the purpose of determining availability, pattern loss, frame loss and signal loss seconds are simply considered as seconds with error ratios exceeding the availability threshold. Power loss seconds are discarded.

If CRC errors are being analyzed, the availability criterion is 320 CRC errors in a second. This CRC error rate corresponds to a BER of 1×10^{-3} with randomly distributed bit errors.

% Unavailability : The number of unavailable seconds during a gating period expressed as a percentage of the number of elapsed seconds.

% Severely-Errored Seconds : The number of seconds during the available time in a gating period which have an error ratio worse than the availability threshold expressed as a percentage of the available time expressed in seconds (as per CCITT Rec G.821).

% ES : The number of seconds which contain errors during the available time in a gating period expressed as a percentage of the available time in seconds.

% Degraded Minutes : The number of 60 second (1 minute) intervals (excluding severely-errored seconds) during which the error ratio is worse than a threshold 1×10^{-6} expressed as a percentage of the available time in minutes (excluding severely errored seconds).

Consecutive Severely-Errored Seconds (CSES) : 3 to 9 consecutive severely-errored seconds.

Severely-Errored Seconds (SES) : A count of the number of seconds during the available time in a gating period which have an error ratio worse than 1×10^{-3}.

Error Seconds (Asynchronous) : The number of seconds which contain errors during the available time in a gating period.

Degraded Minutes : The number of 1 minute intervals (excluding severely-errored seconds) during which the error ratio is worse than 1×10^{-6}.

Alarm Duration

The following alarm durations are measured in seconds :

- Instrument Power Loss
- Signal Loss (except for DS0 Clear Channel)
- AIS (DS1 and DS1C signals)
- DS1C Frame Sync Loss
- DS1 Frame Sync Loss
- DS0B Frame Sync Loss
- Pattern Sync Loss

DS1 JITTER MEASUREMENTS (Option 001)

Jitter Amplitude Measurement

Range 0.00 to 13.00 UI pk-pk (nominal) in 0.01 UI steps. Accuracy specified in range 0.00 to 10.00 UI pk-pk.

Intrinsic Jitter : < 0.02 UI pk-pk (typical) at 25°C
< 0.06 UI pk-pk 0 to 50°C.

Basic Accuracy : 3.0% ± 0.03 UI + pattern dependency.

Internal Filters :

- **LP :** 2 Hz to 40 kHz.
- **HP1 + LP :** 10 Hz to 40 kHz.
- **HP2 + LP :** 8 kHz to 40 kHz.

Filter Tolerances :

- **Upper Cutoff LP :** 40 kHz ± 10%.
- **Lower Cutoff LP :** 2 Hz ± 70%.
- **Lower Cutoff HP1 :** 10 Hz ± 10%.
- **Lower Cutoff HP2 :** 8 kHz ± 10%.

Jitter Analysis

Hit Threshold : Can be set in the range 0.05 to 10.00 UI pk-pk (resolution 0.01 UI pk-pk).

Hit Count : Totalizes the number of times the measured jitter exceeds the hit threshold during the measurement interval.

Display Format : 7-digit display for < 10,000,000 hits.
2 digit mantissa, 2-digit exponent display for ≥ 10,000,000 hits.

Hit Bit Count : Totalizes the number of DS1 clock periods during which the measured jitter amplitude exceeds the hit threshold during the measurement interval.

Display Format : 7-digit display for < 10,000,000 hit bits.
2 digit mantissa, 2-digit exponent display for ≥ 10,000,000 hit bits.

Jitter Hit Bit Ratio : The ratio of the DS1 hit bit count to the total number of DS1 bits in the measurement interval.

Jitter Hit Seconds : The number of seconds in which the hit threshold has been exceeded at least once during the measurement interval. (Measured asynchronously.)

Jitter Hit-Free Seconds : Converse of Jitter Hit Seconds.

DS1 FRAME SLIP MEASUREMENTS

Method : The HP 3787B measures controlled frame slips. This is accomplished by inserting a PRBS in a 56 or 64 kbit/s timeslot of a DS1 signal, passing the signal through the network or switch under test, then recognizing when a 7-bit or 8-bit slice of the PRBS is duplicated or deleted.

Duplicated frames are indicated as positive frame slips. Deleted frames are indicated as negative frame slips.

Valid : Valid when the receiver is set to measure a PRBS in either a 64 kbit/s Clear, 56 kbit/s Switched or a 56 kbit/s DDS channel.

Interface : DS1C, DS1 and DS0.

Display : Simultaneous count of "Positive" and "Negative" controlled frame slips.

DATA LOGGING

Logging Device

Internal Printer - this is the default device. External HP-IB printer in listen-always mode.

Remote Control : When logging to an external HP-IB printer remote is restricted to RS-232-C since the HP-IB port must be set to talk-only in order to drive the external HP-IB printer.

Note : When using the internal printer, no output is available to external printers and vice versa.

Internal Printer

Type : Impact, 24-column.

Capacity : Approximately 6000 lines per paper roll (19 metres).

Print Modes

Manual : At any time the manual PRINT key can be used to cause the displayed "results" (Results, Analysis, Alarm Durations, RX Level or Monitor Word) to be printed on the selected device.

Note that this is the only case in which the RX Level and Monitor Word are logged.

Log During Gating : Logs time of occurrence and number of errors/jitter hits in the errored seconds/jitter hit seconds measurement selected for Result A. The result may be logged for every error/hit second, or only when the error ratio or hit bit ratio in 1 second exceeds a preset threshold 1×10^{-N}, where N can be set in the range 2 to 7.

Alarms : With logging switched on, the printer always prints the occurrence of an alarm change, ie a change in the state of :

- Power Loss
- Signal Loss (DS1 or DS0)
- External Clock Loss (DS1 or DS0)
- Excess Zeros
- RX Level too high or low
- RX Level imbalance
- AIS
- Yellow Alarm
- X-Bit
- Frame Sync Loss (DS1C, Digroup, MFA, DS1 or Sub-rate)
- Pattern Sync Loss
- Frame Slips

As with normal triggered logging, these alarm printouts are printed in a single line together with a timestamp.

An alarm printout is also given for any alarm which is active at the start of a single gating period or sequence of repetitive gating periods.

Squelch : A print-squelch mechanism is implemented such that error/hit second printouts occur on a maximum of 10 consecutive seconds. On the occurrence of the next trigger-free second, the number of elapsed trigger-seconds is printed together with the total number of errors (or hits) accumulated during the squelched period.

End of Gating Summary : Logs measurement results, error performance analysis and alarm durations always or when Result A exceeds a threshold 1×10^{-N}, where N can be set in the range 2 to 7. The user may choose to log all results or only those selected for display.

PROTOCOL ANALYZER PORT

Application

Permits direct connection of a protocol analyzer such as the HP 4952A. When this mode is selected, the internally-generated test pattern is substituted with the protocol analyzer test pattern. The HP 3787B acts as a DS1 channel access unit allowing the following channels to be accessed :

- 64 kbit/s clear channel.
- 2.4, 4.8, 9.6 and 56 kbit/s DDS primary and secondary channels.
- DS1 Extended Super-Frame (ESF) 4 kbit/s datalink.
- DS1 Super-Frame (SF) 4 kbit/s Fs bits.
- DS1 T1 Data Multiplexer (T1DM) 8 kbit/s R-channel.

Connector : 24-pin D-shell.

Function : Full duplex, TX and RX clocks supplied, no handshake lines.

GENERAL

REMOTE OPERATION

Type

HP-IB or RS-232-C. Either can be selected and configured on Page 5 of the CRT.

HP-IB

Implementation : SH1; AH1; T5; TE0; L4; LE0; SR1; RL1; PP0; DC1; DT0; C0.

Modes :

ADDRESSABLE : When the HP 3787B is operated with an external controller the addressable mode allows control of front-panel functions except the HP-IB address and the POWER switch. All current results and flags are available and a local lockout facility is provided. There is no remote control of screen paging.

TALK-ONLY : This mode permits the HP 3787B to be used without an external controller. It is intended for the output of results to a peripheral such as a printer. In this mode the format and frequency of results are as set up for the internal printer operation.

RS-232-C

Connection : Hardwired or Modem.

Duplex : Half or Full. Only Full Duplex is available if hardwired is selected.

Handshake : Xon/Xoff (Full Duplex only)

- **RX Only :** HP 3787B paces rate at which it receives data by sending Xon/Xoff.
- **TX Only :** Controller paces rate at which HP 3787B transmits data by sending Xon/Xoff.
- **RX & TX :** As for both above.
- **Enq/Ack :** On/off.
- **DTR On/Off :** For users who require manual control of DTR this field can be brought into the display by selection of an internal DIL switch.

Baud Rate : 300, 600, 1200, 1800, 2400, 4800, 9600, or SELECT.
CI High Rate : 300, 600, 1200, 1800, 2400, 4800, 9600.
CI Low Rate : 300, 600, 1200, 1800, 2400, 4800, 9600.
Parity : Even, Odd, ones or zeros.
Stop Bits : 1 or 2.

POWER SUPPLY

Mains Input

Voltage Ranges : 88 to 127 V AC, nominally 120 V AC; 176 to 254 V AC, nominally 240 V AC.
Line Frequency : 48 to 66 Hz.
Power Consumption : Approx 110 VA (both ranges).

DC Battery Input (Option 002)

Voltage Range : -40 to -57 V DC, nominally -48 V DC.
Power Consumption : Typically 70 Watts.
Earthing : The positive pole of the DC supply will be grounded.

PHYSICAL

Dimensions

130 mm high; 425 mm wide; 420 mm deep (5.12 x 16.73 x 16.54 inches).

Weight

10.4 kg (23 lb).

Environment

Operating Temperature : 0 to 50°C.
Storage Temperature : -40 to 75°C.

ORDERING INFORMATION

STANDARD INSTRUMENT

The HP 3787B is supplied complete with :

- DS1C/DS1/DS0 interfaces
- Internal printer
- HP-IB and RS-232-C remote control
- Protocol analyzer interface
- Front and rear panel DDS external clock interfaces
- DS1 external clock interface
- An extra DS1/DS1C Output on rear panel
- RS-232-C and protocol analyzer port test plug
- Power cord
- Front panel cover
- Front panel handles
- A set of Operating and Service Manuals

OPTIONS

Option 001 - DS1 Jitter Measurement

Adds DS1 jitter measurement and analysis capability to the HP 3787B.

Option 002 - DC Power Supply

Allows the HP 3787B to be powered from a -40 to -57 V DC supply in addition to AC line power operation.

Option 909 - Rackmount Fittings

Allows the HP 3787B to be fitted in a 19-inch wide equipment rack. The instrument front panel cover is not supplied with this Option.

Option 910 - Additional Operating and Service Manuals

One set of Operating and Service Manuals is supplied with the HP 3787B. This Option provides an extra set.

Option K01 - 32-way DSX-1 Output Unit

This special unit adds a further 32 DS1 outputs to the HP 3787B.

Option K02 - 64-way DSX-1 Output Unit

This special unit adds a further 64 DS1 outputs to the HP 3787B.

ACCESSORIES AVAILABLE

HP 15668A - Front Panel DDS Clock Cable, 5-pin DIN (female) to 5-pin DIN (female), 3 metres (10 feet) long.

HP 15668A-HO1 - Front Panel DDS Clock Cable, 5-pin DIN (female) to 5-pin DIN (female), 12 metres (40 feet) long.

HP 15669A - Rear Panel DDS Clock Cable, 9-pin D-type (male) to 9-pin D-type (male), 3 metres (10 feet) long.

HP 15669A-HO1 - Rear Panel DDS Clock Cable, 9-pin D-type (male) to 9-pin D-type (male), 12 metres (40 feet) long.

HP 15670A - Bantam (male) to Bantam (male) Cable, 3 metres (10 feet) long.

HP 15513A - WECO 310 (male) to WECO 310 (male) Cable, 1 metre (3.3 feet) long.

HP 15513A-HO2 - WECO 310 (male) to WECO 310 (male) Cable, 3 metres (10 feet) long.

Transit Case - HP Part Number 9211-2655

Installation 8

Introduction

This section provides installation instructions for the Hewlett-Packard Model HP 3787B Digital Data Test Set and its accessories. This section also includes information about preparation for use, packaging, storage and shipment.

Preparation For Use

WARNING

TO AVOID THE POSSIBILITY OF INJURY OR DEATH. THE FOLLOWING PRECAUTIONS MUST BE FOLLOWED BEFORE THE INSTRUMENT IS SWITCHED ON.

(A) NOTE THAT THE PROTECTION PROVIDED BY GROUNDING THE INSTRUMENT CABINET MAY BE LOST IF ANY POWER CABLE OTHER THAN THE THREE- PRONGED TYPE SUPPLIED IS USED TO COUPLE THE AC LINE VOLTAGE TO THE INSTRUMENT.

(B) IF THIS INSTRUMENT IS TO BE ENERGIZED VIA AN AUTO-TRANSFORMER TO REDUCE OR INCREASE THE LINE VOLTAGE, MAKE SURE THAT THE COMMON TERMINAL IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SOURCE.

(C) THE POWER CABLE PLUG SHALL ONLY BE INSERTED INTO A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD WITHOUT A PROTECTIVE CONDUCTOR (GROUNDING).

Power Requirements

The instrument requires a power source of 115V AC (+6%, -27%) or 230V AC (+6%, -18%), 48 to 66Hz single phase. Total power consumption is typically 110VA.

Instruments containing Option 002 can also be operated from an external DC power source in the range -40V to -57V DC (see DC Battery Operation on Page 8-2). Power consumption is typically 70W.

Table E-1. Remote Control Messages (continued)

DS0 Clock Source	"DCS n" n = FRONT or 1 n = REAR or 2 "DCS?"	6-16, 6-30	FRONT
RX Dataport Error Correction	"DEC n" n = OFF or Ø n = ON or 1 "DEC?"	6-33	OFF
TX Dataport Error Rate	"DER n" n = OFF or Ø n = LOW or 1 n = HIGH or 2 "DER?"	6-28	OFF
TX DDS Link Type	"DLT n" n = SINGLE or 1 n = MULTI or 2 "DLT?"	6-20	SINGLE
TX Error Add Method	"EAD n" n = SINGLE or 1 n = RATE or 2 "EAD?"	6-27	SINGLE
TX Error Add Rate (Logic, BPV/Code)	"EAR n" n = 1.ØE-8 to 9.ØE-3 "EAR?"	6-27	1.ØE-8
TX Error Add Type	"EAT n" n = OFF or Ø n = LOGIC or 1 n = BPV or CODE or 2 n = FRAME or 3 n = SUBFRAME or 4 n = ESF_CRC or 5 n = DATAPORT or 6 n = BYTE or 7 n = APS or 8 n = ENCODING or 9 "EAT?"	6-27	OFF
BCH Encoding Errors	"EER n" n = OFF or Ø n = ON or 1 "EER?"	6-28	OFF
Output Elapsed Time	"ELP?"	6-47	N/A

Table E-1. Remote Control Messages (continued)

Error Code (Common Capability)	"ERR?"	6-52	N/A
Frame Slips Result Request	"FSL? n" n = POSITIVE or 1 n = NEGATIVE or 2	6-46A	N/A
Gating Period	"GPR d,h,m,s" d = Ø to 99 h = Ø to 23 m = Ø to 59 s = Ø to 59 "GPR?"	6-42	00.00.00.01
Gating Type	"GTY n" n = MANUAL or 1 n = SINGLE or 2 n = REPEAT or 3 n = SHORT_1S or 4 n = SHORT_15S or 5 n = SHORT_5M or 6 n = SHORT_15M or 7 "GTY?"	6-42	MANUAL
TX HL96NY Presence	"HLP n" n = NO or Ø n = YES or 1 "HLP?"	6-22	NO
Output Hub ID	"HUB? n" n = PRESENT or 1 n = PREVIOUS or 2	6-47	N/A
RX DSØ Termination	"IØT n" n = TERMINATED or 1 n = MONITOR or 2 "IØT?"	6-31	TERMINATED
RX DS1/DS1C Input Level	"I1L n" n = AUTO or 1 n = DSX or 2 n = DSX_MON or 3 n = DS_LO or 4 n = DS_LO_MON or 5 n = BRIDGED or 6 "I1L?"	6-30	AUTO

Table E-1. Remote Control Messages (continued)

RX DSØA Termination	"IAT n" n = TERMINATED or 1 n = MONITOR or 2 n = LOGIC_NEAR or 3 n = LOGIC_FAR or 4 "IAT?"	6-31	TERMINATED
RX DSØB Termination	"IBT n" n = TERMINATED or 1 n = MONITOR or 2 "IBT?"	6-31	TERMINATED
Identification (Common Capability)	"ID?"	6-52	N/A
TX Timeslot Insertion	"INS n" n = OFF or Ø n = ON or 1 "INS?"	6-19	OFF
RX Jitter Filter (Option 001 only)	"JFL n" n = LP or 1 n = LP_HP1 or 2 n = LP_HP2 or 3 "JFL?"	6-40	LP
RX Jitter Filter Threshold (Option 001 only)	"JFT n" n = Ø.Ø5 to 1Ø.ØØ UI "JFT?"	6-40	ØØ.Ø5
Key Query (Common Capability)	"KEY?"	6-53	N/A
TX DS0 Loopback Type	"LB0 n" n = NONE or Ø n = ALT_DSU or 1 n = ALT_CHAN or 2 n = ALT_OCU or 3 n = ALT_RPT or 4 n = ALT_HL96 or 5 n = ALT_DSØDP or 6 n = LAT_DSØDP or 7 n = LAT_OCU or 8 n = LAT_CSU or 9 n = LAT_HL222 or 1Ø n = LAT_MJU or 11 "LB0?"	6-21	NONE

Table E-1. Remote Control Messages (continued)

TX DS1 Loopback Type	"LB1 n" n = NONE or Ø n = IN_LINE or 1 n = IN_NETWORK or 2 n = DL_LINE or 3 n = DL_NETWORK or 4 n = DL_PAYLOAD or 5 "LB1?"	6-21	NONE
Return To Local (Common Capability)	"LCL"	6-53	N/A
Log During Gating	"LDG n" n = OFF or Ø n = ERR_SEC or HIT_SEC or 1 n = RATIO or 2 "LDG?"	6-49	OFF
Log During Gating Threshold	"LDT n" n = 2 to 7 LDT?	6-49	1.ØE-2 (2)
Logging Device	"LDV n" n = HP3787B or 1 n = HP-IB or 2 "LDV?"	6-48	HP3787B
Log at End of Gating	"LEG n" n = OFF or Ø n = ALWAYS or 1 n = RATIO or 2 "LEG?"	6-48	OFF
End of Gating Summary Contents	"LES a,b,c,d" a = OFF or Ø a = SELECTED or 1 a = ALL or 2 b = OFF or Ø b = SELECTED or 1 b = ALL or 2 c = OFF or Ø c = SELECTED or 1 c = ALL or 2 d = OFF or Ø d = ON or 1 "LES?"	6-48	OFF,OFF,OFF OFF
Log at End of Gating Threshold	"LET n" n = 2 to 7 "LET?"	6-48	1.ØE-2 (2)

Table E-1. Remote Control Messages (continued)

MJU Loopback Identification	"LHB?"	6-46A	N/A
Log On Demand	"LOD"	6-49	N/A
Logging ON/OFF	"LOG n" n = OFF or Ø n = ON or 1 "LOG?"	6-48	OFF
Output Latching Loopback Mapcode	"MAP?"	6-47	N/A
RX Measurement Source A	"MAS n" n = SEC_CHAN or 1 n = CUST or 2 n = SUBRATE or 3 "MAS?"	6-36	N/A
Measurement Source B	"MBS n" n = OFF or Ø n = SEC_CHAN or 1 n = CUST or 2 n = SUBRATE or 3 n = TIMESLOT or 4 n = DSØ or 5 n = DSØA or 6 n = PSDC or 7 n = DATALINK or 8 n = DIGROUP or 9 n = DS1 or 1Ø n = DS1C or 11 n = R_CHAN or 12 "MBS?"	6-38	OFF
Measurement Display	"MDS n" n = RESULTS or 1 n = ALARMS or 2 n = BIT_MON or 3 n = INP_LEV or 4 n = ANALYSIS or 5 n = SLIPS or 6 "MDS?"	6-51	RESULTS
TX Multipoint Junction Unit Operations	"MJU n" n = SELECT or 1 n = TEST or 2 n = END_TEST or 3 n = BLOCK or 4 n = UNBLOCK or 5 n = RELEASE or 6 "MJU?"	6-20	N/A

Table E-1. Remote Control Messages (continued)

Instrument Mode	"MOD n" n = TX&RX or 1 n = THRU or 2 MOD?	6-16, 6-30	TX&RX
Output Monitor Word Result	"MON?"	6-46A	N/A
RX Measurement Type A	"MTA n" n = LOGIC or 1 n = BPV or CODE or 2 n = FRAMING or 3 n = ESF_CRC or 4 n = JITTER or 5 "MTA?"	6-36	LOGIC
RX Measurement Type B	"MTB n" n = LOGIC or 1 n = BPV or CODE or 2 n = FRAMING or 3 n = ESF_CRC or 4 n = JITTER or 5 "MTB?"	6-38	LOGIC
Option Query (Common Capability)	"OPT?"	6-53	N/A
Protect Panel	"PRP n" n = OFF or Ø n = ON or 1 "PRP?"	6-50	ON
RX DS1/DS1C Coding	"R1C n" n = AMI or 1 n = B8ZS or 2 "R1C?"	6-30	AMI
RX DS1/Digroup Framing	"R1F n" n = OFF or Ø n = T1DM or 1 n = SF or D4 or 2 n = FT or 3 n = ESF or FE or 4 "R1F?"	6-31	SF

Table E-1. Remote Control Messages (continued)

RX Pattern Type	"RCD n" n = PRBS_20 or 1 n = ALL_ONES or 2 n = SETTABLE or 3 n = PRBS_2047 or 4 n = PRBS_511 or 5 n = TRAFFIC or 6 "RCD?"	6-34	PRBS_20
RX DS1C Framing	"RCF n" n = OFF or Ø n = ON or 1 "RCF?"	6-30	ON
Recall Panel	"RCL n" n = Ø to 9	6-50	N/A
RX DSØB Customer Rate	"RCR n" n = 1 to 3 "RCR?"	6-33	9.6 kbits (3)
RX DSØB Customer Number	"RCU n" n = 1 to 20 "RCU?"	6-33	1
RX DDS Channel Type	"RDC n" n = PRIMARY or 1 n = SECONDARY or 2 "RDC?"	6-33	PRIMARY
RX Digroup Number	"RDN n" n = 1 or 2 "RDN?"	6-32	1
RX Data Type	"RDT n" n = PATTERN or 1 n = PROTOCOL or 2 "RDT?"	6-34	PATTERN
Ready Code (Common Capability)	"RDY?"	6-53	N/A
Revision Date (Common Capability)	"REV?"	6-53	N/A

Table E-1. Remote Control Messages (continued)

RX Interface Level	"RIN n" n = DS1C or 1 n = DS1 or 2 n = DSØB or 3 n = DSØA or 4 n = DSØ or 5 "RIN?"	6-30	DS1
Output Jitter Result A (Option 001 only)	"RJA? n" n = HIT_COUNT or 1 n = HB_COUNT or 2 n = HB_RATIO or 3 n = HIT_SECS or 4 n = HITF_SECS or 5 n = PK_TO_PK or 6	6-45	N/A
Output Jitter Result B (Option 001 only)	"RJB? n" n = HIT_COUNT or 1 n = HB_COUNT or 2 n = HB_RATIO or 3 n = HIT_SECS or 4 n = HITF_SECS or 5 n = PK_TO_PK or 6	6-45	N/A
Release Loopback	"RLB"	6-22	N/A
RX Loopback Data	"RLD n" n = NO_LOOP or Ø n = LOOP or 1 "RLD?"	6-34	NO_LOOP
RX Measurement Select	"RMS n" n = OFF or Ø n = DS1C or 1 n = DIGROUP or 2 n = DS1 or 3 n = DSØB or 4 n = DSØA or 5 n = PSDC or 6 n = DSØ or 7 N = DATALINK or 8 n = FS_CHAN or 9 n = R_CHAN or 1Ø "RMS?"	6-32	DS1
Remote (Common Capability)	"RMT"	6-54	N/A

Table E-1. Remote Control Messages (continued)

RX PSDC Pattern Inversion	"RPI n" n - OFF or Ø n = ON or 1 "RPI?"	6-33	OFF
Request Service (Common Capability)	"RQS n" n = NONE or Ø n = RQC or 1 n = PWR or 2 n = FPS or 4 n = LCL or 8 n = RDY or 16 n = ERR or 32 n = RQS or 64 n = MSG or 128 n = EOG or 256 n = AL1 or 512 n = AL2 or 1Ø24 n = LOG or 2Ø48 n = GIP or 4Ø96 n = OFF n = ON "RQS?"	6-54	ERR (32)
RX DSØA/DSØB Data Rate	"RRØ n" n = 1 to 5 "RRØ?"	6-31, 6-32	9.6 kbits (3)
Output Result A	"RSA? n" n = COUNT or 1 n = RATIO or 2 n = SYNC_ES or 3 n = ASYNC_ES or 4 n = ASYNC_EFS or 5 n = PER_EFS or 6	6-45	N/A
Output Result B	"RSB? n" n = COUNT or 1 n = RATIO or 2 n = SYNC_ES or 3 n = ASYNC_ES or 4 n = ASYNC_EFS or 5 n = PER_EFS or 6	6-45	N/A
Reset (Common Capability)	"RST"	6-55	N/A
RX Settable Word	"RSW 'bbbbbbbb'" b = Ø or 1 or f or s "RSW?"	6-35	1Ø1Ø1Ø1Ø

Table E-1. Remote Control Messages (continued)

RX Timeslot Number	"RTS n" n = 1 to 24 "RTS?"	6-32	1
Output, Input Voltage Result	"RXL? n" n = POSITIVE or 1 n = NEGATIVE or 2	6-46	N/A
RX PRBS Zero-Limit	"RZL"	6-34	ON
Save Panel	"SAV n" n = 1 to 9	6-50	N/A
TX Select MJU Branch	"SBR n" n = 1 to 4 'SBR?"	6-20	1
Single Error Add	"SEA"	6-27	N/A
Output Signaling Bits Result	"SGR?"	6-47	N/A
TX Signaling Bits	"SIG xxyy" x = Ø or 1 y = Ø or 1 "SIG?"	6-26	"11 "
Status Register A (Common Capability)	"STA?"	6-55	N/A
Status Register B (Common Capability)	"STB?"	6-55	N/A
TX Stop DDS Codes	"STC"	6-25	N/A
Stop Gating	"STP"	6-42	N/A
Start Gating	"STR"	6-42	N/A
TX DS1/DS1C-Digroup Framing	"T1F n" n = OFF or Ø n = T1DM or 1 n = SF or D4 or 2 n = FT or 3 n = ESF or FE or 4 "T1F?"	6-16	SF
TX DSØA Interface Mode	"TAM n" n = BIPOLAR or 1 n = LOGIC_NEAR or 2 n = LOGIC_FAR or 3 "TAM?"	6-17	BIPOLAR

Table E-1. Remote Control Messages (continued)

TX DS1/DS1C Coding	"TCD n" n = AMI or 1 n = B8ZS or 2 "TCD?"	6-16	AMI
TX DS1C Framing	"TCF n" n = OFF or Ø n = ON or 1 "TCF?"	6-16	ON
TX DS1 Clock	"TCL n" n = INTERNAL or 1 n = EXTERNAL or 2 n = LOOPED or 3 "TCL?"	6-17	INTERNAL
TX DSØA/DSØB Customer Rate	"TCR n" n = 1 to 3 "TCR?"	6-19	9.6 kbits(3)
TX DSØA/DSØB Customer Number	"TCU n" n = 1 to 20 "TCU?"	6-18	1
TX DDS Channel Type	"TDC n" n = PRIMARY or 1 n = SECONDARY or 2 "TDC?"	6-20	PRIMARY
TX Data Type	"TDT n" n = PATTERN or 1 n = CODE or 2 n = PROTOCOL or 3 n = MESSAGE or 4 "TDT?"	6-23	PATTERN
TX DSØA BCH Encoding	"TEC n" n = OFF or Ø n = ON or 1 "TEC?"	6-26	OFF
Time	"TIM h,m,s" h = Ø to 23 m = Ø to 59 s = Ø to 59 "TIM?"	6-15	N/A

Table E-1. Remote Control Messages (continued)

TX Interface Level	"TIN n" n = DS1C or 1 n = DS1 or 2 n = DSØB or 3 n = DSØA or 4 n = DSØ or 5 "TIN?"	6-16	DS1
TX Number Of Intermediate Repeaters (CSU Loopback)	"TIR n" n = Ø to 2 "TIR?"	6-22	Ø
ESF Datalink Message Content	"TMC 'Øddddddd Ø' d = Ø or 1 "TMC?"	6-18	'ØØ1Ø1Ø1Ø'
ESF Datalink Message Type	"TMT n" n = IDLE or 1 n = WORD or 2 "TMT?"	6-18	IDLE
TX Tandem Number (DS0DP Loopback)	"TNU n" n = 1 to 8 "TNU?"	6-22	1
TX DSØA/DSØB Data Rate	"TRØ n" n = 1 to 5 "TRØ?"	6-17,6-18	9.6 kbits(3)
TX DDS Code	"TRC n" n = CMI or 1 n = OCU_LB or 2 n = CHAN_LB or 3 n = DSU_LB or 4 n = TIP or 5 n = LBE or 6 n = FEV or 7 n = TA or 8 n = MA or 9 n = UMC or 1Ø n = BLOCK or 11 n = RLS or 12 n = ASC or 13 n = TEST or 14 n = OOS or 15 n = SETTABLE or 16 "TRC?"	6-25	CMI

Table E-1. Remote Control Messages (continued)

TX Pattern Type	"TRD n" n = PRBS_20 or 1 n = ALL_ONES or 2 n = SETTABLE or 3 n = PRBS_2Ø47 or 4 m = PRBS_511 or 5 n = PREPROG or 6 "TRD?"	6-23	PRBS_20
TX Repeater Number	"TRN n" n = 1 to 2 "TRN?'	6-22	1

TX User Defined Pattern	"TRP #H(data)"
	data = 1 to 256 bytes of data.
	1 byte = 2 Hex Characters
	"TRP?'
		6-24	100 x FF(Hex) &
			100 x ØØ(Hex)

TX/RX Display Select	"TRS n" n = TX or 1 n = RX or 2 "TRS?"	6-51	RX
TX DDS Settable Code	"TSC 'bbbbbbbb'" b = Ø or 1 or s "TSC?"	6-26	SØ1Ø1Ø1Ø
TX Select Level	"TSL n" n = DS1 or 1 n = DSØB or 2 n = DSØA or 3 n = PSDC or 4 n = DSØ or 5 n = DATALINK or 6 n = FS_CHAN or 7 n = R_CHAN or 8 "TSL?"	6-18	DS1
TX Signaling Mode	"TSM n" n = SET or 1 n = RETRANSMIT or 2 "TSM?"	6-26	SET
SELF TEST (Common Capability)	"TST'	6-56	N/A

Table E-1. Remote Control Messages (continued)

TX Settable Word	"TSW 'bbbbbbbb'" b = 0 or 1 or f or s "TSW?"	6-24	10101010
TX Timeslot Number	"TTS n" n = 1 to 24 "TTS?"	6-19	1
TX Start DDS Code	"TXC"	6-25	N/A
TX PRBS_20 Zero Limit	"TZL n" n = OFF or 0 n = ON or 1 "TZL?"	6-23	ON

OPERATING MANUAL UPDATE PACKAGE

Operating Manuals with HP Part Number 03787-90001 apply directly to instruments with serial numbers prefixed 2703U and/or with software version 2726.
This package (03787-90001U0388) updates your Operating Manual for instruments with software version 2822. You can check the software version of your instrument by selecting INDEX display: INSTRUMENT ID. 6

Use this package to replace the correspondingly numbered pages in your manual. Additional pages have a suffix letter eg 6-46 and 6-46A replace Page 6-46.

The additional features with this software version are as follows:

- Frame Slips measurement added.
- Protocol Analysis available at 64kbit/s DS0 and 56kbit/s DS0A and DS0B
- Analysis Results include counts of: consecutive severely errored seconds, severely errored seconds, errored seconds and degraded minutes.
- Transmitted digroups can be framed
- Direct DDS code changeover available with display of current and next codes.
- DS1 In-band Network loopback available in addition to the previous Line loopback (Normal).
- DS1 ESF Datalink loopback available: Line, Network and Payload.
- DS1 ESF Datalink idle code or selectable message available.
- DS0DP alternating loopback available
- MJU latching loopback available.
- Remote control alarm reporting extended to cover frame slips, excess zeros and signal loss.
- THRU mode error add extended to cover logic errors.

HEWLETT PACKARD

OPERATING MANUAL

HP 3787B

DIGITAL DATA TEST SET
(Including Options 001 and 002)

SERIAL NUMBERS / SOFTWARE REVISIONS

This manual has been modified to apply to instruments with serial numbers prefixed 2814U and/or with software revision 2822.

For instruments with serial numbers prefixed 2703U and/or with software revision 2726, an unmodified manual is required.

For additional important information about Serial numbers see INSTRUMENTS COVERED BY MANUAL in Section 7.

For additional information about software revisions, see FIRMWARE / SOFTWARE HISTORY at the start of Section 6.

Manual Part Number: 03787-90001
Microfiche Part Number: 03787-90026

Printed: September 1987

WARNING

READ THE FOLLOWING NOTES BEFORE INSTALLING OR SERVICING ANY INSTRUMENT.

1. IF THIS INSTRUMENT IS TO BE ENERGISED VIA AN AUTO-TRANSFORMER MAKE SURE THAT THE COMMON TERMINAL OF THE AUTO-TRANSFORMER IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SOURCE.

2. THE INSTRUMENT MUST ONLY BE USED WITH THE MAINS CABLE PROVIDED. IF THIS IS NOT SUITABLE, CONTACT YOUR NEAREST HP SERVICE OFFICE. THE MAINS PLUG SHALL ONLY BE INSERTED IN A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD (POWER CABLE) WITHOUT A PROTECTIVE CONDUCTOR (GROUNDING).

3. BEFORE SWITCHING ON THIS INSTRUMENT:

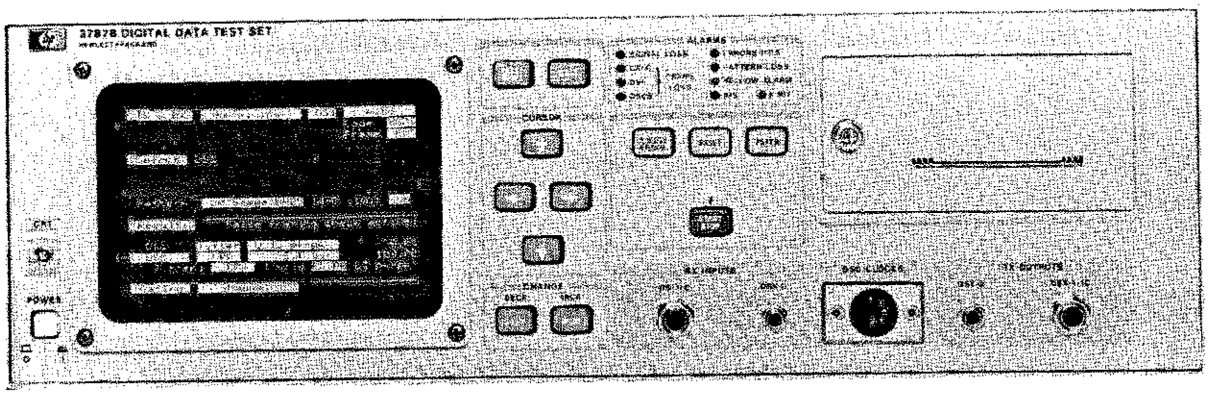
   (a) Make sure the instrument input voltage selector is set to the voltage of the power source.

   (b) Ensure that all devices connected to this instrument are connected to the protective (earth) ground.

   (c) Ensure that the line power (mains) plug is connected to a three-conductor line power outlet that has a protective (earth) ground. (Grounding one conductor of a two-conductor outlet is not sufficient).

   (d) Check correct type and rating of the instrument fuse(s).

Introduction to the HP 3787B Digital Data Test Set



Description

The HP 3787B Digital Data Test Set offers comprehensive error measurement capability for the Digital Transmission hierarchy at the DS1C (3.152 Mbit/s), DS1 (1.544 Mbit/s) and DS0 (64 kbit/s) levels. At DS1 and DS1C it allows on-line nonintrusive monitoring of live digital traffic as well as out-of-service testing. For testing of digital leased services the HP 3787B also offers a wide range of control and test features.

The unit is designed to monitor DS1 and DS1C signals from code, frame, CRC and logic errors and offers comprehensive analysis features. DS1 Jitter performance measurement is optional. For testing DDS, Diginet and similar services a broad range of facilities are offered ranging from simple dataport measurements to multipoint junction unit control and latching loopbacks with secondary channel.

The HP 3787B is microprocessor-based and is compatible with the Hewlett-Packard Interface Bus (HP-IB). (HP-IB is Hewlett-Packard's implementation of IEEE Standard 488-1978). It may also be controlled via an RS-232 port. Results may be logged either on the standard internal printer or to an external printer.

Getting Started 1

Introduction

This section gives a brief introduction to instrument operation and describes how to make measurements. Practical examples are used to familiarize you with the controls by demonstrating how they are used to set up and run measurements. You are shown how to read results and obtain a printout. There are some exercises to try on your own. The section is completed with a summary of what you have learned.

Introduction to Instrument Operation

Configuration and Measurement parameters are displayed in inverse video on the CRT display. These are set using the CURSOR and CHANGE keys. For ease of use the displays are arranged with the most significant parameters at the top left hand corner of the screen. When configuring the instrument it is advisable to work from top to bottom and from left to right.

Press the (START/STOP) key to start the measurement. It will stop automatically at the end of the preset duration but the (START/STOP) key can be used to override the automatic stop.

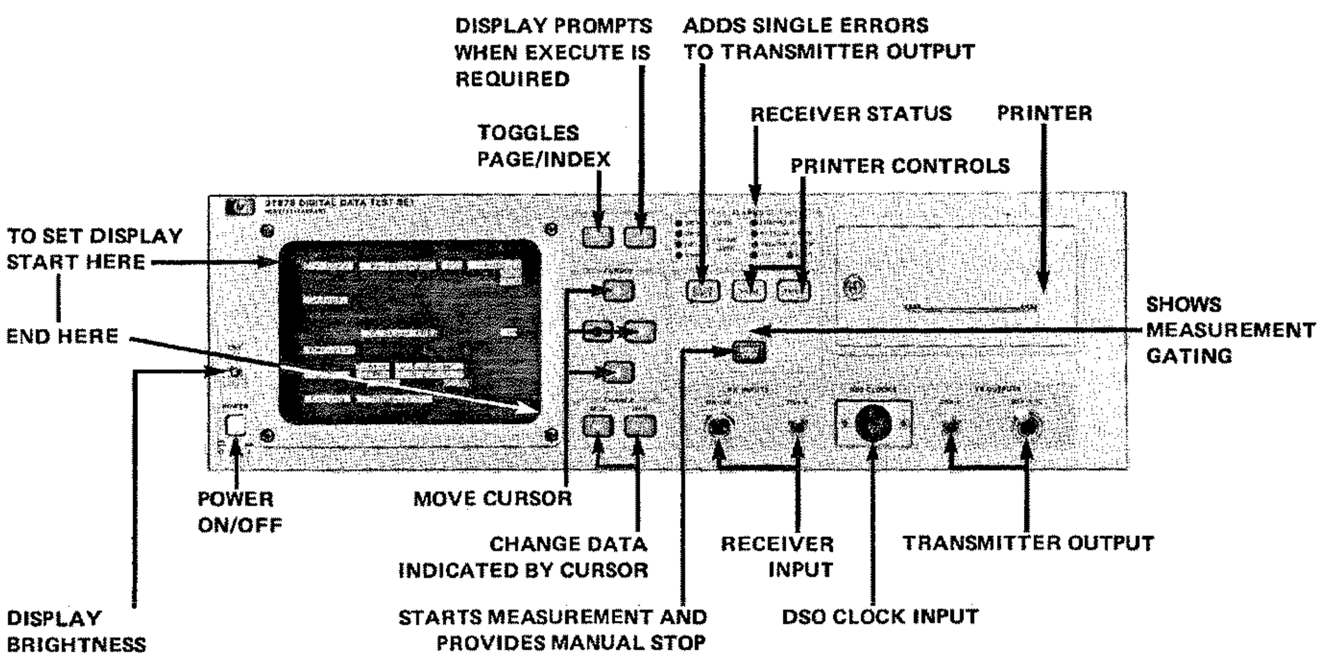
The measurement results are displayed during and after the measurement period. A printout of results can be obtained either automatically by presetting print conditions, or on demand with the (PRINT) key.

CURSOR keys ------ Change the position of the cursor on the screen.

CHANGE keys ------ Change the data indicated by the flashing cursor.

START/STOP key --- Starts the measurement running and stops it manually.

PRINT key -------- Prints results on the built-in printer on demand.



Start-Up

Before Switch-On

Check that the rear panel voltage selector is set for the power line voltage to be used. Refer to the installation section in the Operating Manual.

Switch-On

Connect the power cord and press the [POWER] switch.

The instrument will run its power-up checks automatically (this lasts approximately 12 seconds). During the power-up checks the front panel indicators will come on and the beeper will beep. When the instrument passes the power-up test, the first line of the display will show POWER HAS CYCLED. This message will be cleared when any key is pressed.

The first display will be the "INDEX" page with the flashing cursor positioned at the first item.

Normal Operation 1

Check the state of the gating led above the [START/STOP] key. If it is on, press the [START/STOP] key to switch it off.

```
POWER HAS CYCLED
___________________________________________

                  INDEX
                                       Page
Normal Operation ......................1
Stored Panels & Keyboard Lock .........2
Data Logging ..........................3
Date & Time ...........................4
Remote Configuration ..................5
Instrument ID..........................6
User Confidence Tests .................7
```

Setting the Instrument to the Default State

The instrument automatically starts up in the state it was in when it was last switched off. To start from a known state you may recall a fixed setup stored in the instruments memory.

Use the CURSOR [↑] and [↓] keys to move the flashing cursor to:

Stored Panels & Keyboard Lock . . . 2

then press the [PAGE/INDEX] key.

The "Stored Panels and Keyboard Lock" page is now displayed.

```
Keyboard is _Unlocked   Beeper is Off

Select Panel  0

Press EXEC to  Recall from Panel 0

Last Panel configuration recalled : 0
```

Use the CURSOR keys to move the cursor to Select Panel and

use the CHANGE keys to select 0.

Press the [EXEC] key to recall panel 0. Panel 0 is a fixed state permanently stored in the instrument - later you will see how to store your own selections in panels 1 to 9.

Press the [PAGE/INDEX] key to return to the "INDEX" page.

Use the CURSOR keys to move the cursor to:

Normal Operation . . . 1

Press [PAGE/INDEX] again to display the "Normal Operation" Receiving page.

Note that since measurement results are held until a new measurement is started the result of the previous measurement may be displayed at this stage. The result will be reset to 0 when you start your measurement.

```
_TX & RX    Receiving    DS1    Auto
                                Code   AMI
                                Frame  SF

Select  DS1


Pattern   20 Stage PRBS 14-0 Limit  On
-------------------------------------------
Results

  DS1     Logic  Error Count              0

-------------------------------------------
Elapsed Time              00 Days 00:00:00
```

- SF framing is also known as D4 or multiframe format
- Result of previous measurement may be displayed here.
- Elapsed time of previous measurement may be displayed here.

Making a DS1 Measurement and Adding Single Errors

In the first trial run the transmitter is set to add single errors and the receiver to make logic (binary) error measurements at DS1. The transmitter and receiver are then looped to make a back-to-back measurement.

Selecting the Measurement

The measurement is selected by selecting the results required. As the default state is a logic error count measurement at DS1, you have already selected what you want by recalling panel 0. All you need to do is set a suitable gating interval and the type of error to be added.

REMEMBER:

CURSOR keys ------Move the cursor in the direction of the arrow on the key.

CHANGE keys ------Change the parameter indicated by the cursor.

Set the display from top left to bottom right.

Setting the Gating Interval

Move the cursor to Elapsed Time (at the bottom of the screen) and use the NEXT key to change it to Gating. Move the cursor to Manual and use the NEXT key to change it to Interval. Additional fields will appear in the form DD days HH : MM : SS (Hours : Minutes : Seconds) to allow the interval to be set. Move the cursor to the minutes field and use the NEXT and PREV keys to set 5 minutes .

```
TX & RX   Receiving    DS1   Auto
                             Code   AMI
                             Frame  SF

Select  DS1


 Pattern   20 Stage PRBS 14-0 Limit  On
Results

  DS1     Logic  Error Count        0


Gating    Interval     00 Days 00:05:00
```

- Gating Interval set to 5 minutes.

Setting Single Error Add

Move the cursor to Receiving (at the top of the screen) and press NEXT. The Transmitting settings are now displayed.

The default state is "No Error Add".

To enable the SINGLE ERROR key for the addition of logic errors use the CURSOR and CHANGE keys to set the display as shown:

```
TX & RX   Transmitting   DS1 Code      AMI
                             Frame      SF
                         DS1 Clock     Int

Transmit DS1

Alarms   None

Loopback   (In-band)   Off

 Pattern   20 Stage PRBS 14-0 Limit   On
 Logic Error Add       Single
```

- Select Logic Error Add and then Single.

Recall the Receiving Display to See the Results

Move the cursor to Transmitting and press NEXT. The Receiving settings are now displayed.

Making the Measurement and Adding Single Errors

Now that both the transmitter and receiver are set to make the measurement, you are ready to run it.

As the transmitter output is active it is good practice not to connect the instrument to the system under test before this stage.

Connect the TX OUTPUT DSX-1/1C to the RX INPUT DS1/1C with a WECO 310 to WECO 310 cable.

Note: There is an internal TX/RX link which is broken when a cable is plugged in. Disregard the alarm indications, e.g. signal loss, which occur when one end of the looping cable is connected.

Press the START/STOP key to start the measurement. The gating led above the START/STOP key will come on.

Press the SINGLE ERROR key several times to add errors to the transmitted signal. Observe these errors accumulating on the displayed Logic Error result. They will also be indicated by the ERRORS/HITS led on the front panel.

```
TX & RX  _ Receiving    DS1    Auto
                               Code   AMI
                               Frame  SF

Select  DS1



Pattern   20 Stage PRBS 14-0 Limit  On
------------------------------------------
Results

  DS1     Logic  Error Count             8

------------------------------------------
Gating    Interval   00 Days 00:05:00
```

- Error Count results display.

You are now making a 5-minute DS1 error measurement. To override the selected 5 minute Gating Interval you may press the START/STOP key to stop the measurement.

Making a DS1 Measurement & Adding a Fixed Error Ratio

In the second trial run you add a fixed error ratio to the transmitted signal and look at error count and error ratio results during and after the measurement.

Making a DS1 Measurement & Adding a Fixed Error Ratio

If gating is in progress (led on) press (START/STOP).

Move the cursor to Receiving and press [NEXT]. The Transmitting settings are now displayed.

Move the cursor to Logic Error Add Single and use the [NEXT] key to change it to Ratio.

A new field will appear after Ratio indicating the current setting. Move the cursor to this field and use the CHANGE keys to set the ratio to 5.0 E-7. The transmitter will now introduce 5 errors in 10^7 clock periods. You should now have the following display:

```
TX & RX  _Transmitting   DS1 Code   AMI
                             Frame   SF
                         DS1 Clock  Int

Transmit DS1

Alarms  None

Loopback  (In-band)   Off

 Pattern  20 Stage PRBS 14-0 Limit  On
Logic Error Add      Ratio       5.0 E-7
```

- Set Error Ratio.

Disregard the errors indicated on the ALARMS leds at this stage.

Setting the Gating Interval

Move the cursor to Transmitting and press [NEXT]. The Receiving settings are now displayed.

Use the CURSOR and [NEXT] keys to set the Gating Interval to 4 minutes as shown below:

```
TX & RX   _Receiving     DS1     Auto
                                Code   AMI
                                Frame  SF

Select  DS1


 Pattern   20 Stage PRBS 14-0 Limit  On
Results

  DS1    Logic  Error Count            8


Gating    Interval      00 Days 00:04:00
```

- Result of previous measurement. This will be reset to 0 when you press [START/STOP].
- Gating Interval set to 4 minutes.

Making the Measurement and Reading the Results

Press the [START/STOP] key to start the measurement.

The ERRORS/HITS leds and the Error Count display will indicate each error received as before.

Use the CURSOR keys to move the cursor to Error Count and use the [NEXT] key to change it to Error Ratio.

The displayed value is the currently calculated ratio and will be approaching 5.0 in 10^{-7}.

Use the [NEXT] key to display each of the logic error measurements in turn:

Synchronous Error Seconds	Sync Err Secs
Asynchronous Error Seconds	Async Err Sec
Asynchronous Error Free Seconds	Async E.F.S.
% Error Free Seconds	% E.F.S.
Error Count	Error Count
Error Ratio	Error Ratio

Use the CURSOR and NEXT keys to change Gating to Elapsed Time. The display will show the time that the measurement has been running. When this reaches 4 minutes the measurement will stop and the gating led will go off automatically.

You can now use the CURSOR and CHANGE keys to step through all the Logic Error Results.

```
TX & RX   Receiving   DS1    Auto
                             Code   AMI
                             Frame  SF

Select  DS1


 Pattern   20 Stage PRBS 14-0 Limit  On

Results

  DS1      Logic  Error Ratio     5.0 E-7


Gating    Interval    00 Days 00:04:00
```

- Error Ratio Result.
  With the cursor here the NEXT key is used to display each of the Logic Error Results.
- Change Gating to Elapsed Time to see how long the measurement has been running.

Adding and Measuring Different Error Types

In this trial run you will add different error types to the transmitted signal and see their effect on the result. You also simulate power and signal loss and see their effect on the Alarm Durations display. Finally you will look at the Results Analysis.

You are going to measure two types of Error simultaneously. This is done by introducing a second Results line.

One of the points demonstrated is that only the type of error selected on the Results display is measured: logic, bipolar violations (BPV), frame, cyclic redundancy code (CRC) or, with Option 001 instruments, jitter.

As this run may take a little longer than the last one, the Gating Interval is set to 10 minutes.

Setting up a Second Simultaneous Measurement

Use the CURSOR keys to move the cursor to Error Ratio and use the PREV key to change it to Error Count. This gives a more immediate indication of error accumulation.

Use the CURSOR keys to move the cursor to the marker on the line below and press the NEXT key to display DS1. Move the cursor to the new fields defining this DS1 measurement and use the NEXT key to set them to BPV and Error Count as shown in the Figure below.

Use the CURSOR and NEXT keys to set the Gating Interval to 10 minutes.

```
TX & RX    Receiving     DS1     Auto
                                 Code   AMI
                                 Frame  SF

Select  DS1


Pattern   20 Stage PRBS 14-0 Limit  On

Results

 DS1      Logic  Error Count          8
 DS1     _ BPV   Error Count          0

Gating    Interval    00 Days 00:10:00
```

- The second simultaneous measurement.

- Gating Interval set to 10 minutes.

Press the START/STOP key to start a measurement and watch the received errors accumulate.

Note that the errors recorded are logic errors since you are inserting logic errors in the transmitted signal. No bipolar violations are recorded as you have not introduced any yet.

Changing the Type of Error Added

With the measurement still running (gating led on) use the CURSOR keys to move the cursor to Receiving and use the NEXT key to change it to Transmitting.

Use the CURSOR and NEXT keys to change Logic Error Add to BPV Insertion.

```
TX & RX   Transmitting   DS1 Code    AMI
                             Frame    SF
                        DS1 Clock    Int

Transmit DS1

Alarms   None

Loopback  (In-band)   Off

 Pattern    20 Stage PRBS 14-0 Limit  On
_ BPV Insertion        Ratio        5.0 E-7
```

- Change to BPV Insertion.

Code errors are now being added to the transmitted signal.

Use the CURSOR keys to move the cursor to Transmitting and use the NEXT key to change it back to Receiving.

Note that bipolar violations are being recorded on the Results display. Logic errors are no longer being introduced because BPVs are added by changing positive marks to negative marks and negative marks to positive marks.

Use the NEXT key to set this display to DS1 Signal Loss.

Note that signal loss was not recorded during the power loss.

Pull out one of the TX/RX loop cable WECO connectors to produce signal loss. You will see the signal loss seconds accumulating on the display and being flagged by the ALARM led on the front panel. Reconnect the loop.

```
TX & RX    Receiving    DS1    Auto
                               Code   AMI
                               Frame  SF

Select  DS1


Pattern   20 Stage PRBS 14-0 Limit  On
Alarm Durations

_ DS1 Signal Loss                        7


Gating     Interval    00 Days 00:10:00
```

- Duration of Signal Loss (seconds).

Use the NEXT key to look at all the Alarm Durations measurements again.

DS1 Pattern Loss and DS1 Frame Loss may show a slightly longer time than Signal Loss because of the time required to regain alignment. Move the cursor to Alarm Durations and use the NEXT key to change it to Analysis.

```
TX & RX   Receiving   DS1   Auto
                            Code   AMI
                            Frame  SF

Select  DS1


 Pattern   20 Stage PRBS 14-0 Limit  On
_Analysis

Result A   DS1    Logic

% Availability                  95.4173

Gating    Interval   00 Days 00:10:00
```

- With the cursor here the NEXT key is used to look at all the Analysis results.

You can look at all the Results Analysis displays while the measurement is still running:

% Availability

% Unavailability

% Severe E.S. - % Severely Errored Seconds

% Err Seconds - % Errored Seconds

% Deg. Mins - % Degraded Minutes

CSES - Consecutive Severely Errored Seconds

Severe E.S. - Severely Errored Seconds

Err Seconds - Errored seconds

Deg. Mins - Degraded Minutes

Note that some of these results are triggered only with high error rates, e.g. % Availability may be 100% in this test.

Press the START/STOP key to stop the measurement. You can now repeat the operations to look at all of the results with the measurement complete. The results are held until the START/STOP key is used to start another measurement.

For a printout of results simply press the PRINT key. This produces a printout on demand (only Results or Analysis fields currently displayed will be printed.) The printer can be set to produce printouts at fixed time intervals or under fixed error conditions (see the Printing/Logging Results section).

What You Have Learned

BEFORE YOU START

Check the transmitter parameters before connecting to the equipment under test.

The setup and operation at power loss is restored when power is restored.

SETTING-UP

The transmitter and receiver are independent.

Set up the display from top left to bottom right.

Stored panels are a quick and easy way to set up the instrument.

BEFORE THE MEASUREMENT

You can check cross-connect voltage levels by selecting RX Level. (DS1 & DS1C)

You can check path continuity using single error add.

The type of measurement is selected by setting the Results display.

DURING THE MEASUREMENT

Results and result analysis can be monitored during the measurement.

Only the type of error selected in Results is recorded.

You can add errors singly or at a selectable rate.

You can change the type of error added but not the type of error measured.

The receiver configuration cannot be changed.

During power loss only Power Loss Seconds are recorded.

START/STOP controls measurement gating; the key overrides the display setting.

AFTER THE MEASUREMENT

Results are held until the next measurement START.

The PRINT key produces results printout on demand.

Selected Applications 2

Introduction

This section shows how to use the network control and interface capabilities of the HP 3787B in typical applications. An example of the instrument's Normal Operation displays is given for each of these applications. This section does not tell you how to set up the display or give full details of the measurement capability in any particular application. These details are in Sections 1 and 3.

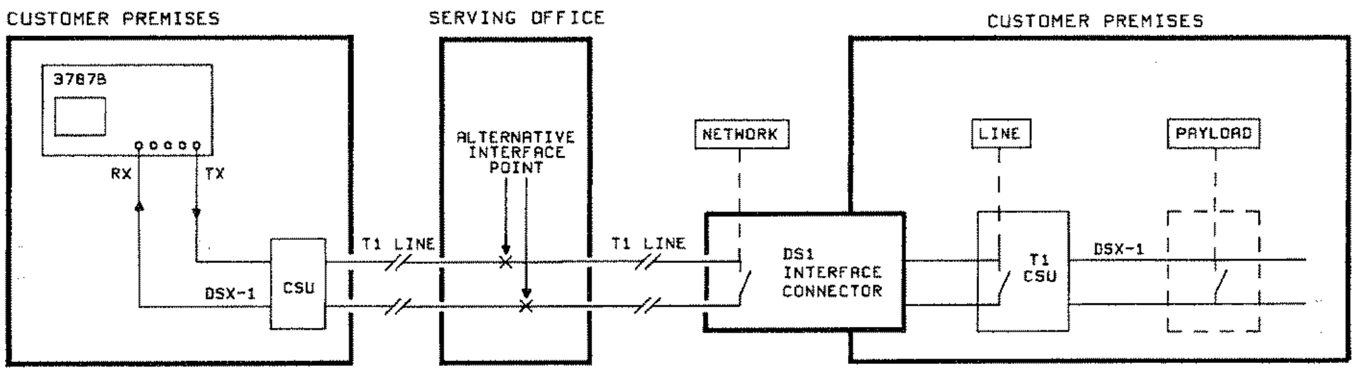
The applications covered in this section are:

DS1 In-Band Loopback

Application

In situations where DS1 Channel Service Units (CSUs) are capable of performing DS1 in-band remote loopback, the HP 3787B can loop-up a remote CSU, perform a bit error measurement and loop-down the remote CSU.

Measurement Configuration



Example: Looping a remote CSU from a customer premises to make a logic error measurement.

This example checks for errors in each of 3 successive 15 minute gating intervals. Typically this should be less than 20 since 14 corresponds to an error ratio of 10^{-8}. You can do this by using Repetitive Gating with a 15 minute interval, and printing an End-of-Gating Summary. See the Printing/Logging Results section for print selection information. The code and framing used in this example are AMI and SF. Set the code and framing parameters on the Receiving and Transmitting displays.

DS1 Loopback, Sample Receiving Display

```
TX & RX   Receiving     DS1   Auto
                              Code   AMI
                              Frame  SF

Select  DS1


Pattern  20 Stage PRBS 14-0 Limit  On
Results

  DS1    Logic  Error Count        0


Gating  _Rpt Interval  00 Days 00:15:00
```

- Set the receive interface.
- You are going to make your measurement on the complete DS1.
- Select the test Pattern.
- Select the measurement.
- Set the measurement Gating Interval.

DS1 Loopback, Sample Transmitting Display

```
TX & RX  Transmitting  DS1 Code   AMI
                           Frame  SF
                       DS1 Clock  Int

Transmit DS1


Alarms  None

Loopback  (In-band)   Line


Press EXEC to Actuate Loopback

 Pattern  20 Stage PRBS 14-0 Limit  On
_Logic Error Add      Single
```

- Set the transmit interface.
- Insert the test pattern in the complete DS1.
- Select the Loopback.

Initiate the loop-up by pressing the EXEC key. "Loopback operation in progress" will flash on the display while the loop is being set. This takes approximately 8 seconds after which "Press EXEC to Release Loopback" is displayed.

Confirmation of Loopback

You can check that loopback has been achieved by one of the following indicators:

An indicator on the local CSU.
Pattern sync indication on the HP 3787B ALARM indicator.
Normal levels of error count during gating.
Adding single errors and seeing them detected on the ERRORS/HITS alarm.

Make the Measurement

Press the (START/STOP) key.

Remember that with Rpt Interval gating the results are not displayed until the end of each gating interval. They then remain displayed through the following gating interval.

When three results have been printed/displayed press the (START/STOP) key to stop the measurement.

Clear the Loopback after the Measurement

Press the (EXEC) key. "Loopback operation in progress" will flash on the display for approximately 8 seconds while the loop is being cleared.

Automatic Protection Switch (APS) Testing

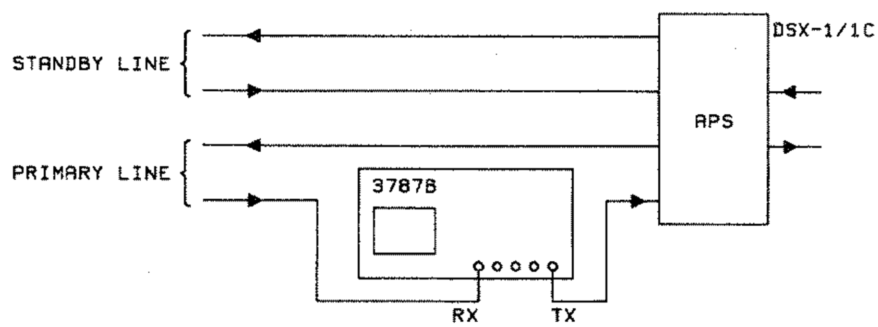
Application

Checking the capability of an automatic protection switch (APS) to change between the primary and standby lines at specified code error rates.

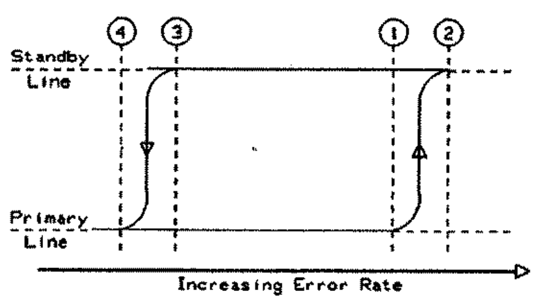
NOTE: The HP 3787B is capable of performing an APS test in both THRU and TX & RX modes. The normal method using THRU mode is used in the following example.

Measurement Configuration

A typical APS test configuration is shown below.



Example: Code errors are introduced at four independently selectable error rates to check the APS switching characteristic. A typical switching characteristic is shown below where points 1 thru 4 correspond to the error rate thresholds set on the HP 3787B.



1. No Transfer - APS remains on Primary Line
2. Transfer - APS switches to Standby Line
3. No Restore - APS remains on Standby Line
4. Restore - APS returns to Primary Line

The code and framing used in this example are AMI and SF framing. These must be compatible with the line and switch being tested and may be set on either the Receiving or Retransmitting displays.

Set the No Transfer, Transfer, Restore, and No Restore ratio thresholds appropriate to the protection equipment type. An error free signal is transmitted in the Start state.

DSX-0A to DSX-1 Test, Sample Transmitting Display

```
TX & RX   Transmitting  DS0A   Bipolar
                         56 kbit/s Service
DS0 Clocks  Front

Point-to-Point

Loopback  Off

Test   Primary Channel

Pattern   2047 Bit PRBS
 No Error Add
```

- Set the transmit interface.
- Select the test Pattern.

DSX-0A to DSX-1 Test, Sample Receiving Display

```
TX & RX   Receiving   DS1   DSX
                        Code    AMI
                        Frame  T1DM

Select  Timeslot 23  DS0A   56 kbit/s
         Primary Channel

 Pattern   2047 Bit PRBS
           Continuous
Results

  DS0A    Logic  Error Count          0

Gating   Interval    00 Days 00:15:00
```

- Set the receive interface.
- Demultiplex the Timeslot to be tested.
- Select the test Pattern.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

Press the START/STOP key.

Remember that you can display Alarm Durations, Analysis, the Received Word (Monitor) and the received DS1 voltage level (RX level) by changing the Results field.

DSX-1 to DSX-0A

The DSX-1 input port of the T1DM is connected to the HP 3787B DS1 transmitter which stimulates the timeslot under test. The corresponding DSX-0A output of the T1DM is connected to the HP 3787B DS0 receiver which performs error measurements on it.

NOTE

For this test the HP 3787B must drive the T1DM input with a DS1 signal whose frequency is locked to the DS0 clock supplied to the T1DM and the HP 3787B.
This can be achieved in two ways:

1) Supply a DS1 clock at the correct frequency to the HP 3787B rear-panel external clock input and select Ext DS1 Clock.
2) Supply any DS1 signal at the correct frequency to the DS1 receiver input and select Looped DS1 Clock. (The Receiver interface must not be set to DS1C).

DSX-1 to DSX-0A Test, Sample Transmitting Display

```
TX & RX  Transmitting  DS1 Code   AMI      - Set the transmit interface.
                           Frame T1DM
Insertion On           DS1 Clock Looped

_Select  Timeslot 23  DS0A  56 kbit/s      - Select the DS1 Timeslot to be tested.

Point-to-Point

Loopback  Off

Test  Primary Channel


Pattern  2047 Bit PRBS                     - Select the test Pattern.
No Error Add
```

DSX-1 to DSX-0A Test, Sample Receiving Display

```
TX & RX   Receiving    DS0A Terminated
                   56 kbit/s Service
DS0 Clocks  Front


 Select    Primary Channel
           (No error correction)

 Pattern    2047 Bit PRBS
            Continuous
Results

  DS0A     Logic  Error Count          0

_

Gating    Interval    00 Days 00:15:00
```

- Set the receive interface.
- Select the test Pattern.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

Press the (START/STOP) key.

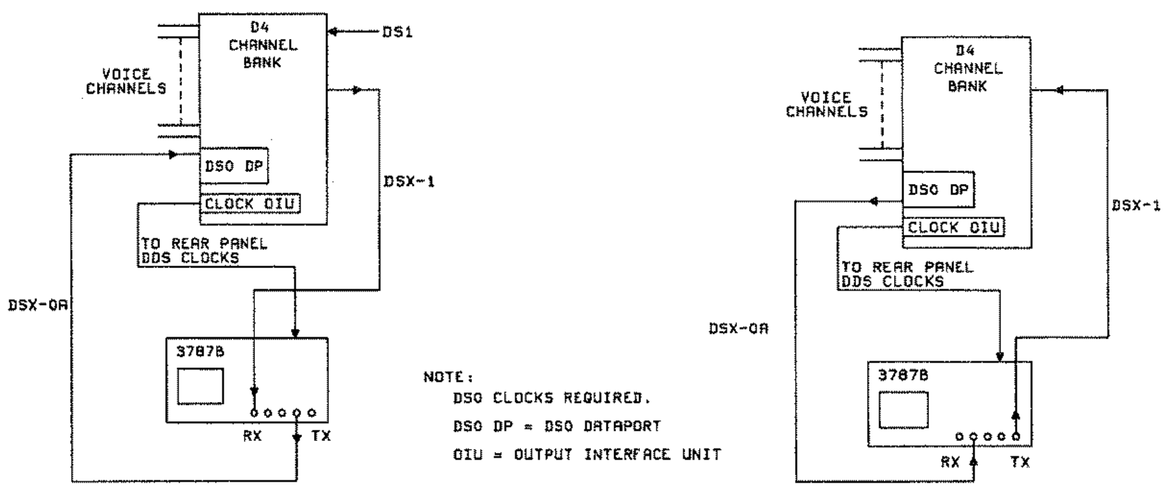
Remember that you can display Alarm Durations, Analysis and the Received Word (Monitor) by changing the Results field.

Dataport Testing

The HP 3787B allows you to measure the performance of Dataport cards installed in channel banks. This can be done from DS0A to DS0A or DS1 to DS1 by looping the channel bank. Alternatively by using the multiplexing/demultiplexing capability of the HP 3787B you can make half-channel measurements (i.e. DS0A to DS1 and DS1 to DS0A).

Measurement Configuration

The D4 channel bank clock source must be set to "LOOPED".



Example: Test a DS0 Dataport (DS0 DP) card in a D4 channel bank using the half-channel method. The 9.6 kbit/s rate has been chosen for this example.

SRDM DSX-0A to DSX-0B, Sample Transmitting Display

```
TX & RX   Transmitting  DS0A   Bipolar
                    9.6 kbit/s Service
DS0 Clocks  Front

Point-to-Point

Loopback  Off

Test   Primary Channel

Pattern   2047 Bit PRBS
  No Error Add
```

- Set the transmit interface.
- Select the test Pattern.

SRDM DSX-0A to DSX-0B, Sample Receiving Display

```
TX & RX    Receiving    DS0B Terminated
                    9.6 kbit/s Service
DS0 Clocks  Front

 Select   Customer 05   9.6 kbit/s
          Primary Channel

Pattern   2047 Bit PRBS
           Continuous
Results

Customer  Logic  Error Count         0

Gating _  Interval   00 Days 00:15:00
```

- Set the receive interface.
- Select the customer under test.
- Remember to select the same test Pattern as on the Transmitting display.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

Press the START/STOP key.

NOTE

If the other inputs to the SRDM are not connected, an all zero pattern may be detected in the DS0B. This will result in the SIGNAL LOSS led being illuminated. Measurements are valid in this condition.

Example: DSX-0B to DSX-0A

Select the DS0B Customer Number on the Transmitting display. This slot will be stimulated with the selected test Pattern; the other slots will be filled with TEST code.

SRDM DSX-0B to DSX-0A, Sample Transmitting Display

```
TX & RX  Transmitting  DS0B
                   9.6 kbit/s Service
DS0 Clocks  Front

Transmit Customer 05  9.6 kbit/s

Point-to-Point

Loopback  Off

Test  Primary Channel


Pattern  2047 Bit PRBS
  No Error Add
```

- Set the transmit interface.
- Select which customer to stimulate with the test Pattern.
- Select the test Pattern.

SRDM DSX-0B to DSX-0A, Sample Receiving Display

```
TX & RX    Receiving    DS0A Terminated
                  9.6 kbit/s Service
DS0 Clocks  Front


 Select   Primary Channel
          (Error Correction  Off )

Pattern   2047 Bit PRBS
          Continuous
Results

  DS0A     Logic  Error Count          0
_


Gating    Interval     00 Days 00:15:00
```

- Set the receive interface.
- Remember to select the same test Pattern as on the Transmitting display.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

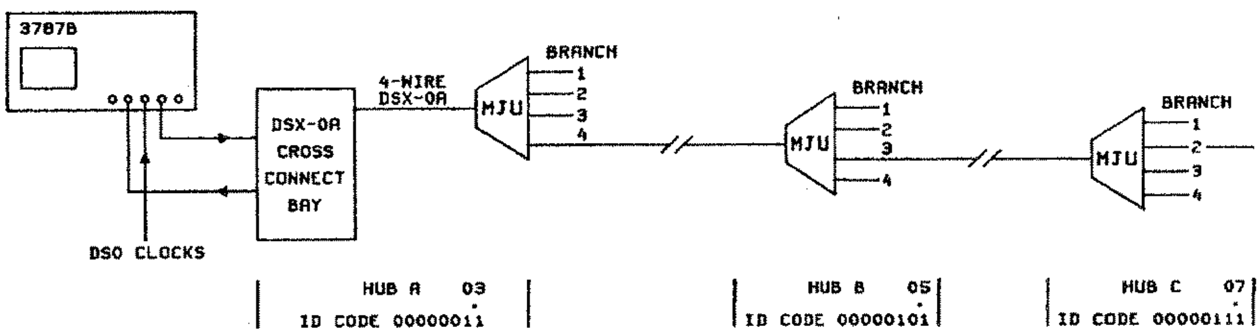
Press the (START/STOP) key.

MJU Branch Selection and Testing

Application

You can select, test, block, unblock and release all branches of a DDS Multi-point Circuit. You can loop-back a selected branch or an MJU. Testing is normally performed downstream from a DSX-0A cross-connect bay by routing each Multi-point Junction Unit in turn. Using the drop and insert capabilities of the HP 3787B, you can also access the circuit at T1.

Measurement Configuration



Example: Select HUB C branch 2 from the HUB A DSX-0A cross connect bay, perform a loopback, make a measurement and release the loopback.

Select Branch

The first operation is to establish the route through the system to the chosen branch. You do this by setting the transmit display for the branch of the first MJU, in this example branch 4, and pressing the EXEC key. When the branch has been selected, the Hub A ID code is returned and is displayed in the "Present" field. You then repeat the operation for branch 3 out of Hub B and branch 2 out of Hub C. This sequence is shown on the following Transmitting displays:

NOTE

The Receiver Pattern must be set to DDS Return codes for the transmitter to display the HUB-ID's.

Branch Selection, Sample Displays

```
TX & RX  Transmitting  DS0A  Bipolar
                9.6 kbit/s Service
DS0 Clocks  Front
```

- Set the transmit interface.

```
_ Multipoint          Select Branch 4

             (Last branch selected X)

                    Present HUB-ID XX
                   Previous HUB-ID XX

Press EXEC to select branch
```

-Select Branch 4 out of Hub A.

- Press EXEC to select Branch 4.

```
_ Multipoint          Select Branch 4

             (Last branch selected 4)

                    Present HUB-ID 03
                   Previous HUB-ID XX

Press EXEC to select branch
```

- Branch 4 has been selected.
- Hub A ID code (03) has been returned.

```
_ Multipoint          Select Branch 3

             (Last branch selected 4)

                    Present HUB-ID 03
                   Previous HUB-ID XX
```

- Select Branch 3 out of Hub B.

Press EXEC to select Branch 3.

```
_ Multipoint          Select Branch 3

             (Last branch selected 3)

                    Present HUB-ID 05
                   Previous HUB-ID 03
```

- Branch 3 has been selected.
- Hub B ID code has been returned.

```
_ Multipoint          Select Branch 2
```

- Repeat the selection process for Hub C Branch 2.

Press EXEC to select Branch 2.

```
             (Last branch selected 2)

                    Present HUB-ID 07
                   Previous HUB-ID 05
```

- Branch 2 has been selected.
- Hub C ID code has been returned.

NOTE

If the receiver is configured to receive routing acknowledgments and fails to receive the correct acknowledgment within two seconds of EXEC the message "MJU ROUTING FAILED" is displayed and the display remains as XX and X respectively.

Test Branch

```
 TX & RX   Transmitting  DSOA   Bipolar
                    9.6 kbit/s Service
DSO Clocks  Front



   Multipoint          _Test Branch

                 (Last branch selected 2)

                        Present HUB-ID 07
                       Previous HUB-ID 05

Press EXEC to test branch
```

- Select Test Branch
- Press EXEC to enter the Test mode.

```
   Multipoint           Test Branch

Loopback  Off

Test   Primary Channel


 Pattern   2047 Bit PRBS
   No Error Add
```

- At this stage the branch can be tested point-to-point but normally this is done by looping back the selected branch.

Setting Loopback and Test Pattern, Sample Display

```
   Multipoint           Test Branch

Loopback  Latching  _OCU   MAPX

Test   Primary Channel

Press EXEC to Actuate Loopback

 Pattern   2047 Bit PRBS
   No Error Add
```

- Select the type of Loopback.
- Select the test Pattern.

Press EXEC to loop-up.

For information on Latching Loopback acknowledgment see Page 2-28.

Set up the Receiver and Make the Measurement

Select the Receiving display, and set it to correspond with your transmitted test signal. Select the required Results and the Gating Interval.

Press the (START/STOP) key to start the measurement.

Setting Measurement, Sample Display

```
TX & RX    Receiving    DSOA Terminated
                    9.6 kbit/s Service
DSO Clocks  Front

 Select   Primary Channel
          (Error Correction  Off )

Pattern   2047 Bit PRBS
           Continuous
Results

  DSOA     Logic  Error Count           0


Gating    Interval     00 Days 00:15:00
```

- Set the receive interface.
- Remember to select the same test Pattern as on the Transmitting display.
- Select the measurement.
- Set the measurement Gating Interval.

After the Measurement

Select the Transmitting display and press EXEC to release the loopback. Change Test Branch to End Test and press EXEC to end the test and cancel the test route.

Releasing the Loopback, Sample Display

```
TX & RX   Transmitting  DS0A  Bipolar
                9.6 kbit/s Service
DS0 Clocks  Front

Multipoint            Test Branch

Loopback  Latching  _OCU   MAP1

Test  Primary Channel

Press EXEC to Release Loopback

Pattern   2047 Bit PRBS
 No Error Add
```

- Press EXEC to Release the Loopback.

Ending the Test, Sample Display

```
TX & RX   Transmitting  DS0A  Bipolar
                9.6 kbit/s Service
DS0 Clocks  Front

Multipoint           _ End Test

               (Last branch selected 2)

                     Present HUB-ID 07
                    Previous HUB-ID 05

Press EXEC to end test
```

- Select End Test
- Press EXEC to End the Test and cancel the test route.

If after testing a branch you wish to leave it blocked simply select Block Branch instead of End Test. See the following section on Blocking and Releasing.

Blocking and Releasing

After selecting a particular branch, you can block or unblock it. This is done by selecting a branch (HUB C branch 2 in the example below), selecting Block Branch or Unblock Branch and pressing EXEC.
The "Release All" function is used (without a previous Branch Select sequence) to release all downstream branches.

Branch Block, Sample Display

```
TX & RX  Transmitting  DS0A  Bipolar
                  9.6 kbit/s Service
DS0 Clocks  Front



  Multipoint        _Block Branch

           (Last branch selected 2)

                  Present HUB-ID 07
                 Previous HUB-ID 05

Press EXEC to block branch
```

- You can select Block Branch
  Unblock Branch
  Release all

- Activate your selection by pressing EXEC.

NOTE

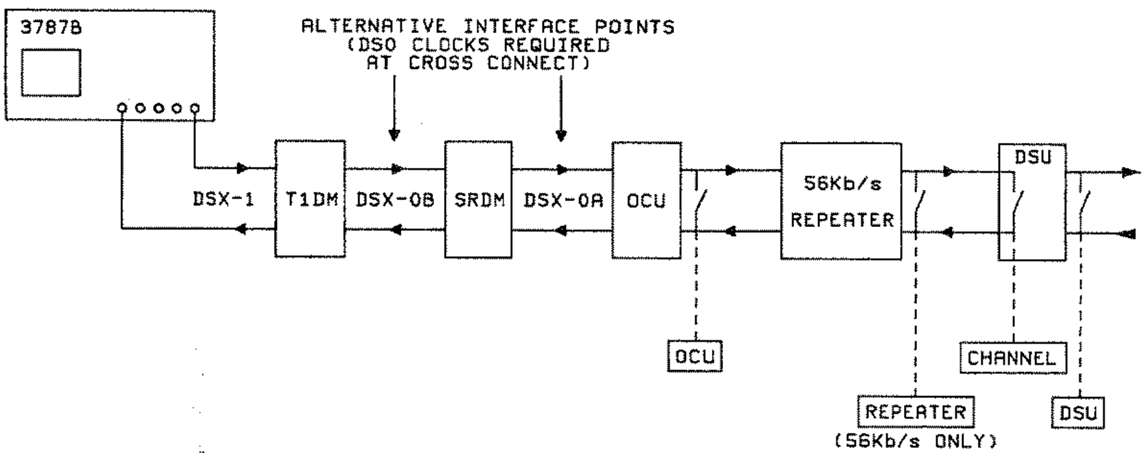
With Block Branch selected both the current and previous HUB-ID are displayed together with the selected branch number of the current MJU. Until EXEC is pressed these displays remain as confirmation of the route selected using BRANCH SELECT. If no branch selection has been attempted or a branch selection has not been acknowledged these displays default to X.

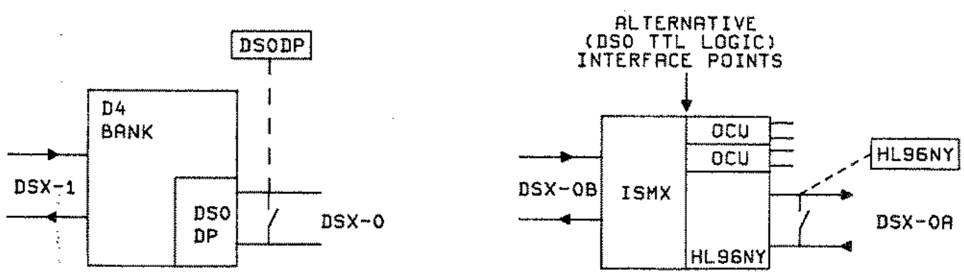
DDS Alternating (Flywheel) Loopbacks

Application

You can set an alternating (flywheel) loopback in the DDS network at any of the points shown in the measurement configuration below and then make a measurement.

Measurement Configuration





Example: From the DSX-1 cross-connect, loopback at the Office Channel Unit (OCU), make customer logic error measurements and release the loopback.

Select the Loopback details on the Transmitting page and press EXEC to initiate the Loopback.

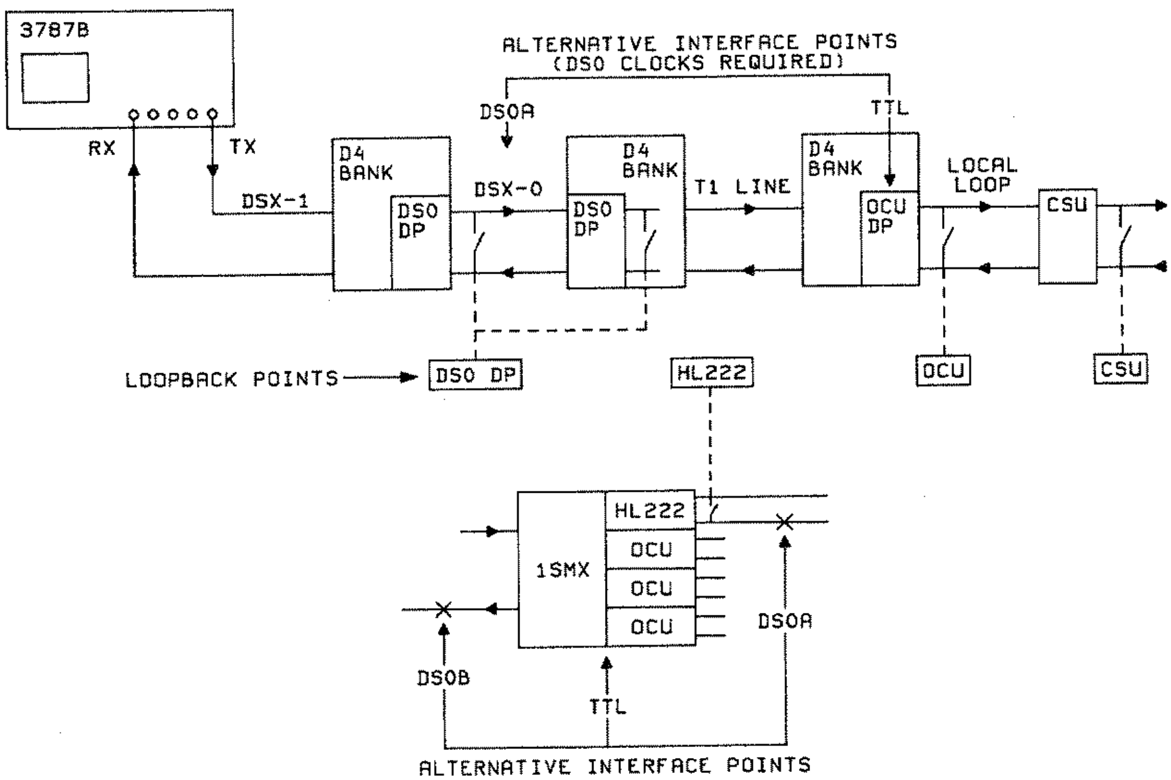
In this example Logic errors are being measured over a 5 minute Gating Interval.

DDS Latching Loopbacks

Application

You can set a latching loopback in the DDS system at any of the points shown in the measurement configuration below, make a measurement and release the loopback. With multipoint DDS circuits, the MJU's can also be looped.

Measurement Configuration



Example: Access at a DSX-1 cross-connect and loopback the second DS0DP Dataport. Make logic error measurements on a 2.4 kbit/s customer circuit and release the loopback.

The HP 3787B can also access at DS0A and DS0B cross-connects and at DS0A logic access points. With DS0 access DDS clocks must be supplied.

If you wish the loopback to be acknowledged select the Receiving display and set the Pattern to Return Codes. This ensures that MAP codes returned from a successful loopback will be displayed on the Transmitting display.

Latching Loopback, Initial Receiving Display

```
TX & RX   Receiving   DS1    Auto
                      Code    AMI
                      Frame  T1DM

Select  Timeslot 01  DS0B  2.4 kbit/s
        Customer 01
        Primary Channel

Pattern  DDS Return Codes

Results
```

- Set the receive interface.
- Select the timeslot parameters and customer number.
- Select the Pattern to DDS Return Codes to obtain the Mapcode on the Transmitting display.

On the Transmitting display select the point at which you wish to loopback the circuit, in this case the second DS0DP unit. Press EXEC to actuate the loopback.

Latching Loopback, Sample Transmitting Display

```
TX & RX  Transmitting  DS1 Code   AMI
                           Frame T1DM
Insertion On          DS1 Clock Looped

Select  Timeslot 01  DS0B  2.4 kbit/s
        Customer 01

Point-to-Point

Loopback  Latching  _DS0DP  MAPX
Tandem Number of Unit 2
Test   Primary Channel

Press EXEC to Actuate Loopback

Pattern   2047 Bit PRBS
  No Error Add
```

- Set the transmit interface.
- Select the timeslot parameters and customer number.
- Select Loopback.
- Select the test Pattern.
- Press EXEC to loop-up.

If you have selected DDS Return Codes on the Receiving page a successful loopback attempt will result in the display of "MAP0 (DS1)" indicating a lineside DS0DP loopback has been achieved.

For the various types of latching loopbacks MAP codes are returned as follows:

DS0DP (dropside), i.e. DS0 side OCU HL222	MAP1 (X110110X)
DS0DP (lineside), i.e. DS1 side CSU (channel)	MAP0 (X001001X)

If an attempt is unsuccessful or if the Receiving display has not been set for acknowledgment (DDS Return Codes) the display will remain as MAPX.

Latching Loopback, Sample Receiving Display

```
TX & RX   Receiving      DS1   Auto
                               Code    AMI
                               Frame  T1DM

Select   Timeslot 01   DS0B  2.4 kbit/s
         Customer 01
         Primary Channel

Pattern   2047 Bit PRBS
           Continuous
Results

Customer  Logic  Error Count            0


Gating   Interval    00 Days  00:05:00
```

- Remember to select the same test Pattern as on the Transmitting display.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

Press the START/STOP key

Releasing the Loopback

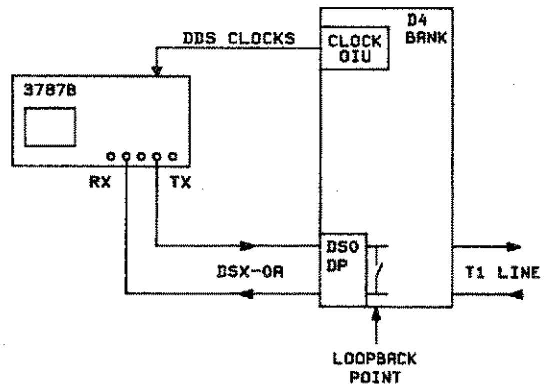
When you have completed your measurement release the loopback by selecting the Transmitting display and pressing the EXEC key. (Ensure "to Release Loopback" is displayed before you press EXEC).

DDS Secondary Channel Testing

Application

You can access and test DDS secondary channel, either end-to-end or by using latching loopbacks. The HP 3787B can access the network at the DSX-0A, DSX-0B or DSX-1 cross-connects or at DS0A logic access points.

Measurement Configuration



Example: Interface at the DSX-0A cross-connect on a 2.4 kbit/s point-to-point circuit. Loopback the first Dataport and measure secondary channel logic errors.

Secondary Channel Test, Sample Transmitting Display

```
TX & RX  Transmitting DS0A  Bipolar
                 2.4 kbit/s Service
DS0 Clocks  Front



Point-to-Point

Loopback  Latching  DS0DP  MAPX
Tandem Number of Unit 1
Test  _Secondary Channel

Press EXEC to Actuate Loopback

Pattern   511 Bit PRBS
 No Error Add
```

- Set the transmit interface.
- Select the Loopback.
- Select Secondary Channel.
- Select the test Pattern.

Press EXEC to loop-up.

For information on Latching Loopback acknowledgment see Page 2-28.

Secondary Channel Test, Sample Receiving Display

```
TX & RX    Receiving    DS0A Terminated
                 2.4 kbit/s Service
DS0 Clocks  Front

 Select   Secondary Channel
          (Error Correction  Off )

Pattern    511 Bit PRBS
Results

Sec Chan   Logic  Error Count          0

Gating      Interval      00 Days 00:05:00
```

- Set the receive interface.
- Demultiplex the test data.
- Remember to select the same test Pattern as on the Transmitting display.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

Press the START/STOP key.

Releasing the Loopback

Select the transmitting display with "Press EXEC to release loopback" displayed and press EXEC.

Practical Aspects of Secondary Channel Testing.

1. During secondary channel testing the primary channel is stimulated with random data.
2. Latching loopbacks are always used; alternating (flywheel) loopbacks are not compatible with secondary channel testing as they would corrupt the C-bit modulation.

Protocol Analysis

Application

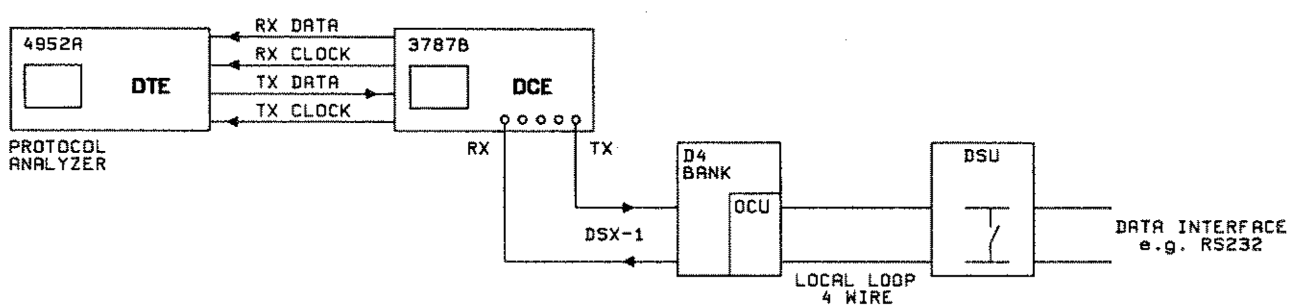
You can perform protocol analysis by using the HP 3787B as a channel access interface between the network under test and a protocol analyzer. The network can be accessed at the DS1, DS0A and DS0B cross-connects and at DS0A logic access points.

The HP 3787B can provide protocol analysis access to:

1. 64 kbit/s DS0 Clear Channel and 56 kbit/s DS0A and DS0B
2. DDS subrate primary channels at 2.4, 4.8 and 9.6 kbit/s.
3. DDS subrate secondary channels at 133 1/3, 266 2/3 and 533 1/3 bit/s.
4. DS1 standard frame (D4) 4 kbit/s Fs data link.
5. DS1 extended frame (ESF) 4 kbit/s data link.
6. DS1 T1DM frame 8 kbit/s R-Channel.

The interface between the protocol analyzer and the HP 3787B is RS232C.

Measurement Configuration



Example: Interface at DS1 and connect to a 4.8kbit/s customer. Loopback at the DSU and test the circuit with data from the protocol analyzer.

To set the channel latching loopback use the procedure described on Pages 2-27/2-29 selecting "Channel" instead of "DS0DP".

Protocol Analyzer Interface, Sample Transmitting Display

```
TX & RX   Transmitting   DS1 Code    AMI
                             Frame   SF
Insertion On               DS1 Clock Looped

Select Timeslot 01  DS0A  4.8 kbit/s

Point-to-Point

Loopback Latching Channel MAP0

Test _Primary Channel

Press EXEC to Release Loopback

 Transmit  Data from Protocol Analyzer
```

- Set the transmit interface.
- Select the DS1 timeslot to be tested.
- Select the HP 3787B/Protocol Analyzer interface. Your test pattern now comes from the protocol analyzer.

Protocol Analyzer Interface, Sample Receiving Display

```
TX & RX   Receiving   DS1     Auto
                             Code   AMI
                             Frame  SF

Select  Timeslot 01  DS0A  4.8 kbit/s
         Primary Channel
         (Error Correction  Off )

Receive  Data to Protocol Analyzer

_Monitor

Received Word  10101111


Gating   Interval   00 Days 00:15:00
```

- Set the receive interface.
- Select the timeslot under test.
- Select the HP 3787B/Protocol Analyzer interface (your receiver test pattern is now output to the protocol analyzer).
- The received data can be displayed on a sampled basis.
- Select the measurement Gating Interval.

NOTE

All protocol analysis functions are also available if the network access is DS0.

Set up The Protocol Analyzer

1. Select the "Setup" menu on the Protocol Analyzer display as shown.

```
Monitor/Simulate Parameter Setup

Protocol   HDLC    Display   2Line
Code      ASCII 8
Bits/sec   4800    Err chk   CCITT
Parity     None



                   DTE clockDCE
Mode       Sync
                   Bit senseNorm.
                   Ext Addr Off
                   Ext Ctrl Off
```

2. Select "EXIT" to enable the next display selection.

3. Select the "Simulate" menu on the Protocol Analyzer display as shown.

```
Simulate DTE

Block  1
Send | THE QUICK BROWN FOX
 JUMPS OVER THE LAZY DOG.
 0123456789CRLF|GG||
  and then
Goto Block  1
```

4. Select "EXIT" to enable the next display selection.

Make the Measurement

5. Select the Protocol Analyzer "Run" menu and press SIMULATE.

6. The transmit and receive data is displayed on alternate lines with the received data in inverse video. Compare the transmit and receive data.

Practical Aspects of Protocol Analysis Testing

- The HP 3787B interfaces with SYNCHRONOUS networks. It is not possible to use the HP 3787B 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 clock is provided by the HP 3787B via the RS232 cable. This is selected by setting the protocol analyzer (DTE) clock source to DCE.

  When using the protocol analyzer to run a BER test through the HP 3787B, setting the "bits/sec" field on the protocol analyzer's BER setup page to "EXT" causes it to take its clock from the HP 3787B.

- The HP 3787B/Protocol Analyzer interface comprises only clock and data lines. When connecting another protocol analyzer to the customer's DSU it MAY be necessary to provide it with the RTS handshake signal (check the DSU manual).

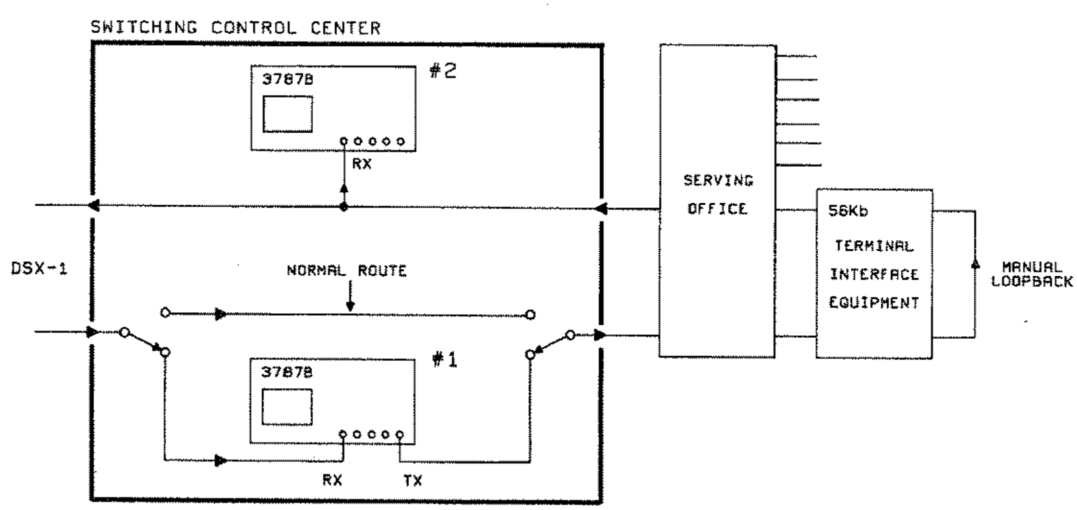
Monitoring Signaling Bits and Seizing a Free Timeslot.

Application

For testing 56 kbit/s switched services you can use the HP 3787B to monitor the standard D4 frame A and B signaling bits or the D5 extended frame A, B, C and D signaling bits. You can therefore monitor the status of live data to check if a timeslot is idle or seized. The HP 3787B can also be set to transmit selectable signaling bits which enable you to seize an idle timeslot and make a measurement on it.

Measurement Configuration

NOTE: This configuration requires hitless switch.



Example: Circuit-switched test on a D4 line.
In this example it is assumed that:

A=0, B=1 for idle,
A=1, B=0 for seized.

Select the timeslot to be tested. Check that it is idle and seize it using HP 3787B #1 without disrupting the traffic on the line. Check the logic errors on HP 3787B #2.

Normal Operation

Selecting the Operating Mode

The transmitting and receiving capability of the HP 3787B are set on the "Normal Operation" page.

The HP 3787B can transmit and/or receive data when it is in the TX & RX mode.

```
TX & RX   Receiving   DS1   Auto
|
THRU
```

In the THRU mode, the instrument retransmits the received signal - only applicable for DS1/1C operation (see Page 3-28).

Display Transmitting when setting up the transmitter and display Receiving when setting up the receiver.

```
TX & RX   Receiving   DS1   Auto
              |
         Transmitting
```

Setting Up the Transmitter (DS1/DS1C)

The following pages contain the information required to transmit at a DS1 or DS1C cross-connect.

Transmit Interface Selection

Select the required cross-connect - DS1 (Page 3-4) or DS1C (Page 3-2). For transmitting at DS0, DS0A or DS0B cross-connects, see Page 3-10.

```
TX & RX   Transmitting   DS1 Code   AMI
                          |
                         DS0B
                          |
                         DS0A
                          |
                         DS0
                          |
                         DS1C
```

Transmitting at DS1C

Select the required code.

```
TX & RX  Transmitting  DS1C Code    AMI
                                      |
                                    B8ZS
```

Set the framing On or Off.

```
TX & RX  Transmitting  DS1C Code    AMI
                            Frame    On
                                      |
                                    Off
```

Select the desired clock source for the digroups in the DS1C.

Int - Generated internally.
Ext - Supplied externally via rear panel clock input.

```
TX & RX  Transmitting  DS1C Code    AMI
                            Frame    On
                        DS1 Clock   Int
                                      |
                                    Ext
```

Select the desired digroup frame format

```
TX & RX  Transmitting  DS1C Code    AMI
                            Frame    On
                        DS1 Clock   Int
                    Digroup Frame   ESF
                                      |
                                    Off
                                      |
                                   T1DM
                                      |
                                     SF
                                      |
                                     Ft
```

Select the alarm to be transmitted and then turn it On and Off as required.

```
TX & RX  Transmitting  DS1C Code    AMI
                            Frame    On
                        DS1 Clock   Int
                    Digroup Frame   ESF

Alarms  None
          |
        X-bit   On
          |      |
        A.I.S.  Off
```

Select the test pattern. With framed DS1C the selected test pattern is transmitted in both digroups. With 20 stage PRBS, the 14-zero data limit is selectable. With the settable word all 8-bits can be set.

```
TX & RX   Transmitting   DS1C Code    AMI
                              Frame    On
                          DS1 Clock   Int
                      Digroup Frame   ESF

Alarms   None

Both digroups contain:
 Pattern  20 Stage PRBS  14-0 Limit  Off

          All Ones Word

          Settable Word  0 1 1 1 0 0 0 0
```

Select the type of error-add desired. Errors can be added singly or as a selectable error ratio. The ratio can be set in the range 1×10^{-8} to 9×10^{-3}.

With B8ZS code selected, Code Error Insert replaces BPV Insertion

When transmitting framed digroups, Logic Error Add Ratio, is only available with the DS1C frame set to Off.

```
TX & RX   Transmitting   DS1C Code    AMI
                              Frame    On
                          DS1 Clock   Int
                      Digroup Frame   ESF

Alarms   None

Both digroups contain:
 Pattern  20 Stage PRBS  14-0 Limit  Off
  No Error Add

 Logic Error Add     Single

  BPV Insertion      Ratio       1.0 E-8

DS1C Ft Error Add

 APS Test
```

If the APS (automatic protection switch) error-add function is selected then the APS state can be selected. An error ratio may be set on all states except Start.

```
APS Test   Start            (No errors)
             |
         No Transfer       Ratio 3.0 E-5
             |
          Transfer
             |
         No Restore
             |
          Restore
```

Transmitting at DS1

Select the required code.

```
TX & RX  Transmitting  DS1 Code   AMI
                                   |
                                  B8ZS
```

Select the desired framing format.

NOTE: SF framing is also known as D4 or multiframe format.

```
TX & RX  Transmitting  DS1 Code   AMI
                           Frame  ESF
                                   |
                                  Off
                                   |
                                  T1DM
                                   |
                                   SF
                                   |
                                   Ft
```

Select the desired DS1 Clock source.

- Int - Generated internally.
- Ext - Supplied externally via rear panel clock input.
- Looped - Looped from a DS1 signal connected to the receiver.

```
TX & RX  Transmitting  DS1 Code   AMI
                           Frame  ESF
                       DS1 Clock  Int
                                   |
                                  Ext
                                   |
                                 Looped
```

When transmitting a framed DS1 signal you may choose to insert the test pattern in the DS1 stream itself or in one of the following lower levels:

- a timeslot
- a customer channel
- a data link

For DDS and Dataport timeslot selection, see Pages 3-10 and 3-11. For details on the DDS facilities available, see Page 3-12.

For Clear Channel pattern and error facilities, see Page 3-12.

For Circuit-Switched timeslots, see Page 3-9.

For details on the test patterns applicable to T1 data links and T1DM R-Channel, see Page 3-8.

```
TX & RX  Transmitting  DS1 Code   AMI
                           Frame  ESF
                       DS1 Clock  Int

Transmit DS1
   |
 Select  Timeslot 08  DSOB 2.4 kbit/s
   |     Customer 05
   |
 Select  Timeslot 03  DSOA 9.6 kbit/s
   |
   |
* Select Timeslot 09  56 kbit/s Switched
   |
* Select Timeslot 24  Clear Channel
   |
   |
* Select 4 kbit/s Data Link
   |
* Select T1DM R-Channel
   |
* Select Fs 4 kbit/s Data Link
```

* These lower level choices depend on the DS1 Frame format. The exact set is shown under Receiving on Page 3-19.

Select the alarms to be transmitted and then turn them On and Off as required.

```
TX & RX  Transmitting  DS1 Code   AMI
                           Frame  ESF
                       DS1 Clock  Int

Transmit DS1

Alarms   None
          |
         Yellow    On
          |        |
         A.I.S.    Off
```

With ESF framing you can select loopbacks operated via datalink messages.

```
Alarms   None

Loopback  In-band   Off
             |
          Datalink
```

Select the type of loopback required: Line for CSU loopback or Network for DS1 interface connector loopback. With Datalink selected Payload is also available.
The actuate message appears whenever loopback is selected. With loopback selected either the actuate or release message can be selected at any time ie:

Press EXEC to Actuate Loopback
or
Press EXEC to Release Loopback

```
TX & RX   Transmitting   DS1 Code    AMI
                             Frame   ESF
                         DS1 Clock   Int

Transmit DS1

-----------------------------------------

Alarms   None

Loopback  Datalink    Off
                       |
                      Line
                       |
                    Network
                       |
                    Payload
```

Select the desired test pattern. With 20-stage PRBS the 14-zero limit is selectable. With the settable word all 8-bits can be set.

```
TX & RX   Transmitting   DS1 Code    AMI
                             Frame   ESF
                         DS1 Clock   Int

Transmit DS1

-----------------------------------------

Alarms   None

Loopback   In-band    Off



 Pattern    20 Stage PRBS 14-0 Limit Off
                 |
            All Ones Word
                 |
            Settable Word 0 0 1 1 1 1 0 0
```

Select the type of error-add desired. Errors can be added singly or at selectable error ratio. The ratio can be set in the range 1×10^{-8} to 9×10^{-3}.

With CRC error-add the ratio selected is the corresponding bit error ratio.

With B8ZS code selected, Code Error Insert replaces BPV Insertion.

```
TX & RX   Transmitting   DS1 Code    AMI
                             Frame   ESF
                         DS1 Clock   Int

Transmit DS1

Alarms   None

Loopback   In-band   Off

 Pattern   20 Stage PRBS 14-0 Limit Off
 No Error Add
        |
 Logic Error Add         Single
        |                  |
 BPV Insertion           Ratio        3.0 E-5
        |
 DS1 CRC Error Add        BER
        |
 Frame Error Add
        |
 APS Test
```

If the APS (automatic protection switch) error-add function is selected then the APS state can be selected. An error ratio may be set on all states except Start.

```
APS Test    Start          (No errors)
              |
         No Transfer     Ratio 4.0 E-6
              |
          Transfer
              |
         No Restore
              |
          Restore
```

DS1 Data Links and T1DM R-Channels

When testing data links, the HP 3787B can transmit one of three patterns.

4 kbit/s data link : ESF, Ft
8 kbit/s R-Channel: T1DM

```
TX & RX   Transmitting   DS1 Code    AMI
                            Frame    ESF
Insertion On             DS1 Clock   Int

Select 4 kbit/s Data Link

Pattern   2047 Bit PRBS
            |
          511 Bit PRBS
            |
          All Ones Word
```

Data links may also be tested with data from a Protocol Analyzer via the HP 3787B rear panel PROTOCOL ANALYZER port.

```
Transmit Data from Protocol Analyzer
```

When 'message' is selected the IDLE code is transmitted.

```
Press EXEC to transmit new message

Message   11111111  00101010
      Current message : Idle
```

When a 16 bit code is required the content is selected using the message fields. The selected message will replace the current message when EXEC is pressed.

```
Press EXEC to transmit new message

Message   11111111  00101010
              |
             Idle
```

Single logic errors can be added when transmitting test patterns.

```
   No Error Add
       |
Logic Error Add        Single
```

56 kbit/s Switched Timeslots

With ESF framing the A, B, C and D signaling bits may be set in the selected timeslot.

With SF framing the A and B signaling bits may be set in the selected timeslot.

```
TX & RX  Transmitting   DS1 Code   AMI
                           Frame   ESF
Insertion On           DS1 Clock   Int

Select  Timeslot 01  56 kbit/s Switched


Signaling Bits   Set   A  B  C  D
                       0  1  0  1
```

Select the desired test pattern. One of the test patterns is a short settable word and another is a long preprogrammable word (up to 256 bytes) which is programmed remotely.

```
 Pattern   Settable Word  1 0 1 0 1 0 1 S
           Preprogrammed
           2047 Bit PRBS
           511 Bit PRBS
           All Ones Word
```

Select the desired error-add type.

```
   No Error Add
  Logic Error Add        Single
   Byte Error Add
```

Setting Up the Transmitter (DS0B, DS0A & DS0)

The following pages contain the information required to transmit at 64 kbit/s cross-connects.

Transmit Interface Selection

Select the required cross-connect - DS0B, DS0A or DS0. For transmitting at DS1 see Page 3-4 or DS1C see Page 3-2.

```
TX & RX  _Transmitting  DS1 Code   AMI
                         |
                        DS0B
                         |
                        DS0A
                         |
                        DS0
                         |
                        DS1C
```

Transmitting at DS0B

Select the desired DS0B rate. For all rates, except 56 kbit/s, the DS0B signal is a multicustomer format as generated by an SRDM. The 56 kbit/s DS0B signal carries a single customer.

When emulating the output of an SRDM where the customer rate is less than the SRDM rate, then the SRDM rate should be selected.

```
TX & RX  Transmitting  DS0B
                   2.4 kbit/s Service
                    |
                   4.8
                    |
                   9.6
                    |
                   56
```

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

```
TX & RX  Transmitting  DS0B
                   2.4 kbit/s Service
DS0 Clocks  Front
             |
            Rear
```

Select the customer slot to be stimulated. The range of customer numbers depend on the service rate selected.

2.4 kbit/s	1 to 20
4.8 kbit/s	1 to 10
9.6 kbit/s	1 to 5

```
TX & RX  Transmitting  DS0B
                   2.4 kbit/s Service
DS0 Clocks  Front


Transmit Customer  01
```

The DS0B customer rate field is displayed when the 4.8 or 9.6 kbit/s service rate is selected. In these two cases it is sometimes necessary to load some slots in the DS0B signal with lower rate customers. See the note on Page 2-14. Select the customer rate in the field shown.

```
TX & RX  Transmitting  DS0B
                    9.6 kbit/s Service
DS0 Clocks  Front

Transmit Customer 01  2.4 kbit/s
                       |
                      4.8
                       |
                      9.6
```

For details on DDS transmission features, see Page 3-12.

Transmitting at DS0A

The network can be stimulated at Logic access points or at DSX (Bipolar).

```
TX & RX  Transmitting  DS0A Logic Near
                                 |
                            Logic Far
                                 |
                             Bipolar
```

Select the DDS customer service rate.

```
TX & RX  Transmitting  DS0A Logic Near
                    2.4 kbit/s Service
                     |
                    4.8
                     |
                    9.6
                     |
                     56
```

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

```
TX & RX  Transmitting  DS0A Logic Near
                    2.4 kbit/s Service
DS0 Clocks  Front
              |
             Rear
```

For details on DDS transmission features, see Page 3-12.

Transmitting at DS0

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

```
TX & RX   Transmitting   DS0
                         Clear Channel
DS0 Clocks   Front
               |
             Rear
```

The set of test patterns include a short settable word and a long preprogrammed word (up to 256 bytes) which is programmed remotely.

```
Pattern    2047 Bit PRBS
                |
            511 Bit PRBS
                |
           All Ones Word
                |
           Settable Word  1 0 1 0 1 0 1 0
                |
           Preprogrammed
```

DS0 Clear Channel can be tested with data from a Protocol Analyzer via the HP 3787B rear panel PROTOCOL ANALYZER port.

```
Transmit Data from Protocol Analyzer
```

With error-add, selected errors can be added singly.

```
Pattern    2047 Bit PRBS
  No Error Add
       |
Logic Error Add      Single
       |
Byte Error Add
```

DDS Transmission Facilities (DS0A/DS0B)

The following DDS features apply also when the HP 3787B is interfaced to the network at the DS0A and DS1 cross-connects.

```
TX & RX   Transmitting   DS0B
                       56 kbit/s Service
DS0 Clocks   Front
```

You can test point-to-point circuits or multipoint circuits. The test capability is the same in both.

```
Point-to-Point
      |
  Multipoint
```

Point-to-Point Circuits

Select the type of loopback required.

With alternating loopbacks only primary channels are tested.

```
Point-to-Point

Loopback Off
         |
         Alternating
         |
         Latching
```

Select the type of alternating loopback required.

```
Point-to-Point

Loopback Alternating  DSU
                      |
                      Channel
                      |
                      OCU
                      |
                      Repeater
                      |
                      HL96NY
                      |
                      Dataport
```

With OCU loopback, specify whether an intermediate HL96NY unit is present.

```
Loopback Alternating _ OCU
HL96NY present No
```

With Channel loopback at the 56 kbit/s service rate, specify the intermediate repeaters (0, 1 or 2).

```
Loopback Alternating _ Channel
Intermediate repeaters 1
```

With Repeater loopback (56 kbit/s only), specify the repeater number (1 or 2).

```
Loopback Alternating _ Repeater
Repeater Number 2
```

With Dataport loopback the tandem number may be selected in the range 1 to 8.

```
Loopback Alternating _Dataport
Tandem Number of Unit 2
```

With all latching loopbacks, both primary and secondary channels may be tested.

Select the type of latching loopback required.

```
Point-to-Point

Loopback Latching DSODP MAPX
                  |
                  OCU
                  |
                  Channel
                  |
                  HL222
```

With DS0DP loopback the tandem number may be selected in the range 1 to 8.

```
Loopback  Latching  _DS0DP  MAPX
Tandem Number of Unit 2
```

The actuate message is displayed whenever alternating or latching loopback is selected. With any loopback selected, the actuate or release message can be selected at any time.

```
Press EXEC to Actuate Loopback
```

```
Press EXEC to Release Loopback
```

Multipoint Circuits

When a multipoint circuit is first selected the next step is branch selection. During branch selection the branch number of each MJU is in the range 1 to 4 since each MJU has 4 output branches.

```
   Multipoint           Select Branch  4
                              |
                         Test Branch
                              |
                          End Test
                              |
                        Block Branch
                              |
                       Unblock Branch
                              |
                         Release All
```

After a sequence of branch selection to select a single leaf branch, testing of this branch can be done exactly as on a point-to-point circuit. This is initiated by pressing the EXEC key.

```
   Multipoint           Select Branch  3

              (Last branch selected X)

                     Present HUB-ID XX
                    Previous HUB-ID XX

Press EXEC to select branch
```

With multipoint circuits you can loopback an MJU.

```
   Multipoint            Test Branch

Loopback  Latching  _MJU   HUB-ID XX
```

You can select primary or secondary channel.

```
   Multipoint            Test Branch

Loopback  Off

Test   Primary Channel
             |
       Secondary Channel
```

Data

As well as transmitting standard test patterns and DDS codes the HP 3787B can insert data from a protocol analyzer into 64 kbit/s Clear Channel, 56 kbit/s DDS and sub-rate timeslots.

```
Pattern    2047 Bit PRBS
   |
  Code
   |
Transmit   Data from Protocol Analyzer
```

The set of test patterns includes a short settable word and a long preprogrammed word (up to 256 bytes) which is programmed remotely.

With the preprogrammed word all bits are settable except bit #1 at the sub-rates (sync bit position).

```
Pattern    2047 Bit PRBS
                |
           511 Bit PRBS
                |
           All Ones Word
                |
           Settable Word S 0 1 0 1 1 0 1
                |
           Preprogrammed
```

The code being transmitted is displayed as the "Current Code". You can select the "next" code to be transmitted and then change the transmission by pressing EXEC.

In addition to the standard codes a settable code is provided.

With settable word only the "data bits" can be set. With settable code, the control/status bit (bit 8) is also settable.

The examples on this page are for the sub-rate case with DS0B access.

```
  Code             CMI         S1111110
                    |
                 OCU L/B
                    |
                CHAN L/B
                    |
                 DSU L/B
                    |
                   TIP
                    |
                   LBE
                    |
                   FEV
                    |
                   TA
                    |
                   MA
                    |
                   UMC
                    |
                  BLOCK
                    |
                   RLS
                    |
                   ASC
                    |
                  TEST
                    |
                   OOS
                    |
           Settable Code S 0 1 0 1 0 1 0
           Current Code : S1111110 (CMI)
```

Error Add

With error-add, selected errors can be added singly using the SINGLE ERROR key.

```
  No Error Add
       |
  Logic Error Add     Single
       |
* Sub Frame Err Add
       |
  Byte Error Add
       |
* Dataport Test       3in5
```

* Depends on measurement set-up.

Setting Up the Receiver (DS1/DS1C)

The following pages contain the information required to receive at a DS1 or DS1C cross-connect.

Receive Interface Selection

Select the required cross-connect - DS1 or DS1C. For receiving at a DS0B, DS0A or DS0 cross-connect, see Page 3-20.

```
TX & RX   Receiving   DS1   Auto
                       |
                      DS0B
                       |
                      DS0A
                       |
                      DS0
                       |
                      DS1C
```

Receiving at DS1C

If the HP 3787B is connected to an unprotected access, select Bridged; otherwise select Auto. If you wish to have an indication of the correct signal level when terminating or when connected to a protected monitor point, select the particular signal expected.

```
TX & RX   Receiving   DS1C   Bridged
                               |
                              Auto
                               |
                              DSX
                               |
                              DSX-MON
                               |
                              DS-LO
                               |
                              DS-LO-MON
```

Select the required code

```
TX & RX   Receiving   DS1C   Auto
               Code   AMI    Frame   On
                       |
                      B8ZS
```

The test patterns available are as shown.

```
Pattern   2047 Bit PRBS
                |
          511 Bit PRBS
                |
          All Ones Word
                |
          Settable Word 1 0 1 0 1 0 1 0
```

DDS Receiving Facilities (DS0A/DS0B)

Either the primary or secondary channel may be measured. This applies to all customer rates and at all interfaces.

```
TX & RX   Receiving      DS1    Auto
                                Code    AMI
                                Frame   ESF

Select   Timeslot 12  DS0A   2.4 kbit/s
          Primary Channel
                |
         Secondary Channel
```

Sub-rate error correction is applicable where a DS1 signal timeslot contains a sub-rate DS0A signal or where the HP 3787B input signal us a sub-rate DS0A signal.

```
TX & RX   Receiving      DS1    Auto
                                Code    AMI
                                Frame   ESF

Select   Timeslot 12  DS0A   2.4 kbit/s
          Primary Channel
         (Error Correction  Off )
                             |
                             On
```

For test pattern measurement the choice is as shown. You may select DDS Return codes for confirmation of either Latching loopback or MJU operations. Confirmation will be displayed on the transmit subpage from which these operations are controlled.

```
Pattern   DDS Return Codes
                |
          2047 Bit PRBS
                |
          511 Bit PRBS
                |
          All Ones Word
                |
          Settable Word 1 0 1 0 1 1 0 1
```

With settable word only the data bits can be set. The two PRBS patterns are used when testing using alternating loopbacks. When receiving from an alternating loopback select from Alternating Loopback.

```
Pattern   2047 Bit PRBS
          Continuous
              |
            from Alternating Loopback
```

As well as measuring the standard test patterns the HP 3787B can also extract data from 64 kbit/s Clear Channel, 56 kbit/s DS0A/DS0B, a sub-rate timeslot or 4kbit/s / 8kbit/s framing channels for protocol analysis.

```
Receive   Data to Protocol Analyzer
```

Results

In addition to displaying BER Results the HP 3787B can display Alarm Durations, (byte) Monitor, RX Level, Analysis results, and Frame Slips.

```
Results
  |
Alarm Durations
  |
Monitor
  |
RX Level
  |
Analysis
  |
Slips
```

BER Results

Measurement A

The source of errors displayed in the first result is determined by your selection in the Select field. For example, when receiving a DS1C signal with a digroup selected the first result is based on the measurement of digroup errors.

```
TX & RX   Receiving   DS1C    Auto
                    Code  AMI Frame  On
                  Digroup Frame (1)  ESF
Select  Digroup   1



Pattern  20 Stage PRBS 14-0 Limit  On
```

Similarly when receiving a DS1 signal with the DS1 input itself selected, the first result is based on the measurement of the DS1 errors.

The error type may be Logic, Frame, Code, CRC, BPV errors or, with Jitter option instruments, Jitter hits depending on the received signal format and content and on the selection on the Select field.

```
Results

Digroup  Logic  Error Count  ..........
           |
          CRC
           |
         Frame
```

With any of the above error sources selected the same set of error result types is available.

```
Results

Digroup  Logic  Error Count  ..........
                     |
                Error Ratio
                     |
                Sync Err Secs
                     |
                Async Err Sec
                     |
                Async E.F.S.
                     |
                   % E.F.S.
```

When measuring jitter (option 001 only) the display types are as shown.

```
Results

 DS1     Jitter  Hit Count
                     |
                Hit Bit Count
                     |
                Hit Bit Ratio
                     |
                 Hit Seconds
                     |
                Hit-Free Secs
                     |
                 U.I. pk-pk
```

When measuring jitter (option 001 only) the filters are selectable.

LP	2Hz to 40kHz
HP1 + LP	10Hz to 40kHz
HP2 + LP	8kHz to 40kHz

The jitter threshold may be set from 00.05 UI pk-pk to 10.00 UI pk-pk in 00.01 steps.

```
Results

 DS1    Jitter   Hit Count

 (Jitter:   LP   T'hold 00.05 UI pk-pk)
            |
          HP1+LP
            |
          HP2+LP
```

Measurement B

On the line below the first result there is an empty block of inverse video. This is a field which allows a second measurement to be selected. The measurement sources selectable are every level between and including the interface point and the level selected.

The measurement types available are the same as for Result A for any given error source.

```
Results

 Timeslot   Logic  Error Count          0

 Timeslot
   |
 Digroup
   |
 DS1C
```

Alarm Durations

All relevant loss seconds can be selected for display at any time during (or after) a measurement.

```
Alarm Durations

  DS1 Pattern Loss
        |
  DS1 Frame Loss
        |
     AIS Seconds
        |
 Instrument Power Loss
        |
  DS1 Signal Loss
```

Rx Level (DS1/DS1C only)

Both positive and negative peaks are displayed. alternately.

```
RX Level

Positive peak : +3.00 Volts

Negative peak : -3.00 Volts
```

Monitor

This DS0 feature displays the sampled byte. When the byte is from a circuit-switched DS1 timeslot the signaling bits are also displayed on a sampled basis.

```
Monitor

Received Word  00000000

Signaling Bits   A  B  C  D
                 1  0  1  0
```

Analysis

If two measurements have been selected (A and B) the source for analysis is selectable.

```
Analysis

Result A   DS1    Logic
       |
       B
```

The same nine analysis types can be selected for any interface and selected measurement source. The types of display can be selected at any time but the source must be selected before the start of the measurement.

```
Analysis

Result A   DS1    Logic

 % Availability
       |
% Unavailability
       |
  % Severe E.S.
       |
  % Err Seconds
       |
  % Deg. Mins
       |
    CSES
       |
 Severe E.S.
       |
 Err Seconds
       |
  Deg. Mins
```

Slips

You can measure frame slips when receiving PRBS: in a 56 kbit/s DDS, 56 kbit/s Switched or DS0 Clear Channel timeslot.

```
Slips

Positive slips :

Negative slips :
```

Elapsed Time and Gating Modes

The time which has elapsed since the start of a gating period and the types of gating available can be displayed on the last line of the Receiving page.

```
Elapsed Time          00 Days 00:00:00

Gating    Manual
             |
          Interval     00 Days 00:00:01
             |
          Rpt Interval
             |
          Short Repeat   1 Second
```

Short Repeat is used for the convenient selection of four standard gating intervals.

1 second
15 seconds
5 minutes
15 minutes

With Interval and Rpt Interval the gating period can be set in the range 1 second to 99 days 23 hours, 59 minutes and 59 seconds with 1 second resolution.

Thru Mode

To enter the Thru mode place the cursor on the TX & RX field then press NEXT followed by EXEC - the page is displayed.

```
THRU     Receiving      DS1   Auto
                              Code   AMI
                              Frame  ESF

Select  DS1


Pattern   20 Stage PRBS 14-0 Limit  On

Results

 DS1    Logic  Error Count            0


Gating  Rpt Interval  00 Days 00:15:00
```

Select Retransmitting.

```
THRU     Receiving      DS1   Auto
            |
         Retransmitting
```

The Insertion field appears whenever a multiplexing function is selected. This must be set to On to enable any selected insertion. This field may be an exception from the rule for setting the display from top left to bottom right. You may wish to set the complete display before switching insertion on. Any subsequent configuration change automatically causes this field to revert to Off.

You can add logic and frame errors to the retransmission. You can also introduce BPV's or run an APS test.

```
THRU   Retransmitting  DS1  Code   AMI
                            Frame  ESF

Insertion  On
           |
           Off
```

Stored Panels and Keyboard Lock

The Stored Panels and Keyboard Lock display is obtained by selecting INDEX Page 2.

Keyboard Lock

When the keyboard is Locked EXEC and START/STOP are inoperative. The CHANGE keys will allow the current instrument state to be displayed but not changed.

```
Keyboard is  Unlocked    Beeper is  Off
                |                    |
              Locked                On
```

Stored Panels

Select the number of the panel to be recalled or accessed for storing the current set-up.

Note: Panel 0 is the fixed default state.

```
Keyboard is  Unlocked    Beeper is  Off

Select Panel  2
              |
           0 to 9
```

Recalling a Stored Panel

To recall a Protected panel press EXEC.

The stored setup is recalled and the number of the recalled panel (n) is shown in "Last panel configuration recalled : n"

```
Keyboard is Unlocked   Beeper is Off

Select Panel  2

Stored Panels  Protected

Press EXEC to Recall from Panel 2


Last Panel configuration recalled : 0
```

To recall a stored panel which is Not Protected, select Recall and press EXEC

```
Keyboard is Unlocked   Beeper is Off

Select Panel  2

Stored Panels Not Protected

Press EXEC to  Recall from Panel 2


Last Panel configuration recalled : 0
```

Storing a Panel

The Stored Panels are normally Protected as a safeguard against overwriting. Before storing a new instrument setup in a panel it is first necessary to select Not Protected. When you press (EXEC) to Save a panel, the current setup is saved and the stored panels field resets to Protected.

```
Keyboard is Unlocked   Beeper is Off

Select Panel  2

Stored Panels Not Protected
                     |
                 Protected
```

Select Save and press (EXEC) to store the panel.

```
Keyboard is Unlocked   Beeper is Off

Select Panel  2

Stored Panels Not Protected

Press EXEC to Save into Panel 2
               |
             Recall from
```

Data Logging

The Data Logging display is obtained by selecting INDEX Page 3.

Full details of internal and external printing are given in Section 5.

Printer Selection

Printer selection depends on Remote Control display selections

Only the internal printer is available when the instrument is configured as an addressable device.

```
Logging On    Logging Device HP3787B

Set the HPIB mode on page 5 to Talk Only
to use an external HPIB printer.
```

The internal printer HP3787B or an external printer HP-IB can be selected when the instrument is configured as a Talk Only device.

```
Logging  On    Logging Device   HPIB
                                  |
                                HP3787B
```

Triggering Prints of Result A Type Errors

With Log During Gating set to On you can chose to have a printout for every second which has error(s) Error Seconds or every second in which the error ratio exceeds a selectable limit Error Ratio >. The information printed is the number of errors (of the type selected for Result A) in the second when the trigger condition occurred.

When a jitter measurement is selected (option 001 only), Hit Bit Ratio or Hit Seconds can be logged.

```
Logging  On    Logging Device   HPIB

Log During Gating  On
          Trigger  Error Ratio >  1.0E-2
                         |
                   Error Second

                   Hit Bit Ratio>  1.0E-2
                         |
                     Hit Second
```

Printing Selected Results

With the End of Gating Summary set to On you can chose to print at the end of each gating period Always, or at the end of gating periods in which the error ratio has exceeded a selectable limit Error Ratio >.

This may be used to obtain prints at timed intervals with with repetitive gating.

```
Logging  On    Logging Device   HPIB

Log During Gating  On
          Trigger  Error Ratio >  1.0E-2

End of Gating Summary  On
                When   Error Ratio >  1.0E-2
                             |
                          Always
```

Select the content of the End of Gating Summary for each type of result:

Results, Analysis and Alarm Durations

`Off` for no print of that type of result.

`Selected` for what is currently selected (whether it is displayed or not).

`All` for all valid results of that type.

Frame Slips

```
End of Gating Summary  On
              When  Error Ratio > 1.0E-2

Content: Results    Off
         Analysis   Off
         Alarm Dur  Off
                     |
                  Selected
                     |
                    All
```

```
Content: Results    All
         Analysis   All
         Alarm Dur  All
         Slips      On
                     |
                    Off
```

Date and Time

The Date and Time display is obtained by selecting INDEX Page 4

Setting the Date and Time

With the Clock Mode at `Set` use the CURSOR and CHANGE keys to set both date and time.

When the Clock Mode is subsequently changed to `Run` the internal clock will run from these settings.

Move the cursor back to Set.

```
Clock Mode  Set

Date        01  January   1987

Time        00 Hrs 00 Mins 00 Secs
```

Press [NEXT] to change the clock mode to Run when the time corresponds to the time you have set.

The clock will then run.

```
Clock Mode  Run
```

Remote Configuration

The Remote Configuration display is obtained by selecting INDEX Page 5

Full details of remote operation are given in Section 6

Instrument Control Selection

Select HP-IB or RS232 control

```
Source  HPIB   Status:Local   Error:    0
         |
        RS232
```

HP-IB Address/External Print Selection

For remote HP-IB control select Addressable and set a unique address.

The default address is 07.

To use an external printer connected to the HP-IB output (without HP-IB control) select Talk only

```
Source  HPIB   Status:Local   Error:    0

                      Addressable   07
                            |
                       Talk Only
```

To select your printer, display the "Data Logging" page (Page 3 on the "INDEX"), then select the printer you want as the Logging Device.

```
Logging  On    Logging Device HP3787B

Set the HPIB mode on page 5 to Talk Only
to use an external HPIB printer.
```

The internal printer is always selected when the instrument is configured as an addressable device.

```
Logging  On    Logging Device    HPIB
```

Logging device selection may be HP3787B or HP-IB when the instrument is configured as a talk only device.

Printing Results on Demand

A time-stamped printout of results can be obtained at any time without affecting the measurement. The HP 3787B outputs the currently selected results on the receiver section of the "Normal Operation" page (page 1 on the "INDEX") when the PRINT key is pressed.

Results Available

The results available for display on the "Normal Operation" page are:

Results (eg Error Count and Error Ratio)
Analysis (eg % Availability and % Severe E. S.)
Alarm Duration (eg DS1 Pattern Loss Seconds and DS1 Frame Loss Seconds)
RX Level (DS1/1C only)
Monitor
Slips

A typical printout of each is given below.

```
03:15:17            Print
RESULT A:
DS1 Logic Results
Error Count...........15

RESULT B:
DS1 Logic Results
Error Ratio......1.1E-06
```

```
00:09:29            Print
ALARM DURATIONS:
Signal loss............0
```

```
23:19:24            Print
FRAME SLIPS:
Positive slips.........0
Negative slips.........0
```

```
00:10:55            Print
MONITOR WORD:
Received word...01100000
```

```
00:10:00            Print
RX LEVEL:
Positive peak.....+3.13V
Negative peak.....-3.28V
```

```
00:09:48            Print
ANALYSIS (A):
Availability.....100.00%
```

* RESULT A corresponds to the first measurement selected in the Results section. If a second measurement is selected it corresponds to RESULT B.

Logging During Gating - Display & Sample Print

A typical display for Log during gating and a sample print of a DS1 measurement are shown below.

```
Logging  On     Logging Device HP3787B

Log During Gating  On
           Trigger  Error Second

End of Gating Summary  Off
```

```
-------------------------
Hewlett-Packard     3787B
00:07:30  01/01/87  START
Gate Manual
DS1 Logic Results
ES Trigger : Async ES

00:07:34 Err Cnt.......1
00:07:36 Err Cnt.......1
00:07:39     DS1 SIG LOSS
00:07:39     DS1 MFA LOSS
00:07:39   DS1 FRAME LOSS
00:07:39     PATTERN LOSS
00:07:39   DS1 SIG REGAIN
00:07:39     RX IMBALANCE
00:07:39     DS1 SIG LOSS
00:07:39   DS1 SIG REGAIN
00:07:39 Err Cnt..401359
00:07:39   DS1 MFA REGAIN
00:07:39   DS1 FRM REGAIN
00:07:39   PATTERN REGAIN
00:07:41      RX LEVEL OK
00:07:50 Err Cnt.......1
00:07:58       POWER LOSS
DATE           01/01/1987
00:08:11     POWER REGAIN
DATE           01/01/1987
00:08:16 Err Cnt.......1
00:08:21             STOP
```

When a power loss occurs during gating with Logging On, the power fail date and time and the power regain date and time are printed.

Whenever an alarm changes state during gating with Logging On, the new state of the alarm is printed.

Logging at the End of Gating

When the End of Gating Summary is selected, a summary of results is printed at the end of the gating interval or when you press the START/STOP key to stop the test. The log can be triggered at the end of each gating interval or after specific gating intervals in which the error ratio exceeds a threshold value set in the range 1.0E-2 to 1.0E-7. The HP 3787B outputs a summary of results under the following headings:

Results
Analysis
Alarm Durations
Slips

The HP 3787B can be set to output any combination of the above to a printer. For Results, Analysis and Alarm Durations the instrument can be set to:

output the results currently selected on the "Normal Operation" page
or
output all the results that are available
or
output no results under this heading

The Frame Slips output can be set On or Off.

Procedure

1. Check that the HP 3787B clock is set to the correct time on the "Date and Time" page.

2. Select the measurement type and suitable gating on the "Normal Operation" page.

3. Display the "Data Logging" page.

4. Set Logging to On.

5. Select the printer (see Page 5-1).

6. Set End of gating summary to On, then select when you want a summary; Always or when the Error ratio exceeds a value set in the range 1.0E-2 to 1.0E-7.

7. For each result type, select the type of summary; Off, Selected or All. (On or Off for Frame Slips).
   Off: no summary
   Selected: the currently selected result
   All: all valid results

8. Start the test (gating led on), by pressing the START/STOP key. The instrument will automatically output the following:

Instrument model number	Measurement type
Start date and time of test	Logging trigger
Type of gating	Alarms (if any)

A summary is printed at the end of the gating interval or after you press the START/STOP key to stop the test.

Logging at the End of Gating - Display & Sample Print

A typical display for an End of Gating Summary and a sample print of a DS1 measurement are shown below.

```
Logging  On     Logging Device HP3787B

Log During Gating  Off

End of Gating Summary  On
                When      Always

Content: Results        All
         Analysis       All
         Alarm Dur      All
         Slips          On
```

When a power loss occurs during gating with Logging On, the power fail date and time and the power regain date and time are printed.

Whenever an alarm changes state during gating with Logging On, the new state of the alarm is printed.

```
--------------------------
Hewlett-Packard     3787B
00:01:49  01/01/87  START
Gate Manual
PSDC Logic Results
ES Trigger : Async ES

00:02:57      DS1 MFA LOSS
00:02:57    DS1 FRAME LOSS
00:02:57      PATTERN LOSS
00:02:57     EXCESS ZEROES
00:02:58      RX IMBALANCE

00:02:58 Err Cnt...33645
00:02:59      LOW RX LEVEL
00:02:59      DS1 SIG LOSS
00:02:59 Err Cnt...33645
00:03:00    1'S DENSITY OK
00:03:00 Err Cnt...33645
00:03:00    DS1 MFA REGAIN
00:03:00    DS1 FRM REGAIN
00:03:00    PATTERN REGAIN
00:03:01    DS1 SIG REGAIN
00:03:01 Err Cnt....3360
00:03:02       RX LEVEL OK

00:03:38        POWER LOSS
DATE            01/01/1987
00:03:51      POWER REGAIN
DATE            01/01/1987
00:03:51      PATTERN LOSS
00:03:51    PATTERN REGAIN
00:03:51      PATTERN LOSS
00:03:51    PATTERN REGAIN
00:03:51 Err Cnt....9666

00:04:13              STOP
00:04:13           Summary
RESULT A:
PSDC Logic Results
Error Count.......113961
Error Ratio......1.6E-02
Sync Err Secs...........4
Asyn Err Secs...........5
Async E.F.S...........125
% E.F.S..........96.1538

(No result B)

ANALYSIS (A):
Availability.....100.00%
Unavailability...0.0000%
Severe E.S.......3.8462%
Err Seconds......3.8462%
Degraded Mins....0.0000%
CSES.....................1
Severe E.S...............5
Err Seconds..............5
Degraded Mins............0

ALARM DURATIONS:
Pattern loss.............5
DS1 frame loss...........3
AIS Seconds..............0
Power loss..............13
Signal loss..............3

FRAME SLIPS:
Positive slips...........0
Negative slips...........0
```

Remote Control 6

Introduction

This section provides the information necessary to allow Remote Control of the HP 3787B via the HP-IB or via RS-232-C.

The HP 3787B can operate in Addressable or Talk Only modes. (Selectable on Page 5). Talk Only mode is explained in Section 5 PRINTING RESULTS.

Response/Program Messages (Continued)

FIRMWARE/SOFTWARE HISTORY

You can check the software version of your instrument manually or remotely.
Manually by selecting INDEX display: INSTRUMENT ID 6
Remotely by using the "FRN?" command.

Programs written for HP 3787B with software version 2726 can be used for any HP 3787B, except where they depend on the default Tx DS1C digroups being unframed, or the default state of alarm mask register 2 being 7. These programs will NOT make use of the additional features available with software version 2822.
Programs written for HP 3787B with software version 2822 and which make use of the additional features, will NOT run on instruments with software version 2726.

The following table lists the mnemonics of the functions which are affected by the software change from version 2726 to 2822 and explains the difference.

VERSION 2726	VERSION 2822	FUNCTION	DIFFERENCE
AL2?	AL2?	Alarm status enquiry	Bit 4 (16) and bit 5 (32) added for negative and positive frame slips. Bit 3 (8) added for signal loss
AM2	AM2	Alarm mask setting	Bits 4 and 5 added for frame slips. Bit 3 added for signal loss.
ANR?	ANR?	Analysis result enquiry	4 additional results.
ATY	ATY	Analysis type setting	4 new measurement types
EAT	EAT	Tx error add setting	Logic errors available in THRU mode (DS1 only)
------	FSL?	Frame slips result enquiry	Additional measurement.
LBT	LB0	DS0 loopback setting.	Additional DS0 loopbacks available.
LBT	LB1	DS1 loopback setting.	Additional DS1 in-band and datalink loopbacks.
LEC	LES	Log end of gating summary.	Frame slips added.
------	LHB?	Hub ID enquiry	Applies to added MJU loopback.
MDS	MDS	Measurement display select.	Frame slips added.
RDT	RDT	Rx data type	PROTOCOL available for 56kbit/s DDS and 64 kbit/s clear channel.
T1F	T1F	T1 framing	Applies to DS1C digroups as well as DS1.
TAM	TAM	DS0A Interface	Mnemonic DSX now DSX or Bipolar.
TDT	TDT	Tx data type.	Provision for ESF datalink message added. PROTOCOL available for 56kbit/s DDS and 64kbit/s clear channel.
------	TMC	ESF datalink message content setting.	ESF datalink has selectable content.
------	TMT	ESF datalink message type setting.	Enables setting of message/idle.
TNU	TNU	Tandem Number	Valid for alternating DS0DP loopback.
TSC	TSC	Tx DDS code	Additional bit selectable.

Setting Calendar (DATE & TIME)

Function	Mnemonic Code	Description
DATE	"DAT y,m,d" y = 1987 to 2050 m = 1 to 12 d = 1 to 31	Sets the Date portion of the Calendar. y = Year, m = Month, d = Day
	"DAT?"	Returns state of DAT ie 'y,m,d'.
TIME	"TIM h,m,s" h = 0 to 23 m = 0 to 59 s = 0 to 59	Sets the Time portion of the Calendar. h = Hours, m = Minutes, s = Seconds
	"TIM?"	Returns Hours, Minutes, Seconds Example:- To set the Calendar to 1143 on 3rd July 1987 send: **OUTPUT 707;"TIM 11,43,0; DAT 1987,7,3"** Example:- To read the calendar send: **OUTPUT 707;"TIM?;DAT?"** **ENTER 707;Hms$,Ymd$** **PRINT Hms$,Ymd$**

Setting TX Parameters (INTERFACE LEVEL)

Function	Mnemonic Code	Description
INSTRUMENT MODE	"MOD n"	
	n = TX&RX or 1	Independent TX & RX mode
	n = THRU or 2	Transmit Received Signal
	"MOD?"	Returns state of MOD ie 1 or 2
DS0 CLOCK SOURCE	"DCS n"	
(DS0/DS0A/DS0B)	n = FRONT or 1	Connect DS0 Clock to Front Panel
	n = REAR or 2	Connect DS0 Clock to Rear Panel
	"DCS?"	Returns state of DCS ie 1 or 2.
INTERFACE LEVEL	"TIN n"	
	n = DS1C or 1	(See TCD,TCF,TCL)
	n = DS1 or 2	(See TCD,T1F,TCL)
	n = DS0B or 3	(See DCS,T0R)
	n = DS0A or 4	(See DCS,T0R,TAM)
	n = DS0 or 5	(See DCS)
	"TIN?"	Returns state of TIN ie 1 to 5.
		Selection of Interface Level determines the Level at the TX output. Selection of Interface Level also incurs further selections eg DS1 incurs selection of Coding (TCD); Framing (T1F); Clock (TCL).
DS1/DS1C CODING	"TCD n"	
	n = AMI or 1	Alternate Mark Inversion
	n = B8ZS or 2	Binary 8 Zeros Substitution
	"TCD?"	Returns state of TCD ie 1 or 2
DS1C FRAMING	"TCF n"	DS1C Interface Level only
	n = OFF or Ø	Transmit Unframed DS1C
	n = ON or 1	Transmit Framed DS1C
	"TCF?"	Returns TCF state ie Ø or 1.
DS1/DS1C DIGROUP FRAMING	"T1F n"	DS1 Interface Level only
	n = OFF or Ø	No Framing
	n = T1DM or 1	T1 Data Multiplexer
	n = SF or D4 or 2	Superframe
	n = FT or 3	Ft only
	n = ESF or FE or 4	Extended Superframe
	"T1F?"	Returns state of T1F ie Ø to 4.

Setting TX Parameters (INTERFACE LEVEL)

Function	Mnemonic Code	Description
DS1 CLOCK	"TCL n"	
	n = INTERNAL or 1	Internal DS1 Clock source
	n = EXTERNAL or 2	External DS1 Clock source
	n = LOOPED or 3	RX Clock Looped to TX
	"TCL?"	Returns state of TCL ie 1 to 3.
		If the Instrument Mode (MOD) selected is *THRU* then the clock is always notionally *LOOPED* ie the TX Clock is derived from the RX Clock. If the instrument Mode selected is *TX&RX* the *LOOPED* Clock is derived from the DS1 RX. The *LOOPED* selection is therefore only valid if the Instrument Mode is *TX&RX* and the RX Interface Level (RIN) is *DS1*.
MULTIPLEXER RATE DS0A/DS0B	"T0R 1"	2.4 kbits
	"T0R 2"	4.8 kbits
	"T0R 3"	9.6 kbits
	"T0R 4"	56 kbits
	"T0R?"	Returns state of T0R ie 1 to 4.
DS0A INTERFACE MODE	"TAM n	
	n = BIPOLAR or 1	DSX cross-connect. Non TTL
	n = LOGIC_NEAR or 2	Logic Near Interface (Tip)
	n = LOGIC_FAR or 3	Logic Far Interface (Ring)
	"TAM?"	Returns state of TAM ie 1 to 3.
		If TAM and IAT (RX DS0A Termination) are both set to Logic then a change from NEAR to FAR or FAR to NEAR in either will cause the other to change automatically.
		EXAMPLE :- Require to Transmit at an Interface Level of DS1 with B8ZS Coding T1DM Framing and an External Clock in the TX&RX Mode :
		OUTPUT 707;"MOD TX&RX;TIN DS1; TCD B8ZS;T1F T1DM;TCL EXTERNAL"

Setting TX Parameters (SELECT LEVEL)

Function	Mnemonic Code	Description
SELECT LEVEL	"TSL n"	Only valid if TX Interface Level is DS1
	n = DS1 or 1	DS1
	n = DS0B or 2	(See TCU,T0R,TCR,TTS,INS)
	n = DS0A or 3	(See T0R,TTS,INS)
	n = PSDC or 4	SF or ESF Framing only(See TTS,INS)
	n = DS0 or 5	Not valid T1DM Framing(See TTS,INS)
	n = DATALINK or 6	ESF Framing only(SeeINS)
	n = FS_CHAN or 7	Ft Framing only(See INS)
	n = R_CHAN or 8	T1DM Framing only(See INS)
	"TSL?"	Returns state of TSL ie 1 to 8.
		This Message is only valid if the Interface Level (TIN) is DS1. Selection of Select Level may incur further selections eg Select level DS0B incurs selection of Customer Number (TCU); Data Rate (T0R); Customer Rate (TCR); Timeslot Insertion (INS); Timeslot Number (TTS).
ESF DATALINK MESSAGE TYPE	"TMT n"	Only valid if TSL is DATALINK
	n = IDLE or 1	Idle code transmitted
	n = WORD or 2	16 bit message (See TMC)
	"TMT?"	Returns state of TMT ie 1 or 2.
ESF DATALINK MESSAGE CONTENT	"TMC '0bbbbbb0'"	Content of 16 bit message is 0dddddd011111111 d = Data bit 0 or 1
	"TMC?"	Returns state of TMC ie '0bbbbbb0'
CUSTOMER NUMBER DS0B	"TCU n"	n depends upon Data Rate set by T0R. T0R = 2.4 kbits n = 1 to 20 T0R = 4.8 kbits n = 1 to 10 T0R = 9.6 kbits n = 1 to 5 T0R = 56 kbits n = 1
	"TCU?"	Returns state of TCU ie 1 to 20.
MULTIPLEXER RATE DS0A/DS0B	"T0R 1"	(2.4 kbits)
	"T0R 2"	(4.8 kbits)
	"T0R 3"	(9.6 kbits)
	"T0R 4"	(56 kbits)
	"T0R?"	Returns state of T0R ie 1 to 4.

Setting TX Parameters (SELECT LEVEL)

Function	Mnemonic Code	Description
CUSTOMER RATE DS0B	"TCR 1" "TCR 2" "TCR 3" "TCR?"	2.4 kbits (Insert Rate) 4.8 kbits (Insert Rate) 9.6 kbits (Insert Rate) Returns state of TCR ie 1 to 3. TCR must be < or = to T0R. If T0R is 56 kbits then TCR is illegal.
TIMESLOT NUMBER	"TTS n" n = 1 to 24 "TTS?"	Designates DS1 Timeslot into which Data is inserted. If DS1 Framing(T1F) is T1DM then selection of Timeslot 24 is illegal. Returns TTS state ie 1 to 24.
TIMESLOT INSERTION	"INS n" n = OFF or Ø n = ON or 1 "INS?"	No Insertion into Timeslot Transmit Data into Timeslot Returns state of INS ie Ø or 1. In *TX&RX* mode, Insertion is always ON. In *THRU* mode INS is only valid if Interface Level is DS1 and Select Level is other than DS1. EXAMPLE :- Wish to insert a 2047 bit PRBS test pattern into the 2.4 kbits Primary Channel of Customer #5 of a 9.6 kbits DS0B. The DS0B is contained within Timeslot 15 of the DS1 signal, which has D4 Framing and AMI Coding. The access is at the DS1 level : **OUTPUT 707;"MOD TX&RX;TIN DS1; TCD AMI;T1F D4;TCL INTERNAL; TSL DS0B;TCU 5;T0R 3;TCR 1;TTS 15; DLT SINGLE;TDC PRIMARY;TDT PATTERN;TRD PRBS_2047"**

Setting TX Parameters (DDS LINK TYPE)

Function	Mnemonic Code	Description
DDS LINK TYPE	"DLT n" n = SINGLE or 1 n = MULTI or 2 "DLT?"	DS0A & DS0B only Point to Point(See TDC) Multi-point(See TDC,SBR,MJU) Returns state of DLT ie 1 or 2. This Message is only valid when Interface Level (TIN) or Select Level (TSL) is DS0A or DS0B.
DDS CHANNEL TYPE	"TDC n" n = PRIMARY or 1 n = SECONDARY or 2 "TDC?"	Not valid for Alt. Loopback(See LBT) DDS Primary Channel DDS Secondary Channel Returns state of TDC ie 1 or 2.
SELECT BRANCH	"SBR n" n = 1 to 4 "SBR?"	Determines which MJU Branch will be affected by next MJU message. Returns state of SBR ie 1 to 4.
MULTI-POINT JUNCTION UNIT OPERATIONS	"MJU n" n = SELECT or 1 n = TEST or 2 n = END_TEST or 3 n = BLOCK or 4 n = UNBLOCK or 5 n = RELEASE or 6 "MJU?"	Select a Branch Test Selected Path Restore Normal Operation Block a Branch Unblock a Branch Unblock All Branches Returns state of MJU ie 1 to 6. EXAMPLE :- Wish to Transmit a 511 bit PRBS into Branch 4 of a Multi-Point Junction Unit :- **OUTPUT 707;"MOD TX&RX;TIN DS1; TCD B8ZS;T1F ESF;TCL INTERNAL;TSL DS0B;TCU 4;T0R 3;TCR 1;TTS 9; DLT MULTI;TDC PRIMARY;SBR 4;MJU SELECT;MJU TEST;LBT NONE;TDT PATTERN;TRD PRBS_511;EAT OFF"**

Setting TX Parameters (LOOPBACK)

Function	Mnemonic Code	Description
DS1 LOOPBACK TYPE	"LB1 n"	
	n = NONE or Ø	No Loopback
	n = IN_LINE or 1	In-band line loopback
	n = IN_NETWORK or 2	In-band network loopback
	n = DL_LINE or 3	ESF Datalink line loopback
	n = DL_NETWORK or 4	ESF Datalink network loopback
	n = DL_PAYLOAD or 5	ESF Datalink payload loopback
	"LB1?"	Returns state of LB1 ie 0 to 5
		Only valid when TIN and TSL are DS1 and ALT is OFF.
		ESF Datalink loopbacks (3 to 5) need TIF to be ESF.
DS0 LOOPBACK TYPE	"LB0 n"	Valid at DS0A and DS0B
	n = NONE or Ø	No Loopback
	n = ALT_DSU or 1	Alternating DSU L/B
	n = ALT_CHAN or 2	Alternating Channel L/B
	n = ALT_OCU or 3	Alternating OCU L/B
	n = ALT_RPT or 4	Alternating Repeater L/B
	n = ALT_HL96 or 5	Alternating HL96 L/B
	n = ALT_DATAPORT or 6	Alternating DS0 Dataport L/B
	n = LAT_DSØDP or 7	Latching DS0 Dataport L/B
	n = LAT_OCU or 8	Latching OCU L/B
	n = LAT_CSU or 9	Latching CSU L/B
	n = LAT_HL222 or 10	Latching HL222 L/B
	n = LAT_MJU or 11	Latching MJU L/B
	"LB0?"	Returns state of LB0 ie 0 to 11
		ALT_RPT Loopback is only valid at 56kbit/s DS0A or DS0B.
		LAT_MJU requires DDS link type DLT to be MULTI
ACTUATE LOOPBACK	"ALB"	For this Message to be valid a Loopback of some type must have been selected and the Gating stopped. If the Instrument is Gating the Message will be ignored and Error -25Ø will be generated.

Setting TX Parameters (LOOPBACK)

Function	Mnemonic Code	Description
RELEASE LOOPBACK	"RLB"	For this Message to be valid a Loopback of some type must have been selected and actuated and the Gating stopped. If the Instrument is Gating the Message will be ignored and Error -25Ø will be generated.
REPEATER NUMBER	"TRN n" n = 1 or 2 "TRN?"	Sets the Repeater Number for a 56 kbits Alternating Repeater Loopback. Returns state of TRN ie 1 or 2.
HL96NY PRESENCE	"HLP n" n = No or Ø n = YES or 1 "HLP?"	Only valid if an Alternating OCU Loopback is selected. HL96NY Card absent HL96NY Card Present Returns state of HLP ie Ø or 1.
TANDEM NUMBER	"TNU n" n = 1 to 8 "TNU?"	Only valid if a latching DS0DP or alternating dataport loopback has been selected. Returns state of TNU ie 1 to 8.
NUMBER OF INTERMEDIATE REPEATERS	"TIR n" n = Ø to 2 "TIR?"	Only valid if a 56 kbit Alternating Channel Loopback is selected. Returns state of TIR ie Ø to 2.

Setting TX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
DATA TYPE	"TDT n"	
	n = PATTERN or 1	(See TRD,TSW,TRP)
	n = CODE or 2	DDS Special Codes. DDS Primary Channel only.(See TRC,TSC,TXC,STC)
	n = PROTOCOL or 3	Data from Protocol Analyzer. Valid for all DDS primary and secondary channels (including 56kbit/s), ESF 4kbit/s Datalink, FS_Chan and R_Chan.
	n = MESSAGE or 4	ESF Datalink only (See TMT, TMC)
	"TDT?"	Returns state of TDT ie 1 to 4. If an Alternating Loopback is selected then TDT must be Pattern. If Code is to be transmitted into a channel which has a Latched Loopback, the Loopback must be established before selecting CODE otherwise Error -252 occurs.
PATTERN TYPE	"TRD n"	
	n = PRBS_20 or 1	2Ø Stage PRBS(See TZL)
	n = ALL_ONES or 2	All Ones Word
	n = SETTABLE or 3	Settable Word(See TSW)
	n = PRBS_2047 or 4	2Ø47 Bit PRBS
	n = PRBS_511 or 5	511 Bit PRBS
	n = PREPROG or 6	User defined Pattern(See TRP)
	"TRD?"	Returns state of TRD ie 1 to 6. The Pattern Type validity depends on Select Level & DDS Channel Type :- *PRBS_2Ø* - Only valid at DS1&DS1C. *ALL_ONES* - Not valid for DDS Secondary Channel or Alt. Loopback *SETTABLE* - NOT valid for Datalink; FS_Chan; R_Chan;DDS Secondary Channel or Alternating Loopback. *PRBS_2Ø47; PRBS_511* - NOT valid for DS1 or DS1C. *PREPROG* - Valid for DS0B; DS0A; DDS Primary Channel; DS0 & PSDC.
14 ZERO LIMIT	"TZL n"	PRBS_20 only.
	n = OFF or Ø	No 14 Zero Limit
	n = ON or 1	PRBS_20 14 Zero Limited
	"TZL?"	Returns state of TZL ie Ø or 1.

Setting TX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
SETTABLE WORD	"TSW 'bbbbbbbb'"	The content of the 8 bit (b) Word depends upon the Interface or Select Level selected:- DS1/DS1C 'dddddddd' 64 kbits Clr. Chan. 'dddddddd' 56 kbits DDS 'ddddddd1' 56 kbits PSDC 'ddddddds' DS0B <56 kbits 'fdddddd1' DS0A <56 kbits '1dddddd1' d = Data bit Ø or 1 s = Signaling bit f = subrate Frame bit
	"TSW?"	Returns state of TSW ie 'bbbbbbbb'.
USER DEFINED PATTERN LOAD	"TRP #H"	This Message allows the user to define a Preprogrammed Pattern . The user can enter any number of Bytes of data in the range 1 to 256, in Block format (IEEE Standard 728 #H). A Byte consists of two Hexadecimal Characters ie two of (0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F). The selectable content (d) of the bytes depends on the interface or "select level" selected: 64 kbits Clr. Chan. 'dddddddd' 56 kbits DDS 'dddddddd' 56 kbits PSDC 'ddddddds' DS0B/DS0A <56 kbits 'fddddddd' In all cases the user enters an 8 bit Byte (2 HEX. Characters). The HP3787B overwrites bit 8 (s) in PSDC and bit 1 (f) in DS0A/B < 56k bit/s. When all bytes have been transmitted the TX starts again at the beginning of the Pattern. Example :-To define a Pattern of 0011001011110000 (32F0H) send : **OUTPUT 707;"TDT PATTERN; TRD PREPROG;TRP #H32FØ"**
	"TRP?"	Returns the currently loaded user defined Pattern in #H Block format.

Setting TX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
DDS CODE	"TRC n"	Only valid if DDS Primary Channel and TX Data Type is Pattern.
	n = CMI or 1	Control Mode Idle
	n = OCU_LB or 2	OCU Loopback
	n = CHAN_LB or 3	Channel Loopback
	n = DSU_LB or 4	DSU Loopback
	n = TIP or 5	Transition In Progress
	n = LBE or 6	Loopback Enable
	n = FEV or 7	Far End Voice
	n = TA or 8	Test Alert
	n = MA or 9	MJU Alert
	n = UMC or 10	Unassigned Mux Channel
	n = BLOCK or 11	MJU Block
	n = RLS or 12	MJU Release
	n = ASC or 13	Abnormal Station Condition
	n = TEST or 14	Test
	n = OOS or 15	Out Of Sync (Mux)
	n = SETTABLE or 16	User Settable Code(See TSC)
	"TRC?"	Returns state of TRC ie 1 to 16.
START DDS CODE	"TXC"	When the DDS Code has been selected the HP 3787B sends an "ALL 1's" PATTERN This Message starts the transmission of the selected Code.
STOP DDS CODE	"STC"	This message stops transmission of the selected Code and the HP 3787B reverts to transmitting an "ALL 1's" PATTERN. The following Messages also perform this function :- Change of TX Interface Level(TIN) Change of TX Multiplexer Rate(T0R) Change of DDS Link Type(DLT) Change of TX Timeslot No.(TTS) Change of TX Customer No.(TCU) Change of TX Customer Rate(TCR) Change of TX Data Type(TDT) Change of TX DDS Channel Type(TDC) Change of TX DDS Code(TRC) Change of TX DDS Settable Code(TSC)

Setting TX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
DDS SETTABLE CODE	"TSC 'bbbbbbbb'"	The content of the 8 bit (b) Code depends upon the DDS Rate selected :- 56 kbits DDS "dddddddd" DS0B <56 kbits "fddddddd" DS0A <56 kbits "1ddddddd" d = Data bit Ø or 1 f = subrate Frame bit
	"TSC?"	Returns state of TSC ie 'bbbbbbbb'. Example :- Transmit a Settable DDS Code of all 0's at a DS0A rate of 2.4 kbits. Interface is at DS1 with D4 Framing and B8ZS Coding and the DS0A is contained in Timeslot 2 **OUTPUT 707;"MOD TX&RX;TIN DS1; TCD AMI;T1F D4;TCL INTERNAL;TSL DS0A;TTS 2;T0R 1;DLT SINGLE;TDC PRIMARY;TDT CODE;TRC SETTABLE; TSC '1ØØØØØØ1'"**
SIGNALING MODE	"TSM n"	
	n = SET or 1	Set Signaling bits. (See SIG)
	n = RETRANSMIT or 2	TX received Signaling bits
	"TSM?"	Returns state of TSM ie 1 or 2. *Retransmit* is only valid in *THRU* mode when receiving PSDC and wishing to retransmit into the same Timeslot.
SIGNALING BITS	"SIG 'xxyy'"	This message is only valid when Select Level is 56 kbits *PSDC* or 4 kbits *DATALINK* (See TSL) and when DS1 Framing is *SF* or *ESF* (See T1F). If DS1 Framing is *SF*, only two bits are valid ie xx, however spaces must be substituted for yy ie "xx ". If DS1 Framing is *ESF*, four bits are valid ie xxyy. x value = Ø or 1, y value = Ø or 1.
	"SIG?"	Returns state of SIG ie 'xx ' or 'xxyy'.

Setting RX Parameters (MEASUREMENT TYPE)

Function	Mnemonic Code	Description
		INTERFACE LEVEL DS1C **Meas Select** — **Meas B Availability** DS1C — As Measurement A Digroup — As Measurement A + DS1C Code/BPV, DS1C Frame DS0B,DS0A, PSDC,Clear Channel, Datalink, FS_Chan & R_Chan — As Measurement A + Digroup Frame, DS1C Frame, DS1C Code/BPV If Framing is ESF and Measurement Select is Digroup then Digroup CRC replaces Digroup Frame. If Framing is ESF and Measurement Select is DS0B, DS0A, PSDC, Clear Channel or Datalink then Digroup CRC & Digroup Frame are available. INTERFACE LEVEL DS1 **Meas Select** — **Meas B Availability** DS1 — As Measurement A DS0B,DS0A PSDC,Clear Channel, Datalink, FS_Chan & R_Chan — As Measurement A + DS1 Code/BPV, DS1 Frame, DS1 Jitter (OPT 001 only) If Framing is ESF then DS1 CRC is available when Measurement Select is DS1, DS0B, DS0A, PSDC, Clear Channel or Datalink. When there is effectively no Measurement Select ie DS1C Unframed, DS1 Unframed, DS0B Interface Level, DS0A Interface Level or DS0 Interface Level then Meas B availability is the same as for Meas A.

Setting RX Parameters (MEASUREMENT TYPE)

Function	Mnemonic Code	Description
JITTER FILTER (Option 001 Only)	"JFL n"	
	n = LP or 1	Low Pass
	n = LP_HP1 or 2	Low Pass & High Pass 1
	n = LP_HP2 or 3	Low Pass & High Pass 2
	"JFL?"	Returns state of JFL ie 1 to 3.
JITTER FILTER THRESHOLD (Option 001 Only)	"JFT n"	
	n = 0.05 to 10.00 UI	Resolution 0.01 UI.
	"JFT?"	Returns state of JFT ie 0.05 to 10.00 UI.
ANALYSIS SOURCE	"ANS n"	
	n = A or 1	Result A
	n = B or 2	Result B
	"ANS?"	Returns state of ANS ie 1 or 2.
		Analysis is only possible on one result during any Gating Period. If analysis of a second result is required a new Gating Period must be used. Analysis is not possible when only Jitter measurements are being performed.
ANALYSIS TYPE	"ATY n"	
	n = AVAIL or 1	% Availability
	n = UNAVAIL or 2	% Unavailability
	n = SEVERE_ES or 3	% Severe Error Seconds
	n = ERROR_SEC or 4	% Error Seconds
	n = MINUTES or 5	% Degraded Minutes
	n = CSES or 6	Consecutive severely errored seconds count
	n = SEVERE_CNT or 7	Severely errored seconds count
	n = ES_CNT or 8	Error seconds count
	n = MINS_CNT or 9	Degraded minutes count
	"ATY?"	Returns state of ATY ie 1 to 9.
ALARM DURATION TYPE	"ADT n"	
	n = PATTERN or 1	Pattern Loss
	n = SUBR_FRAME or 2	Subrate Frame Loss
	n = DS1_FRAME or 3	DS1 Frame Loss
	n = DIGR_FRAME or 4	Digroup Frame Loss
	n = DS1C_FRAME or 5	DS1C Frame Loss
	n = AIS_SECS or 6	AIS Seconds
	n = INST_POWER or 7	Instrument Power Loss
	n = SIGNAL or 8	Signal Loss
	"ADT?"	Returns state of ADT ie 1 to 8
		The Alarm Duration Type availability depends upon the selection of Interface Level and/or Measurement Select :-

Setting RX Parameters (MEASUREMENT TYPE)

Function	Mnemonic Code	Description
		INST_POWER : Always available. *AIS_SECS* : Available when Interface Level is DS1C or DS1. *DS1C_FRAME* : Framed DS1C *DS1_FRAME* : Framed DS1 *DIGR_FRAME* : Framed DS1C & Meas. Select other than DS1C *SUBR_FRAME* : Interface Level or Meas. Select, DS0B <56 kbits. *SIGNAL* : Signal Loss can be DS1C; DS1; DS0B; DS0A and is directly related to the Interface Level. *PATTERN* : Pattern Loss is available at all Interface Levels and all Measurement Select if the RX Data Type is Pattern and the RX Pattern Type is other than Traffic or DDS Codes.

Setting RX Parameters (GATING)

Function	Mnemonic Code	Description
GATING TYPE	"GTY n"	
	n = MANUAL or 1	Manual Gating(See STR,STP)
	n = SINGLE or 2	Single Interval(See GPR,STR)
	n = REPEAT or 3	Repetitive Interval(See GPR,STR,STP)
	n= SHORT_1S or 4	1 Second Repeat(See STR,STP)
	n = SHORT_15S or 5	15 Second Repeat(See STR,STP)
	n = SHORT_5M or 6	5 Minute Repeat (See STR, STP)
	n = SHORT_15M or 7	15 Minute Repeat (See STR, STP)
	"GTY?"	Returns state of GTY ie 1 to 7.
GATING PERIOD	"GPR d,h,m,s" d = Ø to 99 h = Ø to 23 m = Ø to 59 s = Ø to 59	Sets the measurement Gating Period. d = Days, h = Hours, m = Minutes, s = Seconds.
	"GPR?"	Returns state of GPR ie 'd,h,m,s'.
START GATING	"STR"	Clears all results and causes the instrument to start gating.
STOP GATING	"STP"	Causes the instrument to stop gating. The Results are updated. EXAMPLE :- To select and start Repetitive Gating of 1 Day, 23 Hours, 59 Minutes and 9 Second send : **OUTPUT 707;"GTY REPEAT; GPR Ø1,23,59,Ø9" OUTPUT 707;"STR"**

Setting RX Parameters (ALARM MASK/STATUS)

Function	Mnemonic Code	Description
ALARM MASK REGISTER 1	"AM1 n"	Not included in Saved Panel.
	n = NONE or Ø	No AM1 type Alarms
	n = PAT or 1	Pattern Sync Loss
	n = SL1 or 2	DS1/DS1C Signal Loss
	n = SLØ or 4	DS0A/DS0B Signal Loss
	n = CL1 or 8	DS1 External Clock Loss
	n = CLØ or 16	DS0 External Clock Loss
	n = FLC or 32	DS1C Frame Sync Loss
	n = MFA or 64	DS1 Multi-Frame Align Sync Loss
	n = FL1 or 128	DS1 Frame Sync Loss
	n = FLB or 256	DS0B Subframe Sync Loss
	n = AIS or 512	DS1 Alarm Indication Signal
	n = XBT or 1Ø24	X-Bit Alarm
	n = YAL or 2Ø48	Yellow Alarm
	n = ERR or 4Ø96	Errors/Hits
	"AM1?"	Returns the state of AM1 ie Ø to 8191
ALARM MASK REGISTER 2	"AM2 n"	Not included in Saved Panel
	n = NONE or Ø	No AM2 type Alarms
	n = SLH or 1	DS1/DS1C Signal Level High
	n = SLL or 2	DS1/DS1C Signal Level Low
	n = SLI or 4	DS1/DS1C Signal Level Imbalance
	n = SLZ or 8	Signal loss
	n = NFS or 16	Negative frame slip
	n = PFS or 32	Positive frame slip
	"AM2?"	Returns state of AM2 ie Ø to 63.
	If Multiple alarms are required the Message can be specified in 3 ways :- 1. A list of integers ie "AM1 1,8,64,512; AM2 4" 2. A list of mnemonics ie "AM1 PAT,CL1,MFA, AIS;AM2 SLI" 3. A single integer ie "AM1 585;AM2 4" (585 = 1+8+64+512)	NOTE :- All Front Panel Alarms are included in the Alarm Mask Registers. In addition the following "extra" Alarms are included :- Signal Loss (DS0), External Clock Loss (DS0), External Clock Loss (DS1), Multi-Frame Alignment Sync Loss (DS1), Signal Level High (DS1/DS1C), Signal Level Low (DS1/DS1C) and Signal Level Imbalance (DS1/DS1C). The Alarm Mask Registers are used to determine under what Alarm conditions the the instrument should issue an SRQ. To achieve an SRQ on Alarm :- 1. Set the Alarm Mask Registers to the required value (Ø to 8191 &/or Ø to 63). 2. Set Bit 9(AL1) &/or Bit 1Ø(AL2) in Status register A. (See Common Capabilities "STA" Message).

Setting RX Parameters (ALARM MASK/STATUS)

Function	Mnemonic Code	Description
		The instrument will then issue an SRQ whenever Bit 1 (ALC Bit) in the Status Byte (Status Register B) is set.
ALARM STATUS REGISTER 1 RESULT	"AL1?"	Returns the current status of Alarm Status Register 1 as an integer (Ø to 8191). Alarm Weighting is as follows :- *Ø* (No AM1 type Alarms) *1* (Pattern Sync Loss) *2* (DS1/DS1C Signal Loss) *4* (DS0A/DS0B Signal Loss) *8* (DS1 External Clock Loss) *16* (DS0 External Clock Loss) *32* (DS1C Frame Sync Loss) *64* (DS1 Multi-Frame Align Sync Loss) *128* (DS1 Frame Sync Loss) *256* (DS0B Subframe Sync Loss) *512* (DS1/DS1C AIS) *1Ø24* (X-Bit Alarm) *2Ø48* (Yellow Alarm) *4Ø96* (Errors/Hits) The value is updated every 100mS regardless of Gating.
ALARM STATUS REGISTER 2 RESULT	"AL2?"	Returns the current status of Alarm Status Register 2 as an integer (Ø to 63). Alarm Weighting is as follows :- *Ø* (No AM2 type Alarms) *1* (DS1/DS1C Signal Level High) *2* (DS1/DS1C Signal Level Low) *4* (DS1/DS1C Signal Level Imbalance) *8* (Signal loss) *16* (Negative frame slip) *32* (Positive frame slip) The value is updated every Second regardless of Gating.

Setting RX Parameters **(OUTPUT RESULTS)**

Function	Mnemonic Code	Description
RESULT A	"RSA? n" n = COUNT or 1 n = RATIO or 2 n = SYNC_ES or 3 n = ASYNC_ES or 4 n = ASYNC_EFS or 5 n = PER_EFS or 6	Not valid for Jitter results(See RJA?) Error Count Error Ratio Synchronous Error Secs Asynchronous Error Secs Asynchronous Error Free Secs % Error Free Seconds Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
JITTER RESULT A (Option ØØ1 Only)	"RJA? n" n = HIT_COUNT or 1 n = HB_COUNT or 2 n = HB_RATIO or 3 n= HIT_SECS or 4 n = HITF_SECS or 5 n = PK_TO_PK or 6	Only valid for Jitter results. Jitter Hit_Count Jitter Hit Bit Count Jitter Ratio Hit/Bit Jitter Hit Seconds Jitter Hit Free Seconds Peak to Peak Jitter Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
RESULT B	"RSB? n" n = COUNT or 1 n = RATIO or 2 n = SYNC_ES or 3 n = ASYNC_ES or 4 n = ASYNC_EFS or 5 n = PER_EFS or 6	Not valid for Jitter results(See RJB?) Error Count Error Ratio Synchronous Error Secs Asynchronous Error Secs Asynchronous Error Free Secs % Error Free Secs Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
JITTER RESULT B (Option ØØ1 Only)	"RJB? n" n = HIT_COUNT or 1 n = HB_COUNT or 2 n = HB_RATIO or 3 n = HIT_SECS or 4 n = HITF_SECS or 5 n = PK_TO_PK or 6	Only valid for Jitter results Jitter Hit Count Jitter Hit Bit Count Jitter Ratio Hit/Bit Jitter Hit Seconds Jitter Hit Free Seconds Peak to Peak Jitter Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).

Setting RX Parameters (OUTPUT RESULTS)

Function	Mnemonic Code	Description
ANALYSIS RESULT	"ANR? n"	Message is invalid if both Measurement Types (MTA & MTB) are JITTER.
	n = AVAIL or 1	% Availability
	n = UNAVAIL or 2	% Unavailability
	n = SEVERE_ES or 3	% Severe Error Secs
	n = ERROR_SEC or 4	% Error Secs
	n = MINUTES or 5	% Degraded Minutes
	n = CSES or 6	Consecutive Severely Errored Seconds count
	n = SEVERE_CNT or 7	Severely Errored Seconds count
	n = ES_CNT or 8	Errored Seconds count
	n = MINS_CNT or 9	Degraded Minutes count
		Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
ALARM DURATION RESULT	"ALD? n"	
	n = PATTERN or 1	Pattern Loss
	n = SUBR_FRAME or 2	Subrate Frame Loss
	n = DS1_FRAME or 3	DS1 Frame Loss
	n = DIGR_FRAME or 4	Digroup Frame Loss
	n =DS1C_FRAME or 5	DS1C Frame Loss
	n = AIS_SECS or 6	AIS Seconds
	n = INST_POWER or 7	Instrument Power Loss
	n = SIGNAL or 8	Signal Loss
		Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
INPUT VOLTAGE RESULT (DS1/DS1C)	"RXL? n"	
	n = POSITIVE or 1	Peak +ve Voltage
	n = NEGATIVE or 2	Peak -ve Voltage
		Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Only valid if RX Interface is DS1 or DS1C. Result is Voltage measured during the last second. Flag is always 1 (Valid).

Setting RX Parameters (OUTPUT RESULTS)

Function	Mnemonic Code	Description
MONITOR WORD RESULT	"MON?"	Message is valid for DDS Primary Channel, DDS Secondary Channel DS0 Clear Channel and PSDC. Returns the 8 bit Monitor Word as 8 characters enclosed in double quotes, preceded by a Validity Flag. ie Flag, "nnnnnnnn". n = Ø or 1. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
MJU LOOPBACK IDENTIFICATION ENQUIRY	"LHB?"	Valid only when LB0 is set to LAT_MJU Returns: Validity flag,nn where nn is the hub ID in octal and the validity flag is 1 for result valid and 0 for result invalid.
FRAME SLIPS RESULT ENQUIRY	"FSL? n" n = POSITIVE or 1 n = NEGATIVE or 2	Positive frame slip count Negative frame slip count The frame slip measurement is performed automatically when receiving a 56 or 64 kbit/s channel with the receiver data type (RDT) set to PATTERN and the pattern type (RCD) set to PRBS_2047 or PRBS_511. Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Flag is always 1 ie valid result.

Setting RX Parameters (OUTPUT RESULTS)

Function	Mnemonic Code	Description
SIGNALING BITS RESULT	"SGR?"	Is only valid when Measurement selection is 56 kbits PSDC or 4 kbits Datalink and DS1/Digroup Framing is SF or ESF. If Framing is SF, 2 Signaling Bits with 2 trailing spaces("xx ") are returned. If Framing is ESF, 4 Signalling Bits ("xxyy") are returned. Returns Result in the form :- Validity Flag, "xxyy". x = Ø or 1, y = Ø or 1. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
ELAPSED TIME RESULT	"ELP?"	Returns the Elapsed Time since the start of Measurement period. Returns Result in the form :- Validity Flag, Days, Hours, Minutes, Seconds. Days = Ø to 99, Hours = Ø to 23, Minutes = Ø to 59 and Seconds = Ø to 59. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
MJU BRANCH SELECT CODE RESULT	"BSC?"	Only valid if TX DDS Link Type (DLT) is MULTI Returns the MJU Branch Select Code, which is a confirmation from an MJU following a Route Message (See TX Parameters (DDS LINK TYPE), where the MJU indicates which Branch has been selected. Returns Result in the form :- Validity Flag, n. n = 1 to 4. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
MJU HUB-ID RESULT	"HUB? n" n = PRESENT or 1 n = PREVIOUS or 2	Only valid if TX DDS Link Type (DLT) is MULTI. Returns ID number of the present HUB Returns ID number of the previous HUB Returns Result in the form :- Validity Flag, nn. nn = ØØ to 77(Octal). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
LATCHING LOOPBACK MAPCODE RESULT	"MAP?"	Only valid for DS0DP, OCU, CSU and HL222, DDS Latched Loopbacks (See LBT). Reads the MAPCODE (Identity) of equipment that has been looped using a DDS Loopback. Returns Result in the form :- Validity Flag, n. n = Ø or 1. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).

Miscellaneous Parameters (DATA LOGGING)

Function	Mnemonic Code	Description
LOGGING ON/OFF	"LOG n"	
	n = OFF or Ø	(See LOD)
	n = ON or 1	(See LDV,LEG,LES,LET,LDG,LDT)
	"LOG ?"	Returns state of LOG ie Ø or 1.
LOGGING DEVICE	"LDV n"	
	n = HP 3787B or 1	Internal Printer
	n = HP-IB or 2	External Printer. Only via RS-232-C. Not allowed via HP-IB as HP 3787B would need to be in Talk Only.
	"LDV?"	Returns state of LDV ie 1 or 2.
LOG AT END OF GATING	"LEG n"	
	n = OFF or Ø	No Summary at end of Gating period
	n = ALWAYS or 1	Summary at end of every Gating period(See LES)
	n = RATIO or 2	Summary at end of Gating when Error/Hit Ratio exceeds threshold(See LES,LET)
	"LEG?"	Returns state of LEG ie Ø to 2.
CONTENTS OF END OF GATING SUMMARY	"LES a,b,c,d"	
	a = OFF or Ø	No Measurement Results
	a = SELECTED or 1	Only those Measurement Results selected on the RX Page
	a = ALL or 2	All Measurement Results
	b = OFF or Ø	No Analysis Results
	b = SELECTED or 1	Only those Analysis Results selected on the RX Page
	b = ALL or 2	All Analysis Results
	c = OFF or Ø	No Alarm Duration Results
	c = SELECTED or 1	Only those Alarm Duration Results selected on the RX Page
	c = ALL or 2	All Alarm Duration Results
	d = OFF or Ø	No Frame Slips Results
	d = ON or 1	All Frame Slips Results
	"LES?"	Returns state of LES ie 'a,b,c,d'.
ERROR RATIO THRESHOLD FOR END OF GATING SUMMARY	"LET n"	n = 2 to 7 representing an Error Ratio of 1.ØE-2 to 1.ØE-7.
	"LET?"	Returns the state of LET ie 2 to 7.

Miscellaneous Parameters (DATA LOGGING)

Function	Mnemonic Code	Description
		EXAMPLE :- To obtain a summary of Selected Measurement Results, all Alarm Duration results and Frame Slips on the Internal Printer at the end of each Gating period when the Error Rate exceeds 1 in 10 million send : **OUTPUT 707;"LOG ON;LDV HP 3787B; LEG RATIO;LET 7; LES "1,0,2,1"**
LOG DURING GATING	**"LDG n"** n = OFF or Ø n = ERR_SEC or HIT_SEC or 1 n = RATIO or 2 "LDG?"	 No Logging during Gating When an Error Second or a Hit Second (Opt 001 only) occurs. When the Error Ratio or Hit Ratio (Opt 001 only) exceeds threshold.(See LDT) Returns state of LDG ie Ø to 2. Note :-It is possible to have Logging During Gating and Logging at End of Gating both selected.
ERROR RATIO THRESHOLD FOR LOGGING DURING GATING	"LDT n" "LDT?"	n = 2 to 7 representing an Error Ratio of 1.ØE-2 to 1.ØE-7. Returns state of LDT ie 2 to 7.
LOG ON DEMAND	"LOD"	This message mimics the "PRINT' key in Local Mode and will cause the currently selected set of results to be Logged on the Internal Printer even if LOGGING is disabled (LOG OFF). One of the following will be logged :- Measurement Results, Analysis Results, Alarm Duration Results, Monitor Word Result or Input Voltage Result. LOD provides the only remote method of Logging the Monitor Word and Input Voltage Results.

Miscellaneous Parameters (STORED PANELS & BEEPER)

Function	Mnemonic Code	Description
SAVE PANEL	"SAV n" n = 1 to 9	Corresponds to non volatile Memory locations. The current instrument settings are stored in the designated Memory location. This is only possible if Write Protection is OFF ie "PRP Ø". The state of Request Service (RQS), Alarm Mask Registers 1 & 2 (AM1,AM2) and User Defined Pattern (TRP) are not Saved by this Message, nor recalled by the Recall Panel Message (RCL).
PROTECT PANEL	"PRP n"	
	n = OFF or Ø	Write Protection Off. SAV valid
	n = ON or 1	Write Protection On. SAV invalid
	"PRP ?"	Returns state of PRP ie Ø or 1.
RECALL PANEL	"RCL n" n = Ø to 9	Corresponds to non volatile Memory locations. Location Ø holds the instrument DEFAULT settings and cannot be used when saving settings. The instrument settings stored in the designated Memory location are recalled and the instrument configured according to those settings.
AUDIO CONTROL	"AUD n"	
	n = OFF or Ø	Only sounds on User Error
	n = ON or 1	Sounds on User & Bit Errors, & Alarm
	"AUD ?"	Returns state of AUD ie Ø or 1.

Miscellaneous Parameters (DISPLAYS SELECT)

Function	Mnemonic Code	Description
TX/RX DISPLAY	"TRS n" n = TX or 1 n = RX or 2 "TRS ?"	 Display TX Parameters Display RX Parameters Returns state of TRS ie 1 or 2. NOTE :- This Message does not change the programmed measurement. This Function is still available via Front Panel Keys when the HP 3787B is under Remote Control.
MEASUREMENT DISPLAY	"MDS n" n = RESULTS or 1 n = ALARMS or 2 n = BIT_MON or 3 n = INP_LEV or 4 n = ANALYSIS or 5 n = SLIPS or 6 "MDS?"	 Display Measurement Results Display Alarm Durations Display Monitor Word Display Input Voltage Display Analysis Results Display Frame Slips Returns state of MDS ie 1 to 6. NOTE :- This Message does not change the programmed measurement. This Function is still available via Front Panel Keys when the HP 3787B is under Remote Control. Results & Analysis are not valid when receiving :- Framed DS1C with Framed Digroups DDS Secondary Channel + RDT Protocol 56 kbits DS0B with DDS Codes Bit_Mon is only valid for DDS Secondary Channel, Meas. Select DS0 or PSDC Slips is only valid when receiving a 56 or 64 kbit/s channel with PRBS selected.

Common Capability Messages

Function	Mnemonic Code	Description
CLEAR	"CLR"	Clears all instrument errors and flushes all buffers without changing the programmed measurement :- All Buffers Flushed Stops Asserting SRQ Sets "RQS 32"(ERR) Clears Error Register Clears Status Registers A & B. (If the HP 3787B is Gating, GIP Bit 12, of Status Register A is not affected) Sets ready Register to 1
CONFIGURATION	"CON?" "CON ";Block$	Reads the instrument settings in Block format (IEEE Standard 728 #H). The settings can then be stored in the controller. At a later date the instrument can be returned to those settings, using "CON ";Block$ EXAMPLE :- To Store Settings **DIM Block$[2000]** **OUTPUT 707;"CON?"** **ENTER 707;Block$** To return to Stored Settings **OUTPUT 707;"CON";Block$**
ERROR CODE	"ERR?"	Reads the instruments Error Register, which contains an integer in the range -32,768 to 32,767. (See Appendix D for list of Error Codes). The Error Register is cleared by ERR?, RST, CLR, Device Clear and Selective Device Clear.
IDENTIFICATION	"ID?"	Returns "HP 3787B"

Common Capability Messages

Function	Mnemonic Code	Description
RESET	"RST"	Sets the instrument to the Default conditions (See Appendix E) :- Clears all results Stops Gating Stops asserting SRQ Flushes all Buffers Sets RQS to 32 (ERR) Clears Error Register Clears Status Registers A & B Clears Alarm Status Registers 1 & 2 Sets Ready Register to 1 Sets Key Register to Ø
STATUS REGISTER A	"STA?"	Returns an integer in the range Ø to 8191 representing the contents of Status Register A. For weighting See RQS. Register is cleared by RST.
STATUS REGISTER B	"STB?"	Returns an integer in the range Ø to 255 representing the contents of Status Register B ie the STATUS BYTE. Weighting is as follows :- *1* (End Of Gating) *2* (Alarm Change) *4* (Front Panel Key has been pressed) *8* (Power has Cycled) *16* (Data Ready for Output) *32* (Error has occurred) *64* (SRQ generated) *128* (Data Logging has occurred) The Register is cleared by CLR, RST, Device Clear and Selective Device Clear.

Common Capability Messages

Function	Mnemonic Code	Description
USER CONFIDENCE TESTS	"TST n"	
	n = CTRL_ROM or 2	Control CPU ROM CRC
	n = CTRL_RAM or 3	Control CPU RAM
	n = CRT_CTRL or 9	CRT Controller
	n = RTC or 11	Real-Time Clock
	n = RS232 or 12	RS232 Test (needs test connector)
	n = PGA or 13	Pattern Gate Array
	n = DS1 or 14	DS1 Gate Array
	n = DS1C or 15	DS1C Gate Array
	n = DS0_CPU or 16	DS0/CTRL CPU Comms
	n = DS0_ROM or 17	DS0 CPU EPROM
	n = DS0_RAM or 18	DS0 CPU RAM
	n = DS1_IF or 19	DS1/1C Loopback
	n = DS0_IF or 20	DS0 Loopback (needs DS0 clocks)
	n = PA or 21	Protocol Analyzer PLLS
	n = PRINTER or 24	UPI Printer
	n = JITTR or 25	Jitter Option
	n = LEVEL or 26	Level Detector
	n = DO_EXIT or 28	End Tests (Warmstart)
		The instrument performs the User Confidence test specified. The error register should then be read. A response of 0 to "ERR?" signifies a PASS. A response of 100 to "ERR?" signifies a failure.
		After "TST n" Message "TST DO_EXIT" must be issued to return the HP 3787B to normal operation. "TST DO_EXIT" causes a full Warmstart of the HP 3787B which takes 2 to 3 seconds. At the end of this period the HP 3787B returns to the LOCAL state.

Alarm Registers

The HP 3787B has the capability to capture all events in the Alarm Status Registers and issue a Service Request. In order to issue an SRQ the Alarm Mask Register(s) must be set using the AM1 and/or AM2 Messages. In addition the, RQS Mask must be set to enable bit 9 (AL1) and/or bit 10 (AL2). The HP 3787B will then issue an SRQ when any Alarm specified by AM1 and/or AM2 changes state. Alarm Status Registers are not Latched ie they contain instantaneous values . Alarm Status Register 1 is updated every 100mS and Alarm Status Register 2 is updated every second. The Bit maps of the Mask and Status Registers are identical :-

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
0	0	0	ERR	YAL	XBT	AIS	FLB

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
FL1	MFA	FLC	CL0	CL1	SL0	SL1	PAT

Table 6-4. Alarm Status Register 1

Bit	Decimal Value	Description
12	4096	Error :- Set when an Error/Hit has occurred.
11	2048	Yellow ALarm :- Set when Yellow Alarm has occurred.
10	1024	X-Bit :- Set when X-bit Alarm has occurred.
9	512	AIS :- Set when AIS Alarm has occurred.
8	256	Frame Loss B :- Set when DS0B Subframe Sync Loss has occurred.
7	128	Frame Loss 1 :- Set when DS1 Frame Sync Loss has occurred.
6	64	MultiFrame Alignment :- Set when DS1 Multiframe Alignment Sync Loss has occurred.
5	32	Frame Loss C :- Set when DS1C Frame Sync Loss has occurred.
4	16	Clock Loss Ø :- Set when DS0 External Clock Loss has occurred.
3	8	Clock Loss 1 :- Set when DS1 External Clock Loss has occurred.
2	4	Signal Loss Ø :- Set when DS0A/DS0B Signal Loss has occurred.
1	2	Signal Loss 1 :- Set when DS1 or DS1C Signal Loss has occurred.
0	1	Pattern :- Set when Pattern Sync Loss has occurred.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	PFS	NFS	SLZ	SLI	SLL	SLH

Table 6-5. Alarm Status Register 2

Bit	Decimal Value	Description
5	32	PFS :- Set when a Positive Frame Slip has occurred.
4	16	NFS :- Set when a Negative Frame Slip has occurred.
3	8	Signal Level Zero :- Set when Signal is lost.
2	4	Signal Level Imbalance :- Set when Signal Level is imbalanced.
1	2	Signal Level Low :- Set when Signal Level is low.
0	1	Signal Level High :- Set when Signal Level is high.

Additional Registers

The READY and ERROR Registers are also available for interrogation in the HP 3787B.

Ready Register

The Ready Register indicates the readiness of the HP 3787B to accept or output Data and can be interrogated by using RDY?. By setting the RQS Mask bit 4 the HP 3787B will issue an SRQ when bit 3 of the Ready Register is set ie Data Ready for Output.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	DRO	0	0	RAC

Table 6-6. Ready Register

Bit	Decimal Value	Description
3	8	Data Ready for Output :- This Bit is set when a Message causes the HP 3787B to output Data and is cleared when the HP 3787B has finished outputting Data.
0	1	Ready to Accept new Command :- This Bit is set when the Parser has completed Parsing a Message and passed it on to the Executor. Cleared on the receipt of the next Message.

Error Register

The Error Register contains a 16 Bit signed Integer which signifies the Error Number corresponding to the first Error to occur since the register was last cleared. The Error Register can be interrogated using the ERR? Message. The register is cleared by Universal Device Clear, Selective Device Clear, RST, CLR and ERR?. Details of all Error Numbers are given in Appendix D of this Manual.

Demonstration Programs

The following Programs demonstrate some measurement applications of the HP 3787B.

- DS1 Line Loopback (Sometimes called the T1 CSU loopback)
- Alternating OCU Loopback
- Dataport DS1 to DS0

DS1 Line Loopback

This Program configures the HP 3787B to the DS1 Line Loopback condition and Actuates the Loopback. The Loopback is verified by checking that Pattern Loss Alarm clears (ie Pattern Sync) within 20 Seconds of the Loopback code being transmitted.
Three Logic Error Counts are made over a Gating Period of 15 Minutes each. According to the results obtained the following actions are taken :-

All 3 Counts < 21	Line PASS
All 3 Counts > 20	Line FAIL
1 Count > 20	See RE_RUN
2 Counts > 20	See REPEAT

RE_RUN : If 1 of 3 Counts is > 20 makes one more Logic Error Count over a 15 Minute Gating Period. According to the result obtained the following actions are taken :-

Count < 21	Line PASS
Count > 20	See REPEAT

REPEAT : If 2 of 3 Counts are > 20 *or* 1 of 3 Counts and RE_RUN are > 20 then the Loopback is released. The HP 3787B is configured to the DS1 Line Loopback condition and the Loopback Actuated. The Loopback is verified as before and 3 Logic Error Counts are made over a Gating Period of 15 Minutes each. According to the results obtained the following actions are taken :-

All 3 Counts < 20	Line PASS
Any 1 or more Counts > 21	Line FAIL

NOTE

The DS1_lb_set_up subroutine used in this Program envisaged SF Framing, AMI Coding, the PRBS with a 14 Zero limit and the DS1 Clock being provided by the HP 3787B.

```
10    OPTION BASE 1
20    !
30    CLEAR 7
40    PRINTER IS 1                !ASSIGNS DISPLAY AS PRINTER
50    End_of_gating=0
60    D_dts=707
70    DIM Results(3)
80    DIM Pass(3)
90    REMOTE 7
100   ENABLE INTR 7;2
110   ON INTR 7 GOSUB Check_status !DETECT OCCURRENCE OF INTERRUPT
120   GOSUB Ds1_lb_set_up          !THIS SUBROUTINE WILL VARY DEPENDENT ON
130                                !THE USERS EQUIPMENT
140   Time=TIMEDATE
150   GOSUB Start_check            !CHECK LOOPBACK SUCCESS
160   PRINT "PATTERN SYNC HAS BEEN GAINED WHICH SUGGESTS THE LOOPBACK IS GOOD."
170   PRINT "THE PROGRAM CONTINUES AND MAKES ERROR COUNTS OVER"
180   PRINT "THREE 15 MINUTE GATING PERIODS"
190   PRINT " "
200   FOR L=1 TO 3
210   GOSUB Start_meas             !START MEASUREMENT
220   GOSUB Waiting                !WAIT FOR END OF GATING
230   GOSUB Results                !TAKE RESULTS
240   NEXT L
250   GOSUB Value_res              !CONVERT EACH RESULT TO PASS/FAIL
260   GOSUB Evaluate_res           !EVALUATE PASS/FAIL
270   GOSUB Print_res              !PRINT RESULTS
280   GOTO Fini                    !PROGRAM END
290   STOP
300   !-----------------------------------------------------------------------
310   !-----------------------------------------------------------------------
320 Ds1_lb_set_up:  !
330                 OUTPUT D_dts;"RQS EOG,ERR"    ! INTERRUPT ON "END OF GATING"
340                                               !AND "ERROR"
350                 OUTPUT D_dts;"RIN DS1;I1L AUTO;R1C AMI;R1F SF;RMS DS1"
360                 OUTPUT D_dts;"RDT PATTERN;RCD PRBS_20;RZL ON;MTA LOGIC"
370                 OUTPUT D_dts;"MOD TX&RX;TIN DS1;TCL INTERNAL;TCD AMI;T1F SF"
380                 OUTPUT D_dts;"TSL DS1;LB1 IN_LINE;ALT OFF;TDT PATTERN;EAT OFF"
390                 OUTPUT D_dts;"ALB"        !ACTUATE LOOPBACK
400   RETURN
410   !-----------------------------------------------------------------------
420   !-----------------------------------------------------------------------
430 Start_check:    !
440                 IF TIMEDATE>Time+20 THEN
450                   PRINT "PATTERN LOSS 20 SECONDS AFTER END OF LOOPBACK CODE"
460                   PRINT "SUSPECT LOOPBACK UNSUCCESSFULL"
470                   PRINT " "
480                   GOTO Fini
490                 END IF
500                 OUTPUT D_dts;"AL1?"        !INTEROGATE ALARM MASK
510                 ENTER D_dts;F              !FOR PATTERN SYNC
520                 IF BIT(F,0) THEN
```

```
530                GOTO Start_check
540                ELSE
550                                          !SET SINGLE GATING 15 MINUTES
560                OUTPUT D_dts;"GTY SINGLE;GPR00,00,15,00"
570              END IF
580              RETURN
590 !---------------------------------------------------------------------
600 !---------------------------------------------------------------------
610 Waiting:     !
620              IF End_of_gating=0 THEN
630                GOTO Waiting
640                ELSE
650              END IF
660              RETURN
670 !---------------------------------------------------------------------
680 !---------------------------------------------------------------------
690 Start_meas:    !
700                OUTPUT D_dts;"STR"        !START GATING
710                End_of_gating=0
720                ENABLE INTR 7;2
730                RETURN
740 !---------------------------------------------------------------------
750 !---------------------------------------------------------------------
760 Results:       !
770                OUTPUT D_dts;"RSA? COUNT"
780                ENTER D_dts;T(L),Results(L)  !T(L) CONTAINS VALIDITY FLAG
790                RETURN
800 !---------------------------------------------------------------------
810 !---------------------------------------------------------------------
820 Value_res:     !
830                FOR L=1 TO 3
840                SELECT Results(L)
850                CASE <21
860                  Pass(L)=1
870                !
880                CASE ELSE
890                  Pass(L)=0
900                END SELECT
910                NEXT L
920                Pass_value=Pass(1)+Pass(2)+Pass(3)  !PASS VALUE = 0 TO 3
930                RETURN
940 !---------------------------------------------------------------------
950 !---------------------------------------------------------------------
960 Evaluate_res:  !
970                SELECT Pass_value
980                CASE 3
990                  PRINT "ALL THREE COUNTS HAVE REGISTERED < 21 ERRORS"
1000                 PRINT "THE  LINE HAS PASSED"
1010                 PRINT " "
1020                 RETURN
1030               !
1040               CASE 2
1050                 PRINT "ONE ERROR COUNT HAS REGISTERED > 20 ERRORS."
```

Table 7-1 Specifications

Except where otherwise stated, the following parameters are warranted performance specifications. Parameters described as "typical" or "nominal" are supplemental characteristics which provide a useful indication of typical, but non-warranted, performance characteristics.

INTRODUCTION

OPERATING MODES

When interfacing at DS1/DS1C levels, the HP 3787B can operate as a separate Transmitter and Receiver, or in Through (THRU) Mode. In THRU Mode, a DS1/DS1C signal applied to the RX Input is retransmitted from the TX Output. When interfacing at DS0 levels, the HP 3787B operates as a separate Transmitter and Receiver, sharing a common (externally-provided) clock source. Protocol analysis can be performed on channels accessed by the HP 3787B by connecting a protocol analyzer to a rear-panel port.

MEASUREMENT PRESETS

Nine completely independent instrument configurations can be stored in non-volatile memory for later recall. Memory location 0 contains a default instrument configuration. The HP-IB address is not held in the measurement presets.

KEYBOARD LOCK

This feature locks the EXEC and START/STOP keys. The CHANGE keys (PREV and NEXT) are also locked for functions which change the state of the instrument. They are not locked for VIEW functions.

USER CONFIDENCE TESTS

Seventeen independently selectable tests are provided to allow the user to check the functional operation of the instrument.

TRANSMITTER

DS1/DS1C TRANSMITTER

□ Clock Sources

Internal DS1/DS1C TX Clock

Frequency : 1.544 Mbit/s (DS1); 3.152 Mbit/s (DS1C).
Stability : < 25 ppm all causes including 5-year aging and ± 10 ppm temperature 0 to 50°C.

External DS1 TX Clock

Frequency : 1.544 MHz ± 130 ppm.
Sensitivity : Compatible with TTL level signals.
Connector : BNC (rear panel).
Impedance : 75 Ω unbalanced (nominal).
Termination : GND.
Note : This port accepts inputs only at a DS1 rate. When the TX Output is framed DS1C this input can be used to clock the constituent digroup generators.

Looped DS1 TX Clock

Function : DS1 TX timing is derived from a data signal applied to the DS1/DS1C RX Input. This source is also valid if the RX interface is selected to be DS0, provided a DS1 signal is also connected to the DS1/DS1C RX Input.

□ DS1/DS1C Interface

DS1/DS1C TX Line Code

AMI, B8ZS.

DS1/DS1C TX Output

Connector Type : WECO jack to accept WECO type 310 plug.
Impedance : 100 Ω balanced (nominal).

DS1/DS1C TX Level

DSX-1 (Refs : KS-22332. L-171907, T1X1-4/85-032);
DSX-1C.

Pulse Height :

DS1 : ± 3 V ± 600 mV (at the center of the pulse).
DS1C : ± 3.65 V ± 850 mV (at the center of the pulse).

Pulse Imbalance : Ratio of power in positive and negative pulses nominally 0 ± 0.5 dB.

Pulse Width : (Measured at half amplitude)

DS1 : 324 ± 30 ns.
DS1C : 159 ± 20 ns.

Rise and Decay Time :

DS1 : 50 ns ± 25 ns (10% to 90%).
DS1C : 37.5 ns ± 12.5 ns (20% to 80%).

Waveshape :

DS1 : Meets T1X1.4-85-032 (same as CCITT G.703).
DS1C : Meets T1X1.4-85-032 (not defined in CCITT G.703).

DS1/DS1C Additional TX Output

Signal : Identical to main output signal.
Connector : Rear-panel WECO. identical to front-panel port.

DS1/DS1C TX Signal Format

DS1 : Unframed
Framed Ft only, SF(D4), ESF(Fe), T1DM(DDS).
DS1C : Unframed
Framed.

DS0 TRANSMITTER

▫ Clock Sources

DS0 Clocks

For DDS testing, the DS0 transmitter must always be supplied with bit and byte clocks from the DDS system. These clocks can be connected to the front-panel 5-pin connector or to the rear-panel D-shell, the active source being selected via the CRT. The clocks are shared by the DS0 RX circuitry.

If the output format is clear channel these clocks must still be provided.

Frequency :

Bit Rate : 64 kbit/s (nominal).
Byte Rate : 8 kbit/s (nominal).

Indication : Error message on line 1 of screen if instrument fails to receive either bit or byte clock : "NO DS0 CLOCKS".

DS0 Complementary Clocks

Connector : 5-pin DIN male (front-panel).
Format : Separate bit and byte clocks. Both have complementary TTL inputs.
Levels :

Low Level : 0.0 to 0.8 V.
High Level : 2.0 to 5.5 V.

DS0 Channel Bank DDS Clocks

Connector : 9-pin D-shell (rear-panel).
Format : Separate bit and byte clocks, both TTL.
Levels :

Low Level : 0.0 to 0.8 V.
High Level : 2.0 to 5.5 V.

▫ DS0 Interface

DS0 Bipolar Output

Validity : All DS0.
Connector : WECO Bantam.
Impedance : 100 Ω ± 5%, balanced, DC-isolated at DS0 interface.
Transition Time : 0.5 µs maximum.
Transmitted Zero : < 0.7 V.
Transmitted One : 3.2 V peak ± 10%.
Pulse Width : 15 µs (nominal).
Pulse Shape : The ratio of the amplitudes of positive and negative pulses at the center of the pulse interval is in the range 0.95 to 1.05.

The ratio of the widths of positive and negative pulses at the nominal half-amplitude point is in the range 0.95 to 1.05.

(All measured when terminated with 100 Ω ± 5% resistive load.)
Drive Capability : This output will drive up to 1500 feet of 22 AWG balanced, twisted, shielded 100 Ω cable.

DDS Logic Output

Validity : DS0A.
Direction : Near; Far.

With DS0A interface selected for both TX and RX, the selection of Near or Far is commoned with the receiver.
Connector : WECO Bantam - Tip = Near; Ring = Far.
Output Levels :

TTL High : > 2.4 V (Logic 0).
TTL Low : < 0.4 V (Logic 1).

Drive Capability : Output sink current = 16 mA DC (nominal).

DS0 TX Format

DDS DS0A :

XDDDDDDC for sub-rate services (2.4, 4.8 or 9.6 kbit/s);
DDDDDDDC for 56 kbit/s service
where D is data,
C is control or status
X is don't care.

DDS DS0B :

SDDDDDDC for sub-rate services (multi-customer) (2.4, 4.8 or 9.6 kbit/s);
DDDDDDDC for 56 kbit/s service
where D is data,
C is control or status.
S is sub-rate frame sequence.

Clear Channel : DDDDDDDD where D is data.

TEST SIGNALS

□ DS1/DS1C TX Data

Patterns

PRBS : 2^{20}-1, (D20+D17+1=0), a 14-zero limit may be selected.

Word : 8-bit fully programmable.

DS1 In-Band Loopbacks : (Ref TA-TSY-000312, T1C1.2/87-001R3). Latching loopbacks activated and deactivated by the EXEC key. DS1 signals can be framed or unframed.

Network : Set-up, 8 second burst of "11000" repeated.
Clear-down, 8 second burst of "11100" repeated.

Line : Set-up, 8 second burst of "00001" repeated.
Clear-down, 8 second burst of "001" repeated.

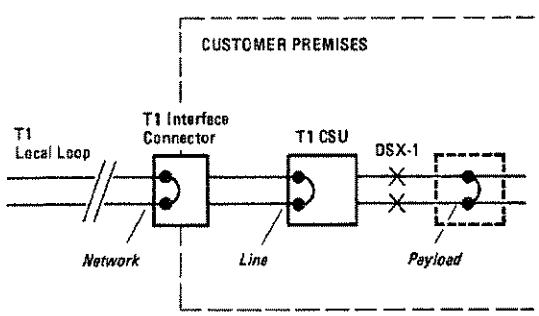
DS1 ESF Datalink Loopbacks : (Ref TR-TSY-000194). Latching loopbacks activated and deactivated by the EXEC key. Bit oriented message on the 4 kbit/s ESF datalink.

Network : Set-up, "00010010 11111111" repeated 10 times.
Clear-down,"00100100 11111111" repeated 10 times.

Line : Set-up, "00001110 11111111" repeated 10 times.
Clear-down, "00111000 11111111" repeated 10 times.

Payload : Set-up, "00010100 11111111" repeated 10 times.
Clear-down, "00110010 11111111" repeated 10 times.

NOTE : The rightmost bit is transmitted first.



DS1/DS1C TX Alarms

AIS : Valid with either DS1 or DS1C interface selected. The selection of AIS overrides any prior frame selection.

Yellow Alarm : Yellow alarm can be transmitted for all four DS1 frame formats. Yellow alarm is introduced in the various framing formats as follows :

SF, "Ft only" : Bit 2 of every timeslot zero.

T1DM : Bit 190 of every frame zero.

ESF : 4 kHz datalink carries repetitive 8 zeros/8 ones pattern.

X-Bit : With DS1C framed signals, the X-bit can be set to "0" (alarm) or "1".

□ DS1 Timeslot Insertion

Available in all DS1 framing modes, all other timeslots filled with a background 2^{20}-1 PRBS.

Timeslot Formats :

Multi-customer DDS (DS0B);
56 kbit/s single-customer DDS;
Dataport single-customer (except 56 kbit/s);
56 kbit/s circuit-switched (PSDC);
64 kbit/s clear channel.

For PSDC the format is DDDDDDDS, where D is data, S is signaling bit (frames 6, 12, etc), (S = 1 in other frames).
For the other formats refer to the DS0 TX Signal Format section. PSDC is available only with SF and ESF. Clear channel is NOT available with T1DM.

Insertion Level : Unless the timeslot is specified to contain DDS multi-customers, the insertion pertains to the complete (single-customer) timeslot.

If the timeslot is specified to be multi-customer DDS, then customer number must be further specified to permit insertion in a particular customer slot. In the TX & RX mode, other customer slots in the chosen timeslot are filled with DDS TEST code. In the THRU mode, they are retransmitted unmodified.

Insertion Data : The data applicable is as specified for the DS0 Transmitter.

With 56 kbit/s PSDC selected, the choice of test patterns is the same. As with clear channel and 56 kbit/s, DDS data received from a protocol analyzer cannot be inserted in a timeslot.

Errors may be added as described in the TX Error Addition section.

Signaling : When 56 kbit/s circuit-switched channels are inserted in a DS1 signal (TX & RX or THRU modes), the signaling bits of the selected channel can be set via the front panel.

SF : A, B bits.
ESF : A, B, C, D bits.

□ T1 Datalink

Types :

With ESF framing, data may be inserted in the 4 kbit/s datalink.
With "Ft only" framing, data may be inserted in the 4 kbit/s Fs link.
With T1DM framing, data may be inserted in the 8 kbit/s R-channel.
Insertion is available in both TX & RX and THRU modes.

Test Patterns :

511-bit PRBS
2047-bit PRBS
All-ones word

In addition, data may be transmitted as received over the rear-panel serial protocol analyzer interface.

DS0 TX Data

Patterns :

511-bit (2^9-1) PRBS. (D9+D5+1=0).
2047-bit (2^{11}-1) PRBS. (D11+D9+1=0).

All-ones word
8-bit word, fully programmable
} Bits 1 and 8 restricted for DDS: bit 8 restricted for PSDC

Preprogrammed sequence : This can be any length from 1 byte to 256 bytes inclusive. The content can be programmed only remotely (HP-IB or RS-232-C). The following number of bits per byte are programmable :

Clear channel - 8
56 kbit/s CSDC - 7
56 kbit/s DDS - 8 (data + status)
Sub-rate DDS - 7 (data + status)

Note : The pattern choice is restricted in the following cases -
DDS Alternating Loopbacks
DDS Secondary Channel
T1 Data Links

See appropriate section for details.

Protocol : Transmitted data is as received over the rear-panel serial link. It is not available with alternating loopbacks.

Background : When the interface is DDS multi-customer DS0B the other customer slots are filled with TEST code.

DDS Multi-Point Signaling Unit

When testing multi-point DDS circuits, any number of multi-point junction units (MJUs) in tandem may be routed to set up a path by sending control sequences from the HP 3787B. The returned MJU branch number and Hub Office Identification are displayed.

Once the path has been set up the branch may be tested, blocked or an existing block cleared.

Control Sequences : The following table describes the code sequences which are transmitted for the various MJU operations.

Operation	Select	Block	Unblock	Release
1 second TA	•			
20 bytes MA*	•			
20 bytes BRN*	•			
20 bytes UMC*	•			
1 second BLK		•		
1 second CMI		•	•	
1 second RLS				•

where :

TA	Test Alert	S1101100
MA	MJU Alert	S1110010
BRN	Branch Select	S0101XY1
UMC	Unassigned Mux	S0011000
BLK	Block	S0001010
CMI	Idle	S1111110
RLS	Release	S1111000

The branch selected is binary-coded into bits "XY" in the range 0 to 3. These are mapped from the branch range 1 to 4 (1 ➤ 0, 2 ➤ 1, etc).

Note : For the multiple byte transmissions marked by * in the table above, the number of bytes is the number transmitted at DS0A after iteration to 64 kbit/s.

Within a DS0B signal the numbers of MA, BRN and UMC bytes are respectively :

1 each for the 2.4 kbit/s case;
2 each for the 4.8 kbit/s case;
4 each for the 9.6 kbit/s case.

DDS Loopback

Alternating and latching loopbacks may be activated and released.

Alternating

Whenever the loopback is selected the HP 3787B transmits the selected test pattern alternated with the appropriate code.

There are six types of alternating loopback. The following table lists them and details the activation codes :

	D1	D2	D3	D4	D5	D6	D7	C8
DSU	0	0	1	0	1	1	0	0
Channel	0	0	1	0	1	0	0	0
OCU	0	0	1	0	1	0	1	0
56 kbit/s Repeater	0	0	1	0	1	0	0	0
HL96NY	0	0	1	0	1	0	1	0
DS0DP*	0	0	1	0	1	0	1	0

* The DS0DP alternating loopback is available only in some DS0DP cards. Please check that your DS0DP card has this capability before attempting a DS0DP alternating loopback.

Column D1 assignment is for 56 kbit/s operation. For sub-rate operation (2.4, 4.8 and 9.6 kbit/s) from a DS0A interface the first bit is a one in all cases. For sub-rate channels when interfacing at DS0B this bit position contains one bit of the sub-rate framing sequence and is designated S.

While testing using alternating loopbacks, test pattern selection is restricted to :

511-bit PRBS (D9+D5+1=0).
2047-bit PRBS (D11+D9+1=0).
Preprogrammed word.

DDS code transmission is not valid during an alternating loopback.

Latching

There are five types of latching loopback.

Control Sequences : The following table describes the code sequences which are transmitted to set up the various latching loopbacks. Note that the number of bytes specified applies to the DS0A interface, ie after iteration.

Operation	DS0DP	OCU	Chan	HL222	MJU
40 bytes TIP	•	•	•	•	
40 bytes TA					•
20 bytes MA					•
20 bytes MJU					•
40 bytes DS0DP	•				
40 bytes OCU		•			
40 bytes CSU			•		
40 bytes HL222				•	
120 bytes LBE	•	•	•	•	
20 bytes UMC					•
40 bytes DMI*	•				
120 bytes LBE*	•				
2 seconds FEV	•	•	•	•	
120 bytes LBE	•	•	•	•	

* This section is transmitted once for every intervening DS0DP unit up to a maximum of 7.

where :

TIP	Transition In Progress	00111010
TA	Test Alert	S1101100
MA	MJU Alert	S1110010
MJU	Loopback Identification	S1010001
DS0DP	Dataport LSC	00000101
OCU	Office Channel Unit LSC	01010101
CSU	Channel Unit LSC	00110001
HL222	HP222 LSC	01000111
LBE	Loopback Enable	01010110
UMC	Unassigned Mux Channel	S0011000
DMI	Data Mode Idle	11111111
FEV	Far-End Voice	01011010
(LSC =	Loopback Select Code	0XXXXXX1)

Assignment of the first bit is for 56 kbit/s. For sub-rate operation (2.4, 4.8 and 9.6 kbit/s) from a DS0A interface the first bit is a one in all cases. For sub-rate channels when interfacing at DS0B this bit position contains one bit of the sub-rate framing sequence and is designated S.

▫ DDS Secondary Channel

Interleave Factor : DDS secondary channel is transmitted by modifying every 3rd control bit (bit 8).

Test Patterns :

511-bit PRBS

2047-bit PRBS

Note : These both contain the secondary channel training sequence of 6 consecutive zeros.

Protocol : As with primary DDS channels, data can be transmitted as received over the rear-panel serial link.

Note : A preamble of 6 consecutive zeros must be transmitted to initialize secondary channel reception. Transmission of twelve or more consecutive ones will cause the secondary channel receiver to drop out.

Loopback : Only latching loopbacks are used to test a secondary channel.

Primary Data : When a secondary channel is transmitted, the primary channel is filled with random data.

Note : When testing the primary channel, the secondary channel is idle.

▫ Special DDS Codes

When any of these special codes are selected, the EXEC key is required to start the generation.

Predefined Codes :

	D1	D2	D3	D4	D5	D6	D7	C8
CMI	1	1	1	1	1	1	1	0
OCU L/B	0	0	1	0	1	0	1	0
CHANNEL L/B	0	0	1	0	1	0	0	0
DSU L/B	0	0	1	0	1	1	0	0
TIP	0	0	1	1	1	0	1	0
LBE	0	1	0	1	0	1	1	0
FEV	0	1	0	1	1	0	1	0
TA	0	1	1	0	1	1	0	0
MA	0	1	1	1	0	0	1	0
UMC	0	0	0	1	1	0	0	0
BLOCK	0	0	0	0	1	0	1	0
RLS	0	1	1	1	1	0	0	0
ASC	0	0	0	1	1	1	1	0
TEST	0	0	0	1	1	1	0	0
OOS	0	0	0	1	1	0	1	0

Column D1 assignment is for 56 kbit/s operation. For sub-rate operation (2.4, 4.8 and 9.6 kbit/s) from a DS0A interface, the first bit is a one in all cases. For sub-rate channels when interfacing at DS0B, this bit position contains one bit of the sub-rate framing sequence and is designated S.

Settable Code

In addition to the above codes, any other code can be transmitted by selecting SETTABLE CODE.

For sub-rate operation (2.4, 4.8 and 9.6 kbit/s) from a DS0A interface, the first bit is a one in all cases. For sub-rate channels when interfacing at DS0B, this bit position contains one bit of the sub-rate framing sequence and is designated S. All other bits are selectable.

ERROR ADDITION

▫ DS1/DS1C Error Add

Error Types

Binary (Logic) Errors : Any DS1/DS1C test pattern.
Any DS1 datalink test pattern.
Bipolar Violation/Code Errors
Frame Errors : T1DM, F-bits and 24th timeslot.
SF, Ft bits and Fs bits.
ESF, Fe bits.
Ft only, Ft bits.
CRC Errors : ESF only.

Insertion

Single : SINGLE ERROR key allows insertion of single logic, BPV, Frame or ESF CRC errors.
Ratio :
Logic and BPV : $Mx10^{-N}$, where M = 1 to 9 and N = 3 to 8 variable in unit steps.
CRC : $1x10^{-0}$ to $4.6x10^{-5}$, selected by setting corresponding BER in the range $3x10^{-4}$ to $1x10^{-8}$.
DS1 Thru Mode : Logic errors are added in the range 9×10^{-3} to 1×10^{-8}.
Notes :
Frame errors can be added only singly.

Datalink errors (ESF and "Ft only") can be added only singly.

T1DM R-channel errors can be added only singly.

If output framed then logic error ratio is wrt data bits.

Logic error insertion does not cause bipolar violations, CRC or frame errors. Both 0 to 1 and 1 to 0 conversions are included without violating the 15-zero constraint in DS1 signals.

Bipolar violation insertion does not cause logic, CRC or frame errors.

CRC error insertion does not cause bit errors.

Automatic Protection Switch (APS) Test

Based on BPV insertion. Five states are sequenced using the NEXT key :
START
NO TRANSFER
TRANSFER
NO RESTORE
RESTORE

In the START state no bipolar violations are inserted. For each of the other states, BPV error ratios are independently selectable in the range $1x10^{-8}$ to $9x10^{-3}$. The states are sequenced using the NEXT key. Valid for both AMI and B8ZS. (Selected set common for DS1 and DS1C).

DS0 TX Error Add

Type : Logic bit, byte or sub-rate frame errors. Sub-rate frame errors apply only with sub-rate cases of DDS DS0B. They cannot be added with secondary channel selected. Logic bit or byte errors cannot be added when remote word or protocol analysis is selected.

Single : The SINGLE ERROR key allows insertion of single logic, byte or sub-rate frame errors. With logic selected, each successive press of the SINGLE ERROR key causes the insertion position to rotate through the set of valid data bit locations. (Ratio error add is provided for Dataport testing.)
Insertion Method : With the DDS formats, DS0A and DS0B bit errors are inserted only in the data bits, ie not in the status or sub-rate framing bits.

With DDS interleaved loopbacks, logic bit and byte errors are inserted only in the data bytes, NOT in the code bytes.
Dataport Test : For testing sub-rate Dataport error correction, every twentieth set of byte iterations can be errored in the following ways :
(1) 2 in every 5 bytes inverted (error correction should cope 100%).
(2) 3 in every 5 bytes inverted (error correction should fail 100%).

DS1/DS1C THRU MODE

Function : In this mode, a signal applied to the DS1/DS1C RX Input passes through the instrument and is retransmitted from the DS1/DS1C TX Output. When the interface is DS1, timeslots can be accessed for measurement as described in the Receiver DS1 Timeslot Extraction section, and data can be inserted in timeslots as described in the Transmitter DS1 Timeslot Insertion section. At DS1C interface points, the THRU mode offers only monitoring access.
Frame : In the THRU mode the retransmitted frame format is always the same as the received format.

Received frame bits are retransmitted unmodified. Hence frame errors are preserved. The only exception occurs with T1DM framing when the R-channel is being stimulated.

While the receiver is not aligned to the incoming frame the entire received signal is retransmitted unmodified. Hence both frame structure and data present in the received stream are preserved intact.

In DS1 operation where insertion is selected, the insertion commences after frame alignment has been achieved.
Code : In the THRU mode the retransmitted line code is always the same as the received line code.

The retransmitted line code is regenerated. Any received code errors are not retransmitted.
Delay : This depends on the line code as follows :
AMI : ~4 bits.
B8ZS : ~20 bits.
Protection : In the event of a failure of the instrument power source a fail-safe relay provides a metallic connection between the RX and TX ports to provide traffic continuity. Also in the THRU mode protection against traffic corruption is provided by an INSERT field which reverts to OFF on selection of ANY new insert configuration. During insertion only the data may be modified.
ESF CRC : When a DS1 signal with ESF framing is being retransmitted the CRC is recalculated (to take account of any

timeslot insertions). However, for every received CRC error an error is inserted in the retransmitted stream to preserve end-to-end CRC-monitoring accuracy.

DDS with Secondary Channel : The insertion of DDS or Dataport primary channel data will corrupt any received secondary channel data pertaining to that customer.

Conversely, the insertion of DDS secondary channel data will corrupt any received primary channel data pertaining to that customer. The received primary channel data will be overwritten with random data.

RECEIVER

DS1/DS1C RECEIVER

DS1/DS1C Input Modes

Terminated/monitor.

Bridged.

DS1/DS1C RX Input

Connector Type : WECO jack to accept WECO type 310 plug.

Impedance :

Terminated : 100 Ω ± 5% balanced (nominal);

Monitor : 100 Ω ± 5% balanced (nominal);

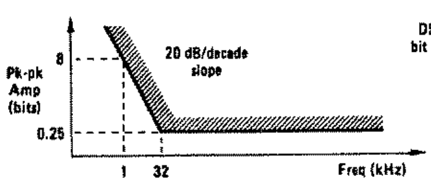
Bridged : 1 kΩ ± 5% balanced (nominal).

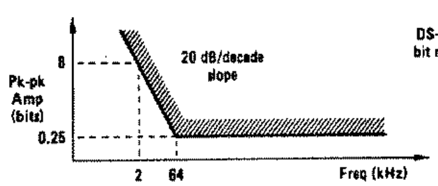
DS1/DS1C RX Rate

DS1 Rate : 1.544 Mbit/s ± 130 ppm.

DS1C Rate : 3.152 Mbit/s ± 30 ppm.

Jitter Tolerance : The input will operate without error in the presence of a signal with a jitter content within the nominal masks shown. These specifications apply for data with maximum zero runs of 14.





DS1/DS1C RX Level

Terminated/Monitor : 80 mV to 5.5 V peak.

Bridged : 800 mV peak (minimum).

Safe operating maximum 10 V peak.

DS1/DS1C Preselectable Levels

DS1 Levels :

DSX-1 : 3.0 V peak ± 600 mV, at pulse center.

DSX-MON : As for DSX-1 less 20 dB.

DS-LO : As for DSX-1 but with loss due to the equivalent of 655 feet (200 m) of ABAM cable.

DS-LO-MON : As for DS-LO less 20 dB.

DS1C Levels :

DSX-1C : 3.65 V peak ± 850 mV, at pulse center.

DSX-MON : As for DSX-1C less 20 dB.

DS-LO : As for DSX-1C but with loss due to the equivalent of 655 feet (200 m) of ABAM cable.

DS-LO-MON : As for DS-LO less 20 dB.

DS1/DS1C RX Level Measurement

The received DS1 or DS1C level can be displayed in peak volts. The positive and negative peaks are displayed simultaneously.

Display Format : X.XX V.

Accuracy : ± 10%

DSX : One LSB = 77 mV.

DS-LO : One LSB = 77 mV.

DSX-MON : One LSB = 39 mV.

DS-LO-MON : One LSB = 39 mV.

Bridged Mode : One LSB = 390 mV.

DS1/DS1C RX Line Code

AMI; B8ZS

Decoding Rules :

AMI : +1 ➤ 1 and -1 ➤ 1.

B8ZS : 0V10V1 ➤ 000000. +1 ➤ 1 and -1 ➤ 1 except in 0V10V1.

DS1/DS1C RX Framing

DS1 Format : SF (D4); Ft only; ESF (Fe); T1DM (DDS); unframed.

DS1C Format : Framed or unframed.

DS1/DS1C Frame Synchronization Criteria

DS1 (T1DM)

Reframe : 5 successive correct timeslot 24 bytes followed by 14 successive correct Ft bits followed by 6 successive correct Fs bits.

Frame Loss : 3 in any 12 successive frames containing errors in either the F bits or timeslot 24.

DS1 (SF)

Reframe : Ft bits - 14 successive error-free.

Frame Loss : Ft bits - 3 in any 7 errored.

Multiframe : Fs bits - 6 successive error-free.

Multiframe Loss : Fs bits - 2 in any 4 errored.

DS1 (ESF)

Reframe : Fe bits - 14 successive error-free.

Frame Loss : Fe bits - 3 in any 7 errored.

DS1 (Ft only)

Reframe : Ft bits - 14 successive error-free.

Frame Loss : Ft bits - 3 in any 7 errored.

DS1C Reframe :

F Bits : 8 error-free, then

M Bits : next "011X" sequence error-free.

DS1C Frame Loss :

F Bits : 3 in error between successive M4 bits, or

M Bits : 3 errors in any 3 consecutive "011" sequences.

Multilevel : If the RX configuration requires synchronization at more than one level the sync processes occur sequentially with the above criteria.

ESF False-Framing Protection : When ESF framing is selected this feature is activated by selecting CRC measurements in result B. A message "FALSE-FRAMING PROTECTION ACTIVE" is displayed in the Results section of the CRT. With this feature active, the complete sync process is :

- 14 successive error-free Fe bits.
- One or more error-free CRC checks in the following decisecond.

DS1/DS1C RX Data

Patterns : PRBS 2^{20}-1, (D20+D17+1=0); a 14-zero limit may be selected.

8-bit word fully programmable.

All-ones word.

Note : If the input signal is DS1C framed, then this signal must be formed by stuffing, multiplexing and scrambling two DS1 digroups.

Traffic : The input signal may be live traffic for all but logic error measurements.

DS1/DS1C Pattern Synchronization Criteria

Sync Loss : Sync loss is deemed to have occurred if the error ratio exceeds ~1/6 as measured over a decisecond.

Sync Gain : Sync is regained after 40 error-free clock periods.

DS1 Timeslot Extraction

DS1 Timeslot Format :

Multi-customer DDS (DS0B).

56 kbit/s single-customer DDS.

Dataport single-customer (except 56 kbit/s).

56 kbit/s circuit-switched (PSDC).

64 kbit/s clear channel.

For 56 kbit/s circuit-switched operation the format is DDDDDDDS where

D is data

S is signaling bit (frames 6, 12 etc) (S = 1 in other frames)

For the other formats refer to the DS0 RX Format section.

Timeslot Data : When demultiplexing of the RX Input to channel or DDS customer level is selected, then the channel or customer data may be selected as for the DS0 Receiver.

With 56 kbit/s PSDC selected, the choice of test patterns is the same. As with clear channel and 56 kbit/s DDS, the data received is not available for protocol analysis.

Data inversion may be selected for the receipt of inverted data from a PSDC loopback. Note that in this case the signaling bits are not inverted.

DS0A Synchronization Criteria :

Sync Gain : Byte 1 = byte 5.

Sync Maintenance : 160 error-free byte comparisons before 20 with errors (byte comparison is byte 1 with byte 5).

Sync Loss : 20 errored byte comparisons before 160 which are error-free.

DS0B Synchronization Criteria : If the RX configuration requires demultiplexing at a lower level (ie DS0B to single-customer), the multi-customer frame sync criteria are as described in the DDS Sub-Rate Frame Synchronization Criteria section.

Error Correction : If the RX configuration requires demultiplexing to a 64 kbit/s channel carrying 2.4, 4.8 or 9.6 kbit/s iterated dataport service (DS0A), error correction can be selected. Note that error correction is not available for a 56 kbit/s dataport channel.

DS0 RECEIVER

DS0 Bipolar Input

Validity : All DS0.

Modes : Terminated; monitor.

Connector : WECO Bantam.

Impedance :

Terminated : 100 Ω balanced (nominal), transformer-coupled.

Monitor : 2 kΩ balanced (nominal), transformer-coupled.

DS0 RX Level : DSX-0. The sampling threshold is set to sample DSX-0 at 1.2 V above or below zero level.

DDS Logic Input

Validity : DS0A.

Direction : Near; Far.

With the DS0A interface selected for both TX and RX, the selection of Near or Far is commoned with the transmitter.

Connector : WECO Bantam - Tip = Near, Ring = Far.

Impedance : 10 kΩ unbalanced (nominal).

Input Levels :

TTL High : > 2.0 V (Logic 0).

TTL Low : < 0.8 V (Logic 1).

DS0 RX Rate

64 kbit/s (nominal).

DS0 RX Clocks

Shared with DS0 TX Clocks - see section in Transmitter specification.

DS0 RX Format

DDS DS0A :

XDDDDDDC for sub-rate services (2.4, 4.8 or 9.6 kbit/s);

DDDDDDDC for 56 kbit/s service

where D is data,

C is control or status

X is don't care.

DDS DS0B :

SDDDDDDC for sub-rate services (multi-customer) (2.4, 4.8 or 9.6 kbit/s);

DDDDDDDC for 56 kbit/s service

where D is data,

C is control or status,

S is sub-rate frame sequence.

Clear Channel : DDDDDDDD where D is data.

DS0 RX Data

Patterns :

511-bit (2^9-1) PRBS. (D9+D5+1=0).

2047-bit (2^{11}-1) PRBS. (D11+D9+1=0).

All-ones word
8-bit word, fully programmable } Bits 1 and 8 restricted for DDS; bit 8 restricted for PSDC

Protocol Mode : Received data is output over the rear-panel serial datalink but no internal measurements (bit, frame, etc) are available. However, ALARM duration measurements and bit monitor functions are available simultaneously.

This feature is not available with alternating loopbacks.

Return Code Mode : Used in conjunction with the transmitter for the acknowledgment of MJU routing or the setting up of latching loopbacks.

Alternating Loopback : While testing using alternating loopbacks, test pattern selection is restricted to :

511-bit PRBS (D9+D5+1=0).

2047-bit PRBS (D11+D9+1=0);

For these test patterns a choice of "Continuous" or "From Alternating Loopback" is offered in the receiver. The latter must always be selected when receiving from an alternating DDS loopback.

It is not assumed that the test pattern bytes have maintained their byte identity through the loopback process.

DS0 Pattern Synchronization Criteria

Sync Loss : Sync loss is deemed to have occurred if the error ratio as measured over a decisecond exceeds ~1/5.

Sync Gain : Sync gain is deemed to have occurred if the error ratio as measured over a decisecond is less than ~1/5.

DDS Sub-Rate Frame Synchronization Criteria

Sync Gain : Searches for 20 consecutive correct frame bits in the following sequences according to the service rate :

01100 for 9.6 kbit/s.

0110010100 for 4.8 kbit/s.

01100101001110000100 for 2.4 kbit/s.

Sync Loss : 2 frame errors in any 6 frame bits.

DDS Secondary Channel

Interleave Factor : DDS secondary channel is implemented by modifying every 3rd control bit (bit 8).

Sync Gain : Locks to an initialization sequence of 6 consecutive zeros in the secondary channel.

Sync Loss : Loses sync on detecting 12 consecutive ones in the secondary channel. A search for a following initialization sequence commences automatically.

Test Patterns : 511-bit PRBS; 2047-bit PRBS.

Protocol : As with primary DDS channels, the received data can be transmitted over the rear-panel serial link.

ALARM INDICATORS (front panel)

These indicators are illuminated whenever the alarm condition exists. They are NOT hierarchical.

The indication remains for 500 ms beyond the duration of the alarm condition.

The following alarm conditions are indicated :

Signal Loss	Pattern Sync Loss
DS1C Frame Loss	Yellow Alarm
DS1 Frame Loss	AIS
DS0B Frame Loss	X-Bit (set to zero)
Errors/Hits Detected	

ERROR DETECTION

DS1C

BPV/Code, Frame, Test Pattern bit errors.

Digroup : Frame errors :

T1DM : F bits and frame bits in timeslot 24.

SF : Ft and Fs.

ESF : Fe.

Ft only : Ft.

CRC errors (ESF only).

Test pattern bit errors.

Digroup Datalink : Test pattern bit errors (ESF, and "Ft only").

Digroup T1DM R-Channel : Test pattern bit errors.

DS1

BPV/Code, CRC (ESF only), Test Pattern bit errors.

Frame errors -

T1DM : F bits and frame bits in timeslot 24.

SF : Ft and Fs.

ESF : Fe.

Ft only : Ft.

Note : Code Error Rules

AMI : Each BPV = one error.

B8ZS : Each BPV not contained in 0V10V1 = one error.

DS1 Datalink

Test Pattern bit errors.

Datalink types :

ESF framing - 4 kbit/s datalink.

Ft only framing - 4 kbit/s link.

T1DM framing - 8 kbit/s.

DS1 Timeslot Extraction

Test Pattern bit errors.

DDS sub-rate frame errors (2.4, 4.8 and 9.6 kbit/s DS0B).

DS1 Timeslot Format :

Multi-customer DDS (DS0B).

56 kbit/s single-customer DDS (before error correction).

Dataport sub-rate single-customer (before or after error correction).

56 kbit/s circuit-switched (PSDC).

64 kbit/s clear channel.

For 56 kbit/s circuit-switched operation the format is DDDDDDDS where

D is data

S is signaling bit (frames 6, 12 etc) (S = 1 in other frames)

For the other formats refer to the DS0 RX Format section.

DS0

DS0B (DDS) : Sub-rate framing errors (except 56 kbit/s). Customer level test pattern bit errors. Secondary channel test pattern bit errors.

DS0A (DDS) : Test pattern bit errors. Secondary channel test pattern bit errors.

Clear Channel : Test pattern bit errors.

ERROR PERFORMANCE MEASUREMENTS

▫ Real-Time Clock

Fundamental Period : 1 decisecond (nominal).

Settability : ± 50 ppm at 25°C (nominal).

Stability : Crystal-controlled -0/+50 ppm including 5-year aging.

Display : Displays of time and date are presented on Page 4 of the CRT.

TIME Format : Time 14 hrs 31 mins 12 secs (example).

DATE Format : Date 24 January 1987 (example).

Both can be set at any time (time display resolution 1 second).

Battery Back-Up : The real-time clock and calendar remain operational during line power failures and when the instrument is switched off.

Elapsed Time

Function : The instrument can monitor the time which has elapsed since the start of a gating period. This facility is available in all GATING modes.

Display : In these modes the ELAPSED TIME display can be selected for display.

▫ Gating Periods

Modes

Manual : Controlled by START/STOP key.

Interval : START key controls start of gating period. End of gating period normally controlled by the internal timer but this can be overridden by the START/STOP key.

Minimum Interval : 1 second.

Maximum Interval : 99 days 23 hrs 59 mins 59 secs.

Resolution : 1 second.

Repeat Interval : START/STOP key controls the start of the first gating period. End of gating periods normally controlled by the internal timer but this can be overridden by the START/STOP key. The START/STOP key ends the sequence of gating periods as well as terminating the current gating period.

Minimum Interval : 1 second.

Maximum Interval : 99 days 23 hrs 59 mins 59 secs.

Resolution : 1 second.

Short (repeats) : As for Repeat Interval but with a short period restricted to a choice of 1 second, 15 seconds, 5 minutes or 15 minutes.

Dead Time : In repeat modes there is NO dead time between gating periods.

Power Failure : In the event of a loss of line power to the instrument during a gating period, measurement results and settings are retained in non-volatile memory. When line power returns the instrument automatically continues gating from the point in the period reached at the time of interruption.

▫ Measurement Results

Two error types can be accumulated simultaneously whenever two types of error can be present. These must be chosen prior to the start of a gating period. Two selected results, Result A and Result B, may be displayed simultaneously.

The form of display, eg Async EFS, can be chosen before, during or after a gating period.

Error Results

Error Count :

Display Format : 7-digit display for < 10,000,000 errors; 2-digit mantissa, 2-digit exponent display for ≥ 10,000,000 errors.

For CRC error counts, an incorrect CRC checksum is counted as one error.

Error Ratio :

Display Format : 2-digit mantissa, 2-digit exponent display.

For CRC error ratio results, the number of clocks is used as the base. For all other ratio results, the number of bits sampled is used as a base.

Error Seconds : Both synchronous and asynchronous.

Error-Free Seconds : Asynchronous.

% Error-Free Seconds : The number of error-free seconds expressed as a percentage of the number of seconds in the gating period.

Display Format : XX.XXXX% or 100.00%.

Validity : Valid for all gating modes and error types.

Display Update

Single Modes : Non-exponent format displays update every 100 ms to show the cumulative result.

Exponent format displays update every second to show the cumulative result.

Repeat Modes : The displays update only at the end of each gating period. Consequently no results are displayed during the first gating period.

Result Hold : After a single gating period or set of gating periods (repetitive) the final result is held until a new gating period is initiated. If the configuration is modified in the meantime the previous result remains until the new gating period is initiated.

Error Analysis

These measurements are based on CCITT Recommendation G.821. Analysis is available for all error sources and gating modes.

% Availability : The number of available seconds during a gating period expressed as a percentage of the number of elapsed seconds.

Availability is as defined in CCITT Rec. G.821. A system becomes "available" when the error ratio measured in 1 second intervals is better than 1×10^{-3} for 10 or more consecutive seconds, ie minimum available period is 10 seconds.

A system becomes "unavailable" when the error ratio measured in 1 second intervals is greater than 1×10^{-3} for 10 or more consecutive seconds.

For the purpose of determining availability, pattern loss, frame loss and signal loss seconds are simply considered as seconds with error ratios exceeding the availability threshold. Power loss seconds are discarded.

If CRC errors are being analyzed, the availability criterion is 320 CRC errors in a second. This CRC error rate corresponds to a BER of 1×10^{-3} with randomly distributed bit errors.

% Unavailability : The number of unavailable seconds during a gating period expressed as a percentage of the number of elapsed seconds.

% Severely-Errored Seconds : The number of seconds during the available time in a gating period which have an error ratio worse than the availability threshold expressed as a percentage of the available time expressed in seconds (as per CCITT Rec G.821).

% ES : The number of seconds which contain errors during the available time in a gating period expressed as a percentage of the available time in seconds.

% Degraded Minutes : The number of 60 second (1 minute) intervals (excluding severely-errored seconds) during which the error ratio is worse than a threshold 1×10^{-6} expressed as a percentage of the available time in minutes (excluding severely errored seconds).

Consecutive Severely-Errored Seconds (CSES) : 3 to 9 consecutive severely-errored seconds.

Severely-Errored Seconds (SES) : A count of the number of seconds during the available time in a gating period which have an error ratio worse than 1×10^{-3}.

Error Seconds (Asynchronous) : The number of seconds which contain errors during the available time in a gating period.

Degraded Minutes : The number of 1 minute intervals (excluding severely-errored seconds) during which the error ratio is worse than 1×10^{-6}.

Alarm Duration

The following alarm durations are measured in seconds :

- Instrument Power Loss
- Signal Loss (except for DS0 Clear Channel)
- AIS (DS1 and DS1C signals)
- DS1C Frame Sync Loss
- DS1 Frame Sync Loss
- DS0B Frame Sync Loss
- Pattern Sync Loss

DS1 JITTER MEASUREMENTS (Option 001)

Jitter Amplitude Measurement

Range 0.00 to 13.00 UI pk-pk (nominal) in 0.01 UI steps. Accuracy specified in range 0.00 to 10.00 UI pk-pk.

Intrinsic Jitter : < 0.02 UI pk-pk (typical) at 25°C;
< 0.06 UI pk-pk 0 to 50°C.

Basic Accuracy : 3.0% ± 0.03 UI + pattern dependency.

Internal Filters :

LP : 2 Hz to 40 kHz.
HP1 + LP : 10 Hz to 40 kHz.
HP2 + LP : 8 kHz to 40 kHz.

Filter Tolerances :

Upper Cutoff LP : 40 kHz ± 10%.
Lower Cutoff LP : 2 Hz ± 70%.
Lower Cutoff HP1 : 10 Hz ± 10%.
Lower Cutoff HP2 : 8 kHz ± 10%.

Jitter Analysis

Hit Threshold : Can be set in the range 0.05 to 10.00 UI pk-pk (resolution 0.01 UI pk-pk).

Hit Count : Totalizes the number of times the measured jitter exceeds the hit threshold during the measurement interval.

Display Format : 7-digit display for < 10,000,000 hits.
2 digit mantissa, 2-digit exponent display for ≥ 10,000,000 hits.

Hit Bit Count : Totalizes the number of DS1 clock periods during which the measured jitter amplitude exceeds the hit threshold during the measurement interval.

Display Format : 7-digit display for < 10,000,000 hit bits.
2 digit mantissa, 2-digit exponent display for ≥ 10,000,000 hit bits.

Jitter Hit Bit Ratio : The ratio of the DS1 hit bit count to the total number of DS1 bits in the measurement interval.

Jitter Hit Seconds : The number of seconds in which the hit threshold has been exceeded at least once during the measurement interval. (Measured asynchronously.)

Jitter Hit-Free Seconds : Converse of Jitter Hit Seconds.

DS1 FRAME SLIP MEASUREMENTS

Method : The HP 3787B measures controlled frame slips. This is accomplished by inserting a PRBS in a 56 or 64 kbit/s timeslot of a DS1 signal, passing the signal through the network or switch under test, then recognizing when a 7-bit or 8-bit slice of the PRBS is duplicated or deleted.

Duplicated frames are indicated as positive frame slips. Deleted frames are indicated as negative frame slips.

Valid : Valid when the receiver is set to measure a PRBS in either a 64 kbit/s Clear, 56 kbit/s Switched or a 56 kbit/s DDS channel.

Interface : DS1C, DS1 and DS0.

Display : Simultaneous count of "Positive" and "Negative" controlled frame slips.

DATA LOGGING

Logging Device

Internal Printer - this is the default device. External HP-IB printer in listen-always mode.

Remote Control : When logging to an external HP-IB printer remote is restricted to RS-232-C since the HP-IB port must be set to talk-only in order to drive the external HP-IB printer.

Note : When using the internal printer, no output is available to external printers and vice versa.

Internal Printer

Type : Impact, 24-column.

Capacity : Approximately 6000 lines per paper roll (19 metres).

Print Modes

Manual : At any time the manual PRINT key can be used to cause the displayed "results" (Results, Analysis, Alarm Durations, RX Level or Monitor Word) to be printed on the selected device.

Note that this is the only case in which the RX Level and Monitor Word are logged.

Log During Gating : Logs time of occurrence and number of errors/jitter hits in the errored seconds/jitter hit seconds measurement selected for Result A. The result may be logged for every error/hit second, or only when the error ratio or hit bit ratio in 1 second exceeds a preset threshold 1×10^{-N}, where N can be set in the range 2 to 7.

Alarms : With logging switched on, the printer always prints the occurrence of an alarm change, ie a change in the state of :

- Power Loss
- Signal Loss (DS1 or DS0)
- External Clock Loss (DS1 or DS0)
- Excess Zeros
- RX Level too high or low
- RX Level imbalance
- AIS
- Yellow Alarm
- X-Bit
- Frame Sync Loss (DS1C, Digroup, MFA, DS1 or Sub-rate)
- Pattern Sync Loss
- Frame Slips

As with normal triggered logging, these alarm printouts are printed in a single line together with a timestamp.

An alarm printout is also given for any alarm which is active at the start of a single gating period or sequence of repetitive gating periods.

Squelch : A print-squelch mechanism is implemented such that error/hit second printouts occur on a maximum of 10 consecutive seconds. On the occurrence of the next trigger-free second, the number of elapsed trigger-seconds is printed together with the total number of errors (or hits) accumulated during the squelched period.

End of Gating Summary : Logs measurement results, error performance analysis and alarm durations always or when Result A exceeds a threshold 1×10^{-N}, where N can be set in the range 2 to 7. The user may choose to log all results or only those selected for display.

PROTOCOL ANALYZER PORT

Application

Permits direct connection of a protocol analyzer such as the HP 4952A. When this mode is selected, the internally-generated test pattern is substituted with the protocol analyzer test pattern. The HP 3787B acts as a DS1 channel access unit allowing the following channels to be accessed :

- 64 kbit/s clear channel.
- All DDS primary and secondary channels.
- DS1 Extended Super-Frame (ESF) 4 kbit/s datalink.
- DS1 Super-Frame (SF) 4 kbit/s Fs bits.
- DS1 T1 Data Multiplexer (T1DM) 8 kbit/s R-channel.

Connector : 24-pin D-shell.

Function : Full duplex, TX and RX clocks supplied, no handshake lines.

GENERAL

REMOTE OPERATION

Type

HP-IB or RS-232-C. Either can be selected and configured on Page 5 of the CRT.

HP-IB

Implementation : SH1; AH1; T5; TE0; L4; LE0; SR1; RL1; PP0; DC1; DT0; C0.

Modes :

ADDRESSABLE : When the HP 3787B is operated with an external controller the addressable mode allows control of front-panel functions except the HP-IB address and the POWER switch. All current results and flags are available and a local lockout facility is provided. There is no remote control of screen paging.

TALK-ONLY : This mode permits the HP 3787B to be used without an external controller. It is intended for the output of results to a peripheral such as a printer. In this mode the format and frequency of results are as set up for the internal printer operation.

RS-232-C

Connection : Hardwired or Modem.

Duplex : Half or Full. Only Full Duplex is available if hardwired is selected.

Handshake : Xon/Xoff (Full Duplex only)

- **RX Only :** HP 3787B paces rate at which it receives data by sending Xon/Xoff.
- **TX Only :** Controller paces rate at which HP 3787B transmits data by sending Xon/Xoff.
- **RX & TX :** As for both above.
- **Enq/Ack :** On/off.
- **DTR On/Off :** For users who require manual control of DTR this field can be brought into the display by selection of an internal DIL switch.

Baud Rate : 300, 600, 1200, 1800, 2400, 4800, 9600, or SELECT.
CI High Rate : 300, 600, 1200, 1800, 2400, 4800, 9600.
CI Low Rate : 300, 600, 1200, 1800, 2400, 4800, 9600.
Parity : Even, Odd, ones or zeros.
Stop Bits : 1 or 2.

POWER SUPPLY

Mains Input

Voltage Ranges : 88 to 127 V AC, nominally 120 V AC; 176 to 254 V AC, nominally 240 V AC.
Line Frequency : 48 to 66 Hz.
Power Consumption : Approx 110 VA (both ranges).

DC Battery Input (Option 002)

Voltage Range : -40 to -57 V DC, nominally -48 V DC.
Power Consumption : Typically 70 Watts.
Earthing : The positive pole of the DC supply will be grounded.

PHYSICAL

Dimensions

130 mm high; 425 mm wide; 420 mm deep (5.12 x 16.73 x 16.54 inches).

Weight

10.4 kg (23 lb).

Environment

Operating Temperature : 0 to 50 °C.
Storage Temperature : -40 to 75 °C.

ORDERING INFORMATION

STANDARD INSTRUMENT

The HP 3787B is supplied complete with :

- DS1C/DS1/DS0 interfaces
- Internal printer
- HP-IB and RS-232-C remote control
- Protocol analyzer interface
- Front and rear panel DDS external clock interfaces
- DS1 external clock interface
- An extra DS1/DS1C Output on rear panel
- RS-232-C and protocol analyzer port test plug
- Power cord
- Front panel cover
- Front panel handles
- A set of Operating and Service Manuals

OPTIONS

Option 001 - DS1 Jitter Measurement

Adds DS1 jitter measurement and analysis capability to the HP 3787B.

Option 002 - DC Power Supply

Allows the HP 3787B to be powered from a -40 to -57 V DC supply in addition to AC line power operation.

Option 909 - Rackmount Fittings

Allows the HP 3787B to be fitted in a 19-inch wide equipment rack. The instrument front panel cover is not supplied with this Option.

Option 910 - Additional Operating and Service Manuals

One set of Operating and Service Manuals is supplied with the HP 3787B. This Option provides an extra set.

Option K01 - 32-way DSX-1 Output Unit

This special unit adds a further 32 DS1 outputs to the HP 3787B.

Option K02 - 64-way DSX-1, Output Unit

This special unit adds a further 64 DS1 outputs to the HP 3787B.

ACCESSORIES AVAILABLE

HP 15668A - Front Panel DDS Clock Cable, 5-pin DIN (female) to 5-pin DIN (female), 3 metres (10 feet) long.

HP 15668A-HO1 - Front Panel DDS Clock Cable, 5-pin DIN (female) to 5-pin DIN (female), 12 metres (40 feet) long.

HP 15669A - Rear Panel DDS Clock Cable, 9-pin D-type (male) to 9-pin D-type (male), 3 metres (10 feet) long.

HP 15669A-HO1 - Rear Panel DDS Clock Cable, 9-pin D-type (male) to 9-pin D-type (male), 12 metres (40 feet) long.

HP 15670A - Bantam (male) to Bantam (male) Cable, 3 metres (10 feet) long.

HP 15513A - WECO 310 (male) to WECO 310 (male) Cable, 1 metre (3.3 feet) long.

HP 15513A-HO2 - WECO 310 (male) to WECO 310 (male) Cable, 3 metres (10 feet) long.

Transit Case - HP Part Number 9211-2655

Installation 8

Introduction

This section provides installation instructions for the Hewlett-Packard Model HP 3787B Digital Data Test Set and its accessories. This section also includes information about preparation for use, packaging, storage and shipment.

Preparation For Use

WARNING

TO AVOID THE POSSIBILITY OF INJURY OR DEATH. THE FOLLOWING PRECAUTIONS MUST BE FOLLOWED BEFORE THE INSTRUMENT IS SWITCHED ON.

(A) NOTE THAT THE PROTECTION PROVIDED BY GROUNDING THE INSTRUMENT CABINET MAY BE LOST IF ANY POWER CABLE OTHER THAN THE THREE- PRONGED TYPE SUPPLIED IS USED TO COUPLE THE AC LINE VOLTAGE TO THE INSTRUMENT.

(B) IF THIS INSTRUMENT IS TO BE ENERGIZED VIA AN AUTO-TRANSFORMER TO REDUCE OR INCREASE THE LINE VOLTAGE, MAKE SURE THAT THE COMMON TERMINAL IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SOURCE.

(C) THE POWER CABLE PLUG SHALL ONLY BE INSERTED INTO A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD WITHOUT A PROTECTIVE CONDUCTOR (GROUNDING).

Power Requirements

The instrument requires a power source of 115V AC (+6%, -27%) or 230V AC (+6%, -18%), 48 to 66Hz single phase. Total power consumption is typically 110VA.

Instruments containing Option 002 can also be operated from an external DC power source in the range -40V to -57V DC (see DC Battery Operation on Page 8-2). Power consumption is typically 70W.

Line Voltage Selection and Fuse

The line voltage is selected by the rear panel switch labeled 120V and 240V.

CAUTION

Before connecting the instrument to a power outlet, ensure that the line voltage selector is correctly set and that a fuse of the correct rating is fitted.

Fuse ratings are given in the table below:

Table 8-1. Fuse Ratings

Nominal Line	Fuse Rating	HP Part Number
120V	3AT/250V	2110-0381
240V	1.5AT/250V	2110-0304

Power Cord

This instrument is equipped with a three-wire power cord. When connected to a power outlet, this cord grounds the instrument case. The type of power cord shipped with each instrument depends on the country of destination. Refer to Figure 8-1 for part numbers of the power cord and plug configurations available. The number shown below each plug is the Hewlett-Packard part number of a power cord equipped with that plug. If the appropriate power cord is not included with the instrument, notify the nearest Hewlett-Packard Sales and Service Office and a replacement will be provided.

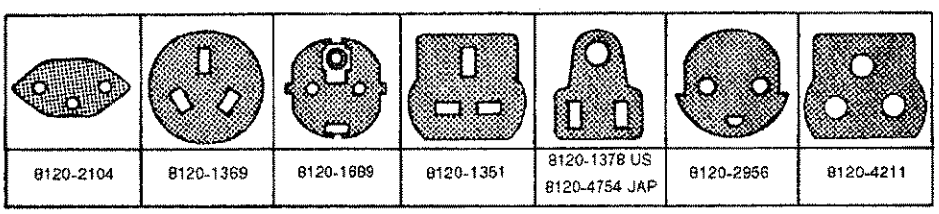


Figure 8-1 Plug Configurations

The color code used in each power cable is given below:

Line : Brown
Neutral : Blue
Ground : Green/Yellow

DC Battery Operation (Option 002 only)

The HP 3787B can be powered from an external DC supply via the BATTERY terminals on the rear panel. For correct operation, the HP 3787B ground terminal should also be connected to ground. The following figure illustrates how the HP 3787B should be connected to a DC supply.

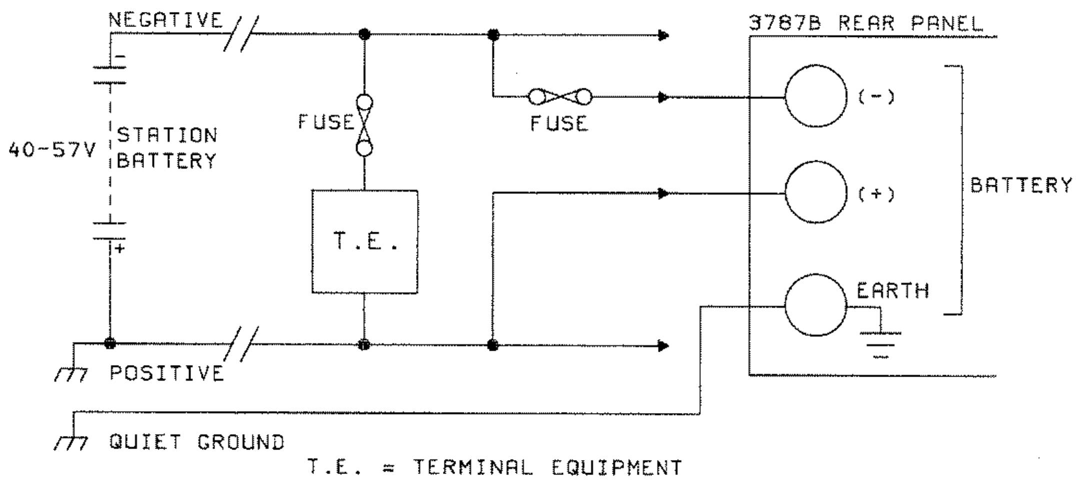


Figure 8-2 Connecting a DC Supply to the HP 3787B (Option 002 Instruments)

Ensure that a 3AT/250V fuse, HP Part Number 2110-0381, is fitted in the fuse holder next to the BATTERY terminals on the HP 3787B rear panel.

WARNING

ENSURE THAT THE SAFETY COVER IS IN POSITION OVER THE AC INPUT SOCKET WHEN THE INSTRUMENT IS WIRED FOR DC OPERATION.

CAUTION

Failure to connect the DC supply to the HP 3787B as shown in Figure 8-2 may result in damage to the instrument.

Operating Environment

Temperature - The instrument may be operated in temperatures from 0 degrees centigrade to +50 degrees centigrade.

Humidity - The instrument may be operated in environments with humidity up to 95% at 40°C. However, the instrument should also be protected from temperature extremes which may cause condensation within the instrument.

Altitude - The instrument may be operated at altitudes up to 4600m (15,000ft).

Air flow - The air intake to the instrument is via a fan mounted on the rear panel. The air exhaust is via the perforated side panels. To provide adequate cooling, an air gap of approximately 3 inches should be maintained around the instrument.

Preventive Maintenance

Internal Batteries

WARNING

DO NOT INCINERATE OR MUTILATE THE BATTERIES. THEY MAY BURST OR RELEASE TOXIC MATERIALS CAUSING PERSONAL INJURY.

The lithium batteries on A5, used as a power supply for the nonvolatile memory and the real time clock, should be checked annually. Life expectancy of the battery is approximately 5 years.

Fan Filter

The fan filter should be removed from the instrument and cleaned in hot soapy water every six months or more frequently if the instrument is operated in a hostile environment.

Mating Connectors

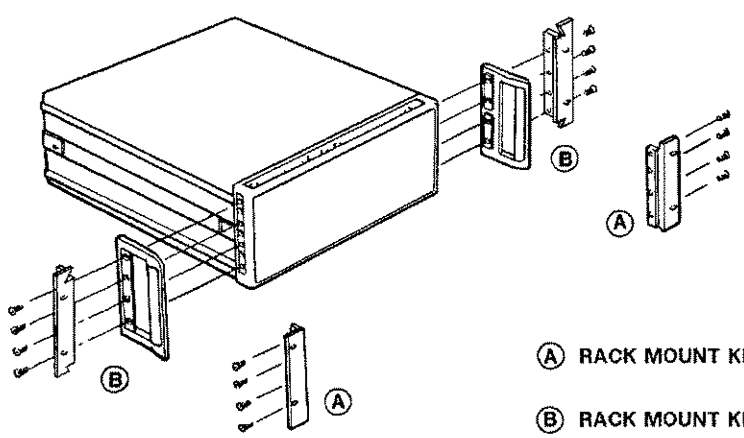
Table 8-2 lists the connectors which mate with the instrument ports.

Table 8-2. Mating Connectors

Connector	Type	Mating Connector Part Number
RX INPUT DS1/1C	WECO 310	HP 1251-0695
RX INPUT DSX-0	BANTAM	HP 1251-3060
TX OUTPUT DSX-1/1C	WECO 310	HP 1251-0695
TX OUTPUT DSX-0	BANTAM	HP 1251-3060
DS0 CLOCKS	5-PIN AUDIO DIN PLUG-F	HP T48733
DDS CLOCK	9 W D SUBMIN	HP 1251-0216 (plug) HP 1251-1551 (hood) HP 1251-0215 (lock)
RS-232-C	25 W D SUBMIN	HP 1251-0063 (plug) HP 1251-1438 (hood)
PROTOCOL ANALYZER	25 W D SUBMIN	HP 1251-0063 (plug) HP 1251-1438 (hood)
HP-IB	AMPHENOL	HP 1251-0293
DS1 CLOCK INPUT	BNC (75Ω)	HP 1250-1448

Rack Mounting

Figure 8-3 illustrates the Rack Mount Kits available for use with the HP 3787B. Refer to the Operating Environment on Page 8-3 regarding the cooling of rack mounted instruments.



The operating instruction tray may prevent rack mounting immediately above another instrument.
A standard bottom cover (without tray) HP Part number 5061-9446, may be used.
The original feet should be fitted to the new cover.

Ⓐ RACK MOUNT KIT WITHOUT FRONT HANDLES HP 5061-9677

Ⓑ RACK MOUNT KIT WITH FRONT HANDLES HP 5061-9683

Figure 8-3 Rack Mount Kits

PROTOCOL ANALYZER Connector (rear panel)

Interface with an HP 4952A Protocol Analyzer is via a directly connected (ie 1 to 1....25 to 25) RS232 cable.

The PROTOCOL ANALYZER connector is an RS232 connector which supplies Tx and Rx clock and Rx data to the protocol analyzer and accepts Tx data from the protocol analyzer. The pin designations for this connector are shown in Figure 8-9.

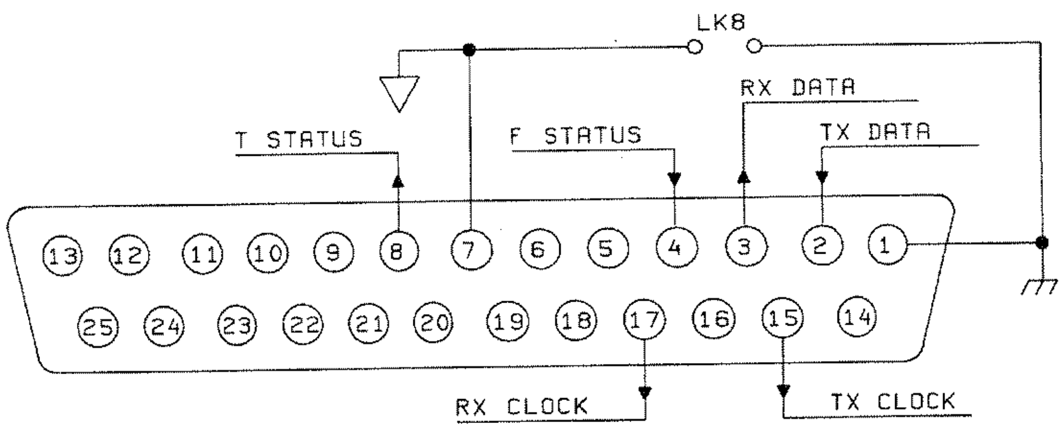
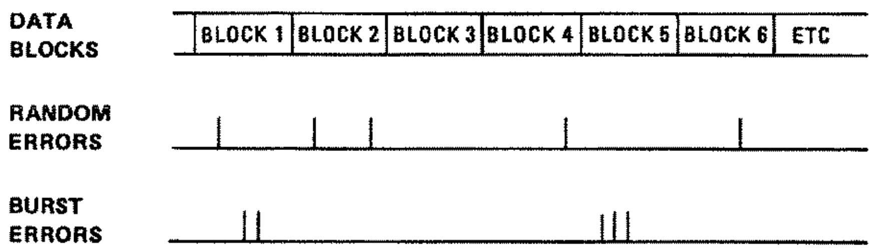


Figure 8-9 Protocol Analyzer Connector

CCITT G.821 Error Analysis B

ERROR DISTRIBUTION

DATA THROUGHPUT IS ASSESSED BY THE DATA BLOCK RETRANSMISSION RATE. RANDOM ERROR DISTRIBUTION HAS A MORE DISRUPTIVE INFLUENCE ON DATA THROUGHPUT THAN BURST ERRORS.



Introduction

In general, information in a communication system is transmitted in data blocks. To guarantee an error-free path, most communication systems use an error correction system which retransmits a block containing one or more errors (normally called error correction by retransmission). Data throughput on these systems is measured in terms of block retransmissions.

In a transmission system using error correction by retransmission, randomly distributed single bit errors present a more disruptive influence than an equal number of bit errors occurring in short bursts since a single error in a block will require a retransmission of the entire block.

For some time, long-term mean error ratio was used to provide a measure of the error performance of a digital communication path. This technique, commonly referred to as Bit Error Rate (BER), assumed that errors occurring in a network resulted from randomly distributed events. In practice, however, it has been found that the majority of errors within a network occur in bursts. Since data block retransmission is dependent on the error distribution, long-term BER results cannot be used to give an indication of the path data throughput rate.

CCITT G.821 analysis provides a true characteristic error performance of a digital communication path. The basic error performance is based on the number of error-free seconds (or error-free second blocks) that occur during the test period.

CCITT G.821 ERROR ANALYSIS

THE HP 3787B PROVIDES ERROR ANALYSIS AS RECOMMENDED BY CCITT G.821.

ERROR ANALYSIS IS DEFINED BY CCITT IN TERMS OF THE PERFORMANCE OBJECTIVES FOR AN INTERNATIONAL 64 kbit/s CIRCUIT. THE MEASUREMENT PARAMETERS ARE:

%AVAILABILITY
%UNAVAILABILITY
SEVERELY ERRORED SECONDS
%SEVERELY ERRORED SECONDS
CONSECUTIVE SEVERELY ERRORED SECONDS
ERROR SECONDS
%ERROR SECONDS
DEGRADED MINUTES
%DEGRADED MINUTES

CCITT G.821 Measurement Parameter Definitions

CCITT G.821 analysis divides the total test period into segments called "available" and "unavailable" time. The error performance measurements refer to available time only. During unavailable time, the error performance measurements remain unaltered. Error performance is evaluated by determining the percentage error-free seconds that occur during the available time of the test period.

% Availability

The number of available seconds during a gating period expressed as a percentage of the number of elapsed seconds.

A system becomes "available" when the error ratio measured in 1 second intervals is better than 1×10^{-3} for 10 or more consecutive seconds (ie minimum available period is 10 seconds).

A system becomes "unavailable" when the error ratio measured in 1 second intervals is greater than 1×10^{-3} for 10 or more consecutive seconds.

For the purpose of determining availability - pattern loss, frame loss and signal loss are simply considered as seconds with error ratios exceeding the availability threshold. Power loss seconds are not included in the analysis.

If CRC errors are being analyzed, the availability criterion is different since the CRC is a block error check. Here the availability threshold for CRC errors is 320 CRC errors in a second, implying a BER of 1×10^{-3} with the bit errors randomly distributed. For CRC error counts, an incorrect CRC checksum is counted as one error. The CRC error ratio uses the number of clocks as the base (eg 320 CRCs errored in one second gives an error ratio of 320/1.544 M). All other ratio results use the number of bits sampled as a base.

% Unavailability

The number of unavailable seconds during a gating period expressed as a percentage of the number of elapsed seconds.

A system becomes "unavailable" when the error ratio measured in 1 second intervals is greater than 1×10^{-3} for 10 or more consecutive seconds.

Severely-Errored Seconds *

The number of seconds during the available time in a gating period which have an error ratio worse than the availability threshold.

% Severely-Errored Seconds

The number of Severely-Errored Seconds expressed as a percentage of the available time expressed in seconds.

Consecutive Severely-Errored Seconds *

The number of contiguous SEQUENCES of 3 to 9 Severely-Errored seconds during the available time.

Error Seconds *

The number of seconds which contain errors during the available time in a gating period.

% Error Seconds

The number of Error Seconds expressed as a percentage of the available time in seconds.

Note : The HP 3787B also provides % Error-Free Seconds over total time as defined in AT&T Pub 62411 and BSTR Pub 41451.

Degraded Minutes *

The number of 1 minute intervals (excluding severely-errored seconds) during which the error ratio is worse than a threshold 1×10^{-6}.

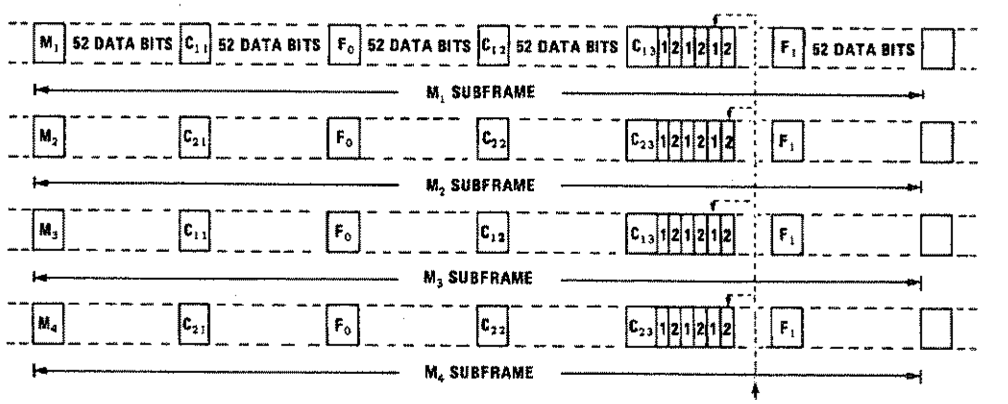
% Degraded Minutes

The number of Degraded Minutes expressed as a percentage of the available time in minutes (excluding severely-errored seconds).

* Derived from CCITT measurements. These measurements are used to help determine the magnitude and dispersion of error bursts.

DS1C, DS1 and DS0 Frame Formats

DS1C (3.152 Mbit/s) FRAME FORMAT



F_0 = 0 F_1 = 1 *Time slots available for stuffed bits (see Note)*

M_1, M_2, M_3, M_4 = 011X where X is an alarm service digit, and is set to 1 for no alarm (X-Bit).
M_1 to M_4 are subframes which constitute a multi-frame.

C_{11}, C_{12}, C_{13} = 000 when no stuffing has occurred. 111 when stuffing has taken place in input 1.

Note: The timeslot available for stuffing input 1 is the third slot for input 1, following C_{13}

DS1C Frame Format

The DS1C (3.152 Mbit/s) signal is achieved by time division multiplexing two DS1 (1.544 Mbit/s) data streams. Pulse stuffing is required because the frequency of the two DS1 streams (digroups) may not be the same. The DS1C format consists of one control bit followed by 52 data bits. The data block is composed of alternating or interleaved bits from the two digroups. The control bits consist of :

1. The F-bit sequence which allows the demultiplexer receiver to separate the data from the control bits (frame alignment signal).

2. The M-bits allow the demultiplexer receiver to identify the stuffed bit positions in the bit sequence (multi-frame alignment).

3. The C-bits indicate pulse stuffing has taken place (stuffing control indicator word).

-400 to -402	Instrument fault, code provides service information.
100	Self test failed
600	Jitter option not fitted

Alphabetical List of Remote Control Messages with Default Settings

E

This Appendix contains an alphabetically arranged list of HP 3787B Remote Control Messages and the Default Settings associated with these Messages where applicable.

Regardless of the current set up the following Message sets the HP 3787B to the Default Settings and clears all HP-IB input and output buffers.

- RST : Reset HP-IB and RS-232-C.

Table E-1. Remote Control Messages

Command Description	Mnemonic	Page Reference	Default Setting
Alarm Duration Type	"ADT n" n = PATTERN or 1 n = SUBR_FRAME or 2 n = DS1_FRAME or 3 n = DIGR_FRAME or 4 n = DS1C_FRAME or 5 n = AIS_SECS or 6 n = INST_POWER or 7 n = SIGNAL or 8 "ADT?"	6-40	PATTERN
Alarm Status Register 1	"AL1?"	6-44	N/A
Alarm Status Register 2	"AL2?"	6-44	N/A
Actuate Loopback	"ALB"	6-21	N/A
Alarm Duration Result	"ALD? n" n = PATTERN or 1 n = SUBR_FRAME or 2 n = DS1_FRAME or 3 n = DIGR_FRAME or 4 n = DS1C_FRAME or 5 n = AIS_SECS or 6 n = INST_POWER or 7 n = SIGNAL or 8	6-46	N/A

Table E-1. Remote Control Messages (continued)

TX Alarm Type DS1/DS1C	"ALT n" n = OFF or Ø n = YELLOW or 1 n = X_BIT or 2 n = AIS or 3 "ALT?"	6-29	OFF
Alarm Mask Register 1	"AM1 n" n = NONE or Ø n = PAT or 1 n = SL1 or 2 n = SLØ or 4 n = CL1 or 8 n = CLØ or 16 n = FLC or 32 n = MFA or 64 n = FL1 or 128 n = FLB or 256 n = AIS or 512 n = XBT or 1Ø24 n = YAL or 2Ø48 n = ERR or 4Ø96 "AM1?"	6-43	8191
Alarm Mask Register 2	"AM2 n" n = NONE or Ø n = SLH or 1 n = SLL or 2 n = SLI or 4 n = SL2 or 8 n = NFS or 16 n = PFS or 32 "AM2?"	6-43	63
Output Analysis Result	"ANR? n" n = AVAIL or 1 n = UNAVAIL or 2 n = SEVERE_ES or 3 n = ERROR_SEC or 4 n = MINUTES or 5 n = CSES or 6 n = SEVERE_CNT or 7 n = ES_CNT or 8 n = MINS_CNT or 9	6-46	N/A
Analysis Source	"ANS n" n = A or 1 n = B or 2 "ANS?"	6-40	A

Table E-1. Remote Control Messages (continued)

TX APS Test Mode	"APM n" n = START or 1 n = NO_TRANSFER or 2 n = TRANSFER or 3 n = NO_RESTORE or 4 n = RESTORE or 5 "APM?"	6-28	START
TX APS Error Rate	"APR r1,r2,r3,r4" r1 = 1.ØE-8 to 9.ØE-3 r2 = 1.ØE-8 to 9.ØE-3 r3 = 1.ØE-8 to 9.ØE-3 r4 = 1.ØE-8 to 9.ØE-3 "APR?"	6-28	All 1.ØE-8
Analysis Type	"ATY n" n = AVAIL or 1 n = UNAVAIL or 2 n = SEVERE_ES or 3 n = ERROR_SEC or 4 n = MINUTES or 5 n = CSES or 6 n = SEVERE_ES or 7 n = ES_CNT or 8 n = MINS_CNT or 9 "ATY?"	6-40	AVAIL
Audio Control	"AUD n" n = OFF or Ø n = ON or 1 "AUD?"	6-50	OFF
Output MJU Branch Select Code	"BSC?"	6-47	N/A
Error Add Rate (ESF_CRC Errors)	"CAR n" n = 1.ØE-8 to 3.ØE-4 "CAR?"	6-27	1.0E-8
Clear (Common Capability)	"CLR"	6-52	N/A
Configuration (Common Capability)	"CON" "CON?"	6-52	N/A
Date	"DAT y,m,d" y = 1987 to 2Ø5Ø m = 1 to 12 d = 1 to 31 "DAT?"	6-15	N/A

Table E-1. Remote Control Messages (continued)

DS0 Clock Source	"DCS n" n = FRONT or 1 n = REAR or 2 "DCS?"	6-16, 6-30	FRONT
RX Dataport Error Correction	"DEC n" n = OFF or Ø n = ON or 1 "DEC?"	6-33	OFF
TX Dataport Error Rate	"DER n" n = OFF or Ø n = LOW or 1 n = HIGH or 2 "DER?"	6-28	OFF
TX DDS Link Type	"DLT n" n = SINGLE or 1 n = MULTI or 2 "DLT?"	6-20	SINGLE
TX Error Add Method	"EAD n" n = SINGLE or 1 n = RATE or 2 "EAD?"	6-27	SINGLE
TX Error Add Rate (Logic, BPV/Code)	"EAR n" n = 1.ØE-8 to 9.ØE-3 "EAR?"	6-27	1.ØE-8
TX Error Add Type	"EAT n" n = OFF or Ø n = LOGIC or 1 n = BPV or CODE or 2 n = FRAME or 3 n = SUBFRAME or 4 n = ESF_CRC or 5 n = DATAPORT or 6 n = BYTE or 7 n = APS or 8 "EAT?"	6-27	OFF
Output Elapsed Time	"ELP?"	6-47	N/A
Error Code (Common Capability)	"ERR?"	6-52	N/A
Frame Slips Result Request	"FSL? n" n = POSITIVE or 1 n = NEGATIVE or 2	6-46A	N/A

Table E-1. Remote Control Messages (continued)

Gating Period	"GPR d,h,m,s" d = Ø to 99 h = Ø to 23 m = Ø to 59 s = Ø to 59 "GPR?"	6-42	00.00,00.01
Gating Type	"GTY n" n = MANUAL or 1 n = SINGLE or 2 n = REPEAT or 3 n = SHORT_1S or 4 n = SHORT_15S or 5 n = SHORT_5M or 6 n = SHORT_15M or 7 "GTY?"	6-42	MANUAL
TX HL96NY Presence	"HLP n" n = NO or Ø n = YES or 1 "HLP?"	6-22	NO
Output Hub ID	"HUB? n" n = PRESENT or 1 n = PREVIOUS or 2	6-47	N/A
RX DSØ Termination	"IØT n" n = TERMINATED or 1 n = MONITOR or 2 "IØT?"	6-31	TERMINATED
RX DS1/DS1C Input Level	"I1L n" n = AUTO or 1 n = DSX or 2 n = DSX_MON or 3 n = DS_LO or 4 n = DS_LO_MON or 5 n = BRIDGED or 6 "I1L?"	6-30	AUTO
RX DSØA Termination	"IAT n" n = TERMINATED or 1 n = MONITOR or 2 n = LOGIC_NEAR or 3 n = LOGIC_FAR or 4 "IAT?"	6-31	TERMINATED
RX DSØB Termination	"IBT n" n = TERMINATED or 1 n = MONITOR or 2 "IBT?"	6-31	TERMINATED

Table E-1. Remote Control Messages (continued)

Identification (Common Capability)	"ID?"	6-52	N/A
TX Timeslot Insertion	"INS n" n = OFF or Ø n = ON or 1 "INS?"	6-19	OFF
RX Jitter Filter (Option 001 only)	"JFL n" n = LP or 1 n = LP_HP1 or 2 n = LP_HP2 or 3 "JFL?"	6-40	LP
RX Jitter Filter Threshold (Option 001 only)	"JFT n" n = Ø.Ø5 to 1Ø.ØØ UI "JFT?"	6-40	ØØ.Ø5
Key Query (Common Capability)	"KEY?"	6-53	N/A
TX DS0 Loopback Type	"LB0 n" n = NONE or Ø n = ALT_DSU or 1 n = ALT_CHAN or 2 n = ALT_OCU or 3 n = ALT_RPT or 4 n = ALT_HL96 or 5 n = ALT_DSØDP or 6 n = LAT_DSØDP or 7 n = LAT_OCU or 8 n = LAT_CSU or 9 n = LAT_HL222 or 1Ø n = LAT_MJU or 11 "LB0?"	6-21	NONE
TX DS1 Loopback Type	"LB1 n" n = NONE or Ø n = IN_LINE or 1 n = IN_NETWORK or 2 n = DL_LINE or 3 n = DL_NETWORK or 4 n = DL_PAYLOAD or 5 "LB1?"	6-21	NONE
Return To Local (Common Capability)	"LCL"	6-53	N/A

Table E-1. Remote Control Messages (continued)

Log During Gating	"LDG n" n = OFF or Ø n = ERR_SEC or HIT_SEC or 1 n = RATIO or 2 "LDG?"	6-49	OFF
Log During Gating Threshold	"LDT n" n = 2 to 7 LDT?	6-49	1.ØE-2 (2)
Logging Device	"LDV n" n = HP3787B or 1 n = HP-IB or 2 "LDV?"	6-48	HP3787B
Log at End of Gating	"LEG n" n = OFF or Ø n = ALWAYS or 1 n = RATIO or 2 "LEG?"	6-48	OFF
End of Gating Summary Contents	"LES a,b,c,d" a = OFF or Ø a = SELECTED or 1 a = ALL or 2 b = OFF or Ø b = SELECTED or 1 b = ALL or 2 c = OFF or Ø c = SELECTED or 1 c = ALL or 2 d = OFF or Ø d = ON or 1 "LES?"	6-48	OFF,OFF,OFF OFF
Log at End of Gating Threshold	"LET n" n = 2 to 7 "LET?"	6-48	1.ØE-2 (2)
MJU Loopback Identification	"LHB?"	6-46A	N/A
Log On Demand	"LOD"	6-49	N/A
Logging ON/OFF	"LOG n" n = OFF or Ø n = ON or 1 "LOG?"	6-48	OFF
Output Latching Loopback Mapcode	"MAP?"	6-47	N/A

Table E-1. Remote Control Messages (continued)

RX Measurement Source A	"MAS n" n = SEC_CHAN or 1 n = CUST or 2 n = SUBRATE or 3 "MAS?"	6-36	N/A
Measurement Source B	"MBS n" n = OFF or Ø n = SEC_CHAN or 1 n = CUST or 2 n = SUBRATE or 3 n = TIMESLOT or 4 n = DSØ or 5 n = DSØA or 6 n = PSDC or 7 n = DATALINK or 8 n = DIGROUP or 9 n = DS1 or 1Ø n = DS1C or 11 n = R_CHAN or 12 "MBS?"	6-38	OFF
Measurement Display	"MDS n" n = RESULTS or 1 n = ALARMS or 2 n = BIT_MON or 3 n = INP_LEV or 4 n = ANALYSIS or 5 n = SLIPS or 6 "MDS?"	6-51	RESULTS
TX Multipoint Junction Unit Operations	"MJU n" n = SELECT or 1 n = TEST or 2 n = END_TEST or 3 n = BLOCK or 4 n = UNBLOCK or 5 n = RELEASE or 6 "MJU?"	6-20	N/A
Instrument Mode	"MOD n" n = TX&RX or 1 n = THRU or 2 MOD?	6-16, 6-30	TX&RX

Table E-1. Remote Control Messages (continued)

Output Monitor Word Result	"MON?"	6-46A	N/A
RX Measurement Type A	"MTA n" n = LOGIC or 1 n = BPV or CODE or 2 n = FRAMING or 3 n = ESF_CRC or 4 n = JITTER or 5 "MTA?"	6-36	LOGIC
RX Measurement Type B	"MTB n" n = LOGIC or 1 n = BPV or CODE or 2 n = FRAMING or 3 n = ESF_CRC or 4 n = JITTER or 5 "MTB?"	6-38	LOGIC
Option Query (Common Capability)	"OPT?"	6-53	N/A
Protect Panel	"PRP n" n = OFF or Ø n = ON or 1 "PRP?"	6-50	ON
RX DSØA/DSØB Data Rate	"RØR n" n = 1 to 4 "RØR?"	6-31, 6-32	2.4 kbits (1)
RX DS1/DS1C Coding	"R1C n" n = AMI or 1 n = B8ZS or 2 "R1C?"	6-30	AMI
RX DS1/Digroup Framing	"R1F n" n = OFF or Ø n = T1DM or 1 n = SF or D4 or 2 n = FT or 3 n = ESF or FE or 4 "R1F?"	6-31	SF

Table E-1. Remote Control Messages (continued)

RX Pattern Type	"RCD n" n = PRBS_20 or 1 n = ALL_ONES or 2 n = SETTABLE or 3 n = PRBS_2047 or 4 n = PRBS_511 or 5 n = TRAFFIC or 6 n = CODES or 7 "RCD?"	6-34	PRBS_20
RX DS1C Framing	"RCF n" n = OFF or Ø n = ON or 1 "RCF?"	6-30	ON
Recall Panel	"RCL n" n = Ø to 9	6-50	N/A
RX DSØB Customer Rate	"RCR n" n = 1 to 3 "RCR?"	6-33	2.4 kbits (1)
RX DSØB Customer Number	"RCU n" n = 1 to 20 "RCU?"	6-33	1
RX DDS Channel Type	"RDC n" n = PRIMARY or 1 n = SECONDARY or 2 "RDC?"	6-33	PRIMARY
RX Digroup Number	"RDN n" n = 1 or 2 "RDN?"	6-32	1
RX Data Type	"RDT n" n = PATTERN or 1 n = PROTOCOL or 2 "RDT?"	6-34	PATTERN
Ready Code (Common Capability)	"RDY?"	6-53	N/A
Revision Date (Common Capability)	"REV?"	6-53	N/A

Table E-1. Remote Control Messages (continued)

RX Interface Level	"RIN n" n = DS1C or 1 n = DS1 or 2 n = DSØB or 3 n = DSØA or 4 n = DSØ or 5 "RIN?"	6-30	DS1
Output Jitter Result A (Option 001 only)	"RJA? n" n = HIT_COUNT or 1 n = HB_COUNT or 2 n = HB_RATIO or 3 n = HIT_SECS or 4 n = HITF_SECS or 5 n = PK_TO_PK or 6	6-45	N/A
Output Jitter Result B (Option 001 only)	"RJB? n" n = HIT_COUNT or 1 n = HB_COUNT or 2 n = HB_RATIO or 3 n = HIT_SECS or 4 n = HITF_SECS or 5 n = PK_TO_PK or 6	6-45	N/A
Release Loopback	"RLB"	6-22	N/A
RX Loopback Data	"RLD n" n = NO_LOOP or Ø n = LOOP or 1 "RLD?"	6-34	NO_LOOP
RX Measurement Select	"RMS n" n = OFF or Ø n = DS1C or 1 n = DIGROUP or 2 n = DS1 or 3 n = DSØB or 4 n = DSØA or 5 n = PSDC or 6 n = DSØ or 7 N = DATALINK or 8 n = FS_CHAN or 9 n = R_CHAN or 1Ø "RMS?"	6-32	DS1
Remote (Common Capability)	"RMT"	6-54	N/A

Table E-1. Remote Control Messages (continued)

RX PSDC Pattern Inversion	"RPI n" n - OFF or 0 n = ON or 1 "RPI?"	6-33	OFF
Request Service (Common Capability)	"RQS n" n = NONE or 0 n = RQC or 1 n = PWR or 2 n = FPS or 4 n = LCL or 8 n = RDY or 16 n = ERR or 32 n = RQS or 64 n = MSG or 128 n = EOG or 256 n = AL1 or 512 n = AL2 or 1024 n = LOG or 2048 n = GIP or 4096 n = OFF n = ON "RQS?"	6-54	ERR (32)
Output Result A	"RSA? n" n = COUNT or 1 n = RATIO or 2 n = SYNC_ES or 3 n = ASYNC_ES or 4 n = ASYNC_EFS or 5 n = PER_EFS or 6	6-45	N/A
Output Result B	"RSB? n" n = COUNT or 1 n = RATIO or 2 n = SYNC_ES or 3 n = ASYNC_ES or 4 n = ASYNC_EFS or 5 n = PER_EFS or 6	6-45	N/A
Reset (Common Capability)	"RST"	6-55	N/A
RX Settable Word	"RSW 'bbbbbbbb'" b = 0 or 1 or f or s "RSW?"	6-35	10101010
RX Timeslot Number	"RTS n" n = 1 to 24 "RTS?"	6-32	1

Table E-1. Remote Control Messages (continued)

Output, Input Voltage Result	"RXL? n" n = POSITIVE or 1 n = NEGATIVE or 2	6-46	N/A
RX PRBS Zero-Limit	"RZL"	6-34	ON
Save Panel	"SAV n" n = 1 to 9	6-50	N/A
TX Select MJU Branch	"SBR n" n = 1 to 4 "SBR?"	6-20	1
Single Error Add	"SEA"	6-27	N/A
Output Signaling Bits Result	"SGR?"	6-47	N/A
TX Signaling Bits	"SIG xxyy" x = Ø or 1 y = Ø or 1 "SIG?"	6-26	"11 "
Status Register A (Common Capability)	"STA?"	6-55	N/A
Status Register B (Common Capability)	"STB?"	6-55	N/A
TX Stop DDS Codes	"STC"	6-25	N/A
Stop Gating	"STP"	6-42	N/A
Start Gating	"STR"	6-42	N/A
TX DSØA/DSØB Data Rate	"TØR n" n = 1 to 4 "TØR?"	6-17,6-18	2.4 kbits(1)
TX DS1/DS1C-Digroup Framing	"T1F n" n = OFF or Ø n = T1DM or 1 n = SF or D4 or 2 n = FT or 3 n = ESF or FE or 4 "T1F?"	6-16	SF
TX DSØA Interface Mode	"TAM n" n = BIPOLAR or 1 n = LOGIC_NEAR or 2 n = LOGIC_FAR or 3 "TAM?"	6-17	BIPOLAR

Table E-1. Remote Control Messages (continued)

TX DS1/DS1C Coding	"TCD n" n = AMI or 1 n = B8ZS or 2 "TCD?"	6-16	AMI
TX DS1C Framing	"TCF n" n = OFF or Ø n = ON or 1 "TCF?"	6-16	ON
TX DS1 Clock	"TCL n" n = INTERNAL or 1 n = EXTERNAL or 2 n = LOOPED or 3 "TCL?"	6-17	INTERNAL
TX DSØA/DSØB Customer Rate	"TCR n" n = 1 to 3 "TCR?"	6-19	2.4 kbits(1)
TX DSØA/DSØB Customer Number	"TCU n" n = 1 to 20 "TCU?"	6-18	1
TX DDS Channel Type	"TDC n" n = PRIMARY or 1 n = SECONDARY or 2 "TDC?"	6-20	PRIMARY
TX Data Type	"TDT n" n = PATTERN or 1 n = CODE or 2 n = PROTOCOL or 3 n = MESSAGE or 4 "TDT?"	6-23	PATTERN
Time	"TIM h,m,s" h = Ø to 23 m = Ø to 59 s = Ø to 59 "TIM?"	6-15	N/A
TX Interface Level	"TIN n" n = DS1C or 1 n = DS1 or 2 n = DSØB or 3 n = DSØA or 4 n = DSØ or 5 "TIN?"	6-16	DS1

Table E-1. Remote Control Messages (continued)

TX Number Of Intermediate Repeaters (CSU Loopback)	"TIR n" n = Ø to 2 "TIR?"	6-22	Ø
ESF Datalink Message Content	"TMC 'Øddddddd Ø' d = Ø or 1 "TMC?"	6-18	'ØØ1Ø1Ø1Ø'
ESF Datalink Message Type	"TMT n" n = IDLE or 1 n = WORD or 2 "TMT?"	6-18	IDLE
TX Tandem Number (DS0DP Loopback)	"TNU n" n = 1 to 8 "TNU?"	6-22	1
TX DDS Code	"TRC n" n = CMI or 1 n = OCU_LB or 2 n = CHAN_LB or 3 n = DSU_LB or 4 n = TIP or 5 n = LBE or 6 n = FEV or 7 n = TA or 8 n = MA or 9 n = UMC or 1Ø n = BLOCK or 11 n = RLS or 12 n = ASC or 13 n = TEST or 14 n = OOS or 15 n = SETTABLE or 16 "TRC?"	6-25	CMI
TX Pattern Type	"TRD n" n = PRBS_20 or 1 n = ALL_ONES or 2 n = SETTABLE or 3 n = PRBS_2Ø47 or 4 m = PRBS_511 or 5 n = PREPROG or 6 "TRD?"	6-23	PRBS_20
TX Repeater Number	"TRN n" n = 1 to 2 "TRN?'	6-22	1

Table E-1. Remote Control Messages (continued)

TX User Defined Pattern	"TRP #H(data)"
	data = 1 to 256 bytes of data.
	1 byte = 2 Hex Characters
	"TRP?"
		6-24	100 x FF(Hex) & 100 x ØØ(Hex)

TX/RX Display Select	"TRS n" n = TX or 1 n = RX or 2 "TRS?"	6-51	RX
TX DDS Settable Code	"TSC 'bbbbbbbb'" b = Ø or 1 or s "TSC?"	6-26	SØ1Ø1Ø1Ø
TX Select Level	"TSL n" n = DS1 or 1 n = DSØB or 2 n = DSØA or 3 n = PSDC or 4 n = DSØ or 5 n = DATALINK or 6 n = FS_CHAN or 7 n = R_CHAN or 8 "TSL?"	6-18	DS1
TX Signaling Mode	"TSM n" n = SET or 1 n = RETRANSMIT or 2 "TSM?"	6-26	SET
SELF TEST (Common Capability)	"TST"	6-56	N/A
TX Settable Word	"TSW 'bbbbbbbb'" b = Ø or 1 or f or s "TSW?"	6-24	1Ø1Ø1Ø1Ø
TX Timeslot Number	"TTS n" n = 1 to 24 "TTS?"	6-19	1
TX Start DDS Code	"TXC"	6-25	N/A
TX PRBS_20 Zero Limit	"TZL n" n = OFF or Ø n = ON or 1 "TZL?"	6-23	ON

HEWLETT PACKARD

OPERATING MANUAL

HP 3787B

DIGITAL DATA TEST SET (Including Options 001 and 002)

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 2703U.

For additional important information about Serial numbers see INSTRUMENTS COVERED BY MANUAL in Section 7.

Manual Part Number: 03787-90001
Microfiche Part Number: 03787-90026
Printed: September 1987

WARNING

READ THE FOLLOWING NOTES BEFORE INSTALLING OR SERVICING ANY INSTRUMENT.

1. IF THIS INSTRUMENT IS TO BE ENERGISED VIA AN AUTO-TRANSFORMER MAKE SURE THAT THE COMMON TERMINAL OF THE AUTO-TRANSFORMER IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SOURCE.

2. THE INSTRUMENT MUST ONLY BE USED WITH THE MAINS CABLE PROVIDED. IF THIS IS NOT SUITABLE, CONTACT YOUR NEAREST HP SERVICE OFFICE. THE MAINS PLUG SHALL ONLY BE INSERTED IN A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD (POWER CABLE) WITHOUT A PROTECTIVE CONDUCTOR (GROUNDING).

3. BEFORE SWITCHING ON THIS INSTRUMENT:

   (a) Make sure the instrument input voltage selector is set to the voltage of the power source.

   (b) Ensure that all devices connected to this instrument are connected to the protective (earth) ground.

   (c) Ensure that the line power (mains) plug is connected to a three-conductor line power outlet that has a protective (earth) ground. (Grounding one conductor of a two-conductor outlet is not sufficient).

   (d) Check correct type and rating of the instrument fuse(s).

Contents

Chapter 6 Remote Control

Chapter 7 General Information

Chapter 8 Installation

INITIAL INSPECTION

CONTENTS

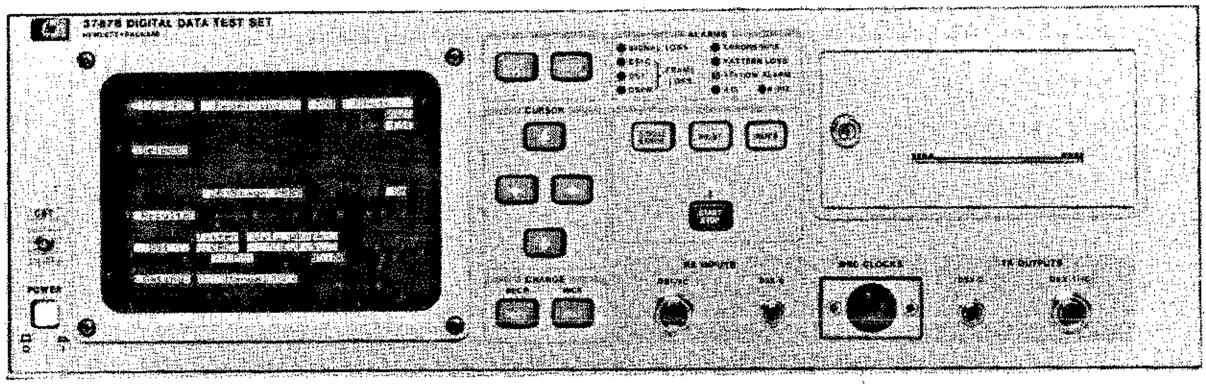
Digital Data Test Set
Power Cord
RS-232-C Test Plug
Front Panel Cover Kit (HP 15672A)
Service Manual
Operating Manual
Operating Guide (held in Instrument tray)

WARNING

TO AVOID HAZARDOUS ELECTRICAL SHOCK. DO NOT PERFORM ELECTRICAL TESTS WHEN THERE ARE SIGNS OF SHIPPING DAMAGE TO ANY PORTION OF THE OUTER ENCLOSURE (COVERS, PANELS, METERS ETC.)

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically. Procedures for checking electrical performance are given in Section 4 of the Service Manual. If the contents are incomplete, if there is mechanical damage or defect or if the HP 3787B does not pass the Performance Tests, notify the nearest Hewlett-Packard office. If the shipping container is damaged or the cushioning material shows signs of stress, notify the carriers as well as the Hewlett-Packard office. Keep the shipping materials for the carriers inspection. The HP office will arrange for repair or replacement at HP option without waiting for claim settlement.

Introduction to the HP 3787B Digital Data Test Set



Description

The HP 3787B Digital Data Test Set offers comprehensive error measurement capability for the Digital Transmission hierarchy at the DS1C (3.152 Mbit/s), DS1 (1.544 Mbit/s) and DS0 (64 kbit/s) levels. At DS1 and DS1C it allows on-line nonintrusive monitoring of live digital traffic as well as out-of-service testing. For testing of digital leased services the HP 3787B also offers a wide range of control and test features.

The unit is designed to monitor DS1 and DS1C signals from code, frame, CRC and logic errors and offers comprehensive analysis features. Jitter performance measurement is optional. For testing DDS, Diginet and similar services a broad range of facilities are offered ranging from simple dataport measurements to multipoint junction unit control and latching loopbacks with secondary channel.

The HP 3787B is microprocessor-based and is compatible with the Hewlett-Packard Interface Bus (HP-IB). (HP-IB is Hewlett-Packard's implementation of IEEE Standard 488-1978). It may also be controlled via an RS-232 port. Results may be logged either on the standard internal printer or to an external printer.

Getting Started 1

Introduction

This section gives a brief introduction to instrument operation and describes how to make measurements. Practical examples are used to familiarize you with the controls by demonstrating how they are used to set up and run measurements. You are shown how to read results and obtain a printout. There are some exercises to try on your own. The section is completed with a summary of what you have learned.

Introduction to Instrument Operation

Configuration and Measurement parameters are displayed in inverse video on the CRT display. These are set using the CURSOR and CHANGE keys. For ease of use the displays are arranged with the most significant parameters at the top left hand corner of the screen. When configuring the instrument it is advisable to work from top to bottom and from left to right.

Press the START/STOP key to start the measurement. It will stop automatically at the end of the preset duration but the START/STOP key can be used to override the automatic stop.

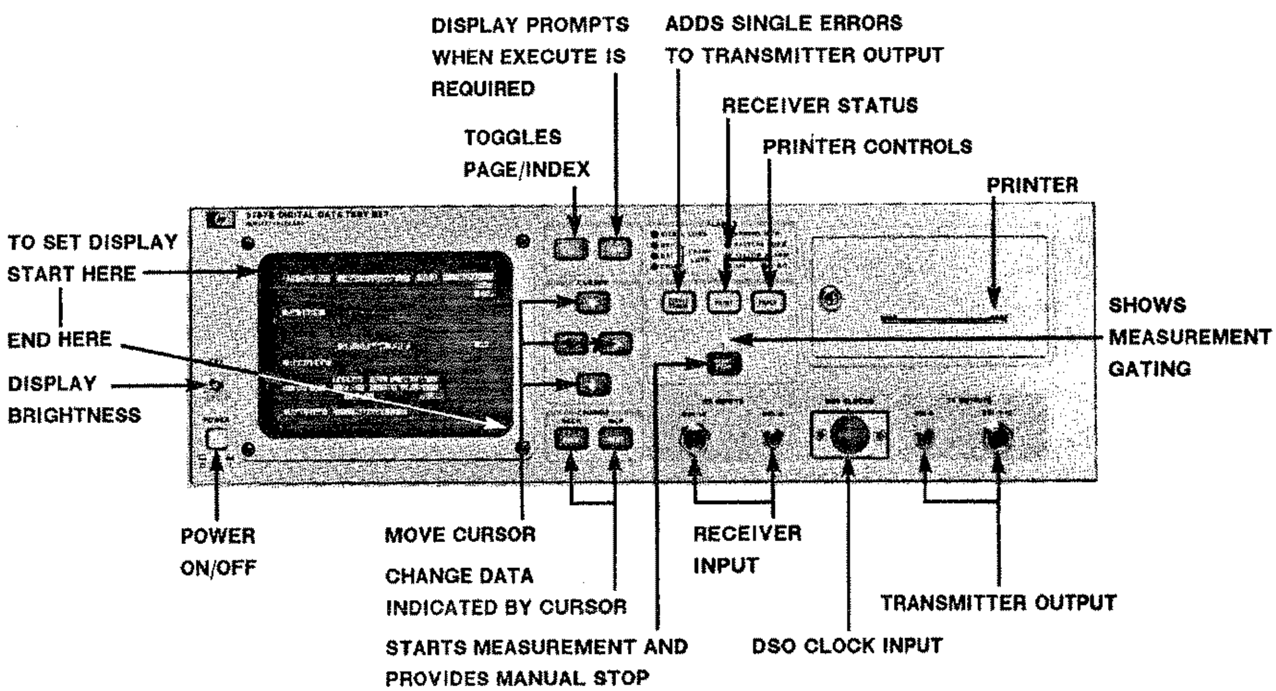
The measurement results are displayed during and after the measurement period. A printout of results can be obtained either automatically by presetting print conditions, or on demand with the PRINT key.

CURSOR keys ------ Change the position of the cursor on the screen.

CHANGE keys ------ Change the data indicated by the flashing cursor.

START/STOP key --- Starts the measurement running and stops it manually.

PRINT key -------- Prints results on the built-in printer on demand.



Start-Up

Before Switch-On

Check that the rear panel voltage selector is set for the power line voltage to be used. Refer to the installation section in the Operating Manual.

Switch-On

Connect the power cord and press the POWER switch.

The instrument will run its power-up checks automatically (this lasts approximately 12 seconds). During the power-up checks the front panel indicators will come on and the beeper will beep. When the instrument passes the power-up test, the first line of the display will show POWER HAS CYCLED. This message will be cleared when any key is pressed.

The first display will be the "INDEX" page with the flashing cursor positioned at the first item.

Normal Operation . . . 1

Check the state of the gating led above the START/STOP key. If it is on, press the START/STOP key to switch it off.

```
POWER HAS CYCLED

                INDEX
                                          Page
Normal Operation .....................1
Stored Panels & Keyboard Lock ........2
Data Logging .........................3
Date & Time ..........................4
Remote Configuration .................5
Instrument ID.........................6
User Confidence Tests ................7
```

Setting the Instrument to the Default State

The instrument automatically starts up in the state it was in when it was last switched off. To start from a known state you may recall a fixed setup stored in the instruments memory.

Use the CURSOR [↑] and [↓] keys to move the flashing cursor to:

Stored Panels & Keyboard Lock . . . 2

then press the [PAGE/INDEX] key.

The "Stored Panels and Keyboard Lock" page is now displayed.

```
Keyboard is _Unlocked   Beeper is Off

Select Panel  0

Press EXEC to  Recall from Panel 0

Last Panel configuration recalled : 0
```

Use the CURSOR keys to move the cursor to Select Panel and use the CHANGE keys to select 0.

Press the [EXEC] key to recall panel 0. Panel 0 is a fixed state permanently stored in the instrument - later you will see how to store your own selections in panels 1 to 9.

Press the [PAGE/INDEX] key to return to the "INDEX" page.

Use the CURSOR keys to move the cursor to:

Normal Operation . . . 1

Press [PAGE/INDEX] again to display the "Normal Operation" Receiving page.

Note that since measurement results are held until a new measurement is started the result of the previous measurement may be displayed at this stage. The result will be reset to 0 when you start your measurement.

```
TX & RX   Receiving     DS1    Auto
                               Code   AMI
                               Frame  SF

Select DS1


Pattern   20 Stage PRBS 14-0 Limit   On
----------------------------------------
Results

 DS1     Logic  Error Count           0
----------------------------------------
Elapsed Time            00 Days 00:00:00
```

- Result of previous measurement may be displayed here.
- Elapsed time of previous measurement may be displayed here.

Making a DS1 Measurement and Adding Single Errors

In the first trial run the transmitter is set to add single errors and the receiver to make logic (binary) error measurements at DS1. The transmitter and receiver are then looped to make a back-to-back measurement.

Selecting the Measurement

The measurement is selected by selecting the results required. As the default state is a logic error count measurement at DS1, you have already selected what you want by recalling panel 0. All you need to do is set a suitable gating interval and the type of error to be added.

REMEMBER:

CURSOR keys ------Move the cursor in the direction of the arrow on the key.

CHANGE keys ------Change the parameter indicated by the cursor.

Set the display from top left to bottom right.

Setting the Gating Interval

Move the cursor to Elapsed Time (at the bottom of the screen) and use the NEXT key to change it to Gating. Move the cursor to Manual and use the NEXT key to change it to Interval. Additional fields will appear in the form DD days HH : MM : SS (Hours : Minutes : Seconds) to allow the interval to be set. Move the cursor to the minutes field and use the NEXT and PREV keys to set 5 minutes .

```
TX & RX   Receiving     DS1     Auto
                                Code    AMI
                                Frame   SF

Select  DS1



Pattern    20 Stage PRBS 14-0 Limit   On
Results

  DS1      Logic  Error Count           0



Gating     Interval     00 Days 00:05:00
```

- Gating Interval set to 5 minutes.

Setting Single Error Add

Move the cursor to Receiving (at the top of the screen) and press NEXT. The Transmitting settings are now displayed.

The default state is "No Error Add".

To enable the SINGLE ERROR key for the addition of logic errors use the CURSOR and CHANGE keys to set the display as shown:

```
 TX & RX   Transmitting   DS1 Code    AMI
                               Frame   SF
                           DS1 Clock   Int

Transmit DS1


Alarms   None

Loopback   Off



 Pattern   20 Stage PRBS 14-0 Limit   On
_Logic Error Add      Single
```

- Select Logic Error Add and then Single.

Recall the Receiving Display to See the Results

Move the cursor to Transmitting and press NEXT. The Receiving settings are now displayed.

Making the Measurement and Adding Single Errors

Now that both the transmitter and receiver are set to make the measurement, you are ready to run it.

As the transmitter output is active it is good practice not to connect the instrument to the system under test before this stage.

Connect the TX OUTPUT DSX-1/1C to the RX INPUT DS1/1C with a WECO 310 to WECO 310 cable.

Note: There is an internal TX/RX link which is broken when a cable is plugged in. Disregard the alarm indications, e.g. signal loss, which occur when one end of the looping cable is connected.

Press the START/STOP key to start the measurement. The gating led above the START/STOP key will come on.

Press the SINGLE ERROR key several times to add errors to the transmitted signal. Observe these errors accumulating on the displayed Logic Error result. They will also be indicated by the ERRORS/HITS led on the front panel.

```
TX & RX  _ Receiving      DS1      Auto
                                  Code    AMI
                                  Frame   SF

Select  DS1



Pattern   20 Stage PRBS 14-0 Limit  On
-----------------------------------------
Results

  DS1     Logic  Error Count          8


-----------------------------------------
Gating     Interval    00 Days 00:05:00
```

- Error Count results display.

You are now making a 5-minute DS1 error measurement. To override the selected 5 minute Gating Interval you may press the (START/STOP) key to stop the measurement.

Making a DS1 Measurement & Adding a Fixed Error Ratio

In the second trial run you add a fixed error ratio to the transmitted signal and look at error count and error ratio results during and after the measurement.

Making a DS1 Measurement & Adding a Fixed Error Ratio

If gating is in progress (led on) press (START/STOP).

Move the cursor to Receiving and press NEXT. The Transmitting settings are now displayed.

Move the cursor to Logic Error Add Single and use the NEXT key to change it to Ratio.

A new field will appear after Ratio indicating the current setting. Move the cursor to this field and use the CHANGE keys to set the ratio to 5.0 E-7. The transmitter will now introduce 5 errors in 10^7 clock periods. You should now have the following display:

```
TX & RX  _Transmitting  DS1 Code   AMI
                           Frame   SF
                     DS1 Clock    Int

Transmit DS1

Alarms   None

Loopback   Off

 Pattern   20 Stage PRBS 14-0 Limit  On
 Logic Error Add      Ratio       5.0 E-7
```

- Set Error Ratio.

Disregard the errors indicated on the ALARMS leds at this stage.

Setting the Gating Interval

Move the cursor to Transmitting and press [NEXT]. The Receiving settings are now displayed.

Use the CURSOR and [NEXT] keys to set the Gating Interval to 4 minutes as shown below:

```
TX & RX  _Receiving     DS1     Auto
                                Code   AMI
                                Frame  SF

Select  DS1


Pattern   20 Stage PRBS 14-0 Limit  On
Results

  DS1     Logic  Error Count              8


Gating    Interval     00 Days 00:04:00
```

- Result of previous measurement. This will be reset to 0 when you press [START/STOP].
- Gating Interval set to 4 minutes.

Making the Measurement and Reading the Results

Press the [START/STOP] key to start the measurement.

The ERRORS/HITS leds and the Error Count display will indicate each error received as before.

Use the CURSOR keys to move the cursor to Error Count and use the [NEXT] key to change it to Error Ratio.

The displayed value is the currently calculated ratio and will be approaching 5.0 in 10^{-7}.

Use the [NEXT] key to display each of the logic error measurements in turn:

Synchronous Error Seconds	Sync Err Secs
Asynchronous Error Seconds	Async Err Sec
Asynchronous Error Free Seconds	Async E.F.S.
% Error Free Seconds	% E.F.S.
Error Count	Error Count
Error Ratio	Error Ratio

Use the CURSOR and [NEXT] keys to change Gating to Elapsed Time. The display will show the time that the measurement has been running. When this reaches 4 minutes the measurement will stop and the gating led will go off automatically.

You can now use the CURSOR and CHANGE keys to step through all the Logic Error Results.

```
TX & RX   Receiving   DS1   Auto
                        Code   AMI
                        Frame  SF

Select  DS1


Pattern  20 Stage PRBS 14-0 Limit On
----------------------------------------
Results

DS1     Logic  Error Ratio       5.0E-7


----------------------------------------
Gating   Interval   00 Days 00:04:00
```

- Error Ratio Result. With the cursor here the [NEXT] key is used to display each of the Logic Error Results.
- Change Gating to Elapsed Time to see how long the measurement has been running.

Adding and Measuring Different Error Types

In this trial run you will add different error types to the transmitted signal and see their effect on the result. You also simulate power and signal loss and see their effect on the Alarm Durations display. Finally you will look at the Results Analysis.

You are going to measure two types of Error simultaneously. This is done by introducing a second Results line.

One of the points demonstrated is that only the type of error selected on the Results display is measured: logic, bipolar violations (BPV), frame, cyclic redundancy code (CRC) or, with Option 001 instruments, jitter.

As this run may take a little longer than the last one, the Gating Interval is set to 10 minutes.

Setting up a Second Simultaneous Measurement

Use the CURSOR keys to move the cursor to Error Ratio and use the PREV key to change it to Error Count. This gives a more immediate indication of error accumulation.

Use the CURSOR keys to move the cursor to the marker on the line below and press the NEXT key to display DS1. Move the cursor to the new fields defining this DS1 measurement and use the NEXT key to set them to BPV and Error Count as shown in the Figure below.

Use the CURSOR and NEXT keys to set the Gating Interval to 10 minutes.

```
TX & RX   Receiving    DS1     Auto
                               Code   AMI
                               Frame  SF

Select  DS1


Pattern    20 Stage PRBS 14-0 Limit  On
Results

 DS1     Logic  Error Count          8
 DS1    _ BPV   Error Count          0

Gating    Interval    00 Days 00:10:00
```

- The second simultaneous measurement.

- Gating Interval set to 10 minutes.

Press the START/STOP key to start a measurement and watch the received errors accumulate.

Note that the errors recorded are logic errors since you are inserting logic errors in the transmitted signal. No bipolar violations are recorded as you have not introduced any yet.

Changing the Type of Error Added

With the measurement still running (gating led on) use the CURSOR keys to move the cursor to `Receiving` and use the NEXT key to change it to `Transmitting`.

Use the CURSOR and NEXT keys to change `Logic Error Add` to `BPV Insertion`.

```
 TX & RX    Transmitting   DS1 Code    AMI
                               Frame    SF
                           DS1 Clock   Int

Transmit DS1

------------------------------------------

Alarms    None

Loopback    Off



 Pattern    20 Stage PRBS 14-0 Limit  On
_ BPV Insertion         Ratio      5.0 E-7
```

- Change to BPV Insertion.

Code errors are now being added to the transmitted signal.

Use the CURSOR keys to move the cursor to `Transmitting` and use the NEXT key to change it back to `Receiving`.

Note that bipolar violations are being recorded on the Results display. Logic errors are no longer being introduced because BPVs are added by changing positive marks to negative marks and negative marks to positive marks.

```
TX & RX  _Receiving    DS1    Auto
                              Code    AMI
                              Frame   SF

Select  DS1



 Pattern   20 Stage PRBS 14-0 Limit  On
Results

  DS1      Logic  Error Count          46
  DS1      BPV    Error Count          59

Gating     Interval    00 Days 00:10:00
```

- BPV errors now added.

Changing the Type of Error Measured

Now try to change the type of error being measured.

Check that the gating led is still on.

Use the CURSOR keys to move the cursor to BPV and press the NEXT key. It will not change and GATING IN PROGRESS will be displayed for a few seconds at the top of the display. This is because during a measurement you cannot change the type of error being measured.

Press the START/STOP key to stop the measurement.

Now press the NEXT key and you will find that you can change the the type of error to be measured to Frame, Jitter with Option 001 instruments, and Logic.

Redisplay BPV (second result) and press START/STOP to start new measurements.

Introducing Alarms and Analysis

Now you will simulate power and signal loss to demonstrate the Alarms and Analysis displays which are alternatives to the Results display.

Move the cursor to Receiving and use the NEXT key to change it to Transmitting.

Use the CURSOR and PREV keys to change the type of error added from BPV Insertion to Logic Error Add Rate 5.0 E-7.

Move the cursor to Transmitting and use the NEXT key to change it to Receiving.

Note that logic errors are being accumulated .

Simulate a power failure by switching the instrument off for several seconds and then switch it back on.

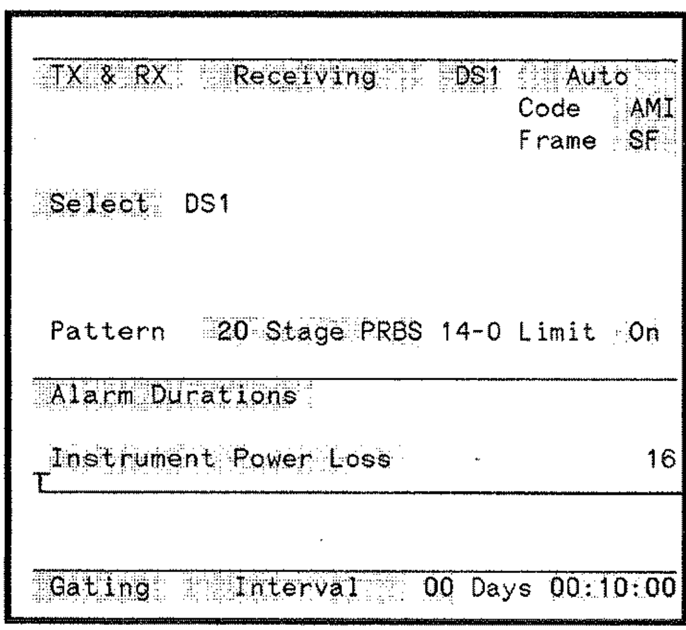
The "INDEX" page will be displayed. Press PAGE/INDEX to return the Receiving page to the display.

Note that your results are not lost and that the instrument is still gating.

Move the cursor to Results and use the NEXT key to display Alarm Durations.

Move the cursor to the alarm duration measurement and use the NEXT key to display each of the following in turn: DS1 Pattern Loss, DS1 Frame Loss, AIS Seconds. Use the NEXT key again to display Instrument Power Loss.

Instrument Power Loss will show the number of seconds the instrument was not measuring due to power loss - this includes 12 seconds for power-up self test.



- Duration of Power Loss (seconds).
With the cursor here the NEXT key is used to display the Alarm Durations Results.

Use the NEXT key to set this display to DS1 Signal Loss.

Note that signal loss was not recorded during the power loss.

Pull out one of the TX/RX loop cable WECO connectors to produce signal loss. You will see the signal loss seconds accumulating on the display and being flagged by the ALARM led on the front panel. Reconnect the loop.

```
TX & RX   Receiving      DS1     Auto
                                 Code    AMI
                                 Frame   SF

Select  DS1


Pattern    20 Stage PRBS 14-0 Limit  On
Alarm Durations

_ DS1 Signal Loss                          7


Gating     Interval     00 Days 00:10:00
```

- Duration of Signal Loss (seconds).

Use the NEXT key to look at all the Alarm Durations measurements again.

DS1 Pattern Loss and DS1 Frame Loss may show a slightly longer time than Signal Loss because of the time required to regain alignment. Move the cursor to Alarm Durations and use the NEXT key to change it to Analysis.

```
TX & RX    Receiving      DS1       Auto
                                    Code   AMI
                                    Frame  SF

Select  DS1


 Pattern    20 Stage PRBS 14-0 Limit  On
_________________________________________
_Analysis

Result A    DS1     Logic

% Availability                    95.4173
_________________________________________
Gating     Interval     00 Days  00:10:00
```

With the cursor here the NEXT key is used to look at all the Analysis results.

You can look at all the Results Analysis displays while the measurement is still running:

% Availability

% Unavailability

% Severe E.S. - % Severely Errored Seconds

% Err Seconds - % Errored Seconds

% Deg. Minutes - % Degraded Minutes

Note that some of these results are triggered only with high error rates, e.g. % Availability may be 100% in this test.

Press the START/STOP key to stop the measurement. You can now repeat the operations to look at all of the results with the measurement complete. The results are held until the START/STOP key is used to start another measurement.

For a printout of results simply press the PRINT key. This produces a printout on demand (only Results or Analysis fields currently displayed will be printed.) The printer can be set to produce printouts at fixed time intervals or under fixed error conditions (see the Printing/Logging Results section).

Making a DDS Measurement & Adding DS0B Frame Errors

In this trial run a test pattern is inserted into customer 2 of a DS0B signal, which is then transmitted in timeslot 11 of a multiplexed DS1 data stream. The receiver demultiplexes to the same customer 2, then measures the errors added to the test pattern. The cross connect voltage levels and path continuity are also checked.

Setting the Transmitter and Receiver for a DDS Measurement

Set the transmitter and receiver - remember, work from the top left of the display to the bottom right.

```
_TX & RX  Transmitting  DS1 Code  AMI
                             Frame T1DM
Insertion On           DS1 Clock  Int

Select  Timeslot 11  DS0B  2.4 kbit/s
        Customer 02

Point-to-Point

Loopback  Off

Test  Primary Channel


Pattern  2047 Bit PRBS
Logic Error Add     Single
```

```
TX & RX   Receiving   DS1    Auto
                             Code  AMI
                             Frame T1DM

Select  Timeslot 11  DS0B  2.4 kbit/s
        Customer 02
         Primary Channel

Pattern  2047 Bit PRBS
          Continuous
Results

Customer  Logic  Error Count        0
_Subrate  Frame  Error Count        0


Gating   Interval   00 Days 00:10:00
```

- Previous measurement results will be displayed.

Checking Path Continuity

Press the START/STOP key to start a measurement and so obtain an indication of received errors.

Press the SINGLE ERROR key and check that the logic errors inserted in the transmitted signal are measured by the receiver. This checks path continuity through the system under test.

```
TX & RX    Receiving      DS1    Auto
                                 Code   AMI
                                 Frame T1DM

Select   Timeslot 11   DS0B   2.4 kbit/s
         Customer 02
          Primary Channel

Pattern   2047 Bit PRBS
          Continuous
Results

Customer   Logic  Error Count          3
 Subrate   Frame  Error Count          0

Gating     Interval    00 Days 00:10:00
```

- Single error recording checks path continuity.

Changing the Type of Error Added to Frame

With the measurement still running (gating led on) use the CURSOR keys to move the cursor to `Receiving` and use the NEXT key to change it to `Transmitting`.

Use the CURSOR and NEXT keys to change `Logic Error Add` to `Sub Frame Err Add` Single.

The SINGLE ERROR key will now add frame errors to the transmitted DS0B data.

Use the CURSOR keys to move the cursor to `Transmitting` and use the NEXT key to change it back to `Receiving`.

Press the SINGLE ERROR key to add frame errors and note that they are recorded on the Results display.

Press the START/STOP key to stop the measurement.

Checking Receiver Input Voltage Levels

Before making measurements at a DS1 cross-connect the receiver input levels may be checked to confirm that the levels are within the recommended limits:

DSX-1 ± 2.4V to ± 3.6V
DSX-1C ± 2.8V to ± 4.5V

Move the cursor to Results and use the NEXT key to change the display to RX Level. The positive and negative peak voltages at the receiver input are displayed simultaneously but are updated alternately.

```
 TX & RX    Receiving    DS1    Auto
                                Code    AMI
                                Frame  T1DM

 Select   Timeslot 11   DS0B   2.4 kbit/s
          Customer 02
          Primary Channel

 Pattern   2047 Bit PRBS
           Continuous
_RX Level

Positive peak :   +3.00 Volts

Negative peak :   -3.00 Volts

 Gating    Interval    00 Days 00:10:00
```

Updated alternately.

Storing and Recalling Measurement Set-ups

This trial run shows you how to use the "stored panels". These stored panels are preset instrument setups which are retained in the instruments memory, even after the power has been removed. One of the panels is fixed, the other 9 are selectable. In this trial run you store the current setup, recall the fixed setup (to reconfigure the instrument) and then recall the one you stored.

Storing a Panel

Use the PAGE/INDEX key to display the index and use the CURSOR keys to move the cursor to

Stored Panels & Keyboard Lock. . . 2

Press the PAGE/INDEX key again to access the Stored Panels display. Use the CURSOR and CHANGE keys to set the display as shown below:

```
Keyboard is  Unlocked    Beeper is  Off

Select Panel  1
Stored Panels Not Protected
Press EXEC to  Save   into Panel 1


Last Panel configuration recalled : 0
```

- Current setup will be stored as Panel 1.

Press EXEC to store the last selected setup in "Stored Panel 1". This will be the setup (both Transmit and Receive) which you used for the DDS measurement.

The Not Protected display will automatically change to Protected. If in future, you wish to overwrite your stored panel you must first change this field from Protected to Not Protected.

Recalling the Fixed Stored Panel

Now use the CURSOR and CHANGE keys to set Select Panel 0.

Remember this is the factory default setting.

```
Keyboard is Unlocked   Beeper is Off

Select Panel  0


Press EXEC to  Recall from Panel 0


Last Panel configuration recalled : 0
```

To access the selected panel press the EXEC key.

Press the PAGE/INDEX key again to return to the "INDEX" page and use the CURSOR keys to move the cursor to

Normal Operation. . . 1

Use the PAGE/INDEX key to display the "Normal Operation" page.

The instrument setup is now the one used for the DSI trial run at the start of this exercise. This is permanently held in stored panel 0.

Recalling the Panel You Stored

Use the PAGE/INDEX key to display the "INDEX" and use the CURSOR keys to move the cursor to

Stored Panels & Keyboard Lock. . . 2

Press the PAGE/INDEX key again to obtain the Stored Panels display. Use the CURSOR and CHANGE keys to set the display as shown below:

```
Keyboard is  Unlocked   Beeper is  Off

Select Panel  1

Stored Panels  Protected

Press EXEC to  Recall from Panel 1


Last Panel configuration recalled : 0
```

Now press EXEC to recall the panel you stored in Stored Panel 1.

Press the PAGE/INDEX key again to return to the "INDEX" page and use the CURSOR keys to move the cursor to

Normal Operation. . . 1

Use the PAGE/INDEX key to display the "Normal Operation" page.

The instrument setup is now the one used for the DDS measurement and stored at the beginning of this trial run.

What You Have Learned

BEFORE YOU START

Check the transmitter parameters before connecting to the equipment under test.

The setup and operation at power loss is restored when power is restored.

SETTING-UP

The transmitter and receiver are independent.

Set up display from top left to bottom right.

Stored panels are a quick and easy way to set up the instrument.

BEFORE THE MEASUREMENT

You can check cross-connect voltage levels by selecting RX Level. (DS1 & DS1C)

You can check path continuity using single error add.

The type of measurement is selected by setting the Results display.

DURING THE MEASUREMENT

Results and result analysis can be monitored during the measurement.

Only the type of error selected in Results is recorded.

You can add errors singly or at a selectable rate.

You can change the type of error added but not the type of error measured.

Gating affects receive NOT transmit.

During power loss only Power Loss Seconds are recorded.

(START/STOP) controls measurement gating; the key overrides the display setting.

AFTER THE MEASUREMENT

Results are held until the next measurement START.

The (PRINT) key produces results printout on demand.

Selected Applications 2

Introduction

This section shows how to use the network control and interface capabilities of the HP 3787B in typical applications. An example of the instrument's Normal Operation displays is given for each of these applications. This section does not tell you how to set up the display or give full details of the measurement capability in any particular application. These details are in Sections 1 and 3.

The applications covered in this section are:

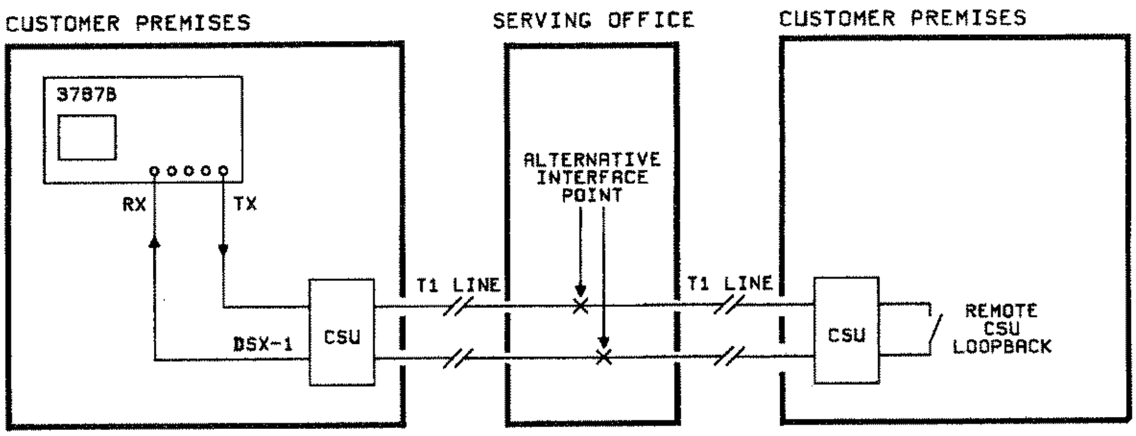
Page

DS1 In-Band Loopback

Application

In situations where DS1 Channel Service Units (CSUs) are capable of performing DS1 in-band remote loopback, the HP 3787B can loop-up a remote CSU, perform a bit error measurement and loop-down the remote CSU.

Measurement Configuration



Example: Looping a remote CSU from a customer premises to make a logic error measurement.

This example checks for errors in each of 3 successive 15 minute gating intervals. Typically this should be less than 20 since 14 corresponds to an error ratio of 10^{-8}. You can do this by using Repetitive Gating with a 15 minute interval, and printing an End-of-Gating Summary. See the Printing/Logging Results section for print selection information. The code and framing used in this example are AMI and SF. Set the code and framing parameters on the Receiving and Transmitting displays.

DS1 Loopback, Sample Receiving Display

```
TX & RX   Receiving   DS1    Auto
                             Code   AMI
                             Frame  SF

Select  DS1

Pattern   20 Stage PRBS 14-0 Limit  On
Results

 DS1     Logic  Error Count            0

Gating  _Rpt Interval  00 Days 00:15:00
```

- Set the receive interface.
- You are going to make your measurement on the complete DS1.
- Select the test Pattern.
- Select the measurement.
- Set the measurement Gating Interval.

DS1 Loopback, Sample Transmitting Display

```
TX & RX   Transmitting   DS1 Code   AMI
                             Frame  SF
                         DS1 Clock  Int

Transmit DS1

Alarms   None

Loopback _Fixed

Press EXEC to Actuate Loopback

 Pattern   20 Stage PRBS 14-0 Limit  On
_Logic Error Add      Single
```

- Set the transmit interface.
- Insert the test pattern in the complete DS1.
- Select the Fixed-format latching Loopback.

Initiate the loop-up by pressing the (EXEC) key. "Loopback operation in progress" will flash on the display while the loop is being set. This takes approximately 8 seconds after which "Press EXEC to Release Loopback" is displayed.

Confirmation of Loopback

You can check that loopback has been achieved by one of the following indicators:

An indicator on the local CSU.
Pattern sync indication on the HP 3787B ALARM indicator.
Normal levels of error count during gating.
Adding single errors and seeing them detected on the ERRORS/HITS alarm.

Make the Measurement

Press the (START/STOP) key.

Remember that with Rpt Interval gating the results are not displayed until the end of each gating interval. They then remain displayed through the following gating interval.

When three results have been printed/displayed press the (START/STOP) key to stop the measurement.

Clear the Loopback after the Measurement

Press the (EXEC) key. "Loopback operation in progress" will flash on the display for approximately 8 seconds while the loop is being cleared.

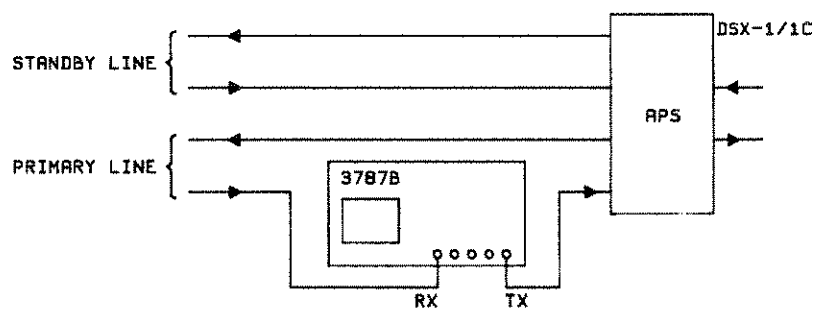
Automatic Protection Switch (APS) Testing

Application

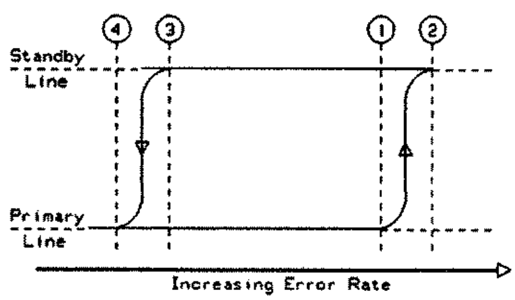
Checking the capability of an automatic protection switch (APS) to change between the primary and standby lines at specified code error rates.

Measurement Configuration

A typical APS test configuration is shown below.



Example: Code errors are introduced at four independently selectable error rates to check the APS switching characteristic. A typical switching characteristic is shown below where points 1 thru 4 correspond to the error rate thresholds set on the HP 3787B.



1. No Transfer - APS remains on Primary Line
2. Transfer - APS switches to Standby Line
3. No Restore - APS remains on Standby Line
4. Restore - APS returns to Primary Line

For this test the HP 3787B operates in the THRU mode.

The code and framing used in this example are AMI and SF framing. These must be compatible with the line and switch being tested and may be set on either the Receiving or Retransmitting displays.

Set the No Transfer, Transfer, Restore, and No Restore ratio thresholds appropriate to the protection equipment type. An error free signal is transmitted in the Start state.

APS Test, Sample Receiving Display

```
THRU      Receiving     DS1   Auto
                              Code   AMI
                              Frame  SF

Select  Off

Results

 No Results valid

_Elapsed Time              00 Days 00:00:00
```

- Set the receive interface.
- In Thru mode you can choose not to measure or demultiplex the received signal.

APS Test, Sample Retransmitting Display

```
THRU    Retransmitting  DS1  Code   AMI
                             Frame  SF

Transmit DS1

Data is Received Traffic
_APS Test    Restore         Ratio 1.0 E-8
```

- Transmitter interface tracks the receiver interface in THRU mode.
- Set to retransmit the received DS1.
- Set up the No Transfer, Transfer, No Restore and Restore ratio to the threshold values for the switch type to be tested.

Make the Measurement

Move the cursor to `Restore`, change it to `Start`, and check that the indicators on the APS equipment show correct operation when the NEXT key is used to select `No Transfer`, `Transfer`, `No Restore`, and `Restore`.

DS1 Data Multiplexer Testing

Application

The HP 3787B allows you to measure the performance of T1DM data multiplexers. This can be done from DS0A to DS0A or DS1 to DS1 by looping the multiplexer.

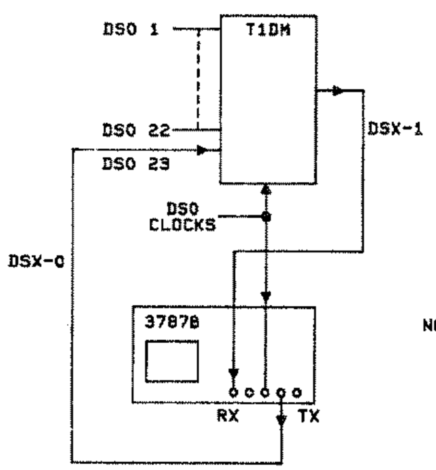
Alternately by using the multiplexing/demultiplexing capability of the HP 3787B you can make half-channel measurements (i.e. DS0 to DS1 and DS1 to DS0).

Note that this configuration is equally applicable to T1WB4 and T1WB5 testing.

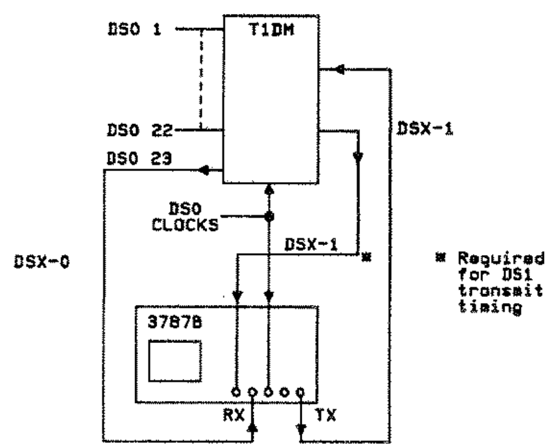
Measurement Configuration

NOTE

T1WB4/5 Multiplexer testing is similar to T1DM testing.



NOTE:
DS0 CLOCKS REQUIRED WHEN USING THE DS0 INTERFACES.



Example: Test a T1DM using the half-channel method with a timeslot assigned to a 56 kbit/s customer.

DSX-0A to DSX-1

The DS0 port to be tested is stimulated by the HP 3787B DS0 transmitter. The DSX-1 output of the T1DM is connected to the HP 3787B DS1 receiver which demultiplexes the timeslot under test and performs error measurements on it.

DSX-0A to DSX-1 Test, Sample Transmitting Display

```
TX & RX   Transmitting  DS0A    DSX
                         56 kbit/s Service
DS0 Clocks  Front

Point-to-Point

Loopback  Off

Test   Primary Channel

Pattern   2047 Bit PRBS
  No Error Add
```

- Set the transmit interface.
- Select the test Pattern.

DSX-0A to DSX-1 Test, Sample Receiving Display

```
TX & RX   Receiving    DS1     DSX
                            Code   AMI
                            Frame  T1DM

Select  Timeslot 23  DS0A   56 kbit/s
         Primary Channel

Pattern   2047 Bit PRBS
          Continuous
Results

  DS0A    Logic  Error Count          0

Gating   Interval   00 Days 00:15:00
```

- Set the receive interface.
- Demultiplex the Timeslot to be tested.
- Select the test Pattern.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

Press the START/STOP key.

Remember that you can display Alarm Durations, Analysis, the Received Word (Monitor) and the received DS1 voltage level (RX level) by changing the Results field.

DSX-1 to DSX-0A

The DSX-1 input port of the T1DM is connected to the HP 3787B DS1 transmitter which stimulates the timeslot under test. The corresponding DSX-0A output of the T1DM is connected to the HP 3787B DS0 receiver which performs error measurements on it.

NOTE

> For this test the HP 3787B must drive the T1DM input with a DS1 signal whose frequency is locked to the DS0 clock supplied to the T1DM and the HP 3787B.
> This can be achieved in two ways:
>
> 1) Supply a DS1 clock at the correct frequency to the HP 3787B rear-panel external clock input and select Ext DS1 Clock.
> 2) Supply any DS1 signal at the correct frequency to the DS1 receiver input and select Looped DS1 Clock. (The Receiver interface must <u>not</u> be set to DS1C).

DSX-1 to DSX-0A Test, Sample Transmitting Display

```
TX & RX  Transmitting  DS1 Code   AMI
                           Frame T1DM
Insertion On          DS1 Clock Looped

_Select  Timeslot 23  DS0A  56 kbit/s


Point-to-Point

Loopback  Off

Test  Primary Channel



Pattern  2047 Bit PRBS
 No Error Add
```

- Set the transmit interface.
- Select the DS1 Timeslot to be tested.
- Select the test Pattern.

DSX-1 to DSX-0A Test, Sample Receiving Display

```
TX & RX   Receiving   DS0A Terminated
                     56 kbit/s Service
DS0 Clocks  Front

 Select   Primary Channel
          (No error correction)

 Pattern   2047 Bit PRBS
           Continuous
Results

  DS0A     Logic  Error Count          0

Gating    Interval    00 Days 00:15:00
```

- Set the receive interface.
- Select the test Pattern.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

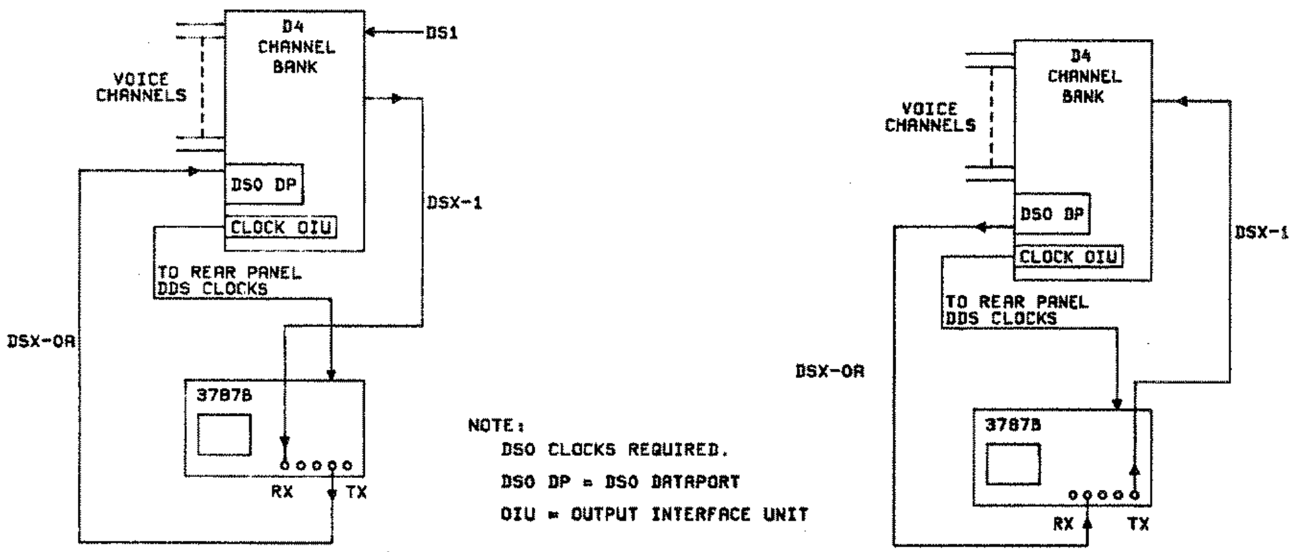
Press the START/STOP key.

Remember that you can display Alarm Durations, Analysis and the Received Word (Monitor) by changing the Results field.

Dataport Testing

The HP 3787B allows you to measure the performance of Dataport cards installed in channel banks. This can be done from DS0A to DS0A or DS1 to DS1 by looping the channel bank. Alternatively by using the multiplexing/demultiplexing capability of the HP 3787B you can make half-channel measurements (i.e. DS0A to DS1 and DS1 to DS0A).

Measurement Configuration



Example: Test a DS0 Dataport (DS0 DP) card in a D4 channel bank using the half-channel method. For this test the data rate can be 2.4, 4.8, 9.6 or 56 kbit/s. The 9.6 kbit/s rate has been chosen for this example.

DSX-0A to DSX-1

Dataport DSX-0A to DSX-1, Sample Transmitting Display

```
TX & RX   Transmitting  DS0A    DSX
                  9.6 kbit/s Service
DS0 Clocks  Rear



Point-to-Point

Loopback  Off

Test   Primary Channel


Pattern    2047 Bit PRBS
 No Error Add
```

- Set the transmit interface.
- If DS0 clocks (not complimentary bit and byte clocks) are supplied from the channel bank, use the rear panel input.
- Select the test Pattern.

Dataport DSX-0A to DSX-1, Sample Receiving Display

```
TX & RX    Receiving     DS1     Auto
                              Code    AMI
                              Frame   SF

Select  Timeslot 01  DS0A  9.6 kbit/s
         Primary Channel
        (Error Correction  Off )

Pattern   2047 Bit PRBS
          Continuous
Results

 DS0A     Logic Sync Err Secs           0



Elapsed Time             00 Days 00:00:00
```

- Set the receive interface.
- Set the Timeslot number to the Dataport under test.
- Remember to select the same test Pattern as on the Transmitting display.
- Select the measurement.

Make the Measurement

Press the START/STOP key. Remember that you can display Alarm Durations, the Received Word (Monitor), the received DS1 voltage level (RX level) and Analysis by changing the Results field.

DSX-1 to DSX-0A

Dataport DSX-1 to DSX-0A, Sample Transmitting Display

```
TX & RX   Transmitting   DS1 Code    AMI
                             Frame   SF
Insertion On             DS1 Clock Looped

Select  Timeslot 01   DS0A  9.6 kbit/s


Point-to-Point

Loopback  Off

Test   Primary Channel



Pattern   2047 Bit PRBS
_ No Error Add
```

- Set the transmit interface.
- Select the DS1 Timeslot to be tested.
- Select the test Pattern.

Dataport DSX-1 to DSX-0A, Sample Receiving Display

```
TX & RX   Receiving    DS0A Terminated
                 9.6 kbit/s Service
DS0 Clocks  Rear


 Select   Primary Channel
          (Error Correction  Off )

Pattern   2047 Bit PRBS
           Continuous
Results

  DS0A    Logic Sync Err Secs          0



Gating _ Interval    00 Days 00:00:01
```

- Set the receive interface.
- If DS0 clocks (not complimentary bit and byte clocks) are supplied from the channel bank, use the rear-panel input.
- Remember to select the same test Pattern as on the transmitting display.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

Press the START/STOP key.

Error Correction Testing

Some dataport cards have a selectable error-correction capability in the DS1 to DS0A direction. The HP 3787B can generate errored data to test this at all subrates. With the HP 3787B transmitter set to produce 3 errored bytes in every 5 bytes (3 in 5) the Dataport error correction will fail to remove the inserted errors and the HP 3787B DS0 receiver should see the added errors. With 2-in-5 selected the Dataport error correction should remove all the inserted errors and the HP 3787B DS0 receiver should see no added errors.

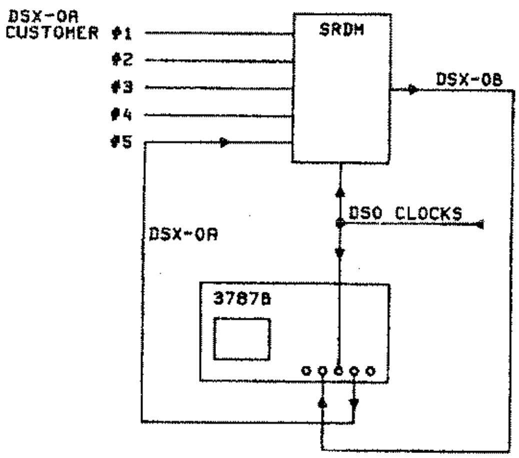
```
TX & RX  Transmitting  DS1 Code   AMI
                           Frame  SF
Insertion On           DS1 Clock Looped

Select  Timeslot 01  DS0A  9.6 kbit/s

Point-to-Point

Loopback  Off

Test  Primary Channel


Pattern   2047 Bit PRBS
_ Dataport Test    3 in 5
```

Sub-Rate Data Multiplexer (SRDM) Testing

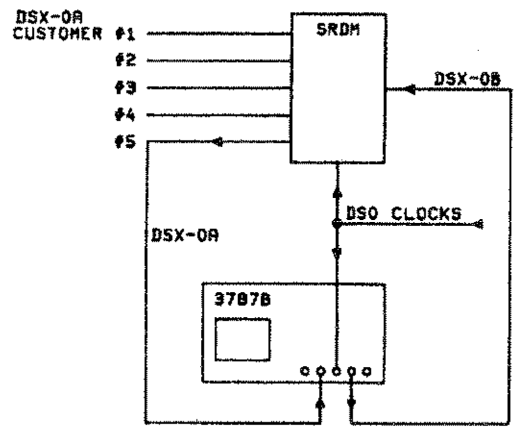
Application

You can run tests on SRDMs from DSX-0A to DSX-0B, and from DSX-0B to DSX-0A, at bit rates of 2.4, 4.8 or 9.6 kbit/s.

Measurement Configuration



DSX-0A to DSX-0B



DSX-0B to DSX-0A

Example: DSX-0A to DSX-0B

In this example the SRDM is configured to multiplex five 9.6 kbit/s customers into a DS0B signal. 4.8 kbit/s and 2.4 kbit/s SRDMs have 10 or 20 inputs respectively. All can be tested by the HP 3787B.

NOTE

SRDMs are sometimes loaded with customers at service rates lower than the capacity of the multiplexer, eg a 2.4 kbit/s customer into a 9.6 kbit/s multiplexer. The HP 3787B can generate and test such signals.

SRDM DSX-0A to DSX-0B, Sample Transmitting Display

```
TX & RX   Transmitting  DSOA    DSX
                     9.6 kbit/s Service
DSO Clocks  Front

Point-to-Point

Loopback  Off

Test   Primary Channel

Pattern    2047 Bit PRBS
  No Error Add
```

- Set the transmit interface.
- Select the test Pattern.

SRDM DSX-0A to DSX-0B, Sample Receiving Display

```
TX & RX    Receiving    DSOB Terminated
                     9.6 kbit/s Service
DSO Clocks  Front

 Select   Customer 05  9.6 kbit/s
           Primary Channel

 Pattern    2047 Bit PRBS
             Continuous
Results

Customer  Logic  Error Count          0

Gating  _  Interval    00 Days 00:15:00
```

- Set the receive interface.
- Select the customer under test.
- Remember to select the same test Pattern as on the Transmitting display.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

Press the START/STOP key.

NOTE

If the other inputs to the SRDM are not connected, an all zero pattern may be detected in the DS0B. This will result in the SIGNAL LOSS led being illuminated. Measurements are valid in this condition.

Example: DSX-0B to DSX-0A

Select the DS0B Customer Number on the Transmitting display. This slot will be stimulated with the selected test Pattern; the other slots will be filled with TEST code.

SRDM DSX-0B to DSX-0A, Sample Transmitting Display

```
TX & RX   Transmitting DS0B
                 9.6 kbit/s Service
DS0 Clocks  Front


Transmit Customer 05  9.6 kbit/s

Point-to-Point

Loopback  Off

Test  Primary Channel



Pattern   2047 Bit PRBS
  No Error Add
```

- Set the transmit interface.
- Select which customer to stimulate with the test Pattern.
- Select the test Pattern.

SRDM DSX-0B to DSX-0A, Sample Receiving Display

```
TX & RX    Receiving   DS0A Terminated
                 9.6 kbit/s Service
DS0 Clocks  Front


 Select   Primary Channel
          (Error Correction  Off )

Pattern   2047 Bit PRBS
           Continuous
Results

  DS0A    Logic  Error Count          0
_


Gating     Interval    00 Days 00:15:00
```

- Set the receive interface.
- Remember to select the same test Pattern as on the Transmitting display.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

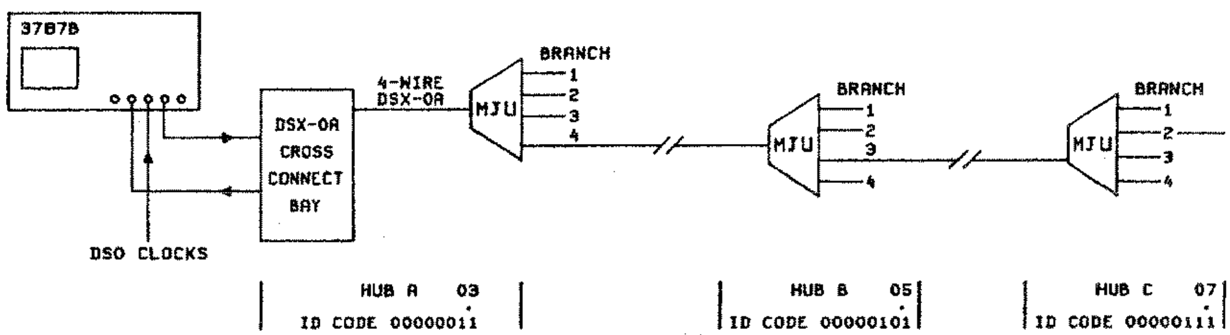
Press the START/STOP key.

Multipoint Junction Unit (MJU) Selection and Testing

Application

You can select, test, block, unblock and release all branches of a DDS Multi-point Circuit. Testing is normally performed downstream from a DSX-0A cross-connect bay by routing each Multi-point Junction Unit in turn. However, you can insert the relevant DS0A signal into a T1 stream.

Measurement Configuration



Example: Select HUB C branch 2 from the HUB A DSX-0A cross connect bay, perform a loopback, make a measurement and release the loopback.

Select Branch

The first operation is to establish the route through the system to the chosen branch. You do this by setting the transmit display for the branch of the first MJU, in this example branch 4, and pressing the EXEC key. When the branch has been selected, the Hub A ID code is returned and is displayed in the "Present" field. You then repeat the operation for branch 3 out of Hub B and branch 2 out of Hub C. This sequence is shown on the following Transmitting displays:

NOTE

The Receiver Pattern must be set to DDS Return codes for the transmitter to display the HUB-ID's.

Branch Selection, Sample Displays

```
TX & RX  Transmitting  DS0A    DSX
                   9.6 kbit/s Service
DS0 Clocks  Front
```

- Set the transmit interface.

```
_ Multipoint          Select Branch  4
              (Last branch selected X)
                    Present HUB-ID XX
                   Previous HUB-ID XX
Press EXEC to select branch
```

-Select Branch 4 out of Hub A.

- Press EXEC to select Branch 4.

```
_ Multipoint          Select Branch  4
              (Last branch selected 4)
                    Present HUB-ID 03
                   Previous HUB-ID XX
Press EXEC to select branch
```

- Branch 4 has been selected.
- Hub A ID code (03) has been returned.

```
_ Multipoint          Select Branch  3
              (Last branch selected 4)
                    Present HUB-ID 03
                   Previous HUB-ID XX
```

- Select Branch 3 out of Hub B.

Press EXEC to select Branch 3.

```
_ Multipoint          Select Branch  3
              (Last branch selected 3)
                    Present HUB-ID 05
                   Previous HUB-ID 03
```

- Branch 3 has been selected.
- Hub B ID code has been returned.

```
_ Multipoint          Select Branch  2
```

- Repeat the selection process for Hub C Branch 2.

Press EXEC to select Branch 2.

```
              (Last branch selected 2)
                    Present HUB-ID 07
                   Previous HUB-ID 05
```

- Branch 2 has been selected.
- Hub C ID code has been returned.

NOTE

If the receiver is configured to receive routing acknowledgments and fails to receive the correct acknowledgment within two seconds of EXEC the message "MJU ROUTING FAILED" is displayed and the display remains as XX and X respectively.

Test Branch

```
TX & RX  Transmitting  DS0A    DSX
                  9.6 kbit/s Service
DS0 Clocks  Front


Multipoint           _Test Branch

              (Last branch selected 2)

                   Present HUB-ID 07
                  Previous HUB-ID 05

Press EXEC to test branch
```

- Select Test Branch
- Press EXEC to enter the Test mode.

```
Multipoint           Test Branch

Loopback  Off

Test  Primary Channel


Pattern   2047 Bit PRBS
No Error Add
```

- At this stage the branch can be tested point-to-point but normally this is done by looping back the selected branch.

Setting Loopback and Test Pattern, Sample Display

```
Multipoint           Test Branch

Loopback  Latching  _OCU   MAPX

Test  Primary Channel

Press EXEC to Actuate Loopback

Pattern   2047 Bit PRBS
No Error Add
```

- Select the type of Loopback.
- Select the test Pattern.

Press EXEC to loop-up.

For information on Latching Loopback acknowledgment see Page 2-28.

Set up the Receiver and Make the Measurement

Select the Receiving display, and set it to correspond with your transmitted test signal. Select the required Results and the Gating Interval.

Press the (START/STOP) key to start the measurement.

Setting Measurement, Sample Display

```
TX & RX    Receiving      DS0A Terminated
                     9.6 kbit/s Service
DS0 Clocks  Front


 Select    Primary Channel
          (Error Correction  Off )

Pattern    2047 Bit PRBS
            Continuous
Results

  DS0A     Logic  Error Count          0



Gating    Interval     00 Days 00:15:00
```

- Set the receive interface.
- Remember to select the same test Pattern as on the Transmitting display.
- Select the measurement.
- Set the measurement Gating Interval.

After the Measurement

To release the loopback and route you have accessed select the Transmitting display. Press EXEC to release the loopback and change Test Branch to End Test. Press EXEC to release the Test route.

Releasing the Loopback, Sample Display

```
TX & RX  Transmitting  DS0A    DSX
                   9.6 kbit/s Service
DS0 Clocks  Front

Multipoint           Test Branch

Loopback  Latching  _OCU   MAP1

Test   Primary Channel

Press EXEC to Release Loopback

Pattern   2047 Bit PRBS
  No Error Add
```

- Press EXEC to Release the Loopback.

Releasing the Route, Sample Display

```
TX & RX  Transmitting  DS0A    DSX
                   9.6 kbit/s Service
DS0 Clocks  Front

Multipoint           _ End Test

               (Last branch selected 2)

                     Present HUB-ID 07
                     Previous HUB-ID 05

Press EXEC to end test
```

- Select End Test
- Press EXEC to End the Test and release the route.

If after testing a branch you wish to leave it blocked simply select Block Branch instead of End Test. See the following section on Blocking and Releasing.

Blocking and Releasing

You can block or release the individual branch selected (in this example HUB C, branch 2) or release all downstream branches by selecting the appropriate Multi-point field on the Transmitting display and pressing EXEC.

Branch Block/Release, Sample Display

```
TX & RX   Transmitting  DS0A    DSX
                   9.6 kbit/s Service
DSO Clocks  Front



  Multipoint          _Block Branch

               (Last branch selected 2)

                     Present HUB-ID 07
                    Previous HUB-ID 05

Press EXEC to block branch
```

- You can select Block Branch
  Unblock Branch
  Release all

- Activate your selection by pressing EXEC.

NOTE

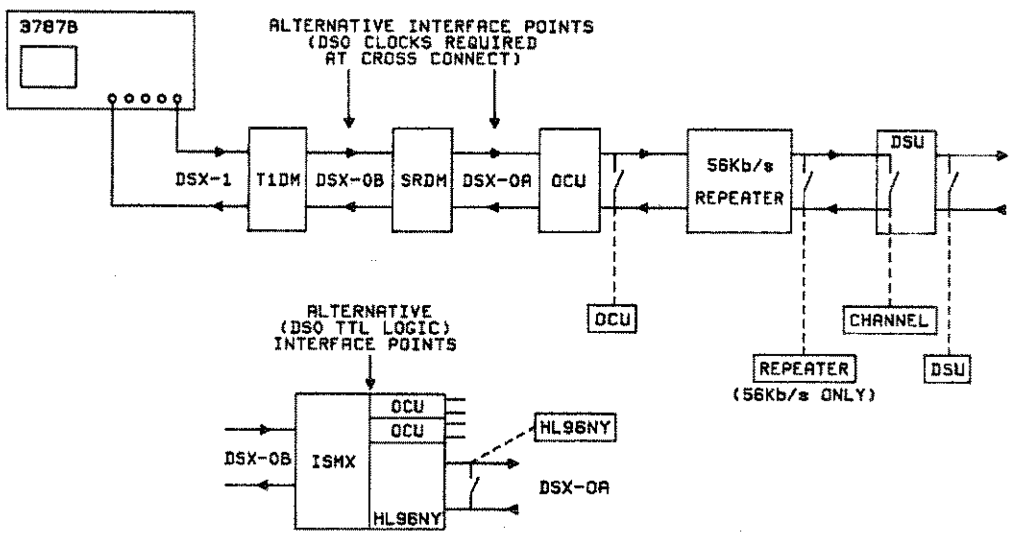
With Block Branch selected both the current and previous HUB-ID are displayed together with the selected branch number of the current MJU. Until EXEC is pressed these displays remain as confirmation of the route selected using BRANCH SELECT. If no branch selection has been attempted or a branch selection has not been acknowledged these displays default to X.

DDS Alternating (Flywheel) Loopbacks

Application

You can set an alternating (flywheel) loopback in the DDS network at any of the points shown in the measurement configuration below and then make a measurement.

Measurement Configuration



Example: From the DSX-1 cross-connect, loopback at the Office Channel Unit (OCU), make customer logic error measurements and release the loopback.

Select the Loopback details on the Transmitting page and press EXEC to initiate the Loopback.

In this example Logic errors are being measured over a 5 minute Gating Interval.

Alternating Loopback, Sample Transmitting Display

```
 TX & RX   Transmitting   DS1 Code    AMI
                              Frame T1DM
Insertion On             DS1 Clock Looped

Select  Timeslot 01   DSOB  2.4 kbit/s
        Customer 01

Point-to-Point

Loopback  Alternating  _  OCU
HL96NY present  No
Test   Primary Channel

Press EXEC to Actuate Loopback

 Pattern   2047 Bit PRBS
  No Error Add
```

- Set the transmit interface.
- Select where in the DS1 you are going to insert your test Pattern.
- Select the loopback point.
- Select the test Pattern.

Then press EXEC to loop-up.

Alternating Loopback, Sample Receiving Display

```
TX & RX   Receiving   DS1    Auto
                           Code    AMI
                           Frame T1DM

Select  Timeslot 01   DSOB  2.4 kbit/s
        Customer 01
         Primary Channel

Pattern   2047 Bit PRBS
           from Alternating Loopback
Results

Customer  Logic  Error Count          0


Gating  _  Interval   00 Days 00:05:00
```

- Set the receive interface.
- Select the timeslot parameters and customer number.
- Remember to select the same test Pattern as on the Transmitting display.
- Select your measurements.
- Set the measurement Gating Interval.

Make the Measurement

Press the START/STOP key.

Releasing the Loopback

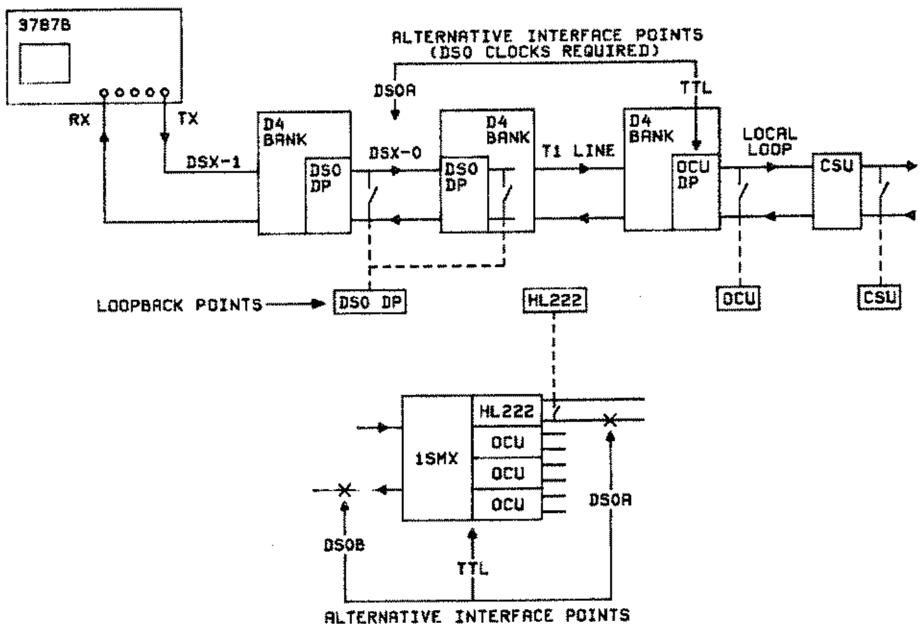
When your measurement is complete release the loopback by selecting the Transmitting display and pressing the EXEC key. (Ensure that "to Release Loopback" is displayed, before you press EXEC key).

DDS Latching Loopbacks

Application

You can set a latching loopback in the DDS system at any of the points shown in the measurement configuration below, make a measurement and release the loopback.

Measurement Configuration



Example: Access at a DSX-1 cross-connect and loopback the second DS0DP Dataport. Make logic error measurements on a 2.4 kbit/s customer circuit and release the loopback.

The HP 3787B can also access at DS0A and DS0B cross-connects and at DS0A logic access points. With DS0 access DDS clocks must be supplied.

If you wish the loopback to be acknowledged select the Receiving display and set the Pattern to Return Codes. This ensures that MAP codes returned from a successful loopback will be displayed on the Transmitting display.

Latching Loopback, Initial Receiving Display

```
TX & RX   Receiving   DS1    Auto
                             Code   AMI
                             Frame T1DM

Select   Timeslot 01   DSOB  2.4 kbit/s
         Customer 01
         Primary Channel

Pattern  DDS Return Codes

Results
```

- Set the receive interface.
- Select the timeslot parameters and customer number.
- Select the Pattern to DDS Return Codes to obtain the Mapcode on the Transmitting display.

On the Transmitting display select the point at which you wish to loopback the circuit, in this case the second DS0DP unit. Press EXEC to actuate the loopback.

Latching Loopback, Sample Transmitting Display

```
TX & RX   Transmitting   DS1 Code   AMI
                             Frame T1DM
Insertion On              DS1 Clock Looped

Select   Timeslot 01   DSOB  2.4 kbit/s
         Customer 01

Point-to-Point

Loopback  Latching  _DSODP  MAPX
Tandem Number of Unit 2
Test   Primary Channel

Press EXEC to Actuate Loopback

Pattern   2047 Bit PRBS
  No Error Add
```

- Set the transmit interface.
- Select the timeslot parameters and customer number.
- Select Loopback.
- Select the test Pattern.
- Press EXEC to loop-up.

If you have selected DDS Return Codes on the Receiving page a successful loopback attempt will result in the display of "MAP0 (DS1)" indicating a lineside DS0DP loopback has been achieved.

For the various types of latching loopbacks MAP codes are returned as follows:

DS0DP (dropside), i.e. DS0 side OCU HL222	MAP1 (X110110X)
DS0DP (lineside), i.e. DS1 side CSU (channel)	MAP0 (X001001X)

If an attempt is unsuccessful or if the Receiving display has not been set for acknowledgment (DDS Return Codes) the display will remain as MAPX.

Latching Loopback, Sample Receiving Display

```
TX & RX   Receiving     DS1   Auto
                              Code   AMI
                              Frame  T1DM

Select  Timeslot 01   DS0B   2.4 kbit/s
        Customer 01
        Primary Channel

Pattern   2047 Bit PRBS
          Continuous
Results

Customer  Logic  Error Count          0



Gating    Interval    00 Days 00:05:00
```

- Remember to select the same test Pattern as on the Transmitting display.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

Press the START/STOP key

Releasing the Loopback

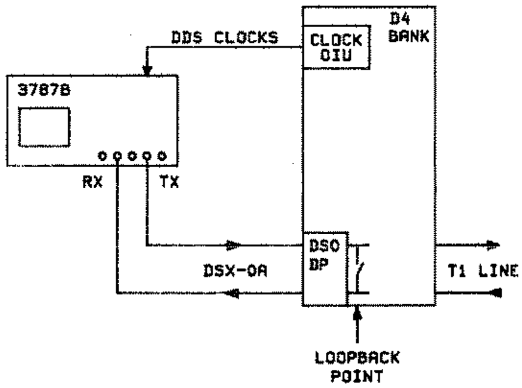
When you have completed your measurement release the loopback by selecting the Transmitting display and pressing the EXEC key. (Ensure "to Release Loopback" is displayed before you press EXEC).

DDS Secondary Channel Testing

Application

You can access and test DDS secondary channel, either end-to-end or by using latching loopbacks. The HP 3787B can access the network at the DSX-0A, DSX-0B or DSX-1 cross-connects or at DS0A logic access points.

Measurement Configuration



Example: Interface at the DSX-0A cross-connect on a 2.4 kbit/s point-to-point circuit. Loopback the first Dataport and measure secondary channel logic errors.

Secondary Channel Test, Sample Transmitting Display

```
TX & RX  Transmitting DS0A   DSX
               2.4 kbit/s Service
DS0 Clocks  Front



Point-to-Point

Loopback  Latching  DS0DP  MAPX
Tandem Number of Unit 1
Test  Secondary Channel

Press EXEC to Actuate Loopback

Pattern   511 Bit PRBS
  No Error Add
```

- Set the transmit interface.
- Select the Loopback.
- Select Secondary Channel.
- Select the test Pattern.

Press EXEC to loop-up.

For information on Latching Loopback acknowledgment see Page 2-28.

Secondary Channel Test, Sample Receiving Display

```
TX & RX    Receiving    DS0A Terminated
                  2.4 kbit/s Service
DS0 Clocks  Front


 Select   Secondary Channel
          (Error Correction  Off )

 Pattern     511 Bit PRBS
-------------------------------------------
 Results

Sec Chan  Logic  Error Count             0


-------------------------------------------
 Gating     Interval    00 Days 00:05:00
```

- Set the receive interface.
- Demultiplex the test data.
- Remember to select the same test Pattern as on the Transmitting display.
- Select the measurement.
- Set the measurement Gating Interval.

Make the Measurement

Press the (START/STOP) key.

Releasing the Loopback

Select the transmitting display with "Press EXEC to release loopback" displayed and press (EXEC).

Practical Aspects of Secondary Channel Testing.

1. During secondary channel testing the primary channel is stimulated with random data.
2. Latching loopbacks are always used; alternating (flywheel) loopbacks are not compatible with secondary channel testing as they would corrupt the C-bit modulation.

Protocol Analysis

Application

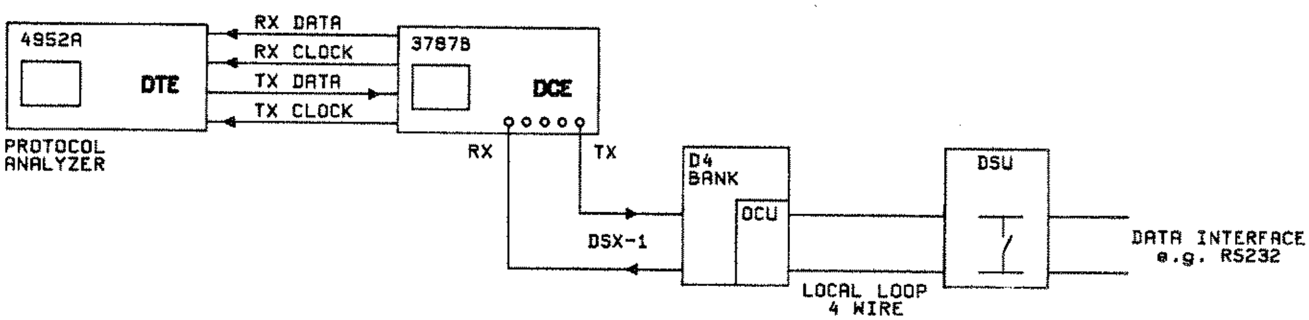
You can perform protocol analysis by using the HP 3787B as a channel access interface between the network under test and a protocol analyzer. The network can be accessed at the DS1, DS0A and DS0B cross-connects and at DS0A logic access points.

The HP 3787B can provide protocol analysis access to:

1. DDS subrate primary channels at 2.4, 4.8 and 9.6 kbit/s.
2. DDS subrate secondary channels at 133 1/3, 266 2/3 and 533 1/3 bit/s.
3. DS1 standard frame (D4) 4 kbit/s Fs data link.
4. DS1 extended frame (ESF) 4 kbit/s data link.
5. DS1 T1DM frame 8 kbit/s R-Channel.

The interface between the protocol analyzer and the HP 3787B is RS232C.

Measurement Configuration



Example: Interface at DS1 and connect to a 4.8kbit/s customer. Loopback at the DSU and test the circuit with data from the protocol analyzer.

To set the channel latching loopback use the procedure described on Pages 2-27/2-29 selecting "Channel" instead of "DS0DP".

Protocol Analyzer Interface, Sample Transmitting Display

```
TX & RX   Transmitting   DS1 Code    AMI
                             Frame   SF
Insertion On              DS1 Clock Looped

Select  Timeslot 01   DS0A   4.8 kbit/s


Point-to-Point

Loopback  Latching  Channel MAPO

Test  _Primary Channel

Press EXEC to Release Loopback

Transmit  Data from Protocol Analyzer
```

- Set the transmit interface.
- Select the DS1 timeslot to be tested.
- Select the HP 3787B/Protocol Analyzer interface. Your test pattern now comes from the protocol analyzer.

Protocol Analyzer Interface, Sample Receiving Display

```
TX & RX    Receiving      DS1     Auto
                             Code    AMI
                             Frame   SF

Select  Timeslot 01   DS0A   4.8 kbit/s
          Primary Channel
        (Error Correction   Off  )

Receive  Data to Protocol Analyzer

_Monitor

Received Word   10101111



Gating     Interval     00 Days 00:15:00
```

- Set the receive interface.
- Select the timeslot under test.
- Select the HP 3787B/Protocol Analyzer interface (your receiver test pattern is now output to the protocol analyzer).
- The received data can be displayed on a sampled basis.
- Select the measurement Gating Interval.

NOTE

All protocol analysis functions are also available if the network access is DS0.

Set up The Protocol Analyzer

1. Select the "Setup" menu on the Protocol Analyzer display as shown.

```
Monitor/Simulate Parameter Setup

Protocol   HLDC    Display   2Line
Code      ASCII 8
Bits/sec   4800    Err chk   CCITT
Parity     None


                   DTE clockDCE
Mode       Sync
                   Bit senseNorm.
                   Ext Addr Off
                   Ext Ctrl Off
```

2. Select "EXIT" to enable the next display selection.

3. Select the "Simulate" menu on the Protocol Analyzer display as shown.

```
Simulate DTE

Block   1
Send ¶ THE QUICK BROWN FOX
 JUMPS OVER THE LAZY DOG.
 0123456789CRLF GG
  and then
Goto Block   1
```

4. Select "EXIT" to enable the next display selection.

Make the Measurement

5. Select the Protocol Analyzer "Run" menu and press SIMULATE.

6. The transmit and receive data is displayed on alternate lines with the received data in inverse video. Compare the transmit and receive data.

Practical Aspects of Protocol Analysis Testing

- The HP 3787B interfaces with SYNCHRONOUS Networks. It is not possible to use the HP 3787B as an interface for asynchronous protocols.

- The HP 3787B is the network access point, and so is a DCE. The protocol analyze must therefore be configured as a DTE.

- The protocol analyzer clock is provided by the HP 3787B via the RS232 cable. This is selected by setting the protocol analyzer (DTE) clock source to DCE.

  When using the protocol analyzer to run a BER test through the HP 3787B, setting the "bits/sec" field on the protocol analyzer's BER setup page to "EXT" causes it to take its clock from the HP 3787B.

- The HP 3787B/Protocol Analyzer interface comprises only clock and data lines. When connecting another protocol analyzer to the customers DSU it MAY be necessary to provide it with the RTS handshake signal (check the DSU manual).

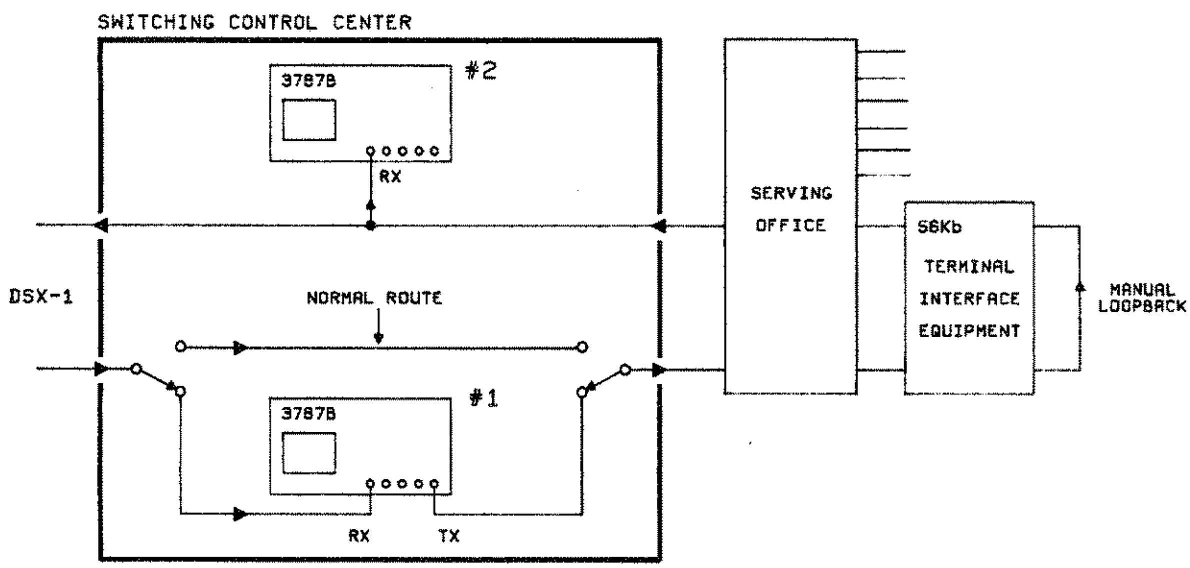
Monitoring Signaling Bits and Seizing a Free Timeslot.

Application

For testing 56 kbit/s switched services you can use the HP 3787B to monitor the standard D4 frame A and B signaling bits or the D5 extended frame A, B, C and D signaling bits. You can therefore monitor the status of live data to check if a timeslot is idle or seized. The HP 3787B can also be set to transmit selectable signaling bits which enable you to seize an idle timeslot and make a measurement on it.

Measurement Configuration

NOTE: This configuration requires hitless switch.



Example: Circuit-switched test on a D4 line. In this example it is assumed that:

A=0, B=1 for idle.
A=1, B=0 for seized.

Select the timeslot to be tested. Check that it is idle and seize it using HP 3787B #1 without disrupting the traffic on the line. Check the logic errors on HP 3787B #2.

Check the Timeslot is Idle Using HP 3787B #1

Before switching HP 3787B #1 into the line set the instrument up as follows.

Select THRU mode and press EXEC to initiate the mode.

On the Receiving display set the interface parameters. The Transmitter interface will be set automatically.

Sample Receiving Display HP 3787B #1

```
 THRU    Receiving    DS1   Auto
                     Code   AMI
                     Frame  SF          - Set the receiver interface.

 Select  Timeslot 07  56 kbit/s Switched


 Pattern   2047 Bit PRBS
           Normal
 Monitor                                - Select Monitor

Received Word  00000000

Signaling Bits:    A  B                 - A=0, B=1 confirms Timeslot is idle.
                   0  1
 Elapsed Time           00 Days 00:00:00
```

Now connect the HP 3787B into the circuit using the hitless switches. Select the timeslot to be tested and use the Monitor mode to examine incoming signaling status. Proceed to test the timeslot only if the signaling bits are A=0, B=1.

NOTE

Normally there will be no test pattern in the received timeslot and the receiver will indicate Pattern Loss.

Seize the Idle Timeslot and Send the Test Pattern

On the Retransmitting display select the test timeslot and test pattern. Set the signaling bits to A=1, B=0 and turn Insertion On to seize the timeslot.

Seizing the Timeslot with HP 3787B #1

```
 THRU   Retransmitting  DS1 Code    AMI
                            Frame   SF
Insertion  On

Select  Timeslot 07   56 kbit/s Switched


Signaling Bits  Set     A   B
                        1   0



 Pattern    2047 Bit PRBS
  No Error Add
```

- Select Retransmitting

- Set to the test timeslot.

- Change to Set A=1, B=0

Set insertion On to seize the timeslot.

Connect HP 3787B #2 and Make the Measurement

Connect HP 3787B #2 to the return path using the monitor mode.

Set the Receiving display as shown.

Note that the return timeslot number is normally the same but need not be so.

Sample Receiving Display HP 3787B #2

```
TX & RX    Receiving    DS1    DSX-MON       - Set the receiver interface.
                               Code    AMI
                               Frame   SF

Select  Timeslot 07  56 kbit/s Switched      - Select the test timeslot.

                                             - Remember to set the test Pattern the
                                               same as the transmitter of #1.
Pattern    2047 Bit PRBS
           Normal
Results

 PSDC    Logic  Error Count            0     - Select the measurement.


Gating     Interval    00 Days 00:05:00      - Set the measurement Gating Interval.
```

Make the Measurement

Press the (START/STOP) key on HP 3787B #1.

NOTE

If your loopback inverts the data change the `Normal` Pattern selection to `Inverse`.

Display Selection Reference 3

Introduction

This section of the manual is a detailed listing of the operating features available to you.

The INDEX Page

The HP 3787B is configured via pages on the display. These pages are accessed via the INDEX page.

```
POWER HAS CYCLED

                INDEX
                                    Page
Normal Operation ......................1
Stored Panels & Keyboard Lock ........2
Data Logging ..........................3
Date & Time ...........................4
Remote Configuration .................5
Instrument ID..........................6
User Confidence Tests ................7
```

Normal Operation

Selecting the Operating Mode

The transmitting and receiving capability of the HP 3787B are set on the "Normal Operation" page.

The HP 3787B can transmit and/or receive data when it is in the TX & RX mode.

```
TX & RX   Receiving   DS1   Auto
   |
 THRU
```

In the THRU mode, the instrument retransmits the received signal - only applicable for DS1/1C operation (see Page 3-28).

Display Transmitting when setting up the transmitter and display Receiving when setting up the receiver.

```
TX & RX   Receiving   DS1   Auto
              |
        Transmitting
```

Setting Up the Transmitter (DS1/DS1C)

The following pages contain the information required to transmit at a DS1 or DS1C cross-connect.

Transmit Interface Selection

Select the required cross-connect - DS1 (Page 3-4) or DS1C (Page 3-2). For transmitting at DS0, DS0A or DS0B cross-connects, see Page 3-10.

```
TX & RX   Transmitting   DS1 Code   AMI
                          |
                         DS0B
                          |
                         DS0A
                          |
                         DS0
                          |
                         DS1C
```

Transmitting at DS1C

Select the required code.

```
TX & RX  Transmitting  DS1C Code   AMI
                                    |
                                   B8ZS
```

Set the framing On or Off.

```
TX & RX  Transmitting  DS1C Code   AMI
                           Frame    On
                                    |
                                   Off
```

Select the desired clock source for the digroups in the DS1C.

Int - Generated internally.
Ext - Supplied externally via rear panel clock input.

```
TX & RX  Transmitting  DS1C Code   AMI
                           Frame    On
                       DS1 Clock   Int
                                    |
                                   Ext
```

Select the alarm to be transmitted and then turn it On and Off as required.

```
TX & RX  Transmitting  DS1C Code   AMI
                           Frame    On
                       DS1 Clock   Int

Alarms  None
         |
        X-bit  On
         |      |
       A.I.S.  Off
```

Select the test pattern. With framed DS1C the selected test pattern is transmitted in both digroups. With 20 stage PRBS, the 14-zero data limit is selectable. With the settable word all 8-bits can be set.

```
 TX & RX    Transmitting  DS1C Code   AMI
                              Frame    On
                          DS1 Clock   Int

Alarms   None

Both digroups contain:
 Pattern    20 Stage PRBS 14-0 Limit Off
                      |
           All Ones Word
                      |
           Settable Word 0 1 1 1 1 0 0 0 0
```

Select the type of error-add desired. Errors can be added singly or as a selectable error ratio. The ratio can be set in the range 1×10^{-8} to 9×10^{-3}.

```
 TX & RX    Transmitting  DS1C Code   AMI
                              Frame    On
                          DS1 Clock   Int

Alarms   None

Both digroups contain:
 Pattern    20 Stage PRBS 14-0 Limit Off
  No Error Add
          |
 Logic Error Add      Single
          |              |
  BPV Insertion        Ratio        1.0 E-8
          |
DS1C Ft Error Add
          |
 APS Test
```

If the APS (automatic protection switch) error-add function is selected then the APS state can be selected. An error ratio may be set on all states except Start.

```
APS Test    Start        (No errors)
              |
         No Transfer     Ratio
              |
           Transfer
              |
          No Restore
              |
           Restore
```

Transmitting at DS1

Select the required code.

```
TX & RX   Transmitting   DS1 Code   AMI
                                     |
                                    B8ZS
```

Select the desired framing format.

```
TX & RX   Transmitting   DS1 Code   AMI
                            Frame   ESF
                                     |
                                    Off
                                     |
                                    T1DM
                                     |
                                    SF
                                     |
                                    Ft
```

Select the desired DS1 Clock source.

Int - Generated internally.
Ext - Supplied externally via rear panel clock input.
Looped - Looped from a DS1 signal connected to the receiver.

```
TX & RX   Transmitting   DS1 Code   AMI
                            Frame   ESF
                     DS1 Clock      Int
                                     |
                                    Ext
                                     |
                                  Looped
```

When transmitting a framed DS1 signal you may choose to insert the test pattern in the DS1 stream itself or in one of the following lower levels:

- a timeslot
- a customer channel
- a data link

For DDS and Dataport timeslot selection, see Pages 3-10 and 3-11. For details on the DDS facilities available, see Page 3-12.

For Clear Channel pattern and error facilities, see Page 3-12.

For Circuit-Switched timeslots, see Page 3-9.

For details on the test patterns applicable to T1 data links and T1DM R-Channel, see Page 3-8.

```
TX & RX  Transmitting  DS1 Code   AMI
                           Frame  ESF
                       DS1 Clock  Int

Transmit DS1
   |
 Select  Timeslot 08  DS0B 2.4 kbit/s
   |     Customer 05
   |
 Select  Timeslot 03  DS0A 9.6 kbit/s
   |
* Select  Timeslot 09  56 kbit/s Switched
   |
* Select  Timeslot 24  Clear Channel
   |
* Select  4 kbit/s Data Link
   |
* Select  T1DM R-Channel
   |
* Select  Fs 4 kbit/s Data Link
```

* These lower level choices depend on the DS1 Frame format. The exact set is shown under Receiving on Page 3-19.

Select the alarms to be transmitted and then turn them On and Off as required.

```
TX & RX  Transmitting  DS1 Code   AMI
                           Frame  ESF
                       DS1 Clock  Int

Transmit DS1

Alarms  None
          |
        Yellow   On
          |       |
        A.I.S.   Off
```

Select loopback if desired. The actuate message appears whenever loopback is selected. With loopback selected either the actuate or release message can be selected at any time ie:

Press EXEC to Actuate Loopback
or
Press EXEC to Release Loopback

```
TX & RX   Transmitting   DS1 Code   AMI
                             Frame   ESF
                         DS1 Clock   Int

Transmit DS1

Alarms   None

Loopback   Off
            |
          Fixed
```

Select the desired test pattern. With 20-stage PRBS the 14-zero limit is selectable. With the settable word all 8-bits can be set.

```
TX & RX   Transmitting   DS1 Code   AMI
                             Frame   ESF
                         DS1 Clock   Int

Transmit DS1

Alarms   None

Loopback   Off



 Pattern   20 Stage PRBS 14-0 Limit Off
                 |
           All Ones Word
                 |
           Settable Word 0 0 1 1 1 1 0 0
```

Select the type of error-add desired. Errors can be added singly or at selectable error ratio. The ratio can be set in the range 1×10^{-8} to 9×10^{-3}.

With CRC error-add the ratio selected is the corresponding bit error ratio.

```
 TX & RX   Transmitting   DS1 Code    AMI
                             Frame    ESF
                       DS1 Clock      Int

Transmit DS1

Alarms    None

Loopback   Off

 Pattern   20 Stage PRBS 14-0 Limit Off
   No Error Add
          |
 Logic Error Add      Single
          |              |
   BPV Insertion       Ratio       3.0 E-5
          |
DS1 CRC Error Add       BER
          |
 Frame Error Add
          |
 APS Test
```

If the APS (automatic protection switch) error-add function is selected then the APS state can be selected. An error ratio may be set on all states except Start.

```
 APS Test     Start            (No errors)
                |
           No Transfer      Ratio 4.0 E-6
                |
            Transfer
                |
           No Restore
                |
             Restore
```

DS1 Data Links and T1DM R-Channels

When testing data links, the HP 3787B can transmit one of three patterns.

4 kbit/s data link : ESF, Ft
8 kbit/s R-Channel: T1DM

```
TX & RX   Transmitting    DS1 Code    AMI
                              Frame   ESF
Insertion On              DS1 Clock   Int

Select 4 kbit/s Data Link



Pattern   2047 Bit PRBS
          |
          511 Bit PRBS
          |
          All Ones Word
```

Data links may also be tested with data from a Protocol Analyzer via the HP 3787B rear panel PROTOCOL ANALYZER port.

```
Transmit Data from Protocol Analyzer
```

Single logic errors can be added when transmitting test patterns.

```
No Error Add
   |
Logic Error Add        Single
```

56 kbit/s Switched Timeslots

With ESF framing the A, B, C and D signaling bits may be set in the selected timeslot.

With SF framing the A and B signaling bits may be set in the selected timeslot.

```
TX & RX   Transmitting    DS1 Code    AMI
                              Frame   ESF
Insertion On             DS1 Clock    Int

Select  Timeslot 01  56 kbit/s Switched

Signaling Bits   Set   A  B  C  D
                       0  1  0  1
```

Select the desired test pattern. One of the test patterns is a short settable word and another is a long preprogrammable word (up to 256 bytes) which is programmed remotely.

```
Pattern   Settable Word 1 0 1 0 1 0 1 S
                   |
          Preprogrammed
                   |
          2047 Bit PRBS
                   |
          511 Bit PRBS
                   |
          All Ones Word
```

Select the desired error-add type.

```
   No Error Add
          |
Logic Error Add        Single
          |
 Byte Error Add
```

Setting Up the Transmitter (DS0B, DS0A & DS0)

The following pages contain the information required to transmit at 64 kbit/s cross-connects.

Transmit Interface Selection

Select the required cross-connect - DS0B, DS0A or DS0. For transmitting at DS1 see Page 3-4 or DS1C see Page 3-2.

```
TX & RX  _Transmitting  DS1 Code   AMI
                         |
                        DS0B
                         |
                        DS0A
                         |
                        DS0
                         |
                        DS1C
```

Transmitting at DS0B

Select the desired DS0B rate. For all rates, except 56 kbit/s, the DS0B signal is a multicustomer format as generated by an SRDM. The 56 kbit/s DS0B signal carries a single customer.

When emulating the output of an SRDM where the customer rate is less than the SRDM rate, then the SRDM rate should be selected.

```
TX & RX  Transmitting  DS0B
                  2.4 kbit/s Service
                   |
                  4.8
                   |
                  9.6
                   |
                  56
```

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

```
TX & RX  Transmitting  DS0B
                  2.4 kbit/s Service
DS0 Clocks  Front
             |
            Rear
```

Select the customer slot to be stimulated. The range of customer numbers depend on the service rate selected.

2.4 kbit/s	1 to 20
4.8 kbit/s	1 to 10
9.6 kbit/s	1 to 5

```
TX & RX  Transmitting  DS0B
                  2.4 kbit/s Service
DS0 Clocks  Front


Transmit Customer  01
```

The DS0B customer rate field is displayed when the 4.8 or 9.6 kbit/s service rate is selected. In these two cases it is sometimes necessary to load some slots in the DS0B signal with lower rate customers. See the note on Page 2-14. Select the customer rate in the field shown.

For details on DDS transmission features, see Page 3-12.

```
 TX & RX   Transmitting  DS0B
                   9.6 kbit/s Service
DS0 Clocks  Front


Transmit Customer 01  2.4 kbit/s
                       |
                      4.8
                       |
                      9.6
```

Transmitting at DS0A

The network can be stimulated at Logic access points or at DSX.

```
 TX & RX   Transmitting  DS0A Logic Near
                                   |
                                 Logic Far
                                   |
                                  DSX
```

Select the DDS customer service rate.

```
 TX & RX   Transmitting  DS0A Logic Near
                   2.4 kbit/s Service
                    |
                   4.8
                    |
                   9.6
                    |
                    56
```

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

For details on DDS transmission features, see Page 3-12.

```
 TX & RX   Transmitting  DS0A Logic Near
                   2.4 kbit/s Service
DS0 Clocks  Front
              |
            Rear
```

Transmitting at DS0

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

```
TX & RX   Transmitting  DS0
                        Clear Channel
DS0 Clocks  Front
             |
            Rear
```

The set of test patterns include a short settable word and a long preprogrammed word (up to 256 bytes) which is programmed remotely.

```
Pattern   2047 Bit PRBS
               |
           511 Bit PRBS
               |
          All Ones Word
               |
          Settable Word 1 0 1 0 1 0 1 0
               |
          Preprogrammed
```

With error-add, selected errors can be added singly.

```
Pattern   2047 Bit PRBS
 No Error Add
       |
Logic Error Add      Single
       |
Byte Error Add
```

DDS Transmission Facilities (DS0A/DS0B)

The following DDS features apply also when the HP 3787B is interfaced to the network at the DS0A and DS1 cross-connects.

```
TX & RX   Transmitting  DS0B
                       _56 kbit/s Service
DS0 Clocks  Front
```

You can test point-to-point circuits or multi-point circuits. The test capability is the same in both.

```
Point-to-Point
       |
   Multipoint
```

Point-to-Point Circuits

Select the type of loopback required.

With alternating loopbacks only primary channels are tested.

```
Point-to-Point

Loopback  Off
           |
          Alternating
           |
          Latching
```

Select the type of alternating loopback required.

```
Point-to-Point

Loopback  Alternating    DSU
                          |
                        Channel
                          |
                         OCU
                          |
                        Repeater
                          |
                         HL96NY
```

With OCU loopback, specify whether an intermediate HL96NY unit is present.

```
Loopback  Alternating  _  OCU
HL96NY present  No
```

With Channel loopback at the 56 kbit/s service rate, specify the intermediate repeaters (0, 1 or 2).

```
Loopback  Alternating  _ Channel
Intermediate repeaters 1
```

With Repeater loopback (56 kbit/s only), specify the repeater number (1 or 2).

```
Loopback  Alternating  _ Repeater
Repeater Number 2
```

With all latching loopbacks, both primary and secondary channels may be tested.

Select the type of latching loopback required.

```
Point-to-Point

Loopback  Latching  DS0DP  MAPX
                     |
                    OCU
                     |
                   Channel
                     |
                    HL222
```

With DSODP latching loopbacks the tandem number may be selected in the range 1 to 8.

```
Loopback Latching  DSODP  MAPX
Tandem Number of Unit 2
```

The actuate message is displayed whenever alternating or latching loopback is selected. With any loopback selected, the actuate or release message can be selected at any time.

```
Press EXEC to Actuate Loopback
```

```
Press EXEC to Release Loopback
```

Multipoint Circuits

When a multipoint circuit is first selected the next step is branch selection. During branch selection the branch number of each MJU is in the range 1 to 4 since each MJU has 4 output branches.

```
  Multipoint            Select Branch   4
                              |
                         Test Branch
                              |
                          End Test
                              |
                         Block Branch
                              |
                        Unblock Branch
                              |
                         Release All
```

After a sequence of branch selection to select a single leaf branch, testing of this branch can be done exactly as on a point-to-point circuit. This is initiated by pressing the EXEC key.

```
  Multipoint            Select Branch   3

                   (Last branch selected X)

                          Present HUB-ID XX
                         Previous HUB-ID XX

Press EXEC to select branch
```

You can select primary or secondary channel.

```
  Multipoint             Test Branch

Loopback  Off

Test   Primary Channel
             |
        Secondary Channel
```

Data

As well as transmitting standard test patterns and DDS codes the HP 3787B can insert data from a protocol analyzer into sub-rate timeslots.

```
Pattern   2047 Bit PRBS
  |
Code
  |
Transmit  Data from Protocol Analyzer
```

The set of test patterns includes a short settable word and a long preprogrammed word (up to 256 bytes) which is programmed remotely.

With the preprogrammed word all bits are settable except bit #1 at the sub-rates (sync bit position).

```
Pattern   2047 Bit PRBS
                |
          511 Bit PRBS
                |
          All Ones Word
                |
          Settable Word S 0 1 0 1 1 0 1
                |
          Preprogrammed
```

In addition to the standard codes a settable code is provided.

With both settable word and settable code only the "data bits" can be set.

The examples on this page are for the sub-rate case with DS0B access.

```
  Code            CMI           S1111110
                   |
               OCU L/B
                   |
              CHAN L/B
                   |
               DSU L/B
                   |
                  TIP
                   |
                  LBE
                   |
                  FEV
                   |
                  TA
                   |
                  MA
                   |
                  UMC
                   |
                 BLOCK
                   |
                  RLS
                   |
                  ASC
                   |
                 TEST
                   |
                  OOS
                   |
          Settable Code S 0 1 0 1 0 1 0
```

Error Add

With error-add, selected errors can be added singly using the (SINGLE ERROR) key.

```
No Error Add
  |
Logic Error Add      Single
  |
* Sub Frame Err Add
  |
Byte Error Add
  |
* Dataport Test      3in5
```

* Depends on measurement set-up.

Setting Up the Receiver (DS1/DS1C)

The following pages contain the information required to receive at a DS1 or DS1C cross-connect.

Receive Interface Selection

Select the required cross-connect - DS1 or DS1C. For receiving at a DS0B, DS0A or DS0 cross-connect, see Page 3-20.

```
TX & RX   Receiving   DS1    Auto
                       |
                      DS0B
                       |
                      DS0A
                       |
                      DS0
                       |
                      DS1C
```

Receiving at DS1C

If the HP 3787B is connected to an unprotected access, select Bridged; otherwise select Auto. If you wish an indication of the correct signal level when terminating or connected to a protected monitor point, select the particular signal expected.

```
TX & RX   Receiving   DS1C   Bridged
                               |
                              Auto
                               |
                              DSX
                               |
                            DSX-MON
                               |
                             DS-LO
                               |
                           DS-LO-MON
```

Select the required code

```
TX & RX   Receiving   DS1C    Auto
                Code   AMI  Frame  On
                        |
                       B8ZS
```

Turn the DS1C framing on or off as required.

```
TX & RX   Receiving   DS1C    Auto
               Code   AMI Frame  On
                                 |
                                 Off
```

When a framed DS1C signal is received one of the digroups may also be specified framed. The digroup specified is selected by using the Select field (see below) to select the digroup number.

```
TX & RX   Receiving   DS1C    Auto
               Code   AMI Frame  On
           Digroup Frame (1)     ESF
                                  |
                                 Off
                                  |
                                 T1DM
                                  |
                                 SF
                                  |
                                 Ft
```

When receiving a framed DS1C signal you may choose to measure on the DS1C stream or select a digroup, timeslot, customer channel or a digroup data link

The lower level choices available depend on the digroup frame format selected.

For explanations of the DDS and Dataport timeslot selections see Pages 3-21 and 3-22.

For details of the further DDS receiver facilities available, see Pages 3-23 and 3-24.

For details of Clear Channel pattern selection, see Pages 3-22 and 3-23.

For details on Circuit-Switched timeslot facilities, see Page 3-20.

For details of the test patterns applicable to the digroup data links, see below.

```
TX & RX   Receiving   DS1C    Auto
               Code   AMI Frame  On
           Digroup Frame (1)     ESF
Select  DS1C
  |
Select Digroup   2
  |
Select Digroup   2
  |    Timeslot 08  DS0B  2.4 kbit/s
  |    Customer 07
  |     Primary Channel
  |
Select Digroup   1
  |    Timeslot 20  DS0A  2.4 kbit/s
  |     Primary Channel
  |    (Error Correction  Off )
  |
Select Digroup   1
  |    Timeslot 01  56 kbit/s Switched
  |
Select Digroup   1
  |    Timeslot 14  Clear Channel
  |
Select Digroup   1
       4 kbit/s Data Link
```

Select the desired pattern. With framed DS1C the pattern applies to the (unframed) constituent digroups. With framed digroups a DS1C pattern cannot be selected. With the 20-stage PRBS the 14-zero data limit is always selectable.

With settable word, all 8-bits can be set.

```
TX & RX    Receiving    DS1C    Auto
               Code   AMI Frame   On
          Digroup Frame (1)      Off
Select  DS1C




Both digroups contain:
Pattern   20 Stage PRBS 14-0 Limit  On
               |
          All Ones Word
               |
          Settable Word 1 0 1 0 1 0 1 0
               |
             Traffic
```

Receiving at DS1

If the HP 3787B is connected to an unprotected access, select Bridged; otherwise select Auto. If you require an indication of the correct signal level when terminating or connected to a protected monitor point, select the signal expected.

```
TX & RX    Receiving    DS1    Bridged
                                  |
                                 Auto
                                  |
                                  DSX
                                  |
                                DSX-MON
                                  |
                                 DS-LO
                                  |
                               DS-LO-MON
```

Select the desired code.

```
TX & RX    Receiving    DS1     Auto
                           Code   AMI
                                   |
                                  B8ZS
```

Select the desired framing format.

```
TX & RX     Receiving     DS1     Auto
                                 Code   AMI
                                 Frame  ESF
                                         |
                                        Off
                                         |
                                        T1DM
                                         |
                                        SF
                                         |
                                        Ft
```

When receiving a framed DS1 signal you may choose to measure on the DS1 stream or select a timeslot, a customer channel or a data link. The lower level choices available depend on the particular DS1 frame format selected.

For explanations of the DDS and Dataport timeslot selections, see Pages 3-21 and 3-22. For details of further DDS facilities available, see Pages 3-23 and 3-24.

For details of Clear Channel pattern selection, see Pages 3-22 and 3-23.

For further details of the Circuit-Switched timeslot facilities, see Page 3-20.

For details of the test patterns applicable to the digroup data links, see below.

```
TX & RX     Receiving     DS1     Auto
                                 Code   AMI
                                 Frame  ESF

Select  DS1
  |
Select  Timeslot 12    DSOB   2.4 kbit/s
  |     Customer 20
  |      Primary Channel
  |
Select  Timeslot 01    DSOA   4.8 kbit/s
  |      Primary Channel
  |     (Error Correction  Off )
  |
Select  Timeslot 03    56 kbit/s Switched
  |
Select  Timeslot 14    Clear Channel
  |
Select  4 kbit/s Data Link
```

Select the desired pattern.

```
TX & RX     Receiving     DS1     Auto
                                 Code   AMI
                                 Frame  SF

Select  DS1


Pattern   20 Stage PRBS 14-0 Limit  On
                 |
           All Ones Word
                 |
           Settable Word 1 0 1 0 1 0 1 0
                 |
               Traffic
```

DS1 Data link (ESF Framing)

For test pattern transmission the choice is as shown. With test patterns, Logic errors may be added singly.

```
Pattern   2047 Bit PRBS
              |
          511 Bit PRBS
              |
          All Ones Word
```

Alternatively, the link can be stimulated with data received via the HP 3787B rear panel PROTOCOL ANALYZER port.

```
Receive   Data to Protocol Analyzer
```

56 kbit/s Switched Timeslot (SF Framing)

The test patterns available are as shown.

```
Pattern   2047 Bit PRBS
              |
          511 Bit PRBS
              |
          All Ones Word
              |
          Settable Word 1 0 1 0 1 0 1 S
```

The Normal/Inverse field allows measurements on data returned from an inverting loopback.

```
Pattern   2047 Bit PRBS
          Normal
            |
          Inverse
```

Setting Up the Receiver (DS0B, DS0A & DS0)

The following pages contain the information required to receive data at a DS0B, DS0A or DS0 cross-connect.

Receive Interface Selection

Select the required cross-connect - DS0B, DS0A or DS0. For receiving at a DS1 or DS1C cross-connect, see Page 3-16.

```
TX & RX   Receiving   DS0B   Monitor
                       |
                      DS0A
                       |
                      DS0
                       |
                      DS1C
                       |
                      DS1
```

Receiving at DS0B

DS0B signals can be accessed at monitor points. Alternatively, the HP 3787B can terminate a DSX-0B signal.

```
TX & RX     Receiving    DS0B Terminated
                                |
                             Monitor
```

Select the desired DS0B rate. For all rates, except 56 kbit/s, the DS0B signal is a multicustomer format as generated by an SRDM. A 56 kbit/s DS0B signal carries a single customer.

When receiving a DS0B signal in which the customer service rate is less than the SRDM rate, then the SRDM rate should be selected.

```
TX & RX     Receiving    DS0B Terminated
                  2.4 kbit/s Service
                   |
                  4.8
                   |
                  9.6
                   |
                  56
```

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

```
TX & RX     Receiving    DS0B Terminated
                  2.4 kbit/s Service
DS0 Clocks  Front
              |
            Rear
```

Select the customer slot to be measured. The range of customer numbers depends on the service rate selected.

2.4 kbit/s	1 to 20
4.8 kbit/s	1 to 10
9.6 kbit/s	1 to 5

```
TX & RX     Receiving    DS0B Terminated
                  2.4 kbit/s Service
DS0 Clocks  Front


 Select   Customer 20
```

The DS0B customer rate field is displayed when the 4.8 or 9.6 kbit/s service rate is selected. In these cases some customer slots in the DS0B signal may contain lower rate traffic. Select the customer rate in this field.

For details of the DDS receiver features available, see Page 3-23.

```
TX & RX     Receiving    DS0B Terminated
                  9.6 kbit/s Service
DS0 Clocks  Front


 Select   Customer 05  2.4 kbit/s
                        |
                       4.8
                        |
                       9.6
```

Receiving at DS0A

DS0A signals can be accessed at monitor points. Alternatively, the HP 3787B can terminate a DSX-0A signal. Some equipments allow logic access to DS0A signals - the HP 3787B can access near and far logic signals.

```
 TX & RX    Receiving    DS0A Terminated
                                   |
                                 Monitor
                                   |
                                Logic Near
                                   |
                                Logic Far
```

Select the required DS0A customer service rate.

```
 TX & RX    Receiving    DS0A Terminated
                 2.4 kbit/s Service
                   |
                  4.8
                   |
                  9.6
                   |
                  56
```

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

For details of the DDS receiver features available, see Page 3-23.

```
 TX & RX    Receiving    DS0A Terminated
                 2.4 kbit/s Service
DS0 Clocks  Front
              |
            Rear
```

Receiving at DS0

Clear Channel signals can be accessed at monitor points. Alternatively, the HP 3787B can terminate a DSX signal.

```
 TX & RX    Receiving    DS0  Terminated
                                  |
                               Monitor
```

DDS clock port selection - the external DDS clocks can be supplied to the HP 3787B via:

The front panel DIN connector
or
The rear panel D-shell connector

```
 TX & RX    Receiving    DS0  Terminated
                         Clear Channel
DS0 Clocks  Front
              |
            Rear
```

The test patterns available are as shown.

```
Pattern    2047 Bit PRBS
           |
           511 Bit PRBS
           |
           All Ones Word
           |
           Settable Word 1 0 1 0 1 0 1 0
```

DDS Receiving Facilities (DS0A/DS0B)

Either the primary or secondary channel may be measured. This applies to all customer rates and at all interfaces.

```
TX & RX    Receiving    DS1    Auto
                               Code   AMI
                               Frame  ESF

Select   Timeslot 12  DSOA  2.4 kbit/s
          Primary Channel
              |
         Secondary Channel
```

Sub-rate error correction is applicable where a DS1 signal timeslot contains a sub-rate DS0A signal or where the HP 3787B input signal us a sub-rate DS0A signal.

```
TX & RX    Receiving    DS1    Auto
                               Code   AMI
                               Frame  ESF

Select   Timeslot 12  DSOA  2.4 kbit/s
          Primary Channel
         (Error Correction  Off )
                             |
                             On
```

For test pattern measurement the choice is as shown. You may select DDS Return codes for confirmation of either Latching loopback or MJU operations. Confirmation will be displayed on the transmit subpage from which these operations are controlled.

```
Pattern    DDS Return Codes
           |
           2047 Bit PRBS
           |
           511 Bit PRBS
           |
           All Ones Word
           |
         Settable Word 1 0 1 0 1 1 0 1
```

With settable word only the data bits can be set. The two PRBS patterns are used when testing using alternating loopbacks. When receiving from an alternating loopback select `from Alternating Loopback`.

```
Pattern   2047 Bit PRBS
         Continuous
              |
          from Alternating Loopback
```

As well as measuring the standard test patterns the HP 3787B can also extract data from a sub-rate timeslot for protocol analysis.

```
Receive  Data to Protocol Analyzer
```

Results

In addition to displaying BER Results the HP 3787B can display Alarm Durations, (byte) Monitor, RX Level and Analysis results..

```
Results
   |
Alarm Durations
   |
Monitor
   |
RX Level
   |
Analysis
```

BER Results

Measurement A

The source of errors displayed in the first result is determined by your selection in the Select field. For example, when receiving a DS1C signal with a digroup selected the first result is based on the measurement of digroup errors.

```
TX & RX    Receiving     DS1C     Auto
                  Code   AMI Frame  On
               Digroup Frame (1)   ESF
Select  Digroup   1



Pattern  20 Stage PRBS 14-0 Limit  On

Results

Digroup   Logic  Error Count  ..........
            |
           CRC
            |
          Frame
```

Similarly when receiving a DS1 signal with the DS1 input itself selected, the first result is based on the measurement of the DS1 errors.

The error type may be Logic, Frame, Code, CRC, BPV errors or, with Jitter option instruments, Jitter hits depending on the received signal format and content and on the selection on the Select field.

With any of the above error sources selected the same set of error result types is available.

```
Results

Digroup   Logic  Error Count  ..........
                      |
                 Error Ratio
                      |
                Sync Err Secs
                      |
                Async Err Sec
                      |
                Async E.F.S.
                      |
                  % E.F.S.
```

When measuring jitter (option 001 only) the display types are as shown.

```
Results

 DS1    Jitter   Hit Count
                      |
                Hit Bit Count
                      |
                Hit Bit Ratio
                      |
                 Hit Seconds
                      |
                Hit-Free Secs
                      |
                 U.I. pk-pk
```

When measuring jitter (option 001 only) the filters are selectable.

LP	2Hz to 40kHz
HP1 + LP	10Hz to 40kHz
HP2 + LP	8kHz to 40kHz

The jitter threshold may be set from 00.05 UI pk-pk to 10.00 UI pk-pk in 00.01 steps.

```
Results

 DS1     Jitter   Hit Count

 (Jitter:   LP   T'hold 00.05 UI pk-pk)
            |
          HP1+LP
            |
          HP2+LP
```

Measurement B

On the line below the first result there is an empty block of inverse video. This is a field which allows a second measurement to be selected. The measurement sources selectable are every level between and including the interface point and the level selected.

The measurement types available are the same as for Result A for any given error source.

```
Results

Timeslot   Logic  Error Count          0

Timeslot
   |
Digroup
   |
DS1C
```

Alarm Durations

All relevant loss seconds can be selected for display at any time during (or after) a measurement.

```
Alarm Durations

  DS1 Pattern Loss
          |
  DS1 Frame Loss
          |
     AIS Seconds
          |
Instrument Power Loss
          |
  DS1 Signal Loss
```

Rx Level (DS1/DS1C only)

Both positive and negative peaks are displayed. These are updated alternately.

```
RX Level

Positive peak : +3.00 Volts

Negative peak : -3.00 Volts
```

Monitor

This DS0 feature displays the sampled byte. When the byte is from a circuit-switched DS1 timeslot the signaling bits are also displayed on a sampled basis.

```
Monitor

Received Word   00000000

Signaling Bits    A  B  C  D
                  1  0  1  0
```

Analysis

If two measurements have been selected (A and B) the source for analysis is selectable.

```
Analysis

Result A   DS1    Logic
       |
       B
```

The same five analysis types can be selected for any interface and selected measurement source. The types of display can be selected at any time but the source must be selected before the start of the measurement.

```
Analysis

Result A   DS1    Logic

 % Availability
       |
% Unavailability
       |
  % Severe E.S.
       |
  % Err Seconds
       |
  % Deg. Mins
```

Elapsed Time and Gating Modes

The time which has elapsed since the start of a gating period and the types of gating available can be displayed on the last line of the Receiving page.

```
Elapsed Time                00 Days 00:00:00

Gating     Manual
           Interval         00 Days 00:00:01
           Rpt Interval
           Short Repeat     1 Second
```

Short Repeat is used for the convenient selection of four standard gating intervals.

- 1 second
- 15 seconds
- 5 minutes
- 15 minutes

With Interval and Rpt Interval the gating period can be set in the range 1 second to 99 days 23 hours, 59 minutes and 59 seconds with 1 second resolution.

Thru Mode

To enter the Thru mode place the cursor on the TX & RX field then press NEXT followed by EXEC - the page is displayed.

```
THRU      Receiving      DS1      Auto
                                  Code    AMI
                                  Frame   ESF

Select   DS1


Pattern   20 Stage PRBS 14-0 Limit   On

Results

  DS1     Logic   Error Count              0


Gating   Rpt Interval  00 Days 00:15:00
```

Select Retransmitting.

```
THRU      Receiving      DS1      Auto
          Retransmitting
```

The Insertion field appears whenever a multiplexing function is selected. This must be set to On to enable any selected insertion. This field may be an exception from the rule for setting the display from top left to bottom right. You may wish to set the complete display before switching insertion on. Any subsequent configuration change automatically causes this field to revert to Off.

```
THRU   Retransmitting  DS1  Code    AMI
                            Frame   ESF

Insertion  On
           |
           Off
```

Stored Panels and Keyboard Lock

The Stored Panels and Keyboard Lock display is obtained by selecting INDEX Page 2.

Keyboard Lock

When the keyboard is Locked EXEC and START/STOP are inoperative. The CHANGE keys will allow the current instrument state to be displayed but not changed.

```
Keyboard is  Unlocked    Beeper is  Off
                |                    |
              Locked                 On
```

Stored Panels

Select the number of the panel to be recalled or accessed for storing the current set-up.

Note: Panel 0 is the fixed default state.

```
Keyboard is  Unlocked    Beeper is  Off

Select Panel  2
              |
            0 to 9
```

Recalling a Stored Panel

To recall a `Protected` panel press EXEC.

The stored setup is recalled and the number of the recalled panel (n) is shown in "Last panel configuration recalled : n"

```
Keyboard is  Unlocked   Beeper is  Off

Select Panel  2

Stored Panels  Protected

Press EXEC to Recall from Panel 2


Last Panel configuration recalled : 0
```

To recall a stored panel which is `Not Protected`, select `Recall` and press EXEC

```
Keyboard is  Unlocked   Beeper is  Off

Select Panel  2

Stored Panels Not Protected

Press EXEC to Recall from Panel 2


Last Panel configuration recalled : 0
```

Storing a Panel

The Stored Panels are normally Protected as a safeguard against overwriting. Before storing a new instrument setup in a panel it is first necessary to select Not Protected. When you press EXEC to Save a panel, the current setup is saved and the stored panels field resets to Protected.

```
Keyboard is  Unlocked   Beeper is  Off

Select Panel  2

Stored Panels Not Protected
                  |
                 Protected
```

Select Save and press EXEC to store the panel.

```
Keyboard is  Unlocked   Beeper is  Off

Select Panel  2

Stored Panels Not Protected

Press EXEC to Save  into Panel 2
              |
              Recall from
```

Data Logging

The Data Logging display is obtained by selecting INDEX Page 3.

Full details of internal and external printing are given in Section 5.

Printer Selection

Printer selection depends on Remote Control display selections

Only the internal printer is available when the instrument is configured as an addressable device.

```
Logging  On    Logging Device HP3787B

Set the HPIB mode on page 5 to Talk Only
to use an external HPIB printer.
```

The internal printer HP3787B or an external printer HP-IB can be selected when the instrument is configured as a Talk Only device.

```
Logging  On     Logging Device    HPIB
                                   |
                                 HP3787B
```

Triggering Prints of Result A Type Errors

With Log During Gating set to On you can chose to have a printout for every second which has error(s) Error Seconds or every second in which the error ratio exceeds a selectable limit Error Ratio >. The information printed is the number of errors (of the type selected for Result A) in the second when the trigger condition occurred.

When a jitter measurement is selected (option 001 only), Hit Bit Ratio or Hit Seconds can be logged.

```
Logging  On     Logging Device    HPIB

Log During Gating  On
         Trigger  Error Ratio > 1.0E-2
                        |
                  Error Second

                  Hit Bit Ratio> 1.0E-2
                        |
                   Hit Second
```

Printing Selected Results

With the End of Gating Summary set to On you can chose to print at the end of each gating period Always , or at the end of gating periods in which the error ratio has exceeded a selectable limit Error Ratio >.

This may be used to obtain prints at timed intervals with with repetitive gating.

```
Logging  On     Logging Device    HPIB

Log During Gating  On
         Trigger  Error Ratio > 1.0E-2

End of Gating Summary  On
            When  Error Ratio > 1.0E-2
                       |
                     Always
```

Select the content of the End of Gating Summary for each type of result.

Off for no print of that type of result.

Selected for what is currently selected (whether it is displayed or not).

All for all valid results of that type.

```
Logging  On    Logging Device    HPIB

Log During Gating  On
          Trigger  Error Ratio > 1.0E-2

End of Gating Summary  On
             When  Error Ratio > 1.0E-2

Content: Results    Off
         Analysis   Off
         Alarm Dur  Off
                     |
                 Selected
                     |
                    All
```

Date and Time

The Date and Time display is obtained by selecting INDEX Page 4

Setting the Date and Time

With the Clock Mode at Set use the CURSOR and CHANGE keys to set both date and time.

When the Clock Mode is subsequently changed to Run the internal clock will run from these settings.

Move the cursor back to Set.

```
Clock Mode  Set

Date        01  January    1987

Time        00 Hrs 00 Mins 00 Secs
```

Press [NEXT] to change the clock mode to Run when the time corresponds to the time you have set.

The clock will then run.

```
Clock Mode  Run
```

Remote Configuration

The Remote Configuration display is obtained by selecting INDEX Page 5

Full details of remote operation are given in Section 6

Instrument Control Selection

Select HP-IB or RS232 control

```
Source  HPIB   Status:Local   Error:   0
         |
        RS232
```

HP-IB Address/External Print Selection

For remote HP-IB control select Addressable and set a unique address.

The default address is 07.

To use an external printer connected to the HP-IB output (without HP-IB control) select Talk only

```
Source  HPIB   Status:Local   Error:   0

                       Addressable   07
                           |
                        Talk Only
```

RS-232-C Control

With the Instrument Control set to RS232, set the type of Connection, Modem or Hardwired. With Modem select Full or Half Duplex operation.

```
Source  RS232   Status:Local   Error:    0

Connection    Modem       Duplex  Full
                |                   |
            Hardwired              Half
```

Set the type of handshake, ENQ/ACK or XON/XOFF (DC1/DC3), to suit the controller:

No handshake

```
Source  RS232   Status:Local   Error:    0

Connection    Modem       Duplex  Full

   Enq/Ack  Off        Xon/Xoff    Off
```

With Half Duplex, Set ENQ/ACK.

```
Source  RS232   Status:Local   Error:    0

Connection    Modem       Duplex  Half

   Enq/Ack  On
            |
            Off
```

With Full Duplex, set ENQ/ACK or XON/XOFF to suit the controller and set the other one to Off

```
Source  RS232   Status:Local   Error:    0

Connection    Modem       Duplex  Full

   Enq/Ack  Off        Xon/Xoff   RX Only
            |                        |
            On                    TX Only
                                     |
                                  RX & TX
                                     |
                                    Off
```

DTR (Data Terminal Ready) is normally set On and not displayed. It can be displayed as a variable (On/Off) by setting an internal switch. See Manual Control of DTR in section 8.

```
Source  RS232   Status:Local   Error:   0

Connection   Modem       Duplex  Full

    Enq/Ack  On           Xon/Xoff   Off

         DTR  Off
               |
               On
```

Set the Speed to suit the modem and controller.

```
Source  RS232   Status:Local   Error:   0

Connection   Modem       Duplex  Full

    Enq/Ack  On           Xon/Xoff   Off


       Speed    300
                 |
                600
                 |
               1200
                 |
               1800
                 |
               2400
                 |
               4800
                 |
               9600
                 |
              Select    Low Speed   300
                        High Speed  300
                                     |
                               300 to 9600
```

Set the Parity and Stop Bits to suit the controller

```
Source  RS232   Status:Local   Error:   0

Connection   Modem      Duplex  Full

   Enq/Ack  On         Xon/Xoff   Off

       DTR  Off

     Speed    300

(7 Bit Data) Parity  0's   Stop Bits 1
                      |              |
                     1's             2
                      |
                     Odd
                      |
                     Even
```

Instrument Identification

The Instrument Identification display is obtained by selecting INDEX Page 6.

The Instrument Identification (ID) display specifies the software status of the instrument. This information may be required for instrument service.

```
              Instrument ID

             ROM - REV & CRC


Software Version :  2726
Date/Time Stamp  : 15th June 1987
                    17:00

Options fitted   :  DS1 Jitter Meas
```

User Confidence Tests

The User Confidence Test display is obtained by selecting INDEX Page 7.

Full details of the Power on Self Tests and User Confidence Tests are given in the HP3787 Service Manual, Section 8.3 Built-in Service Facilities

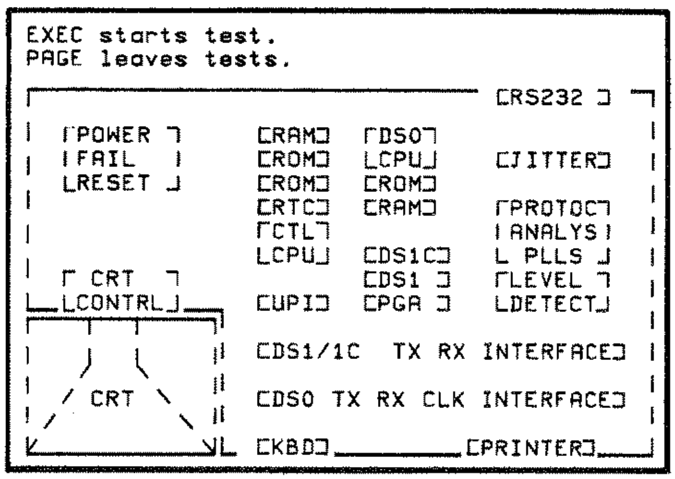
The User Confidence Tests provide a high confidence level that the instrument operates to specification and also provides service information for fault location.

The only external equipment required for these tests is a DS0 clock source for the DS0 interface test and an RS232 test connector for the RS232 Self Test.

The User Confidence Tests can be performed individually and repeatedly cycled or all tests can be performed in sequence. Instructions for performing these tests are given on the display.

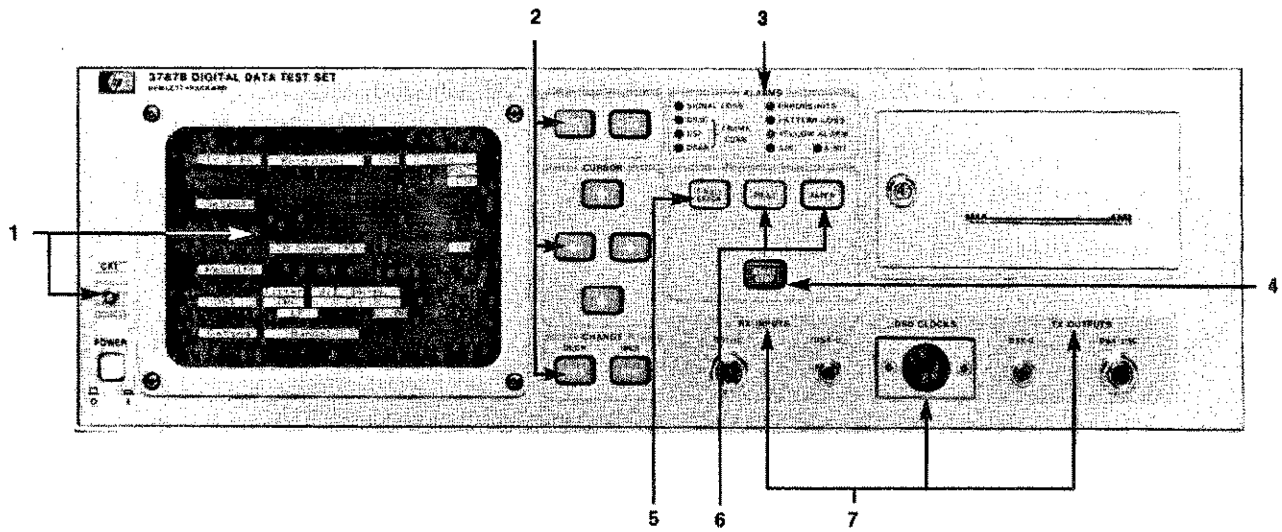
```
      USER CONFIDENCE SELF TESTS

To select all tests press the "EXEC" key

To select a specific test press   "NEXT"

Ensure that there is nothing connected
to the DSX-1/1C and DSX-0 transmit and
receive front panel interfaces.

Front panel DS0 clocks are required for
the DS0 interface test.

The loopback test connector is required
for the RS232 port test.
```

If you press EXEC you get a graphic display of the self tests being performed.



Front and Rear Panel Features

Front Panel Features



1 The HP 3787B is controlled by means of a CRT display and a simple "keyboard". Information on instrument status, configuration, results, etc. is displayed to the operator in "pages" of information. These may be accessed for viewing or change via the keyboard. The information "pages" are listed in numeric order on an Index page which indicates the information content of each page. There are seven pages excluding the index page. For ease of use the HP 3787B may often be driven from the "Normal Operation" page, Page 1. When the instrument powers up the index page is always displayed. The brightness of the display may be altered using the CRT control.

```
POWER HAS CYCLED

                  INDEX
                                     Page
Normal Operation ....................1
Stored Panels & Keyboard Lock ........2
Data Logging ........................3
Date & Time .........................4
Remote Configuration ................5
Instrument ID........................6
User Confidence Tests ...............7
```

2 When the Index page is displayed one of the information page numbers is highlighted by the cursor (flashing green square). The PAGE/INDEX key alternates the display between the Index page and the page being highlighted. When the information page being highlighted is displayed the cursor always appears in the top left-hand corner of the display.

Changeable items on the display are highlighted by a green background (inverse video). The highest ranked item appears at the top left-hand corner of the display, with the lower ranked items following on in order left to right and top to bottom. Changing an item may also cause lower ranked items further down the display to change automatically. To move the cursor from one changeable item to another use the CURSOR keys.

To change an item, use the CHANGE keys until the item you want is displayed. If the instrument is running a test (START/STOP gating led lit), you cannot make changes which affect the operation of the instrument Receiver setup - if you try, the instrument emits an audible "beep" and displays "GATING IN PROGRESS".

When certain functions are selected a "Press EXEC to . . . . " instruction will appear in the display - press EXEC to execute the function.

3 The instrument monitors the incoming signal for certain alarm conditions. If any of these conditions occur the appropriate ALARMS leds are lit while the alarm conditions exist.

4 Pressing the START/STOP key (led lit) starts a new measurement and also clears old results from the display. Pressing START/STOP again stops the measurement.

5 When the transmitter is configured to "add single errors", pressing the SINGLE ERROR key inserts a single error into the transmitted (TX OUTPUT) signal.

6 To obtain a time stamped record of the current instrument measurement(s), press the PRINT key. A typical print out is shown below.

```
03:15:17            Print
RESULT A:
DS1 Logic Results
Error Count...........15
```

Pressing the PAPER key causes a paper feed. If the printer is currently printing when you press the PAPER key the current line is printed before the paper feed occurs. A record of results is automatically printed when the instrument is configured for data logging (see Page 5-1).

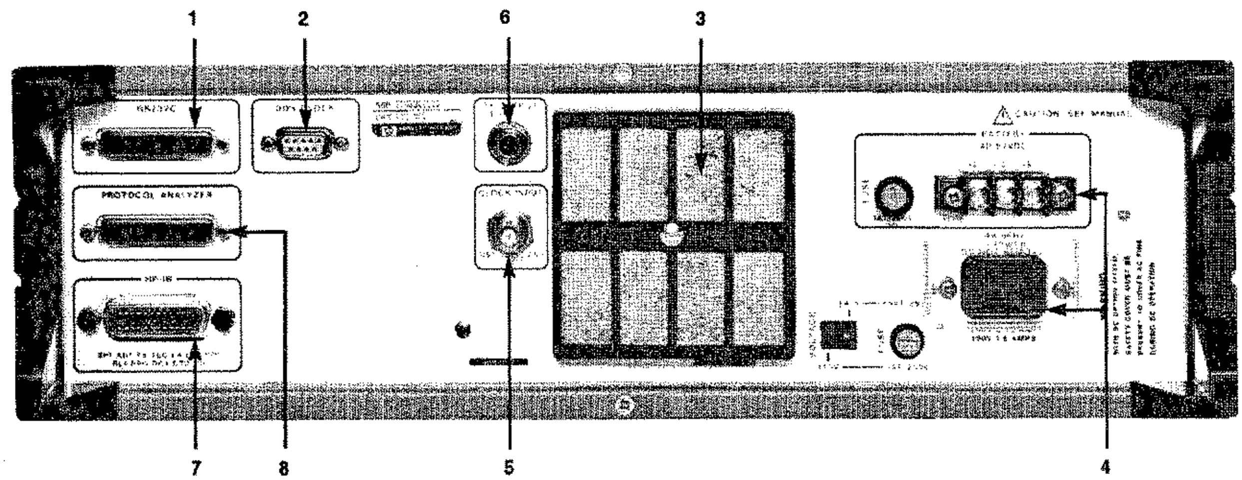
7 On the front panel there are two receiver inputs (RX INPUTS) and two transmitter outputs (TX OUTPUTS). The receiver inputs provide DS1/1C and DS0 access respectively. The active input is selected via the CRT.

One transmitter output provides a DSX-1 or DSX-1C signal while the other gives a DSX-0 signal. (The DS1/1C output is duplicated on the rear panel). Either the DS1/1C outputs or the DS0 output may be active at any one time.

Select the DS1/1C ports to connect to either a DS1 (1.544 Mbit/s) or DS1C (3.152 Mbit/s) access.

Select the DSX-0 port to connect to a DS0 (64 kbit/s) level - DS0A (single customer) or DS0B. To operate at the DSX-0 digital cross connect the front panel DS0 CLOCKS input or the rear panel DDS CLOCKS input must be connected to the 8 kHz and 64 kHz DDS office clocks.

Rear Panel Features



1 To control the instrument remotely via the RS-232-C interface, connect a suitable controller to the RS232C port.

2 When interfacing at a DS0 level, the HP 3787B must be supplied with 8 kHz and 64 kHz DDS office clocks. The rear panel DDS CLOCKS input is used, this is compatible with DDS clocks supplied from a D4 channel bank.

3 Fan - the fan-filter should be cleaned at regular 6-monthly intervals.

4 The standard instrument is powered from an AC power supply. An Option 002 instrument can also be powered from an office battery (-40 VDC to -57 VDC). When the AC supply is unreliable the instrument should be powered by an office battery for long-term uninterrupted measurements.

The instrument is protected by fuses: 3 Amp for 120 VAC operation, 1.5 Amp for 240 VAC operation and 3 Amp for battery operation. There is also a protective cover which ensures that only one power source can be connected (AC power supply or battery but not both).

5 The 75 Ohm DS1 CLOCK input can be used to synchronize the DS1 Transmitter to other DS1 equipment.

6 The DSX-1/1C TX OUTPUT is identical to the front panel DSX-1/1C output and is useful for testing M1C multiplexers.

7 The HP-IB port has a dual function: it can be used to control the instrument remotely or it can be used to print out results on an external HP-IB printer. To control the instrument remotely, connect a suitable controller and configure the instrument as an "ADDRESSABLE" device.

To print out results on an external HP-IB printer connect a suitable printer (eg an HP 2225A) and configure the instrument as a "TALK ONLY" device. The printer must be configured to "LISTEN ALWAYS".

8 To perform protocol analysis, connect a suitable analyzer (eg an HP 4952A with an HP 18180A Interface Pod) to the PROTOCOL ANALYZER port.

Printing/Logging Results 5

Introduction

The HP 3787B can output results to its internal printer or to an external printer without using an external controller. A copy of results can be manually requested on demand or the HP 3787B can be set to automatically log results. There are two ways to log automatically:

1. Logging can be triggered by error events while the HP 3787B is gating.

2. A summary of results can be printed at the end of gating.

The type of logging selected depends on the application. For example, if events such as intermittent errors are to be traced then log during gating would be selected. If a circuits' performance is to be evaluated then end of gating summary would be selected. Both types of logging may be selected simultaneously.

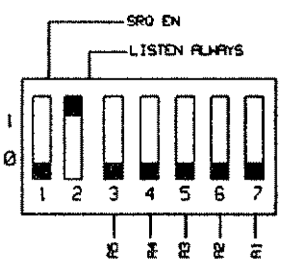
The date and time are printed at the start and stop of gating and the date is also printed at midnight. All logged results and triggers are time-stamped.

Printer Selection

As previously stated results can be logged on the HP 3787B internal printer or an external printer connected to the rear panel HP-IB port.

To print results on an external printer, configure the HP 3787B as a TALK ONLY device on the "Remote Configuration" page (Page 5). The external printer must be set to LISTEN ALWAYS and be the only device connected to the HP 3787B HP-IB port.

If an HP 2225A ThinkJet printer is used, set the rear panel switches as shown below.



To select your printer, display the "Data Logging" page (Page 3 on the "INDEX"), then select the printer you want as the Logging Device.

```
Logging On    Logging Device HP3787B

Set the HPIB mode on page 5 to Talk Only
to use an external HPIB printer.
```

The internal printer is always selected when the instrument is configured as an addressable device.

```
Logging On    Logging Device HPIB
```

Logging device selection may be HP3787B or HP-IB when the instrument is configured as a talk only device.

Printing Results on Demand

A time-stamped printout of results can be obtained at any time without affecting the measurement. The HP 3787B outputs the currently selected results on the receiver section of the "Normal Operation" page (page 1 on the "INDEX") when the PRINT key is pressed.

Results Available

The results available for display on the "Normal Operation" page are:

Results (eg Error Count and Error Ratio)
Analysis (eg % Availability and % Severe E. S.)
Alarm Duration (eg DS1 Pattern Loss Seconds and DS1 Frame Loss Seconds)
RX Level (DS1/1C only)
Monitor

A typical printout of each is given below.

```
03:15:17             Print
RESULT A:
DS1 Logic Results
Error Count...........15

RESULT B:
DS1 Logic Results
Error Ratio......1.1E-06
```

```
00:10:55             Print
MONITOR WORD:
Received word...01100000
```

```
00:10:00             Print
RX LEVEL:
Positive peak.....+3.13V
Negative peak.....-3.28V
```

```
00:09:29             Print
ALARM DURATIONS:
Signal loss............0
```

```
00:09:48             Print
ANALYSIS (A):
Availability.....100.00%
```

* RESULT A corresponds to the first measurement selected in the Results section. If a second measurement is selected it corresponds to RESULT B.

Logging During Gating

When the HP 3787B is set to log during gating, the printer is triggered by error events. The error events which trigger the printer are selected from either Error Seconds or an Error Ratio which exceeds a threshold set in the range 1.0E-2 to 1.0E-7. In the case of a jitter measurement (option 001 only) the trigger is either Hit Seconds or Hit Bit Ratio.

When logging is triggered, the number of errors in the second which caused the trigger is printed.

NOTE

The source of the trigger and the Error Count printed always pertain to Result A.

The HP 3787B has a printer-squelch function which saves paper by not allowing trigger seconds to be printed when an unmanageable number of errors occur. Printing stops when the logging trigger (error seconds or error ratio) occurs on 10 consecutive seconds. Printing starts again on the next trigger-free second - the HP 3787B then outputs the time elapsed since the printout was squelched and the total number of errors (or hits for optional jitter measurements) counted since the start of the squelch. An example print is shown below.

```
------------------------
Hewlett-Packard    3787B
03:33:16  01/01/87 START
Gate Manual
DS1 Logic Results
ES Trigger : ER > 1.0E-7

03:33:21 Err Cnt.......6
03:33:22 Err Cnt.......6
03:33:23 Err Cnt.......6
03:33:24 Err Cnt.......4
03:33:25 Err Cnt.......6
03:33:26 Err Cnt.......6
03:33:27 Err Cnt.......6
03:33:28 Err Cnt.......7
03:33:29 Err Cnt.......6
03:33:30 Err Cnt.......5
03:33:30       SQUELCHED
03:33:37     UNSQUELCHED
Trigger secs...........6
Total Errors..........30
```

Procedure

1. Check that the HP 3787B clock is set to the correct time on the "Date and Time" page (page 4 on the "INDEX").

2. Select the measurement type and suitable gating on the "Normal Operation" page.

3. Display the "Data Logging" page.

4. Set Logging to On.

5. Select the printer (see Page 5-1).

6. Set Log during gating to On, then select the logging Trigger; Error Second or Error Ratio. The Error ratio threshold can be set in the range 1.0E-2 to 1.0E-7.

7. Start the test (gating led on), by pressing the START/STOP key . The instrument will automatically output the following:

   Instrument model number
   Start date and time of test
   Type of gating
   Measurement type
   Logging trigger
   Active Alarms (if any)

   Whenever the Trigger selected in step 6 occurs, the time and number of errors in the trigger second are printed.

Logging During Gating - Display & Sample Print

A typical display for Log during gating and a sample print of a DS1 measurement are shown below.

```
Logging On     Logging Device HP3787B

Log During Gating On
          Trigger Error Second

End of Gating Summary Off
```

```
------------------------
Hewlett-Packard    3787B
00:07:30  01/01/87 START
Gate Manual
DS1 Logic Results
ES Trigger : Async ES

00:07:34 Err Cnt.......1
00:07:36 Err Cnt.......1
00:07:39    DS1 SIG LOSS
00:07:39    DS1 MFA LOSS
00:07:39  DS1 FRAME LOSS
00:07:39    PATTERN LOSS
00:07:39  DS1 SIG REGAIN
00:07:39    RX IMBALANCE
00:07:39    DS1 SIG LOSS
00:07:39  DS1 SIG REGAIN
00:07:39 Err Cnt..401359
00:07:39  DS1 MFA REGAIN
00:07:39  DS1 FRM REGAIN
00:07:39  PATTERN REGAIN
00:07:41     RX LEVEL OK
00:07:50 Err Cnt.......1
00:07:58      POWER LOSS
DATE          01/01/1987
00:08:11    POWER REGAIN
DATE          01/01/1987
00:08:16 Err Cnt.......1
00:08:21            STOP
```

When a power loss occurs during gating with Logging On, the power fail date and time and the power regain date and time are printed.

Whenever an alarm changes state during gating with Logging On, the new state of the alarm is printed.

Logging at the End of Gating

When the End of Gating Summary is selected, a summary of results is printed at the end of the gating interval or when you press the START/STOP key to stop the test. The log can be triggered at the end of each gating interval or after specific gating intervals in which the error ratio exceeds a threshold value set in the range 1.0E-2 to 1.0E-7. The HP 3787B outputs a summary of results under the following headings:

Results
Analysis
Alarm Durations

The HP 3787B can be set to output any combination of the above to a printer. Within each heading the instrument can be set to either;

output the results currently selected on the "Normal Operation" page
or
output all the results that are available
or
output no results under this heading

Procedure

1. Check that the HP 3787B clock is set to the correct time on the "Date and Time" page.

2. Select the measurement type and suitable gating on the "Normal Operation" page.

3. Display the "Data Logging" page.

4. Set Logging to On.

5. Select the printer (see Page 5-1).

6. Set End of gating summary to On, then select when you want a summary; Always or when the Error ratio exceeds a value set in the range 1.0E-2 to 1.0E-7.

7. For each result type, select the type of summary; Off, Selected or All.

   Off: no summary
   Selected: the currently selected result
   All: all valid results

8. Start the test (gating led on), by pressing the START/STOP key. The instrument will automatically output the following:

Instrument model number	Measurement type
Start date and time of test	Logging trigger
Type of gating	Alarms (if any)

   A summary is printed at the end of the gating interval or after you press the START/STOP key to stop the test.

Logging at the End of Gating - Display & Sample Print

A typical display for an End of Gating Summary and a sample print of a DS1 measurement are shown below.

```
Logging  On     Logging Device HP3787B

Log During Gating  Off

End of Gating Summary  On
             When      Always

Content: Results      All
         Analysis     All
         Alarm Dur _  All
```

When a power loss occurs during gating with Logging On, the power fail date and time and the power regain date and time are printed.

Whenever an alarm changes state during gating with Logging On, the new state of the alarm is printed.

```
------------------------
Hewlett-Packard    3787B
00:53:21  01/01/87 START
Gate Single 00d00h02m01s
DS1 Logic Results

00:54:12     DS1 SIG LOSS
00:54:12     DS1 MFA LOSS
00:54:12   DS1 FRAME LOSS
00:54:12     PATTERN LOSS
00:54:13     RX IMBALANCE
00:54:13   DS1 SIG REGAIN
00:54:13   DS1 MFA REGAIN
00:54:13   DS1 FRM REGAIN
00:54:13   PATTERN REGAIN
00:54:15      RX LEVEL OK
00:54:33       POWER LOSS
DATE           01/01/1987
00:54:46     POWER REGAIN
DATE           01/01/1987
00:55:35             STOP
00:55:35          Summary
```

```
RESULT A:
DS1 Logic Results
Error Count.......350212
Error Ratio......1.9E-03
Sync Err Secs..........4
Asyn Err Secs..........5
Async E.F.S..........116
% E.F.S..........95.8678

(No result B)

ANALYSIS (A):
Availability.....100.00%
Unavailability...0.0000%
Severe E.S.......1.6529%
Err Seconds......4.9587%
Degraded Mins....0.0000%

ALARM DURATIONS:
Pattern loss...........2
DS1 frame loss.........2
AIS Seconds............0
Power loss............13
Signal loss............1
```

Remote Control 6

Introduction

This section provides the information necessary to allow Remote Control of the HP 3787B via the HP-IB or via RS-232-C.

The HP 3787B can operate in Addressable or Talk Only modes. (Selectable on Page 5). Talk Only mode is explained in Section 5 PRINTING RESULTS.

Methods Of Remote Control

Two methods of Remote Control are available with the HP 3787B ie. HP-IB or RS-232-C.

HP-IB :- This provides a parallel interface which allows the connection of other devices to the system. HP-IB allows great flexibility in communicating data and controlling information between the Controller and the HP 3787B. HP-IB is one of the easiest methods of constructing automatic test systems. If long distance communication is required, suitable HP-IB Extenders must be connected within the Test System at both ends of the communications link.

RS-232-C :- This provides a serial interface which can be connected directly to a Modem RS-232-C port. Only a Controller and the HP 3787B can be connected to the system. RS-232-C does not allow the same degree of flexibility in controlling information as is possible via HP-IB ie. Serial Poll and Interrupt Handling.

Default Selection

NOTE: Changing A5 S202 causes loss of NVM including stored panels.

The instrument will default to HP-IB or RS-232-C depending on the position of A5 S202 switch 6. This "default" will only occur with a physical reset e.g. after selecting manual control of DTR and NOT as a result of the "RST" command or power return after failure.

Connecting The HP 3787B To HP-IB

The following points should be considered when connecting the HP 3787B to the HP-IB:-

- Communication with other devices on the Bus
- Operating distances

Communication With The Bus Controller

Usually, each device on the bus must have a unique address to allow the controller to access each one individually. On the HP 3787B this address is set on Page 5 of the display using the Front Panel keys :-

1. Select and view Page 5 using the Page Index and Cursor Keys.

2. Using the Cursor and Next/Prev Keys set the Page 5 display as shown in Figure 6-1 below.

```
Source  HP-IB   Status:Local   Error:  0

                    Addressable   07
```

Figure 6-1 Remote Configuration Page (HP-IB)

NOTE

Figure 6-1 shows address 07 selected. Any Address in the range 0 to 30 can be selected.

Operating Distances

The total length of HP-IB cable used must not exceed 2 meters (6 feet) times the number of devices in the system.

The total length of HP-IB cable, used to interconnect all devices, must not exceed 20 meters (65 feet).

Refer to INSTALLATION (Section 8) for HP-IB cable details.

Operating distances can be increased by using HP-IB Extenders.

Up to 1000 meters: Use two HP 37203A or two HP 37201A or two HP 37204A.

Over 1000 meters : Use two HP 37201A and suitable Modems.

Connecting The HP 3787B To RS-232-C

The following points should be considered when connecting the HP 3787B to the RS-232-C :-

- Operating distances
- Communication with the Controller

Operating Distances

The RS-232-C Interface allows Remote Control of the HP 3787B as an alternative to HP-IB. Using the RS-232-C Interface the HP 3787B can be controlled, from a few feet away using a simple 3 wire cable (Hardwired), or from distances up to thousands of miles using suitable Modems and the Telephone Network (Modem).

Hardwired :- The maximum recommended length of cable is 15 meters (50 feet).

Modem :- The maximum distance is only limited by the extent of the Telephone Network.

Communication With The Controller

Before information can be successfully transferred between the HP 3787B and the Controller a connection method must be decided :-

- Is the connection to be Hardwired or Modem? (See Operating Distances)

Hardwired Connection

In this type of connection the HP 3787B is connected directly to the Controller via a length of cable. (Maximum recommended length 15 meters [50 feet]).

Before making the connection it is necessary to determine whether the Controllers RS-232-C Interface is configured as Data Terminal Equipment (DTE) or Data Communications Equipment (DCE). This affects cabling required for connection to the HP 3787B and should be available in the Controller manuals.

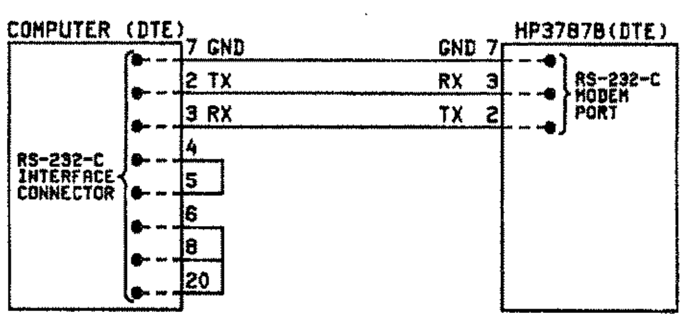


Figure 6-2 Controller (DTE)

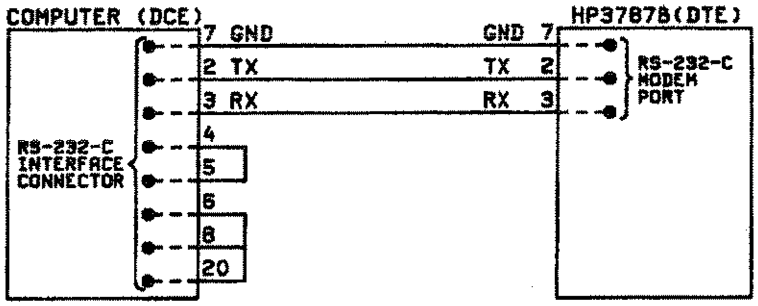


Figure 6-3 Controller (DCE)

NOTE

The pin numbers used refer to the RS-232-C connector which may differ from Controller to Controller.

Some Controllers will require connections across certain pins of their RS-232-C Interface, or the operation of a switch, to simulate the initial handshake that takes place with a Modem prior to Data transfer. The information required should be available in the Controller Manuals.

Configure the Controller and the HP 3787B

Having made the connection it is necessary to establish a communications link. Prior to establishing the link it is necessary to set the protocol parameters on the HP 3787B to match those of the Controller :-

- What Speed (Baud Rate) is to be used? 300, 600, 1200, 1800, 2400, 4800 or 9600?
- What Parity is to be used? Odd, Even, Zeros or Ones?
- How many Stop Bits are required? 1 or 2?
- Is ENQ/ACK Handshake required? Off or On.
- Is XON/XOFF Handshake required? Off, RX Only; TX Only or RX & TX.

NOTE

1. Only one of the Handshake methods listed is allowed at a time ie ENQ/ACK OR XON/XOFF. Alternatively no Handshake, ie ENQ/ACK - Off; XON/XOFF - Off, is allowed.

2. Most Controllers refer to XON/XOFF as DC1/DC3.

To set the Controller protocol refer to the Controller manuals.

To set the HP 3787B protocol proceed as follows :-

1. Using the Page Index and Cursor keys select and display the Remote Configuration page (5).

2. Using the Next key set the Instrument Control parameter to RS232.

3. Using the Cursor and Next keys set the Connection parameter to Hardwired.

4. Using the Next/Prev and Cursor keys set the ENQ/ACK, XON/XOFF, Speed, Parity and Stop Bits parameters to match those selected on the Controller.

```
Source  RS232  Status:Local  Error:   0

Connection _Hardwired

   ENQ/ACK  On         XON/XOFF   Off


     Speed   1200


(7 Bit Data) Parity  0's   Stop Bits  1
```

Figure 6-4 Remote Configuration Page (RS-232-C Hardwired)

Modem Connection

In this type of connection the HP 3787B is connected to a Modem which forms part of an established communications link.

Before connecting the HP 3787B to the Modem the following action should be taken.

Configure the Local and Remote Modems.

The following characteristics of the HP 3787B should be taken into account when configuring the Local and Remote Modems :-

- The HP 3787B provides 10 Bit Asynchronous Data (1 Start, 7 Data, 1 Parity & Stop Bits)
- The HP 3787B can be configured for Half or Full Duplex.
- The HP 3787B has a choice of Speeds (Baud Rates) 300, 600, 1200, 1800, 2400, 4800 or 9600 Bauds. In addition, the HP 3787B has a Dual Speed capability. For this to be utilized the Modems and the Controller must also have a Dual Speed capability.

NOTE

1. If Dual Speed operation is required the HP 3787B Data Rate Select Strapping must match that of the Modem and the Controller.

2. The RS-232-C defines two circuits, CH and CI as Data Rate selectors. The circuit definitions are identical, except that CH is used by the DTE to control the Modem Speed and CI is used by the Modem to control the DTE. The two circuits are mutually exclusive but both are assigned to pin 23 and the decision as to which circuit to implement is left up to "the supplier". This is an unsatisfactory arrangement since a Dual Speed Modem ideally needs both CH and CI. The HP 3787B overcomes this by using pin 12 as the CI circuit and pin 23 as the CH circuit, with the capability of modifying this arrangement by means of hardware wire links on the A6 Assembly. The HP 3787B is factory preset to have CH on pin 23, high (+V) and CI on pin 12. For detailed instructions on modifying this arrangement see the Installation Section (8) of this manual.

Establish the communication link Modem to Modem (Leased or Dial- Up line)

Configure the Controller and the HP 3787B

Prior to connecting the Controller and the HP 3787B it is necessary to set the RS-232-C protocol parameters. The HP 3787B protocol must match the Controller protocol and be compatible with the Modem configuration.

The following points should be taken into consideration :-

- What Speed is the Modem set to? Dual Speed and/or 300, 600, 1200, 1800, 2400, 4800 or 9600?
- What Duplex is selected on the Modem? Half or Full?
- What Parity is required? Odd, Even, Zeros or Ones?
- How many Stop Bits are required? 1 or 2?
- Is ENQ/ACK Handshake required? Off or On?
- Is XON/XOFF Handshake required? Off, RX Only, TX Only, or RX & TX?

NOTE

1. Only one of the Handshake methods listed is allowed at a time ie ENQ/ACK OR XON/XOFF. Alternatively No Handshake, ie ENQ/ACK - Off; XON/XOFF - Off, is allowed.

2. XON/XOFF is only possible with FULL Duplex.

3. Most Controllers refer to XON/XOFF as DC1/DC3.

To set the Controller protocol and connect the Controller to the Modem refer to the Controller manuals.

To set the HP 3787B protocol proceed as follows :-

1. Using the Page Index and Cursor keys, select and display the Remote Configuration page (5).

2. Using the Next key set the Instrument Control parameter to RS232.

3. Using the Cursor and Next keys, set the Connection parameter to Modem.

4. Using the Next/Prev and Cursor keys, set the Half/Full Duplex, ENQ/ACK, XON/XOFF, Speed, Parity and Stop Bit parameters to match those selected on the Controller.

5. Connect the HP 3787B to the Modem using an RS-232-C cable HP P/N 5060-4461.

NOTE

1. If the cable HP P/N 5060-4461 is not available, or its connector is not compatible with your Modem, then you will need to provide a compatible cable. Any substitute cable must have a conductor for each of the RS-232-C signals implemented by the HP 3787B. (See General RS-232-C Information)

2. Data Terminal Ready (DTR) is Factory Preset to be always On. Control of DTR can be achieved by altering a switch on the A5 Assembly. This causes a choice of DTR - Off or On to appear on the Remote Configuration page (5). For details of switch settings refer to the Installation Section (8) of this manual.

```
Source RS232   Status:Local   Error:    0

Connection  Modem     Duplex  Full

    ENQ/ACK  Off          XON/XOFF  RX & TX


      Speed   1200

(7 Bit Data) Parity  0's   Stop Bits  1

                                  DTR
```

Figure 6-5 Remote Configuration Page (RS-232-C Modem)

General Programming Characteristics

Command Format

The programming commands have three parts:-

- an alpha header mnemonic
- a list of command parameters (if required)
- a command terminator

Spaces within the command string are ignored provided they do not occur within a header or parameter.

Command Parameters

Parameter lists consist of decimal numbers, or mnemonics, separated by commas or spaces. String parameters can be enclosed in double or single quotes provided both quotes are of the same type.

The HP 3787B returns string data enclosed in double quotes with commas as separators.

Combining Commands

It is possible to combine several commands into one string by using a semicolon (;) as a command separator. Each command is executed when the command separator is received (See command validity).

In HP 200 series controllers this is written as OUTPUT 707;"command1; command2; etc"

Command Terminators

A command string is terminated by one of three things:-

- ASCII new line (identical to the linefeed character <lf>).
- ASCII carriage return + 1 linefeed <cr lf>.
- An interface EOI with the last byte of the command.

In most controllers a BASIC statement of the form OUTPUT 707;"CLR" includes a <cr lf>.

The HP 3787B does not execute a command until one of these terminators is received.

Command Validity

A command will be rejected if:-

- it contains a syntax error
- it cannot be identified
- it has too few or too many parameters
- a parameter is out of range
- it is out of context

Initialising The HP 3787B

Regardless of the current set up the following Message initializes the HP 3787B. It sets the HP 3787B to the Default state and clears all HP-IB input and output buffers.

- RST : reset

The Default Settings are listed in Appendix E.

The HP 3787B Response/Program Messages

Response/Program Messages, unique to the HP 3787B, allow the instrument to be controlled remotely via the HP-IB or RS-232-C.

NOTE

1. In most cases, programming the HP 3787B is simply a matter of determining the local page settings and converting these to Response/Program Messages. These Messages are listed, on succeeding pages, in the order in which the parameters appear on the HP 3787B TX and RX displays ie starting from the top left of the display and progressing to the bottom right.

2. Since the HP 3787B TX and RX displays are hierarchical the parameters have been split into groupings. Within these groupings a selection or change of one parameter will often entail selection of one or more other parameters. Additionally a selection or change of parameter will often entail further selections within succeeding groupings.

3. The HP 3787B must be set to Addressable before operation via the HP-IB is possible.(See Connecting the HP 3787B to the HP-IB).

4. The RS-232-C Interface must be setup before operation via RS-232-C is possible. (See Connecting The HP 3787B To The RS-232-C).

5. Examples given are in HP BASIC relating to an HP 200 series controller. These examples assume the HP 3787B has an Address of 07, operating via the HP-IB.

Setting Calendar (DATE & TIME)

Function	Mnemonic Code	Description
DATE	"DAT y,m,d" y = 1987 to 2050 m = 1 to 12 d = 1 to 31	Sets the Date portion of the Calendar. y = Year, m = Month, d = Day
	"DAT?"	Returns state of DAT ie ´y,m,d´.
TIME	"TIM h,m,s" h = 0 to 23 m = 0 to 59 s = 0 to 59	Sets the Time portion of the Calendar. h = Hours, m = Minutes, s = Seconds
	"TIM?"	Returns Hours, Minutes, Seconds Example:- To set the Calendar to 1143 on 3rd July 1987 send: **OUTPUT 707;"TIM 11,43,0; DAT 1987,7,3"** Example:- To read the calendar send: **OUTPUT 707;"TIM?;DAT?"** **ENTER 707;Hms$,Ymd$** **PRINT Hms$,Ymd$**

Setting TX Parameters (INTERFACE LEVEL)

Function	Mnemonic Code	Description
INSTRUMENT MODE	"MOD n"	
	n = TX&RX or 1	Independent TX & RX mode
	n = THRU or 2	Transmit Received Signal
	"MOD?"	Returns state of MOD ie 1 or 2
DS0 CLOCK SOURCE (DS0/DS0A/DS0B)	"DCS n"	
	n = FRONT or 1	Connect DS0 Clock to Front Panel
	n = REAR or 2	Connect DS0 Clock to Rear Panel
	"DCS?"	Returns state of DCS ie 1 or 2.
INTERFACE LEVEL	"TIN n"	
	n = DS1C or 1	(See TCD,TCF,TCL)
	n = DS1 or 2	(See TCD,T1F,TCL)
	n = DS0B or 3	(See DCS,T0R)
	n = DS0A or 4	(See DCS,T0R,TAM)
	n = DS0 or 5	(See DCS)
	"TIN?"	Returns state of TIN ie 1 to 5.
		Selection of Interface Level determines the Level at the TX output. Selection of Interface Level also incurs further selections eg DS1 incurs selection of Coding (TCD); Framing (T1F); Clock (TCL).
DS1/DS1C CODING	"TCD n"	
	n = AMI or 1	Alternate Mark Inversion
	n = B8ZS or 2	Binary 8 Zeros Substitution
	"TCD?"	Returns state of TCD ie 1 or 2
DS1C FRAMING	"TCF n"	DS1C Interface Level only
	n = OFF or Ø	Transmit Unframed DS1C
	n = ON or 1	Transmit Framed DS1C
	"TCF?"	Returns TCF state ie Ø or 1.
DS1 FRAMING	"T1F n"	DS1 Interface Level only
	n = OFF or Ø	No Framing
	n = T1DM or 1	T1 Data Multiplexer
	n = SF or D4 or 2	Superframe
	n = FT or 3	Ft only
	n = ESF or FE or 4	Extended Superframe
	"T1F?"	Returns state of T1F ie Ø to 4.

Setting TX Parameters (INTERFACE LEVEL)

Function	Mnemonic Code	Description
DS1 CLOCK	"TCL n"	
	n = INTERNAL or 1	Internal DS1 Clock source
	n = EXTERNAL or 2	External DS1 Clock source
	n = LOOPED or 3	RX Clock Looped to TX
	"TCL?"	Returns state of TCL ie 1 to 3.
		If the Instrument Mode (MOD) selected is *THRU* then the clock is always notionally *LOOPED* ie the TX Clock is derived from the RX Clock. If the instrument Mode selected is *TX&RX* the *LOOPED* Clock is derived from the DS1 RX. The *LOOPED* selection is therefore only valid if the Instrument Mode is *TX&RX* and the RX Interface Level (RIN) is *DS1*.
MULTIPLEXER RATE DS0A/DS0B	"T0R 1"	2.4 kbits
	"T0R 2"	4.8 kbits
	"T0R 3"	9.6 kbits
	"T0R 4"	56 kbits
	"T0R?"	Returns state of T0R ie 1 to 4.
DS0A INTERFACE MODE	"TAM n	
	n = DSX or 1	DSX cross-connect. Non TTL
	n = LOGIC_NEAR or 2	Logic Near Interface (Tip)
	n = LOGIC_FAR or 3	Logic Far Interface (Ring)
	"TAM?"	Returns state of TAM ie 1 to 3.
		If TAM and IAT (RX DS0A Termination) are both set to Logic then a change from NEAR to FAR or FAR to NEAR in either will cause the other to change automatically.
		EXAMPLE :- Require to Transmit at an Interface Level of DS1 with B8ZS Coding T1DM Framing and an External Clock in the TX&RX Mode :
		OUTPUT 707;"MOD TX&RX;TIN DS1; TCD B8ZS;T1F T1DM;TCL EXTERNAL"

Setting TX Parameters (SELECT LEVEL)

Function	Mnemonic Code	Description
SELECT LEVEL	"TSL n"	Only valid if TX Interface Level is DS1
	n = DS1 or 1	DS1
	n = DS0B or 2	(See TCU,T0R,TCR,TTS,INS)
	n = DS0A or 3	(See T0R,TTS,INS)
	n = PSDC or 4	SF or ESF Framing only(See TTS,INS)
	n = DS0 or 5	Not valid T1DM Framing(See TTS,INS)
	n = DATALINK or 6	ESF Framing only(SeeINS)
	n = FS_CHAN or 7	Ft Framing only(See INS)
	n = R_CHAN or 8	T1DM Framing only(See INS)
	"TSL?"	Returns state of TSL ie 1 to 8.
		This Message is only valid if the Interface Level (TIN) is DS1. Selection of Select Level may incur further selections eg Select level DS0B incurs selection of Customer Number (TCU); Data Rate (T0R); Customer Rate (TCR); Timeslot Insertion (INS); Timeslot Number (TTS).
CUSTOMER NUMBER DS0B	"TCU n"	n depends upon Data Rate set by T0R.
		T0R = 2.4 kbits n = 1 to 20
		T0R = 4.8 kbits n = 1 to 10
		T0R = 9.6 kbits n = 1 to 5
		T0R = 56 kbits n = 1
	"TCU?"	Returns state of TCU ie 1 to 20.
MULTIPLEXER RATE DS0A/DS0B	"T0R 1"	(2.4 kbits)
	"T0R 2"	(4.8 kbits)
	"T0R 3"	(9.6 kbits)
	"T0R 4"	(56 kbits)
	"T0R?"	Returns state of T0R ie 1 to 4.
CUSTOMER RATE DS0B	"TCR 1"	2.4 kbits (Insert Rate)
	"TCR 2"	4.8 kbits (Insert Rate)
	"TCR 3"	9.6 kbits (Insert Rate)
	"TCR?"	Returns state of TCR ie 1 to 3.
		TCR must be < or = to T0R. If T0R is 56 kbits then TCR is illegal.

Setting TX Parameters (SELECT LEVEL)

Function	Mnemonic Code	Description
TIMESLOT NUMBER	"TTS n" n = 1 to 24	Designates DS1 Timeslot into which Data is inserted. If DS1 Framing(T1F) is T1DM then selection of Timeslot 24 is illegal.
	"TTS?"	Returns TTS state ie 1 to 24.
TIMESLOT INSERTION	"INS n"	
	n = OFF or Ø	No Insertion into Timeslot
	n = ON or 1	Transmit Data into Timeslot
	"INS?"	Returns state of INS ie Ø or 1. In *TX&RX* mode, Insertion is always ON. In *THRU* mode INS is only valid if Interface Level is DS1 and Select Level is other than DS1. EXAMPLE :- Wish to insert a 2047 bit PRBS test pattern into the 2.4 kbits Primary Channel of Customer #5 of a 9.6 kbits DS0B. The DS0B is contained within Timeslot 15 of the DS1 signal, which has D4 Framing and AMI Coding. The access is at the DS1 level : **OUTPUT 707;"MOD TX&RX;TIN DS1; TCD AMI;T1F D4;TCL INTERNAL; TSL DS0B;TCU 5;T0R 3;TCR 1;TTS 15; DLT SINGLE;TDC PRIMARY;TDT PATTERN;TRD PRBS_2047"**

Setting TX Parameters (DDS LINK TYPE)

Function	Mnemonic Code	Description
DDS LINK TYPE	"DLT n" n = SINGLE or 1 n = MULTI or 2 "DLT?"	DS0A & DS0B only Point to Point(See TDC) Multi-point(See TDC,SBR,MJU) Returns state of DLT ie 1 or 2. This Message is only valid when Interface Level (TIN) or Select Level (TSL) is DS0A or DS0B.
DDS CHANNEL TYPE	"TDC n" n = PRIMARY or 1 n = SECONDARY or 2 "TDC?"	Not valid for Alt. Loopback(See LBT) DDS Primary Channel DDS Secondary Channel Returns state of TDC ie 1 or 2.
SELECT BRANCH	"SBR n" n = 1 to 4 "SBR?"	Determines which MJU Branch will be affected by next MJU message. Returns state of SBR ie 1 to 4.
MULTI-POINT JUNCTION UNIT OPERATIONS	"MJU n" n = SELECT or 1 n = TEST or 2 n = END_TEST or 3 n = BLOCK or 4 n = UNBLOCK or 5 n = RELEASE or 6 "MJU?"	Select a Branch Test Selected Path Restore Normal Operation Block a Branch Unblock a Branch Unblock All Branches Returns state of MJU ie 1 to 6. EXAMPLE :- Wish to Transmit a 511 bit PRBS into Branch 4 of a Multi-Point Junction Unit :- **OUTPUT 707;"MOD TX&RX;TIN DS1; TCD B8ZS;T1F ESF;TCL INTERNAL;TSL DS0B;TCU 4;T0R 3;TCR 1;TTS 9; DLT MULTI;TDC PRIMARY;SBR 4;MJU SELECT;MJU TEST;LBT NONE;TDT PATTERN;TRD PRBS_511;EAT OFF"**

Setting TX Parameters (LOOPBACK)

Function	Mnemonic Code	Description
LOOPBACK TYPE	"LBT n"	
	n = NONE or Ø	No Loopback
	n = DS1 or 1	Fixed DS1 L/B
	n = ALT_DSU or 2	Alternating DSU L/B
	n = ALT_CHAN or 3	Alternating Channel L/B
	n = ALT_OCU or 4	Alternating OCU L/B
	n = ALT_RPT or 5	Alternating Repeater L/B
	n = ALT_HL96 or 6	Alternating HL96 L/B
	n = DS0DP or 7	Latched DS0 Dataport L/B
	n = OCU or 8	Latched OCU L/B
	n = CSU or 9	Latched CSU L/B
	n = HL222 or 1Ø	Latched HL222 L/B
	"LBT?"	Returns state of LBT ie 1 to 1Ø.
		ALT_DSU: ALT_CHAN: ALT_OCU: ALT_HL96: DS0DP: OCU: CSU & HL222 Loopbacks are only valid at DS0A & DS0B.
		ALT_RPT Loopback is only valid at DS0A & DS0B < 56 kbits.
		DS1 Loopback is only valid if TIN & TSL are both DS1.
ACTUATE LOOPBACK	"ALB"	For this Message to be valid a Loopback of some type must have been selected and the Gating stopped. If the Instrument is Gating the Message will be ignored and Error -25Ø will be generated.
RELEASE LOOPBACK	"RLB"	For this Message to be valid a Loopback of some type must have been selected and actuated and the Gating stopped. If the Instrument is Gating the Message will be ignored and Error -25Ø will be generated.
REPEATER NUMBER	"TRN n"	Sets the Repeater Number for a 56 kbits Alternating Repeater Loopback.
	n = 1 or 2	
	"TRN?"	Returns state of TRN ie 1 or 2.
HL96NY PRESENCE	"HLP n"	Only valid if an Alternating OCU Loopback is selected.
	n = No or Ø	HL96NY Card absent
	n = YES or 1	HL96NY Card Present
	"HLP?"	Returns state of HLP ie Ø or 1.

Setting TX Parameters (LOOPBACK)

Function	Mnemonic Code	Description
TANDEM NUMBER	"TNU n" n = 1 to 8 "TNU?"	Only valid if a Latched DS0 Dataport Loopback (DS0DP) is selected. Returns state of TNU ie 1 to 8.
NUMBER OF INTERMEDIATE REPEATERS	"TIR n" n = Ø to 2 "TIR?"	Only valid if a 56 kbit Alternating Channel Loopback is selected. Returns state of TIR ie Ø to 2.

Setting TX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
DATA TYPE	"TDT n"	
	n = PATTERN or 1	(See TRD,TSW,TRP)
	n = CODE or 2	DDS Special Codes. DDS Primary Channel only.(See TRC,TSC,TXC,STC)
	n = PROTOCOL or 3	Data from Protocol Analyzer. Only valid for DDS Primary Channel <56 kbits, DDS Secondary Channel, Datalink, FS_Chan and R_Chan.
	"TDT?"	Returns state of TDT ie 1 to 3.
		If an Alternating Loopback is selected then TDT must be Pattern.
		If Code is to be transmitted into a channel which has a Latched Loopback, the Loopback must be established before selecting CODE otherwise Error -252 occurs.
PATTERN TYPE	"TRD n"	
	n = PRBS_20 or 1	2Ø Stage PRBS(See TZL)
	n = ALL_ONES or 2	All Ones Word
	n = SETTABLE or 3	Settable Word(See TSW)
	n = PRBS_2047 or 4	2Ø47 Bit PRBS
	n = PRBS_511 or 5	511 Bit PRBS
	n = PREPROG or 6	User defined Pattern(See TRP)
	"TRD?"	Returns state of TRD ie 1 to 6.
		The Pattern Type validity depends on Select Level & DDS Channel Type :-
		PRBS_2Ø - Only valid at DS1&DS1C.
		ALL_ONES - Not valid for DDS Secondary Channel or Alt. Loopback
		SETTABLE - NOT valid for Datalink; FS_Chan; R_Chan;DDS Secondary Channel or Alternating Loopback.
		PRBS_2Ø47; PRBS_511 - NOT valid for DS1 or DS1C.
		PREPROG - Valid for DS0B; DS0A; DDS Primary Channel; DS0 & PSDC.
14 ZERO LIMIT	"TZL n"	PRBS_20 only.
	n = OFF or Ø	No 14 Zero Limit
	n = ON or 1	PRBS_20 14 Zero Limited
	"TZL?"	Returns state of TZL ie Ø or 1.

Setting TX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
SETTABLE WORD	"TSW 'bbbbbbbb'"	The content of the 8 bit (b) Word depends upon the Interface or Select Level selected:- DS1/DS1C 'dddddddd' 64 kbits Clr. Chan. 'dddddddd' 56 kbits DDS 'ddddddd1' 56 kbits PSDC 'ddddddds' DS0B <56 kbits 'fdddddd1' DS0A <56 kbits '1dddddd1' d = Data bit Ø or 1 s = Signaling bit f = subrate Frame bit
	"TSW?"	Returns state of TSW ie 'bbbbbbbb'.
USER DEFINED PATTERN LOAD	"TRP #H"	This Message allows the user to define a Preprogrammed Pattern . The user can enter any number of Bytes of data in the range 1 to 256, in Block format (IEEE Standard 728 #H). A Byte consists of two Hexadecimal Characters ie two of (0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F). The selectable content (d) of the bytes depends on the interface or "select level" selected: 64 kbits Clr. Chan. 'dddddddd' 56 kbits DDS 'dddddddd' 56 kbits PSDC 'ddddddds' DS0B/DS0A <56 kbits 'fddddddd' Irrespective of the Data Rate, the user enters an 8 bit Byte (2 HEX. Characters) and, the HP 3787B compensates automatically. When all bytes have been transmitted the TX starts again at the beginning of the Pattern. Example :-To define a Pattern of 0011001011110000 (32F0H) send : **OUTPUT 707;"TDT PATTERN; TRD PREPROG;TRP #H32FØ"**
	"TRP?"	Returns the currently loaded user defined Pattern in #H Block format.

Setting TX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
DDS CODE	"TRC n"	Only valid if DDS Primary Channel and TX Data Type is Pattern.
	n = CMI or 1	Control Mode Idle
	n = OCU_LB or 2	OCU Loopback
	n = CHAN_LB or 3	Channel Loopback
	n = DSU_LB or 4	DSU Loopback
	n = TIP or 5	Transition In Progress
	n = LBE or 6	Loopback Enable
	n = FEV or 7	Far End Voice
	n = TA or 8	Test Alert
	n = MA or 9	MJU Alert
	n = UMC or 10	Unassigned Mux Channel
	n = BLOCK or 11	MJU Block
	n = RLS or 12	MJU Release
	n = ASC or 13	Abnormal Station Condition
	n = TEST or 14	Test
	n = OOS or 15	Out Of Sync (Mux)
	n = SETTABLE or 16	User Settable Code(See TSC)
	"TRC?"	Returns state of TRC ie 1 to 16.
START DDS CODE	"TXC"	When the DDS Code has been selected the HP 3787B sends an "ALL 1's" PATTERN This Message starts the transmission of the selected Code.
STOP DDS CODE	"STC"	This message stops transmission of the selected Code and the HP 3787B reverts to transmitting an "ALL 1's" PATTERN. The following Messages also perform this function :- Change of TX Interface Level(TIN) Change of TX Multiplexer Rate(TOR) Change of DDS Link Type(DLT) Change of TX Timeslot No.(TTS) Change of TX Customer No.(TCU) Change of TX Customer Rate(TCR) Change of TX Data Type(TDT) Change of TX DDS Channel Type(TDC) Change of TX DDS Code(TRC) Change of TX DDS Settable Code(TSC)

Setting TX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
DDS SETTABLE CODE	"TSC 'bbbbbbbb'"	The content of the 8 bit (b) Code depends upon the DDS Rate selected :- 56 kbits DDS "dddddddØ" DS0B <56 kbits "fdddddd1" DS0A <56 kbits "1dddddd1" d = Data bit Ø or 1 f = subrate Frame bit
	"TSC?"	Returns state of TSC ie 'bbbbbbbb'. Example :- Transmit a Settable DDS Code of all 0's at a DS0A rate of 2.4 kbits. Interface is at DS1 with D4 Framing and B8ZS Coding and the DS0A is contained in Timeslot 2 **OUTPUT 707;"MOD TX&RX;TIN DS1; TCD AMI;T1F D4;TCL INTERNAL;TSL DS0A;TTS 2;T0R 1;DLT SINGLE;TDC PRIMARY;TDT CODE;TRC SETTABLE; TSC '1ØØØØØØ1'"**
SIGNALING MODE	"TSM n" n = SET or 1 n = RETRANSMIT or 2	Set Signaling bits. (See SIG) TX received Signaling bits
	"TSM?"	Returns state of TSM ie 1 or 2. *Retransmit* is only valid in *THRU* mode when receiving PSDC and wishing to retransmit into the same Timeslot.
SIGNALING BITS	"SIG 'xxyy'"	This message is only valid when Select Level is 56 kbits *PSDC* or 4 kbits *DATALINK* (See TSL) and when DS1 Framing is *SF* or *ESF* (See T1F). If DS1 Framing is *SF*, only two bits are valid ie xx, however spaces must be substituted for yy ie "xx ". If DS1 Framing is *ESF*, four bits are valid ie xxyy. x value = Ø or 1. y value = Ø or 1.
	"SIG?"	Returns state of SIG ie 'xx ' or 'xxyy'.

Setting TX Parameters (ERROR ADD)

Function	Mnemonic Code	Description
ERROR ADD TYPE	"EAT n"	Not valid if TDT is PROTOCOL or CODE or TDT is PATTERN & TRD is PREPROG
	n = OFF or Ø	No Errors Added
	n = LOGIC or 1	Pattern Only(See EAD,SEA,EAR)
	n = BPV or CODE or 2	DS1/DS1C(See EAD,SEA,EAR)
	n = FRAME or 3	Framed DS1/DS1C(See EAD,SEA)
	n = SUBFRAME or 4	DS0B <56 kbits(See EAD,SEA)
	n = ESF_CRC or 5	DS1 with ESF Framing(See EAD, SEA,CAR)
	n = DATAPORT or 6	DS0A <56 kbits(See DER)
	n = BYTE or 7	DS0,DS0A,DS0B(See EAD,SEA)
	n = APS or 8	DS1/DS1C Automatic Protection Switch Test(See APR,APM)
	"EAT?"	Returns state of EAT ie Ø to 8.
ERROR ADD METHOD	"EAD n"	Not valid when EAT is OFF or APS
	n = SINGLE or 1	(See SEA)
	n = RATE or 2	Not valid when EAT is FRAME, SUBFRAME, DATAPORT, BYTE, APS (See EAR,CAR)
	"EAD?"	Returns state of EAD ie 1 or 2.
SINGLE ERROR ADD	"SEA"	Adds a single Error if EAD 1 (single) is selected and EAT is other than Ø.
ERROR ADD RATE (LOGIC, BPV/CODE)	"EAR n"	Sets the Error Ratio for LOGIC or BPV/CODE Errors. The Mantissa must be Ø.
	n = 1.ØE-8 to 9.ØE-3	
	"EAR?"	Returns state of EAR ie 1.ØE-8 to 9.ØE-3.
		EXAMPLE :- To Add Logic Errors at a rate of 1 in 1000 send :
		OUTPUT 707;"EAT LOGIC;EAD RATE; EAR 1.ØE-3"
ERROR ADD RATE (ESF_CRC ERRORS)	"CAR n"	Sets the Error Ratio for ESF_CRC errors. The Mantissa must be Ø. Is only valid when a DS1 signal with ESF Framing is being transmitted. The error rate set is the equivalent bit error rate, not the actual CRC error rate.
	n = 1.ØE-8 to 3.ØE-4	
	"CAR?"	Returns state of CAR ie 1.ØE-8 to 3.ØE-4.

Setting TX Parameters (ERROR ADD)

Function	Mnemonic Code	Description
ERROR ADD RATE DATAPORT	"DER n"	Only valid at DS0A <56kbits
	n = OFF or Ø	No Bytes Errored
	n = LOW or 1	2 in 5 Bytes Errored
	n = HIGH or 2	3 in 5 Bytes Errored
	"DER?"	Returns state of DER ie Ø to 2.
		EXAMPLE :- To Add Dataport Errors of 3 in 5 Bytes Errored send :
		OUTPUT 707;"EAT DATAPORT; DER HIGH"
APS ERROR RATE (DS1 & DS1C only)	"APR r1,r2,r3,r4"	The Mantissa must be Ø.
	r1 = 1.ØE-8 to 9.ØE-3	Sets Error Rate for *NO TRANSFER*
	r2 = 1.ØE-8 to 9.ØE-3	Sets Error Rate for *TRANSFER*
	r3 = 1.ØE-8 to 9.Øe-3	Sets Error Rate for *NO RESTORE*
	r4 = 1.ØE-8 to 9.Øe-3	Sets Error Rate for *RESTORE*
	"APR?"	Returns state of APR ie 'r1,r2,r3,r4'.
APS TEST MODE (DS1 & DS1C only)	"APM n"	
	n = START or 1	Rate always Ø errors
	n = NO_TRANSFER or 2	Rate defined by APR r1
	n = TRANSFER or 3	Rate defined by APR r2
	n = NO_RESTORE or 4	Rate defined by APR r3
	n = RESTORE or 5	Rate defined by APR r4
	"APM?"	Returns state of APM ie 1 to 5.
		EXAMPLE :- To Define typical Error Rates for DDS Automatic Protection Switches send :
		OUTPUT 707;"EAT APS;APR 3.ØE-7, 1.ØE-6, 3.ØE-7, 2.ØE-8"
		The individual rates can then be transmitted by use of the appropriate APM message.

Setting TX Parameters (ALARMS)

Function	Mnemonic Code	Description
ALARM TYPE DS1/DS1C	"ALT n"	
	n = OFF or Ø	No Alarms
	n = YELLOW or 1	Only valid when transmitting Framed DS1 with Select Level DS1.
	n = X_BIT or 2	Only valid when transmitting Framed DS1C.
	n = AIS or 3	Only valid when transmitting DS1 or DS1C with Select Level DS1.
	"ALT?"	Returns state of ALT ie Ø to 3.

Setting RX Parameters (INTERFACE LEVEL)

Function	Mnemonic Code	Description
INSTRUMENT MODE	"MOD n"	
	n = TX&RX or 1	Independent TX & RX mode
	n = THRU or 2	Through mode
	"MOD?"	Returns state of MOD ie 1 or 2.
DS0 CLOCK SOURCE (DS0/DS0A/DS0B)	"DCS n"	
	n = FRONT or 1	Connect DS0 Clock to Front Panel
	n = REAR or 2	Connect DS0 Clock to Rear Panel
	"DCS?"	Returns state of DCS ie 1 or 2.
INTERFACE LEVEL	"RIN n"	
	n = DS1C or 1	(See I1L,R1C,RCF,R1F)
	n = DS1 or 2	(See I1L,R1C,R1F)
	n = DS0B or 3	(See DCS,IBT,RØR)
	n = DS0A or 4	(See DCS,IAT,RØR)
	n = DS0 or 5	(See DCS,IØT)
	"RIN?"	Returns state of RIN ie 1 to 5.
		Selection of Interface Level should match Level at RX input. Selection of Interface Level also incurs further selections eg DS1C incurs selection of Input Level Range (I1L); Coding (R1C); DS1C Framing (RCF). Additionally if "RCF ON" is selected this incurs selection of Digroup Framing (R1F).
INPUT LEVEL RANGE (DS1/DS1C)	"I1L n"	
	n = AUTO or 1	Automatic
	n = DSX or 2	DS cross-connect
	n = DSX_MON or 3	DS cross-connect Monitor
	n = DS_LO or 4	DS Lo
	n = DS_LO_MON or 5	DS Lo Monitor
	n = BRIDGED or 6	Bridging Mode
	"I1L?"	Returns state of I1L ie 1 to 6.
DS1/DS1C CODING	"R1C n"	
	n = AMI or 1	Alternate Mark Inversion
	n = B8ZS or 2	Binary 8 Zeros Substitution
	"R1C?"	Returns state of R1C ie 1 or 2.
DS1C FRAMING	"RCF n"	Only valid if RX Interface Level is DS1C
	n = OFF or Ø	Unframed DS1C
	n = ON or 1	Framed DS1C(See R1F)
	"RCF?"	Returns state of RCF ie Ø or 1.

Setting RX Parameters (INTERFACE LEVEL)

Function	Mnemonic Code	Description
DS1/DS1C-DIGROUP FRAMING	"R1F n"	Only valid if RX Interface Level is DS1 or DS1C with Framing On.
	n = OFF or Ø	No Framing
	n = T1DM or 1	T1 Data Multiplexer
	n = SF or D4 or 2	Superframe
	n = FT or 3	Ft only
	n = ESF or FE or 4	Extended Superframe
	"R1F?"	Returns state of R1F ie Ø to 4.
		EXAMPLE :- The signal at the RX Input is a Framed DS1C from the DS Cross-connect (DSX) with B8ZS Coding. The Digroups have T1DM Framing :
		OUTPUT 707;"RIN DS1C;I1L DSX; R1C B8ZS;RCF ON;R1F T1DM"
DS0B TERMINATION	"IBT n"	
	n = TERMINATED or 1	Terminated
	n = MONITOR or 2	Monitor
	"IBT?"	Returns state of IBT ie 1 or 2.
DS0A TERMINATION	"IAT n"	
	n = TERMINATED or 1	Terminated
	n = MONITOR or 2	Monitor
	n = LOGIC_NEAR or 3	Logic Near(Tip)
	n = LOGIC_FAR or 4	Logic Far(Ring)
	"IAT?"	Returns state of IAT ie 1 to 4.
		If IAT and TAM (TX DS0A Interface Mode) are both set to Logic, then a change from NEAR to FAR or FAR to NEAR in either the TX or RX will cause the other to change automatically.
DS0 TERMINATION	"IØT n"	
	n = TERMINATED or 1	Terminated
	n = MONITOR or 2	Monitor
	"IØT?"	Returns state of IØT ie 1 or 2.
MULTIPLEXER RATE DS0A/DS0B	"RØR 1"	(2.4 kbits)
	"RØR 2"	(4.8 kbits)
	"RØR 3"	(9.6 kbits)
	"RØR 4"	(56 kbits)
	"RØR?"	Returns state of RØR ie 1 to 4.

Setting RX Parameters (MEASUREMENT SELECT)

Function	Mnemonic Code	Description
MEASUREMENT SELECT	"RMS n"	Only valid if the RX Interface Level (RIN) is DS1 or DS1C.
	n = OFF or Ø	Valid in THRU mode only
	n = DS1C or 1	DS1C only
	n = DIGROUP or 2	Framed DS1C only(See RDN)
	n = DS1 or 3	DS1 only
	n = DS0B or 4	(See RCU,RØR,RCR,RTS,RDC,RDN)
	n = DS0A or 5	(See RØR,RDC,DEC,RDN)
	n = PSDC or 6	SF & ESF Framing only(See RTS,RPI,RDN)
	n = DS0 or 7	Not T1DM Framing(See RTS,RDN)
	n = DATALINK or 8	ESF Framing only(See RDN)
	n = FS_CHAN or 9	Ft Framing only(See RDN)
	n = R_CHAN or 1Ø	T1DM Framing only(See RDN)
	"RMS?"	Returns state of RMS ie Ø to 1Ø.
		The Measurement Select must be equal to or less than the Interface Level eg if Interface Level is DS1 then Measurement Select of DS1C or Digroup are not allowed but all others are, providing Framing requirements are met. Selection of Measurement Select may incur further selections eg DS0A incurs selection of Data Rate (RØR); Timeslot Number (RTS); DDS Channel Type (RDC); Dataport Error Correction (DEC).
DIGROUP NUMBER	"RDN n"	Only valid if RX Interface Level is DS1C
	n = 1	Digroup 1
	n = 2	Digroup 2
	"RDN?"	Returns state of RDN ie 1or 2.
MULTIPLEXER RATE DS0A/DS0B	"RØR 1"	(2.4 kbits)
	"RØR 2"	(4.8 kbits)
	"RØR 3"	(9.6 kbits)
	"RØR 4"	(56 kbits)
	"RØR?"	Returns state of RØR ie 1 to 4.
TIMESLOT NUMBER	"RTS n"	Designates DS1 Timeslot from which DS0 Data is extracted. Is only valid if RMS is DS0B, DS0A, PSDC or DS0. If T1DM Framing is selected (ie "R1F 1") then selection of Timeslot 24 is not allowed.
	n = 1 to 24	
	"RTS?"	Returns state of RTS ie 1 to 24.

Setting RX Parameters (MEASUREMENT SELECT)

Function	Mnemonic Code	Description
CUSTOMER NUMBER DS0B	"RCU n"	n depends upon Data Rate set by RØR:- RØR = 2.4 kbits - n = 1 to 2Ø RØR = 4.8 kbits - n = 1 to 1Ø RØR = 9.6 kbits - n = 1 to 5 RØR = 56 kbits - n = 1
	"RCU?"	Returns state of RCU ie 1 to 2Ø.
CUSTOMER RATE DS0B	"RCR 1"	(2.4 kbits)
	"RCR 2"	(4.8 kbits)
	"RCR 3"	(9.6 kbits)
	"RCR?"	Returns state of RCR ie 1 to 3.
		RCR must be < or = to RØR. If RØR is 56 kbits then RCR is illegal.
DDS CHANNEL TYPE (DS0A/DS0B)	"RDC n"	Only valid if RX Interface Level or Measurement Select is DS0A or DS0B.
	n = PRIMARY or 1	DDS Primary Channel
	n = SECONDARY or 2	DDS Secondary Channel
	"RDC?"	Returns state of RDC ie 1 or 2.
DATAPORT ERROR CORRECTION	"DEC n"	Only valid at DS0A < 56kbits. Not valid if Framing is T1DM.
	n = OFF or Ø	No Error Correction
	n = ON or 1	Perform Error Correction
	"DEC?"	Returns state of DEC ie Ø or 1.
PATTERN INVERSION (PSDC ONLY)	"RPI n"	Only valid when RX Measurement Select is PSDC.
	n = OFF or Ø	Normal Pattern expected
	n = ON or 1	Inverted Pattern expected
	"RPI?"	Returns state of RPI ie Ø or 1.
		EXAMPLE :- The signal at the RX Input is a Framed DS1C from the DS Cross-connect with B8ZS Coding. The Digroups have T1DM Framing. Wish to test the Primary Channel of Customer #2 within a 9.6 DS0B. The DS0B is contained within Timeslot 20 of Digroup 2 : OUTPUT 707;"RIN DS1C;I1L DSX; R1C B8ZS;RCF ON;R1F T1DM; RMS DS0B;RDN 2;RTS 2Ø;RØR 3; RCU 2;RCR 1;RDC PRIMARY"

Setting RX Parameters (DATA TYPE)

Function	Mnemonic Code	Description
DATA TYPE	"RDT n"	
	n = PATTERN or 1	(See RCD)
	n = PROTOCOL or 2	RX Data is passed to Protocol Analyzer. Protocol is only valid for DDS Primary Channel <56 kbits; DDS Secondary Channel;Datalink; FS_Chan & R_Chan.
	"RDT?"	Returns state of RDT ie 1 or 2.
PATTERN TYPE	"RCD n"	
	n = PRBS_20 or 1	2Ø Stage PRBS(See RZL)
	n = ALL_ONES or 2	All Ones Word
	n = SETTABLE or 3	Settable Word(See RSW)
	n = PRBS_2047 or 4	2Ø47 Bit PRBS
	n = PRBS_511 or 5	511 Bit PRBS
	n = TRAFFIC or 6	RX Traffic
	n = CODES or 7	DDS Return Codes
	"RCD?"	Returns state of RCD ie 1 to 6. The Pattern Type available depends upon the Measurement Select and DDS Channel Type:- *PRBS_2Ø* - Only available at Digroup; DS1; DS1C *ALL_ONES* - Not available for DDS Secondary Channel *SETTABLE* - Not available at Datalink; R_Chan; FS_Chan; DDS Secondary Channel. *PRBS_2Ø47; PRBS_511* - NOT available at DS1; Digroup; DS1C *TRAFFIC* - Only available at Digroup; DS1; DS1C. *CODES* - Only available at DS0B and DS0A. DDS Primary Channel
14 ZERO LIMIT	"RZL n"	PRBS_20 only
	n = OFF or Ø	No 14 Zero Limit
	n = ON or 1	PRBS_20. 14 Zero limited
	"RZL?"	Returns state of RZL ie Ø or 1.
LOOPBACK DATA	"RLD n"	Only valid for DS0B and DS0A. DDS Primary Channel with PRBS_2047 or PRBS_511
	n = NO_LOOP or Ø	Data Only
	n = LOOP or 1	Data Alternated with Loopback Code
	"RLD?"	Returns state of RLD ie Ø or 1.

Setting RX Parameters **(DATA TYPE)**

Function	Mnemonic Code	Description
SETTABLE WORD	"RSW 'bbbbbbbb'"	The content of the 8 bit (b) Word depends upon the Interface Level or Measurement Select, selection :- DS1/DS1C "dddddddd" 64 kbits Clr. Chan. "dddddddd" 56 kbits DDS "ddddddd1" 56 kbits PSDC "ddddddds" DS0B <56 kbits "fdddddd1" DS0A <56 kbits "1dddddd1" d = Data bit Ø or 1 s = Signaling bit f = subrate Frame bit
	"RSW?"	Returns state of RSW ie "bbbbbbbb"

Setting RX Parameters (MEASUREMENT TYPE)

<table>
<tr><th>Function</th><th>Mnemonic Code</th><th>Description</th></tr>
<tr><td>MEASUREMENT SOURCE A</td><td>"MAS n"
n = SEC_CHAN or 1
n = CUST or 2
n = SUBRATE or 3
"MAS?"</td><td>Only valid if Data Rate is <56 kbits
Valid DS0B Secondary Channel only
Valid DS0B Primary Channel only
Valid DS0B only
Returns state of MAS ie 1 to 3.</td></tr>
<tr><td>MEASUREMENT TYPE A</td><td>"MTA n"
n = LOGIC or 1

n = BPV or CODE or 2
n =FRAMING or 3
n = ESF_CRC or 4

n = JITTER or 5

"MTA?"</td><td>
Only valid if RDT is PATTERN and RCD is not CODES or TRAFFIC.
Valid DS1C & DS1 only
Valid Framed DS1C, DS1, DS0B only.
Only valid DS1 or Digroup, with ESF Framing.
Only valid at DS1 with Jitter Option (See JFL,JFT)
Returns state of MTA ie 1 to 5.

Measurement Source & Type A are automatically selected by Measurement Select except in the case of DS0B. If DS0B is selected in conjunction with a Primary DDS Channel then a choice of Customer (Logic), all rates, or Subrate (Frame), rates < 56kbits, is necessary. If DS0B is selected in conjunction with a Secondary DDS Channel then a choice of Sec_Chan (Logic), all rates, or Subrate (Frame), rates < 56kbits, is necessary. Setting RDT to PROTOCOL or RCD to CODES makes all results invalid except Subrate Frame when DS0B is < 56kbits. The correlation between Measurement Select, Measurement Source A & Measurement Type A is :-
<table>
<tr><th>Meas Select</th><th>Meas Source A</th><th>Meas Type A</th></tr>
<tr><td>DS1C</td><td>DS1C</td><td>Frame
Code/BPV</td></tr>
<tr><td>Digroup</td><td>Digroup</td><td>Frame
Logic</td></tr>
<tr><td>DS1</td><td>DS1</td><td>Frame
Logic
Code/BPV
Jitter</td></tr>
</table></td></tr>
</table>

Setting RX Parameters (MEASUREMENT TYPE)

Function	Mnemonic Code	Description
		DS0B with (Primary Channel) — Customer Subrate — Logic Frame DS0B with (Sec. Chan) — Sec_Chan Subrate — Logic Frame DS0A with (Primary Channel) — DS0A — Logic DS0A with (Secondary Channel) — Sec_Chan — Logic PSDC — PSDC — Logic DS0 Clear Channel — Timeslot — Logic Datalink — Datalink — Logic Fs_Chan — Datalink — Logic R_Chan — R_Chan — Logic If Framing is ESF and Measurement Select is Digroup then Digroup Frame is replaced by Digroup CRC. If Framing is ESF and Measurement Select is DS1 then DS1 CRC is available in addition to DS1 Frame. When there is effectively no Measurement Select, due to choice of Interface Level. Measurement Source A is selected according to the Interface Level :- **Interface Level — Meas Source A — Meas Type** DS1C (Unframed) — DS1C — Logic Code/BPV DS1 (Unframed) — DS1 — Logic Code/BPV

Setting RX Parameters (MEASUREMENT TYPE)

Function	Mnemonic Code	Description
		At Interface Levels of DS0B, DS0A & DS0 Measurement Source A and Measurement Type A are the same as those specified under Measurement Select DS0B, DS0A and DS0.
MEASUREMENT SOURCE B	"MBS n"	
	n = OFF or Ø	No Measurement
	n = SEC_CHAN or 1	Only valid if DS0B Secondary Channel and RDT is PATTERN.
	n = CUST or 2	Only valid if DS0B Primary Channel and RDT is PATTERN.
	n = SUBRATE or 3	Only valid if DS0B Primary Channel < 56 kbits.
	n = TIMESLOT or 4	Only valid if PSDC or DS0 extracted from DS1 or DS1C.
	n = DS0 or 5	Only valid if DS0 Interface Level.
	n = DS0A or 6	Only valid for DS0A.
	n = PSDC or 7	Only valid if Framing is SF or ESF.
	n = DATALINK or 8	Only valid for Datalink & FS_Chan.
	n = DIGROUP or 9	Only valid for DS1C Interface Level.
	n = DS1 or 1Ø	Only valid for DS1.
	n = DS1C or 11	Only valid for DS1C
	n = R_CHAN or 12	Only valid if Framing is T1DM.
	"MBS?"	Returns state of MBS ie Ø to 12.
MEASUREMENT TYPE B	"MTB n"	
	n = LOGIC or 1	Not valid if RCD is CODES or TRAFFIC.
	n = BPV or CODE or 2	Valid DS1C, DS1 only
	n = FRAMING or 3	Valid Framed DS1C, DS1, DS0B only.
	n = ESF_CRC or 4	Only valid DS1, Digroup, with ESF Framing.
	n = JITTER or 5	Only valid at DS1 with Jitter Option (See JFL,JFT)
	"MTB?"	Returns state of MTB ie 1 to 5.
		Measurement Source B and Measurement Type B must be selected using the MBS and MTB messages. The Measurement Source and Type available are dependent on the Interface Level and Measurement Select. Measurement Source and Type B always allows the same Measurements as are available with Measurement Source and Type A. An additional list of Measurements are available due to the Interface Level selected :-

Setting RX Parameters (MEASUREMENT TYPE)

Function	Mnemonic Code	Description
		INTERFACE LEVEL DS1C **Meas Select** — **Meas B Availability** DS1C — As Measurement A Digroup — As Measurement A + DS1C Code/BPV, DS1C Frame DS0B, DS0A, PSDC, Clear Channel, Datalink, FS_Chan & R_Chan — As Measurement A + Digroup Frame, DS1C Frame, DS1C Code/BPV If Framing is ESF and Measurement Select is Digroup then Digroup CRC replaces Digroup Frame. If Framing is ESF and Measurement Select is DS0B, DS0A, PSDC, Clear Channel or Datalink then Digroup CRC & Digroup Frame are available. INTERFACE LEVEL DS1 **Meas Select** — **Meas B Availability** DS1 — As Measurement A DS0B, DS0A PSDC, Clear Channel, Datalink, FS_Chan & R_Chan — As Measurement A + DS1 Code/BPV, DS1 Frame, DS1 Jitter (OPT 001 only) If Framing is ESF then DS1 CRC is available when Measurement Select is DS1, DS0B, DS0A, PSDC, Clear Channel or Datalink. When there is effectively no Measurement Select ie DS1C Unframed, DS1 Unframed, DS0B Interface Level, DS0A Interface Level or DS0 Interface Level then Meas B availability is the same as for Meas A.

Setting RX Parameters (MEASUREMENT TYPE)

Function	Mnemonic Code	Description
JITTER FILTER (Option 001 Only)	"JFL n"	
	n = LP or 1	Low Pass
	n = LP_HP1 or 2	Low Pass & High Pass 1
	n = LP_HP2 or 3	Low Pass & High Pass 2
	"JFL?"	Returns state of JFL ie 1 to 3.
JITTER FILTER THRESHOLD (Option 001 Only)	"JFT n"	
	n = 0.05 to 10.00 UI	Resolution 0.01 UI.
	"JFT?"	Returns state of JFT ie 0.05 to 10.00 UI.
ANALYSIS SOURCE	"ANS n"	
	n = A or 1	Result A
	n = B or 2	Result B
	"ANS?"	Returns state of ANS ie 1 or 2. Analysis is only possible on one result during any Gating Period. If analysis of a second result is required a new Gating Period must be used. Analysis is not possible when only Jitter measurements are being performed.
ANALYSIS TYPE	"ATY n"	
	n = AVAIL or 1	% Availability
	n = UNAVAIL or 2	% Unavailability
	n = SEVERE_ES or 3	% Severe Error Seconds
	n = ERROR_SEC or 4	% Error Seconds
	n = MINUTES or 5	% Degraded Minutes
	"ATY?"	Returns state of ATY ie 1 to 5.
ALARM DURATION TYPE	"ADT n"	
	n = PATTERN or 1	Pattern Loss
	n = SUBR_FRAME or 2	Subrate Frame Loss
	n = DS1_FRAME or 3	DS1 Frame Loss
	n = DIGR_FRAME or 4	Digroup Frame Loss
	n = DS1C_FRAME or 5	DS1C Frame Loss
	n = AIS_SECS or 6	AIS Seconds
	n = INST_POWER or 7	Instrument Power Loss
	n = SIGNAL or 8	Signal Loss
	"ADT?"	Returns state of ADT ie 1 to 8 The Alarm Duration Type availability depends upon the selection of Interface Level and/or Measurement Select :- *INST_POWER* : Always available.

Setting RX Parameters (MEASUREMENT TYPE)

Function	Mnemonic Code	Description
		AIS_SECS : Available when Interface Level is DS1C or DS1. *DS1C_FRAME* : Framed DS1C *DS1_FRAME* : Framed DS1 *DIGR_FRAME* : Framed DS1C & Meas. Select other than DS1C *SUBR_FRAME* : Interface Level or Meas. Select, DS0B <56 kbits. *SIGNAL* : Signal Loss can be DS1C; DS1; DS0B; DS0A and is directly related to the Interface Level. *PATTERN* : Pattern Loss is available at all Interface Levels and all Measurement Select if the RX Data Type is Pattern and the RX Pattern Type is other than Traffic or DDS Codes.

Setting RX Parameters (GATING)

Function	Mnemonic Code	Description
GATING TYPE	"GTY n" n = MANUAL or 1 n = SINGLE or 2 n = REPEAT or 3 n= SHORT_1S or 4 n = SHORT_15S or 5 "GTY?"	 Manual Gating(See STR,STP) Single Interval(See GPR,STR) Repetitive Interval(See GPR,STR,STP) 1 Second Repeat(See STR,STP) 15 Second Repeat(See STR,STP) Returns state of GTY ie 1 to 5.
GATING PERIOD	"GPR d,h,m,s" d = Ø to 99 h = Ø to 23 m = Ø to 59 s = Ø to 59 "GPR?"	Sets the measurement Gating Period. d = Days, h = Hours, m = Minutes, s = Seconds. Returns state of GPR ie ′d,h,m,s′.
START GATING	"STR"	Clears all results and causes the instrument to start gating.
STOP GATING	"STP"	Causes the instrument to stop gating. The Results are updated. EXAMPLE :- To select and start Repetitive Gating of 1 Day, 23 Hours, 59 Minutes and 9 Second send : **OUTPUT 707;"GTY REPEAT; GPR Ø1,23,59,Ø9" OUTPUT 707;"STR"**

Setting RX Parameters (ALARM MASK/STATUS)

Function	Mnemonic Code	Description
ALARM MASK REGISTER 1	"AM1 n"	Not included in Saved Panel.
	n = NONE or Ø	No AM1 type Alarms
	n = PAT or 1	Pattern Sync Loss
	n = SL1 or 2	DS1/DS1C Signal Loss
	n = SLØ or 4	DS0A/DS0B Signal Loss
	n = CL1 or 8	DS1 External Clock Loss
	n = CLØ or 16	DS0 External Clock Loss
	n = FLC or 32	DS1C Frame Sync Loss
	n = MFA or 64	DS1 Multi-Frame Align Sync Loss
	n = FL1 or 128	DS1 Frame Sync Loss
	n = FLB or 256	DS0B Subframe Sync Loss
	n = AIS or 512	DS1 Alarm Indication Signal
	n = XBT or 1Ø24	X-Bit Alarm
	n = YAL or 2Ø48	Yellow Alarm
	n = ERR or 4Ø96	Errors/Hits
	"AM1?"	Returns the state of AM1 ie Ø to 8191.
ALARM MASK REGISTER 2	"AM2 n"	Not included in Saved Panel
	n = NONE or Ø	No AM2 type Alarms
	n = SLH or 1	DS1/DS1C Signal Level High
	n = SLL or 2	DS1/DS1C Signal Level Low
	n = SLI or 4	DS1/DS1C Signal Level Imbalance
	"AM2?"	Returns state of AM2 ie Ø to 7.
	If Multiple alarms are required the Message can be specified in 3 ways :- 1. A list of integers ie "AM1 1,8,64,512; AM2 4" 2. A list of mnemonics ie "AM1 PAT,CL1,MFA, AIS;AM2 SL1" 3. A single integer ie "AM1 585;AM2 4" (585 = 1+8+64+512)	NOTE :- All Front Panel Alarms are included in the Alarm Mask Registers. In addition the following "extra" Alarms are included :- Signal Loss (DS0), External Clock Loss (DS0), External Clock Loss (DS1), Multi-Frame Alignment Sync Loss (DS1), Signal Level High (DS1/DS1C), Signal Level Low (DS1/DS1C) and Signal Level Imbalance (DS1/DS1C). The Alarm Mask Registers are used to determine under what Alarm conditions the the instrument should issue an SRQ. To achieve an SRQ on Alarm :- 1. Set the Alarm Mask Registers to the required value (Ø to 8191 &/or Ø to 7). 2. Set Bit 9(AL1) &/or Bit 1Ø(AL2) in Status register A. (See Common Capabilities "STA" Message). The instrument will then issue an SRQ whenever Bit 1 (ALC Bit) in the Status Byte (Status Register B) is set.

Setting RX Parameters (ALARM MASK/STATUS)

Function	Mnemonic Code	Description
ALARM STATUS REGISTER 1 RESULT	"AL1?"	Returns the current status of Alarm Status Register 1 as an integer (Ø to 8191). Alarm Weighting is as follows :- *Ø* (No AM1 type Alarms) *1* (Pattern Sync Loss) *2* (DS1/DS1C Signal Loss) *4* (DS0A/DS0B Signal Loss) *8* (DS1 External Clock Loss) *16* (DS0 External Clock Loss) *32* (DS1C Frame Sync Loss) *64* (DS1 Multi-Frame Align Sync Loss) *128* (DS1 Frame Sync Loss) *256* (DS0B Subframe Sync Loss) *512* (DS1/DS1C AIS) *1Ø24* (X-Bit Alarm) *2Ø48* (Yellow Alarm) *4Ø96* (Errors/Hits) The value is updated every 100mS regardless of Gating.
ALARM STATUS REGISTER 2 RESULT	"AL2?"	Returns the current status of Alarm Status Register 2 as an integer (Ø to 7). Alarm Weighting is as follows :- *Ø* (No AM2 type Alarms) *1* (DS1/DS1C Signal Level High) *2* (DS1/DS1C Signal Level Low) *4* (DS1/DS1C Signal Level Imbalance) The value is updated every Second regardless of Gating.

Setting RX Parameters **(OUTPUT RESULTS)**

Function	Mnemonic Code	Description
RESULT A	"RSA? n" n = COUNT or 1 n = RATIO or 2 n = SYNC_ES or 3 n = ASYNC_ES or 4 n = ASYNC_EFS or 5 n = PER_EFS or 6	Not valid for Jitter results(See RJA?) Error Count Error Ratio Synchronous Error Secs Asynchronous Error Secs Asynchronous Error Free Secs % Error Free Seconds Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
JITTER RESULT A (Option ØØ1 Only)	"RJA? n" n = HIT_COUNT or 1 n = HB_COUNT or 2 n = HB_RATIO or 3 n= HIT_SECS or 4 n = HITF_SECS or 5 n = PK_TO_PK or 6	Only valid for Jitter results. Jitter Hit_Count Jitter Hit Bit Count Jitter Ratio Hit/Bit Jitter Hit Seconds Jitter Hit Free Seconds Peak to Peak Jitter Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
RESULT B	"RSB? n" n = COUNT or 1 n = RATIO or 2 n = SYNC_ES or 3 n = ASYNC_ES or 4 n = ASYNC_EFS or 5 n = PER_EFS or 6	Not valid for Jitter results(See RJB?) Error Count Error Ratio Synchronous Error Secs Asynchronous Error Secs Asynchronous Error Free Secs % Error Free Secs Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
JITTER RESULT B (Option ØØ1 Only)	"RJB? n" n = HIT_COUNT or 1 n = HB_COUNT or 2 n = HB_RATIO or 3 n = HIT_SECS or 4 n = HITF_SECS or 5 n = PK_TO_PK or 6	Only valid for Jitter results Jitter Hit Count Jitter Hit Bit Count Jitter Ratio Hit/Bit Jitter Hit Seconds Jitter Hit Free Seconds Peak to Peak Jitter Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).

Setting RX Parameters (OUTPUT RESULTS)

Function	Mnemonic Code	Description
ANALYSIS RESULT	"ANR? n"	Message is invalid if both Measurement Types (MTA & MTB) are JITTER.
	n = AVAIL or 1	% Availability
	n = UNAVAIL or 2	% Unavailability
	n = SEVERE_ES or 3	% Severe Error Secs
	n = ERROR_SEC or 4	% Error Secs
	n = MINUTES or 5	% Degraded Minutes
		Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
ALARM DURATION RESULT	"ALD? n"	
	n = PATTERN or 1	Pattern Loss
	n = SUBR_FRAME or 2	Subrate Frame Loss
	n = DS1_FRAME or 3	DS1 Frame Loss
	n = DIGR_FRAME or 4	Digroup Frame Loss
	n =DS1C_FRAME or 5	DS1C Frame Loss
	n = AIS_SECS or 6	AIS Seconds
	n = INST_POWER or 7	Instrument Power Loss
	n = SIGNAL or 8	Signal Loss
		Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
INPUT VOLTAGE RESULT (DS1/DS1C)	"RXL? n"	
	n = POSITIVE or 1	Peak +ve Voltage
	n = NEGATIVE or 2	Peak -ve Voltage
		Returns Result in the form :- Validity Flag, sn.nnnnnnEsnn (s = sign, n = number and E = Exponent). Only valid if RX Interface is DS1 or DS1C. Result is Voltage measured during the last second. Flag is always 1 (Valid).
MONITOR WORD RESULT	"MON?"	Message is valid for DDS Primary Channel, DDS Secondary Channel DS0 Clear Channel and PSDC. Returns the 8 bit Monitor Word as 8 characters enclosed in double quotes, preceded by a Validity Flag. ie Flag, "nnnnnnnn". n = Ø or 1. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).

Setting RX Parameters (OUTPUT RESULTS)

Function	Mnemonic Code	Description
SIGNALING BITS RESULT	"SGR?"	Is only valid when Measurement selection is 56 kbits PSDC or 4 kbits Datalink and DS1/Digroup Framing is SF or ESF. If Framing is SF, 2 Signaling Bits with 2 trailing spaces("xx ") are returned. If Framing is ESF, 4 Signalling Bits ("xxyy") are returned. Returns Result in the form :- Validity Flag, "xxyy". x = Ø or 1, y = Ø or 1. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
ELAPSED TIME RESULT	"ELP?"	Returns the Elapsed Time since the start of Measurement period. Returns Result in the form :- Validity Flag, Days, Hours, Minutes, Seconds. Days = Ø to 99, Hours = Ø to 23, Minutes = Ø to 59 and Seconds = Ø to 59. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
MJU BRANCH SELECT CODE RESULT	"BSC?"	Only valid if TX DDS Link Type (DLT) is MULTI Returns the MJU Branch Select Code, which is a confirmation from an MJU following a Route Message (See TX Parameters (DDS LINK TYPE), where the MJU indicates which Branch has been selected. Returns Result in the form :- Validity Flag, n. n = 1 to 4. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
MJU HUB-ID RESULT	"HUB? n" n = PRESENT or 1 n = PREVIOUS or 2	Only valid if TX DDS Link Type (DLT) is MULTI. Returns ID number of the present HUB Returns ID number of the previous HUB Returns Result in the form :- Validity Flag, nn. nn = ØØ to 77(Octal). Flag = Ø (Result Invalid). Flag = 1 (Result Valid).
LATCHING LOOPBACK MAPCODE RESULT	"MAP?"	Only valid for DS0DP, OCU, CSU and HL222. DDS Latched Loopbacks (See LBT). Reads the MAPCODE (Identity) of equipment that has been looped using a DDS Loopback. Returns Result in the form :- Validity Flag, n. n = Ø or 1. Flag = Ø (Result Invalid). Flag = 1 (Result Valid).

Miscellaneous Parameters **(DATA LOGGING)**

Function	Mnemonic Code	Description
LOGGING ON/OFF	"LOG n"	
	n = OFF or Ø	(See LOD)
	n = ON or 1	(See LDV,LEG,LEC,LET,LDG,LDT)
	"LOG ?"	Returns state of LOG ie Ø or 1.
LOGGING DEVICE	"LDV n"	
	n = HP 3787B or 1	Internal Printer
	n = HP-IB or 2	External Printer. Only via RS-232-C. Not allowed via HP-IB as HP 3787B would need to be in Talk Only.
	"LDV?"	Returns state of LDV ie 1 or 2.
LOG AT END OF GATING	"LEG n"	
	n = OFF or Ø	No Summary at end of Gating period
	n = ALWAYS or 1	Summary at end of every Gating period(See LEC)
	n = RATIO or 2	Summary at end of Gating when Error/Hit Ratio exceeds threshold(See LEC,LET)
	"LEG?"	Returns state of LEG ie Ø to 2.
CONTENTS OF END OF GATING SUMMARY	"LEC x,y,z"	
	x = OFF or Ø	No Measurement Results
	x = SELECTED or 1	Only those Measurement Results selected on the RX Page
	x = ALL or 2	All Measurement Results
	y = OFF or Ø	No Analysis Results
	y = SELECTED or 1	Only those Analysis Results selected on the RX Page
	y = ALL or 2	All Analysis Results
	z = OFF or Ø	No Alarm Duration Results
	z = SELECTED or 1	Only those Alarm Duration Results selected on the RX Page
	z = ALL or 2	All Alarm Duration Results
	"LEC?"	Returns state of LEC ie ´x,y,z´.
ERROR RATIO THRESHOLD FOR END OF GATING SUMMARY	"LET n"	n = 2 to 7 representing an Error Ratio of 1.ØE-2 to 1.ØE-7.
	"LET?"	Returns the state of LET ie 2 to 7.

Miscellaneous Parameters (DATA LOGGING)

Function	Mnemonic Code	Description
		EXAMPLE :- To obtain a summary of Selected Measurement Results and All Alarm Duration results on the Internal Printer at the end of each Gating period when the Error Rate exceeds 1 in 10 million send : **OUTPUT 707;"LOG ON;LDV HP 3787B; LEG RATIO;LET 7; LEC 1,Ø,2"**
LOG DURING GATING	"LDG n" n = OFF or Ø n = ERR_SEC or HIT_SEC or 1 n = RATIO or 2 "LDG?"	No Logging during Gating When an Error Second or a Hit Second (Opt 001 only) occurs. When the Error Ratio or Hit Ratio (Opt 001 only) exceeds threshold.(See LDT) Returns state of LDG ie Ø to 2. Note :-It is possible to have Logging During Gating and Logging at End of Gating both selected.
ERROR RATIO THRESHOLD FOR LOGGING DURING GATING	"LDT n" "LDT?"	n = 2 to 7 representing an Error Ratio of 1.ØE-2 to 1.ØE-7. Returns state of LDT ie 2 to 7.
LOG ON DEMAND	"LOD"	This message mimics the "PRINT" key in Local Mode and will cause the currently selected set of results to be Logged on the Internal Printer even if LOGGING is disabled (LOG OFF). One of the following will be logged :- Measurement Results, Analysis Results, Alarm Duration Results, Monitor Word Result or Input Voltage Result. LOD provides the only remote method of Logging the Monitor Word and Input Voltage Results.

Miscellaneous Parameters (STORED PANELS & BEEPER)

Function	Mnemonic Code	Description
SAVE PANEL	"SAV n" n = 1 to 9	Corresponds to non volatile Memory locations. The current instrument settings are stored in the designated Memory location. This is only possible if Write Protection is OFF ie "PRP Ø". The state of Request Service (RQS), Alarm Mask Registers 1 & 2 (AM1,AM2) and User Defined Pattern (TRP) are not Saved by this Message, nor recalled by the Recall Panel Message (RCL).
PROTECT PANEL	"PRP n" n = OFF or Ø n = ON or 1 "PRP ?"	 Write Protection Off. SAV valid Write Protection On. SAV invalid Returns state of PRP ie Ø or 1.
RECALL PANEL	"RCL n" n = Ø to 9	Corresponds to non volatile Memory locations. Location Ø holds the instrument DEFAULT settings and cannot be used when saving settings. The instrument settings stored in the designated Memory location are recalled and the instrument configured according to those settings.
AUDIO CONTROL	"AUD n" n = OFF or Ø n = ON or 1 "AUD ?"	 Only sounds on User Error Sounds on User & Bit Errors, & Alarm Returns state of AUD ie Ø or 1.

Miscellaneous Parameters (DISPLAYS SELECT)

Function	Mnemonic Code	Description
TX/RX DISPLAY	"TRS n" n = TX or 1 n = RX or 2 "TRS ?"	Display TX Parameters Display RX Parameters Returns state of TRS ie 1 or 2. NOTE :- This Message does not change the programmed measurement. This Function is still available via Front Panel Keys when the HP 3787B is under Remote Control.
MEASUREMENT DISPLAY	"MDS n" n = RESULTS or 1 n = ALARMS or 2 n = BIT_MON or 3 n = INP_LEV or 4 n = ANALYSIS or 5 "MDS?"	Display Measurement Results Display Alarm Durations Display Monitor Word Display Input Voltage Display Analysis Results Returns state of MDS ie 1 to 5. NOTE :- This Message does not change the programmed measurement. This Function is still available via Front Panel Keys when the HP 3787B is under Remote Control. Results & Analysis are not valid when receiving :- Framed DS1C with Framed Digroups DDS Secondary Channel + RDT Protocol 56 kbits DS0B with DDS Codes Bit_Mon is only valid for DDS Secondary Channel, Meas. Select DS0 or PSDC

Common Capability Messages

Function	Mnemonic Code	Description
CLEAR	"CLR"	Clears all instrument errors and flushes all buffers without changing the programmed measurement :- All Buffers Flushed Stops Asserting SRQ Sets "RQS 32"(ERR) Clears Error Register Clears Status Registers A & B. (If the HP 3787B is Gating, GIP Bit 12, of Status Register A is not affected) Sets ready Register to 1
CONFIGURATION	"CON?" "CON ";Block$	Reads the instrument settings in Block format (IEEE Standard 728 #H). The settings can then be stored in the controller. At a later date the instrument can be returned to those settings, using "CON ";Block$ EXAMPLE :- To Store Settings **DIM Block$[2000]** **OUTPUT 707;"CON?"** **ENTER 707;Block$** To return to Stored Settings **OUTPUT 707;"CON";Block$**
ERROR CODE	"ERR?"	Reads the instruments Error Register, which contains an integer in the range -32,768 to 32,767. (See Appendix D for list of Error Codes). The Error Register is cleared by ERR?, RST, CLR, Device Clear and Selective Device Clear.
IDENTIFICATION	"ID?"	Returns "HP 3787B"

Common Capability Messages

Function	Mnemonic Code	Description
KEY QUERY	"KEY?"	Returns an integer in the range 1 to 12 which represents the last Front Panel Key pressed. If no Key has been pressed since the last time the Message was issued Ø is returned. *Ø* = NO KEY PRESSED *1* = PAGE/INDEX *2* = EXECUTE *3* = UP CURSOR *4* = SINGLE ERROR *5* = PRINT *6* = PAPER *7* = LEFT CURSOR *8* = RIGHT CURSOR *9* = START/STOP *1Ø* = DOWN CURSOR *11* = PREVIOUS/DECR *12* = NEXT/INCR
LOCAL	"LCL"	RS-232-C only. Clears Local Lockout and returns HP 3787B to Local Control.
OPTION QUERY	"OPT?"	Returns Ø or 1 to indicate presence/absence of Jitter Option. *Ø* = No Jitter Option *1* = Jitter Option Fitted
READY CODE	"RDY?"	Returns the status of the READY REGISTER which is weighted as follows :- *1* RAC (Ready to Accept new Command) *2* OST (Not used in the HP 3787B) *4* AOC (All Operations Complete) *NOTE :- AOC is always Ø as the HP 3787B is only capable of executing one Command at a time.* *8* DRO (Data Ready for Output) The Ready Register is set to 1 by RDY?, CLR, RST, Device Clear and Selective Device Clear.
REVISION DATE	"REV?"	Returns the Firmware Revision Date and the latest applicable Codes and Format Date in the form "yyww,yyww". yy represents the YEAR from 196Ø and ww represents the WEEK (range 1 to 52).*ie 2721 means 1987 Week 21*

Common Capability Messages

Function	Mnemonic Code	Description
REQUEST SERVICE	"RQS n"	Not included in Saved Panel.
	n = NONE or Ø	No SRQ
	n = RQC or 1	Not used, always Ø
	n = PWR or 2	Not used, always Ø
	n = FPS or 4	Front Panel Key has been pressed
	n = LCL or 8	Power has Cycled
	n = RDY or 16	Data Ready for Output
	n = ERR or 32	Error has occurred
	n = RQS or 64	SRQ generated
	n = MSG or 128	Not used, always Ø
	n = EOG or 256	End Of Gating
	n = AL1 or 512	Alarm Change, Alarm Register 1
	n = AL2 or 1Ø24	Alarm Change, Alarm Register 2
	n = LOG or 2Ø48	Data Logging has occurred
	n = GIP or 4Ø96	Gating in Progress
	n = OFF	Disables all reasons for SRQ but remembers stored Mask.
	n = ON	Enables reasons for SRQ as determined by the Mask setting. If "RQS ON" is not preceded by "RQS OFF" will default to "RQS ERR"(32).
	"RQS?"	Returns state of RQS ie Ø to 8191.
	If multiple reasons for SRQ are required the Message can be specified in 3 ways :- 1. A list of integers ie "RQS 32,256,512,1Ø24" 2. A list of mnemonics ie "RQS ERR,EOG, AL1,AL2" 3. A single integer ie "RQS 1824" (1824 = 32+ 256+512+1Ø24)	The Service Request Mask (RQS) is used to determine the reason or reasons for issuing a SRQ. The SRQ Mask Bit Map is identical to Status Register A Bit Map (See Status Reporting, Table 6-3). The Mask is set to 32 (ERR) by CLR, RST, Device Clear and Selective Device Clear.
REMOTE	"RMT"	RS-232-C only. Sets the instrument to Remote with Local Lockout.

Common Capability Messages

Function	Mnemonic Code	Description
RESET	"RST"	Sets the instrument to the Default conditions (See Appendix E) :- Clears all results Stops Gating Stops asserting SRQ Flushes all Buffers Sets RQS to 32 (ERR) Clears Error Register Clears Status Registers A & B Clears Alarm Status Registers 1 & 2 Sets Ready Register to 1 Sets Key Register to Ø
STATUS REGISTER A	"STA?"	Returns an integer in the range Ø to 8191 representing the contents of Status Register A. For weighting See RQS. Register is cleared by RST.
STATUS REGISTER B	"STB?"	Returns an integer in the range Ø to 255 representing the contents of Status Register B ie the STATUS BYTE. Weighting is as follows :- *1* (End Of Gating) *2* (Alarm Change) *4* (Front Panel Key has been pressed) *8* (Power has Cycled) *16* (Data Ready for Output) *32* (Error has occurred) *64* (SRQ generated) *128* (Data Logging has occurred) The Register is cleared by CLR, RST, Device Clear and Selective Device Clear.

Common Capability Messages

Function	Mnemonic Code	Description
USER CONFIDENCE TESTS	"TST n"	
	n = CTRL_ROM or 2	Control CPU ROM CRC
	n = CTRL_RAM or 3	Control CPU RAM
	n = CRT_CTRL or 9	CRT Controller
	n = RTC or 11	Real-Time Clock
	n = PGA or 13	Pattern Gate Array
	n = DS1 or 14	DS1 Gate Array
	n = DS1C or 15	DS1C Gate Array
	n = DS0_CPU or 16	DS0/CTRL CPU Comms
	n = DS0_ROM or 17	DS0 CPU EPROM
	n = DS0_RAM or 18	DS0 CPU RAM
	n = DS1_IF or 19	DS1/1C Loopback
	n = DS0_IF or 20	DS0 Loopback
	n = PA or 21	Protocol Analyzer PLLS
	n = PRINTER or 24	UPI Printer
	n = JITTR or 25	Jitter Option
	n = LEVEL or 26	Level Detector
	n = DO_EXIT or 28	End Tests (Warmstart)
		The instrument performs the User Confidence test specified. The error register should then be read. A response of 0 to "ERR?" signifies a PASS. A response of 100 to "ERR?" signifies a failure.
		After "TST n" Message "TST DO_EXIT" must be issued to return the HP 3787B to normal operation. "TST DO_EXIT" causes a full Warmstart of the HP 3787B which takes 2 to 3 seconds. At the end of this period the HP 3787B returns to the LOCAL state.

Status Reporting

The HP 3787B contains 6 Registers which can be interrogated. Status Registers A & B; Alarm Registers 1 & 2; Ready Register and Error Register.

To determine the current status of the HP 3787B you must interrogate the Primary Status Byte register (Status Register B). Three methods of of interrogation are available via the HP-IB, but only one method is available via the RS-232-C. Table 6-1 lists the three methods and their availability according to the remote interface selected :-

Table 6-1. Status Reporting

Methods Of Interrogation	HP-IB Interface	RS-232-C Interface
Poll using STB? (Common Capability Message)	YES	YES
Repeated Serial Poll (SPOLL)	YES	NO
Poll using a Service Request Interrupt routine.	YES	NO

Service Request Interrupt Routine

- Select the condition(s), under which you require the HP 3787B to Request Service by using the Common Capability Message RQS.
- Specify the action to be taken when the HP 3787B issues an Interrupt by using the controller dependent ENABLE INTR and ON INTR (Basic) statements.
- Acquire the Primary Status Byte using the SPOLL (Basic) statement.

NOTE

An example of a Service Request Interrupt routine occurs in the DS1 Loopback Application Program. (Lines 100, 320 and 2090 to 2140)

Poll Using STB?

- Select the condition(s), under which you require the HP 3787B to Request Service by using the RQS message.
- Enter a Waiting loop and acquire the Primary Status Byte using the STB? message.

Primary Status Byte

The Primary Status Byte returned in response to a serial poll or STB? is the contents of Status Register B :-

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
LOG	RQS	ERR	RDY	LCL	FPS	ALC	EOG

Table 6-2. Primary Status Byte

Bit	Decimal Value	Description
7	128	Logging has occurred :- This Bit is set when Data Logging occurs. Cleared by Device Clear, Selective Device Clear, RST, CLR and any Message that causes Results to be output
6	64	ReQuest Service :- This Bit is set if an SRQ is generated for any reason. Cleared by Device Clear, Selective Device Clear, SPOLL, RST, CLR and STB?.
5	32	Error has occurred :- This Bit is set when an Error occurs. Cleared by Device Clear, Selective Device Clear, RST, CLR and ERR?.
4	16	Ready :- This Bit is set when a Program Message causes the HP 3787B to output Data and is cleared when the HP 3787B has finished outputting Data.
3	8	Local :- This Bit is set when the Power has cycled. Cleared by Device Clear, Selective Device Clear, RST, CLR, STB? and STA?.
2	4	Front Panel Service :- This Bit is set when a front panel Key is pressed. Cleared by Device Clear, Selective Device Clear, RST, CLR and KEY?.
1	2	Alarm Change :- This Bit is set when an Alarm, which has been specified using an AM1/AM2 Program Message, (Alarm Mask Status) causes AL1 or AL2 in Status Register A to be set. Cleared by Device Clear, Selective Device Clear, RST, CLR and AL1? or AL2?.
0	1	End Of Gating :- This Bit is set when the HP 3787B reaches the end of its gating period, irrespective of the type of gating. Cleared by Device Clear, Selective Device Clear, RST, CLR, STR and any Message that causes Results to be output.

Request Service Mask

The HP 3787B has the capability to request service on the occurrence of any of the events recorded by Status Register A. The setting of the RQS Mask determines the events which will cause an interrupt. The RQS Mask, whose Bit map is identical to Status Register A Bit map, is set using the RQS Message :-

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
0	0	0	GIP	LOG	AL2	AL1	EOG

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	RQS	ERR	RDY	LCL	FPS	0	0

Table 6-3. Request Service Mask

Bit	Decimal Value	Description
12	4096	Gating In Progress :- This Bit indicates the current state of the Gating. Is set when Gating starts (Delay of 100 to 200mS before this bit is set) Cleared when Gating ends or by RST.
11	2048	Logging has occurred :- This Bit is set when Data Logging occurs. Cleared by Device Clear, Selective Device Clear, RST, CLR and any Message that causes Results to be output.
10	1024	ALarm change 2 :- This Bit is set when any Bit in Alarm Status Register 2 changes state, providing the appropriate mask bit is set in Alarm Mask Register 2. Cleared by Device Clear, Selective Device Clear, RST, CLR and AL2?
9	512	ALarm change 1 :- This Bit is set when any bit in Alarm Status Register 1 changes state, providing the appropriate mask bit is set in Alarm Mask Register 1. Cleared by Device Clear, Selective Device Clear, RST, CLR and AL1?.
8	256	End Of Gating :- This Bit is set when the HP 3787B reaches the end of its gating period, irrespective of the type of gating. Cleared by Device Clear, Selective Device Clear, RST, CLR, STR and any Message that causes results to be output. Maximum 100mS delay before this bit is set.

Table 6-3. Request Service Mask (continued)

7	128	Not Used.
6	64	ReQuest Service :- This Bit is set if an SRQ is generated for any reason. Cleared by Device Clear, Selective Device Clear, SPOLL, RST, CLR and STB?.
5	32	Error :- This Bit is set when an error occurs. Cleared by Device Clear, Selective Device Clear, RST, CLR and ERR?.
4	16	Ready :- This bit is set when a Message causes the HP 3787B to output Data and is cleared when the HP 3787B has finished outputting Data. (Is a direct reflection of the DRO bit of the Ready Register).
3	8	Local :- This Bit is set when the Power has cycled. Cleared by Device Clear, Selective Device Clear, RST, STA?, STB? and CLR.
2	4	Front Panel Service :- This Bit is set when a front panel Key is pressed. Cleared by Device Clear, Selective Device Clear, RST, CLR and KEY?.
1	2	Not Used.
0	1	Not Used.

Alarm Registers

The HP 3787B has the capability to capture all events in the Alarm Status Registers and issue a Service Request. In order to issue an SRQ the Alarm Mask Register(s) must be set using the AM1 and/or AM2 Messages. In addition the, RQS Mask must be set to enable bit 9 (AL1) and/or bit 10 (AL2). The HP 3787B will then issue an SRQ when any Alarm specified by AM1 and/or AM2 changes state. Alarm Status Registers are not Latched ie they contain instantaneous values . Alarm Status Register 1 is updated every 100mS and Alarm Status Register 2 is updated every second. The Bit maps of the Mask and Status Registers are identical :-

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8
0	0	0	ERR	YAL	XBT	AIS	FLB

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
FL1	MFA	FLC	CL0	CL1	SL0	SL1	PAT

Table 6-4. Alarm Status Register 1

Bit	Decimal Value	Description
12	4096	Error :- Set when an Error/Hit has occurred.
11	2048	Yellow ALarm :- Set when Yellow Alarm has occurred.
10	1024	X-Bit :- Set when X-bit Alarm has occurred.
9	512	AIS :- Set when AIS Alarm has occurred.
8	256	Frame Loss B :- Set when DS0B Subframe Sync Loss has occurred.
7	128	Frame Loss 1 :- Set when DS1 Frame Sync Loss has occurred.
6	64	MultiFrame Alignment :- Set when DS1 Multiframe Alignment Sync Loss has occurred.
5	32	Frame Loss C :- Set when DS1C Frame Sync Loss has occurred.
4	16	Clock Loss Ø :- Set when DS0 External Clock Loss has occurred.
3	8	Clock Loss 1 :- Set when DS1 External Clock Loss has occurred.
2	4	Signal Loss Ø :- Set when DS0A/DS0B Signal Loss has occurred.
1	2	Signal Loss 1 :- Set when DS1 or DS1C Signal Loss has occurred.
0	1	Pattern :- Set when Pattern Sync Loss has occurred.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	SLI	SLL	SLH

Table 6-5. Alarm Status Register 2

Bit	Decimal Value	Description
2	4	Signal Level Imbalance :- Set when Signal Level is imbalanced.
1	2	Signal Level Low :- Set when Signal Level is low.
0	1	Signal Level High :- Set when Signal Level is high.

Additional Registers

The READY and ERROR Registers are also available for interrogation in the HP 3787B.

Ready Register

The Ready Register indicates the readiness of the HP 3787B to accept or output Data and can be interrogated by using RDY?. By setting the RQS Mask bit 4 the HP 3787B will issue an SRQ when bit 3 of the Ready Register is set ie Data Ready for Output.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	DRO	0	0	RAC

Table 6-6. Ready Register

Bit	Decimal Value	Description
3	8	Data Ready for Output :- This Bit is set when a Message causes the HP 3787B to output Data and is cleared when the HP 3787B has finished outputting Data.
0	1	Ready to Accept new Command :- This Bit is set when the Parser has completed Parsing a Message and passed it on to the Executor. Cleared on the receipt of the next Message.

Error Register

The Error Register contains a 16 Bit signed Integer which signifies the Error Number corresponding to the first Error to occur since the register was last cleared. The Error Register can be interrogated using the ERR? Message. The register is cleared by Universal Device Clear, Selective Device Clear, RST, CLR and ERR?. Details of all Error Numbers are given in Appendix D of this Manual.

Demonstration Programs

The following Programs demonstrate some measurement applications of the HP 3787B.

- DS1 Fixed Loopback
- Alternating OCU Loopback
- Dataport DS1 to DS0

DS1 Fixed Loopback

This Program configures the HP 3787B to the DS1 Fixed Loopback condition and Actuates the Loopback. The Loopback is verified by checking that Pattern Loss Alarm clears (ie Pattern Sync) within 20 Seconds of the Loopback code being transmitted.
Three Logic Error Counts are made over a Gating Period of 15 Minutes each. According to the results obtained the following actions are taken :-

All 3 Counts < 21	Line PASS
All 3 Counts > 20	Line FAIL
1 Count > 20	See RE_RUN
2 Counts > 20	See REPEAT

RE_RUN : If 1 of 3 Counts is > 20 makes one more Logic Error Count over a 15 Minute Gating Period. According to the result obtained the following actions are taken :-

Count < 21	Line PASS
Count > 20	See REPEAT

REPEAT : If 2 of 3 Counts are > 20 *or* 1 of 3 Counts and RE_RUN are > 20 then the Loopback is released. The HP 3787B is configured to the DS1 Fixed Loopback condition and the Loopback Actuated. The Loopback is verified as before and 3 Logic Error Counts are made over a Gating Period of 15 Minutes each. According to the results obtained the following actions are taken :-

All 3 Counts < 20	Line PASS
Any 1 or more Counts > 21	Line FAIL

NOTE

The DS1_lb_set_up subroutine used in this Program envisaged SF Framing, AMI Coding, the PRBS with a 14 Zero limit and the DS1 Clock being provided by the HP 3787B.

```
10    OPTION BASE 1
20    !
30    CLEAR 7
40    PRINTER IS 1                !ASSIGNS DISPLAY AS PRINTER
50    End_of_gating=0
60    D_dts=707
70    DIM Results(3)
80    DIM Pass(3)
90    REMOTE 7
100   ENABLE INTR 7;2
110   ON INTR 7 GOSUB Check_status !DETECT OCCURRENCE OF INTERRUPT
120   GOSUB Ds1_lb_set_up         !THIS SUBROUTINE WILL VARY DEPENDENT ON
130                               !THE USERS EQUIPMENT
140   Time=TIMEDATE
150   GOSUB Start_check           !CHECK LOOPBACK SUCCESS
160   PRINT "PATTERN SYNC HAS BEEN GAINED WHICH SUGGESTS THE LOOPBACK IS GOOD."
170   PRINT "THE PROGRAM CONTINUES AND MAKES ERROR COUNTS OVER"
180   PRINT "THREE 15 MINUTE GATING PERIODS"
190   PRINT " "
200   FOR L=1 TO 3
210   GOSUB Start_meas            !START MEASUREMENT
220   GOSUB Waiting               !WAIT FOR END OF GATING
230   GOSUB Results               !TAKE RESULTS
240   NEXT L
250   GOSUB Value_res             !CONVERT EACH RESULT TO PASS/FAIL
260   GOSUB Evaluate_res          !EVALUATE PASS/FAIL
270   GOSUB Print_res             !PRINT RESULTS
280   GOTO Fini                   !PROGRAM END
290   STOP
300   !-------------------------------------------------------------------------
310   !-------------------------------------------------------------------------
320 Ds1_lb_set_up:  !
330               OUTPUT D_dts;"RQS EOG,ERR"    ! INTERRUPT ON "END OF GATING"
340                                             !AND "ERROR"
350               OUTPUT D_dts;"RIN DS1;I1L AUTO;R1C AMI;R1F SF;RMS DS1"
360               OUTPUT D_dts;"RDT PATTERN;RCD PRBS_20;RZL ON;MTA LOGIC"
370               OUTPUT D_dts;"MOD TX&RX;TIN DS1;TCL INTERNAL;TCD AMI;T1F SF"
380               OUTPUT D_dts;"TSL DS1;LBT DS1;ALT OFF;TDT PATTERN;EAT OFF"
390               OUTPUT D_dts;"ALB"        !ACTUATE LOOPBACK
400   RETURN
410   !-------------------------------------------------------------------------
420   !-------------------------------------------------------------------------
430 Start_check:    !
440               IF TIMEDATE>Time+20 THEN
450                 PRINT "PATTERN LOSS 20 SECONDS AFTER END OF LOOPBACK CODE"
460                 PRINT "SUSPECT LOOPBACK UNSUCCESSFULL"
470                 PRINT " "
480                 GOTO Fini
490               END IF
500               OUTPUT D_dts;"AL1?"       !INTEROGATE ALARM MASK
510               ENTER D_dts;F             !FOR PATTERN SYNC
520               IF BIT(F,0) THEN
```

```
530                 GOTO Start_check
540                 ELSE
550                                           !SET SINGLE GATING 15 MINUTES
560                 OUTPUT D_dts;"GTY SINGLE;GPR00,00,15,00"
570               END IF
580               RETURN
590 !---------------------------------------------------------------------------
600 !---------------------------------------------------------------------------
610 Waiting:      !
620               IF End_of_gating=0 THEN
630                 GOTO Waiting
640                 ELSE
650               END IF
660               RETURN
670 !---------------------------------------------------------------------------
680 !---------------------------------------------------------------------------
690 Start_meas:     !
700                 OUTPUT D_dts;"STR"          !START GATING
710                 End_of_gating=0
720                 ENABLE INTR 7;2
730                 RETURN
740 !---------------------------------------------------------------------------
750 !---------------------------------------------------------------------------
760 Results:        !
770                 OUTPUT D_dts;"RSA? COUNT"
780                 ENTER D_dts;T(L),Results(L)  !T(L) CONTAINS VALIDITY FLAG
790                 RETURN
800 !---------------------------------------------------------------------------
810 !---------------------------------------------------------------------------
820 Value_res:      !
830                 FOR L=1 TO 3
840                 SELECT Results(L)
850                 CASE <21
860                   Pass(L)=1
870                 !
880                 CASE ELSE
890                   Pass(L)=0
900                 END SELECT
910                 NEXT L
920                 Pass_value=Pass(1)+Pass(2)+Pass(3)  !PASS VALUE = 0 TO 3
930                 RETURN
940 !---------------------------------------------------------------------------
950 !---------------------------------------------------------------------------
960 Evaluate_res:   !
970                 SELECT Pass_value
980                 CASE 3
990                   PRINT "ALL THREE COUNTS HAVE REGISTERED < 21 ERRORS"
1000                  PRINT "THE  LINE HAS PASSED"
1010                  PRINT " "
1020                  RETURN
1030                !
1040                CASE 2
1050                  PRINT "ONE ERROR COUNT HAS REGISTERED > 20 ERRORS."
```

```
1060                        PRINT "ONE FURTHER RUN WILL BE MADE "
1070                        PRINT " "
1080                        GOTO Re_run
1090                      !
1100                      CASE 1
1110                        PRINT "TWO ERROR COUNT RUNS HAVE REGISTERED > 20 ERRORS"
1120                        PRINT "ALL THREE ERROR COUNT RUNS WILL BE REPEATED"
1130                        PRINT " "
1140                        GOSUB Print_res
1150                        GOTO Repeat
1160                      !
1170                      CASE 0
1180                        PRINT "ALL THREE ERROR COUNT RUNS HAVE REGISTERED"
1190                        PRINT "> 20 ERRORS. THE LINE HAS FAILED"
1200                        PRINT " "
1210                        RETURN
1220                      END SELECT
1230 !-------------------------------------------------------------------------
1240 !-------------------------------------------------------------------------
1250 Re_run:               !              USED IF 1 OF THREE ERROR COUNTS IS > 20
1260                      GOSUB Print_res
1270                      GOSUB Start_meas
1280                      GOSUB Waiting
1290                      OUTPUT D_dts;"RSA? COUNT"
1300                      ENTER D_dts;T(1),Re_run_res       ! T(1) CONTAINS
1310                      IF T(1)=0 THEN                    ! VALIDITY FLAG
1320                      PRINT "RE-RUN RESULT INVALID"
1330                      ELSE
1340                      !
1350                      SELECT Re_run_res
1360                      CASE <21
1370                        PRINT "ERROR COUNT < 21 LINE PASSED"
1380                        PRINT " "
1390                        PRINT "ERROR COUNT = ";Re_run_res
1400                        PRINT " "
1410                        GOTO Fini
1420                      !
1430                      CASE >20
1440                        PRINT "ERROR COUNT > 20. FULL TEST WILL BE REPEATED"
1450                        PRINT "ERROR COUNT = ";Re_run_res
1460                        PRINT " "
1470                        GOTO Repeat
1480                      END SELECT
1490                      END IF
1500 !-------------------------------------------------------------------------
1510 !-------------------------------------------------------------------------
1520 Repeat:               !            USED IF 2 OF 3 ERROR COUNTS ARE > 20 ;  OR
1530                      !            1 OF 3 ERROR COUNTS IS >20 & RE-RUN IS >20
1540                      GOSUB Ds1_lb_set_up
1550                      Time=TIMEDATE
1560                      GOSUB Start_check
1570                      PRINT "PATTERN SYNC GAINED. SUGGESTS THE LOOPBACK IS GOOD"
1580                      PRINT "THE PROGRAM CONTINUES AND REPEATS THE FULL TEST"
```

```
1590            PRINT " "
1600            FOR L=1 TO 3
1610            GOSUB Start_meas
1620            GOSUB Waiting
1630            GOSUB Results
1640            NEXT L
1650            GOSUB Value_res
1660            SELECT Pass_value           !EVALUATE PASS/FAIL
1670            CASE 3
1680              PRINT "ALL THREE ERROR COUNTS REGISTERED <21 ERRORS"
1690              PRINT "THE LINE HAS PASSED"
1700              PRINT " "
1710            !
1720            CASE ELSE
1730              PRINT "1 OR MORE ERROR COUNTS REGISTERED >20 ERRORS"
1740              PRINT "THE LINE HAS FAILED"
1750              PRINT " "
1760            END SELECT
1770            !
1780            GOSUB Print_res
1790            GOTO Fini
1800 !-----------------------------------------------------------------------------
1810 !-----------------------------------------------------------------------------
1820 Print_res:   !
1830            IF T(1)=0 THEN
1840              PRINT "RESULT 1 INVALID"
1850              PRINT ""
1860              ELSE
1870              PRINT "ERROR COUNT 1 =  ";Results(1)
1880              PRINT ""
1890            END IF
1900            !
1910            IF T(2)=0 THEN
1920              PRINT "RESULT 2 INVALID"
1930              PRINT ""
1940              ELSE
1950              PRINT "ERROR COUNT 2 =  ";Results(2)
1960              PRINT ""
1970            END IF
1980            !
1990            IF T(3)=0 THEN
2000              PRINT "RESULT 3 INVALID"
2010              PRINT ""
2020              ELSE
2030              PRINT "ERROR COUNT 3 =  ";Results(3)
2040              PRINT " "
2050            END IF
2060            RETURN
2070 !-----------------------------------------------------------------------------
2080 !-----------------------------------------------------------------------------
2090 Check_status:  !
2100            Status=SPOLL(D_dts)
2110            IF BIT(Status,0) THEN End_of_gating=1
```

```
2120                IF BIT(Status,5) THEN GOTO Error_read
2130                ENABLE INTR 7;2
2140                RETURN
2150 !-----------------------------------------------------------------
2160 !-----------------------------------------------------------------
2170 Error_read:        !
2180                OUTPUT D_dts;"ERR?"
2190                ENTER D_dts;Error_no
2200                PRINT "ERROR NUMBER = ";Error_no
2210                GOTO Fini
2220 !-----------------------------------------------------------------
2230 !-----------------------------------------------------------------
2240 Fini:   !
2250         OUTPUT D_dts;"RLB"          !RELEASE LOOPBACK
2260         WAIT 20                     !ALLOWS 20 SECONDS FOR LOOPBACK
2270                                     !TO BE RELEASED
2280         PRINT "PROGRAM END"
2290         END
```

Alternating OCU Loopback

This Program configures the HP 3787B to the Alternating OCU Loopback condition. The Interface is at DS1 with Insert at DS0A. The Loopback is actuated, and verified by checking that the Pattern Loss Alarm clears (ie Pattern Sync) within 20 Seconds of the Loopback code being transmitted.
Measurements of Logic Error Count and % Error Free Seconds are made over a 15 Minute Gating Period and the results printed.

NOTE

The Alt_lb_set_up subroutine in this Program was devised for a Channel bank with SF Framing, with the OCU in Timeslot 12 and No HL96NY card present.

```
10     OPTION BASE 1
20     !
30     CLEAR 7
40     PRINTER IS 1                 !ASSIGNS DISPLAY AS PRINTER
50     End_of_gating=0              !SET END OF GATING 'FLAG'
60     D_dts=707
70     REMOTE 7
80     ENABLE INTR 7;2
90     ON INTR 7 GOSUB Check_status  !DETECT OCCURRENCE OF INTERRUPT
100    GOSUB Alt_lb_set_up          !THIS SUBROUTINE WILL VARY DEPENDENT ON
110                                 !THE USERS EQUIPMENT
120    Time=TIMEDATE
130    GOSUB Start_check            !CHECK LOOPBACK SUCCESS
140    PRINT "PATTERN SYNC HAS BEEN GAINED WHICH SUGGESTS THE LOOPBACK IS GOOD"
150    PRINT "THE PROGRAM CONTINUES AND MEASURES ERROR COUNT AND % ERROR FREE"
160    PRINT "SECONDS OVER A 15 MINUTE GATING PERIOD"
170    PRINT ""
180    GOSUB Start_meas             !START MEASUREMENT
190    GOSUB Waiting                !WAIT FOR END OF GATING
200    GOSUB Results                !TAKE RESULTS
210    GOSUB Print_results          !PRINT RESULTS
220    GOTO Fini                    !PROGRAM END
230    STOP
240    !-------------------------------------------------------------------
250    !-------------------------------------------------------------------
260 Alt_lb_set_up:   !
270                OUTPUT D_dts;"RQS EOG,ERR"  !INTERRUPT ON "END OF GATING"
280                                            !AND ERROR
290                OUTPUT D_dts;"MOD TX&RX;RIN DS1;I1L AUTO;R1C AMI;R1F SF"
300                OUTPUT D_dts;"RMS DS0A;ROR 3;RTS 12;RDC PRIMARY"
310                OUTPUT D_dts;"RDT PATTERN;RCD PRBS_2047;RLD LOOP;MTA LOGIC"
320                OUTPUT D_dts;"MBS DS0A;MTB LOGIC;TIN DS1;TCD AMI;TIF SF"
330                OUTPUT D_dts;"TCL LOOPED;TSL DS0A;TTS 12;TOR 3;DLT SINGLE"
340                OUTPUT D_dts;"LBT ALT_OCU;HLP NO;TRD PRBS_2047;EAT OFF"
```

```
350                    OUTPUT D_dts;"ALB"          !ACTUATE LOOPBACK
360                    RETURN
370   !-------------------------------------------------------------------------
380   !-------------------------------------------------------------------------
390 Start_check:      !
400                   IF TIMEDATE>Time+20 THEN
410                    PRINT "PATTERN LOSS PRESENT 20 SECONDS AFTER LOOPBACK CODE"
420                    PRINT "SUSPECT LOOPBACK UNSUCCESSFUL"
430                    PRINT ""
440                    GOTO Fini
450                   END IF
460                   OUTPUT D_dts;"AL1?"       !INTERROGATE ALARM MASK
470                   ENTER D_dts;F             !FOR PATTERN SYNC
480                   IF BIT(F,0) THEN
490                    GOTO Start_check
500                    ELSE
510                                             !SET SINGLE GATING 15 MINUTES
520                    OUTPUT D_dts;"GTY SINGLE;GPR 00,00,15,00"
530                  END IF
540                  RETURN
550  !-------------------------------------------------------------------------
560  !-------------------------------------------------------------------------
570 Waiting:          !
580                   IF End_of_gating=0 THEN
590                     GOTO Waiting            !WAIT FOR END OF GATING
600                     ELSE
610                   END IF
620                   RETURN
630  !-------------------------------------------------------------------------
640  !-------------------------------------------------------------------------
650 Start_meas:       !
660                   OUTPUT D_dts;"STR"        !START GATING
670                   End_of_gating=0
680                   ENABLE INTR 7;2
690                   RETURN
700  !-------------------------------------------------------------------------
710  !-------------------------------------------------------------------------
720 Results:          !
730                   OUTPUT D_dts;"RSA? PER_EFS"
740                   ENTER D_dts;T,Result_a        !T CONTAINS VALIDITY FLAG
750                   OUTPUT D_dts;"RSB? COUNT"
760                   ENTER D_dts;S,Result_b        !S CONTAINS VALIDITY FLAG
770                   RETURN
780  !-------------------------------------------------------------------------
790  !-------------------------------------------------------------------------
800 Print_results:    !
810                   IF T=0 THEN
820                     PRINT "RESULT A INVALID"
830                     PRINT ""
840                     ELSE
850                     PRINT "% E.F.S. =  ";Result_a
860                     PRINT ""
870                   END IF
```

```
880                   !
890                   IF S=0 THEN
900                     PRINT "RESULT B INVALID"
910                     PRINT ""
920                     ELSE
930                     PRINT "Frame Error Count =  ";Result_b
940                     PRINT ""
950                   END IF
960                   RETURN
970  !-----------------------------------------------------------------------------
980  !-----------------------------------------------------------------------------
990 Check_status:     !
1000                  Status=SPOLL(D_dts)
1010                  IF BIT(Status,0) THEN End_of_gating=1
1020                  IF BIT(Status,5) THEN GOTO Error_read
1030                  ENABLE INTR 7;2
1040                  RETURN
1050 !-----------------------------------------------------------------------------
1060 !-----------------------------------------------------------------------------
1070 Error_read:      !
1080                  OUTPUT D_dts;"ERR?"
1090                  ENTER D_dts;Error_no
1100                  PRINT "ERROR NUMBER = ";Error_no
1110                  GOTO Fini
1120 !-----------------------------------------------------------------------------
1130 !-----------------------------------------------------------------------------
1140 Fini:            !
1150                  OUTPUT D_dts;"RLB"        !RELEASE LOOPBACK
1160                  WAIT 20                   !ALLOWS 20 SECONDS FOR LOOPBACK
1170                                            !TO BE RELEASED
1180                  PRINT "PROGRAM END "
1190                  END
```

Dataport DS1 to DS0

This Program configures the HP 3787B to transmit at the DS1 Interface level with insert at DS0A and receive at the DS0A Interface Level. The connection is verified by checking that the Pattern Loss Alarm clears (ie Pattern Sync) within 5 Seconds of the connection being made.
Measurements of DS0A Logic Synchronous Error Seconds and DS1 BPV Error Ratio are made over a 15 Minute Gating Period and the results printed.

NOTE

The Data_port subroutine in this Program was devised for a Channel bank with SF Framing, and the Dataport in Timeslot 10. The DS0 Clock was connected to the Rear Panel of the HP 3787B.

```
10    OPTION BASE 1
20    !
30    CLEAR 7
40    PRINTER IS 1                    !ASSIGNS DISPLAY AS PRINTER
50    End_of_gating=0                 !SET END OF GATING 'FLAG'
60    DIM Ratio$[100]
70    D_dts=707
80    REMOTE 7
90    ENABLE INTR 7;2
100   ON INTR 7 GOSUB Check_status    !DETECT OCCURRENCE OF INTERRUPT
110   GOSUB Data_port                 !THIS SUBROUTINE WILL VARY DEPENDENT
120                                   !ON THE USERS EQUIPMENT
130   Time=TIMEDATE
140   GOSUB Start_check               !CHECK CONNECTION SUCCESS
150   PRINT "PATTERN SYNC HAS BEEN GAINED WHICH SUGGESTS THE CONNECTION IS GOOD"
160   PRINT "THE PROGRAM CONTINUES AND MEASURES SYNCH ERROR SECONDS AND"
170   PRINT "BPV ERROR RATIO OVER A 15 MINUTE GATING PERIOD."
180   PRINT ""
190   GOSUB Start_meas                !START MEASUREMENT
200   GOSUB Waiting                   !WAIT FOR END OF GATING
210   GOSUB Results                   !TAKE RESULTS
220   GOSUB Print_results             !PRINT RESULTS
230   GOTO Fini                       !PROGRAM END
240   STOP
250   !---------------------------------------------------------------
260   !---------------------------------------------------------------
270 Data_port:        !
280               OUTPUT D_dts;"RQS EOG,ERR" !INTERRUPT ON "END OF GATING"
290                                          !AND "ERROR"
300               OUTPUT D_dts;"MOD TX&RX;RIN DS1;I1L AUTO;R1C AMI;R1F SF"
310               OUTPUT D_dts;"RMS DS0A;RTS 10;ROR 3;RDC PRIMARY;DEC ON"
320               OUTPUT D_dts;"RDT PATTERN;RCD PRBS_2047;RLD NO_LOOP"
330               OUTPUT D_dts;"MTA LOGIC;MBS DS1;MTB BPV;TIN DS0A;TAM DSX"
```

```
340                 OUTPUT D_dts;"TDC PRIMARY;TOR 3;DCS REAR;DLT SINGLE"
350                 OUTPUT D_dts;"LBT NONE;TDT PATTERN;TRD PRBS_2047;EAT OFF"
360                 RETURN
370    !----------------------------------------------------------------
380    !----------------------------------------------------------------
390 Start_check:    !
400                 IF TIMEDATE>Time+5 THEN
410                   PRINT "PATTERN LOSS PRESENT 5 SECONDS AFTER CONNECTION"
420                   PRINT "SUSPECT CONNECTION FAULTY"
430                   PRINT ""
440                   GOTO Fini
450                 END IF
460                 OUTPUT D_dts;"AL1?"     !INTERROGATE ALARM MASK
470                 ENTER D_dts;F           !FOR PATTERN SYNC
480                 IF BIT(F,0) THEN
490                   GOTO Start_check
500                   ELSE
510                                         !SET SINGLE GATING 15 MINUTES
520                   OUTPUT D_dts;"GTY SINGLE;GPR 00,00,15,00"
530                 END IF
540                 RETURN
550   !-----------------------------------------------------------------
560   !-----------------------------------------------------------------
570 Start_meas:     !
580                 OUTPUT D_dts;"STR"     !START GATING
590                 End_of_gating=0
600                 ENABLE INTR 7;2
610                 RETURN
620   !-----------------------------------------------------------------
630   !-----------------------------------------------------------------
640 Waiting:        !
650                 IF End_of_gating=0 THEN
660                   GOTO Waiting           !WAIT FOR END OF GATING
670                   ELSE
680                 END IF
690                 RETURN
700   !-----------------------------------------------------------------
710   !-----------------------------------------------------------------
720 Results:        !
730                 OUTPUT D_dts;"RSA? SYNC_ES"
740                 ENTER D_dts;T,Result_a         !T CONTAINS VALIDITY FLAG
750                 OUTPUT D_dts;"RSB? RATIO"
760                 ENTER D_dts;S,Ratio$           !S CONTAINS VALIDITY FLAG
770                 RETURN
780   !-----------------------------------------------------------------
790   !-----------------------------------------------------------------
800 Print_results:  !
810                 IF T=0 THEN
820                   PRINT "RESULT A INVALID"
830                   PRINT ""
840                   ELSE
850                   PRINT "SYNC ERR SECS =  ";Result_a
860                   PRINT ""
```

```
870                     END IF
880                     !
890                     IF S=0 THEN
900                       PRINT "RESULT B INVALID"
910                       PRINT ""
920                       ELSE
930                       PRINT "DS1 BPV ERROR RATIO =  ";Ratio$
940                       PRINT ""
950                     END IF
960                     RETURN
970  !--------------------------------------------------------------------------
980  !--------------------------------------------------------------------------
990 Check_status:       !
1000                    Status=SPOLL(D_dts)
1010                    IF BIT(Status,0) THEN End_of_gating=1
1020                    IF BIT(Status,5) THEN GOTO Error_read
1030                      ENABLE INTR 7;2
1040                    RETURN
1050 !--------------------------------------------------------------------------
1060 !--------------------------------------------------------------------------
1070 Error_read:        !
1080                    OUTPUT D_dts;"ERR?"
1090                    ENTER D_dts;Error_no
1100                    PRINT "ERROR NUMBER = ";Error_no
1110                    GOTO Fini
1120 !--------------------------------------------------------------------------
1130 !--------------------------------------------------------------------------
1140 Fini:              !
1150                    PRINT "PROGRAM END "
1160                    END
```

General HP-IB Information

The HP 3787B Digital Data Test Set can operate in Addressable or Talk Only Mode. This is selected on Page 5 (Remote Control) of the display.

In Talk Only Mode the parameters selected on Page 3 (Data Logging) are output via the HP-IB to a suitable printer set to Listen Always. (See Sections 5 and 8 for further information).

In Addressable mode the HP 3787B can TALK and LISTEN but only when designated to do so by a suitable controller. The controller may also manage other instruments connected in the same Bus configuration, addressing only one instrument at a time to carry out the transfer of Data.

Useful Reference Publications

Further information on HP-IB standards and concepts is available in the publications listed below :-

- IEEE Interface Standard 488-1978
- ANSI Interface Standard MC1.1
- Improving Measurements in Engineering and Manufacturing (HP P/N 5952-0078)
- Condensed Description of Hewlett-Packard Interface Bus (HP P/N 59401-90030)

HP-IB Capability

SH1	complete capability
AH1	complete capability
T5	basic talker, serial poll, talk only mode, unaddress if MLA
TE0	NO extended talker capability
L4	basic listener, unaddress if MTA
LE0	No extended listener capability
SR1	complete SRQ capability
RL1	complete remote-local capability
PP0	NO parallel poll capability
DC1	complete device clear capability
DT0	NO device trigger capability
C0	NO controller capability

HP-IB Universal Commands

- DEVICE CLEAR
- SELECTIVE DEVICE CLEAR
- INTERFACE CLEAR
- REMOTE ENABLE
- LOCAL
- LOCAL LOCKOUT

1. DEVICE CLEAR (DCL) & SELECTIVE DEVICE CLEAR (SDC)

These commands are usually sent at the beginning of a program to reset the instrument to a known state without changing the HP 3787B panel settings :-

- All Buffers flushed
- Stops asserting SRQ
- Sets RQS 32 (ERR)
- Clears Error Register
- Clears Status Registers A & B (If the HP 3787B is Gating, GIP Bit 12, of Status Register A is not affected)
- Sets Ready Register to 1
- Sets KEY Register to 0
- Alarm Status Registers 1 & 2 are unchanged

DEVICE CLEAR command using an HP 200 series controller is :-

CLEAR 7 (Where 7 is the Bus I/O select code)

SELECTIVE DEVICE CLEAR command using an HP 200 series controller is :-

CLEAR 707 (Where 7 is the Bus I/O select code and 07 is the device address)

2. INTERFACE CLEAR (IFC)

The HP 3787B response to IFC is to become UNADDRESSED without any effect on any of the internal buffers.

INTERFACE CLEAR command using an HP 200 series controller is :-

ABORT 7 (Where 7 is the Bus I/O select code)

3. REMOTE ENABLE (REN) & LOCAL LOCKOUT (LLO)

A Remote command instructs the HP 3787B to accept instructions via the HP-IB. When the HP 3787B receives this command it displays the Remote message on the Display.

The following Front Panel Keys are disabled on receipt of the Remote command :-

SINGLE ERROR, PRINT, PAPER, START/STOP. The EXEC Key is also disabled unless the Remote Configuration Page (5) is selected. In this case the EXEC Key can be used to return the HP 3787B to LOCAL control.

It is strongly recommended that the HP 3787B be in the "Remote With local Lockout State" (RWLS) when being controlled via the HP-IB. This will disable the use of the EXEC Key return to LOCAL facility and guarantee that the system controller has sole control of the instrument at all times.

REMOTE with LOCAL LOCKOUT using an HP 200 series controller is :-

REMOTE 707, LOCAL LOCKOUT 707 (Where 7 is the Bus I/O select code and 07 is the device address).

4. LOCAL

The Local command returns the HP 3787B to Front Panel, Local control.

LOCAL command using an HP 200 series controller is :-

LOCAL 707 (Where 7 is Bus I/O select code and 07 is the device address)
This command does not override LOCAL LOCKOUT.

LOCAL 7 (Affects all devices on the Bus)
This command overrides LOCAL LOCKOUT.

General RS-232-C Information

The HP 3787B can be remotely controlled via the RS-232-C interface as an alternative to HP-IB.

RS-232-C is an American data communication standard maintained by the Electronic Industries Association (EIA). An equivalent international standard is CCITT V.24/V.28.

The standard defines the functional, electrical and mechanical details of a serial interface for use in connecting Data Terminal Equipment (DTE), eg Computer or Printer, to Data Circuit terminating Equipment (DCE), eg a Modem. The standard does not specify the format, transmission speed or protocol of the Data passed across the interface.

RS-232-C Capability

Table 6-7. RS-232-C Signals Implemented by the HP 3787B

Pin	Circuit	Circuit Name	V.24
		GROUND	
1	AA	Protective Ground	101
7	AB	Signal Ground	102
		DATA	
2	BA	Transmitted Data (TXD)	103
3	BB	Received Data (RXD)	104
		CONTROL	
4	CA	Request To Send (RTS)	105
5	CB	Clear To Send (CTS)	106
6	CC	Data Set Ready (DSR)	107
8	CF	Received Line Signal Detector - sometimes called Data Carrier Detect (DCD)	109
20	CD	Data Terminal Ready (DTR)	108.2
22	CE	Ring Indicator	125
23	CH	Data Signal Rate Selector (DTE)	111
12	CI	Data Signal Rate Selector (DCE)	112

NOTE

Numbers listed under V.24 are the designations of the equivalent signals in the CCITT V.24 Interface.

The Signals

Ground

Pin 1 is Protective Ground and should be connected to chassis. Pin 7 is Signal Ground and is the common reference for all signal lines.

Data

Pin 2 is Transmitted Data which passes from the DTE to the DCE, pin 3 is Received Data which passes from the DCE to the DTE.

Modem Control

The following descriptions are extremely brief and are only intended as an overview. The reader is referred to the RS-232-C standard for the full definition.

The modem control signals can be separated into two groups, those responsible for answering, holding and dropping the telephone line, and those responsible for controlling data flow once the line is established.

Group 1 - Line Control.

Circuit CC - Data Set Ready (CCITT 107)

In the broadest sense Data Set Ready on tells the DTE "you're through". More specifically, it means that the modem is connected to the line, has completed any call establishment procedure and is NOT in a test, talk or dial mode.

Circuit CD - Data Terminal Ready (CCITT 108.2)

Data Terminal Ready indicates that the terminal equipment is ready to communicate.

This signal controls the switching of the modem to the communications channel in that Data Terminal Ready must be on before the modem can connect to the communications channel and must remain on to maintain the connection. If Data Terminal Ready is turned off then the modem will disconnect.

Circuit CE - Ring Indicator (CCITT 125)

The on condition indicates that the modem has detected a ringing signal on the line. The signal is on during "rings" and off between "rings". The signal is off at all other times. This signal can be monitored by the DTE and used to turn DTR (Data Terminal Ready) on, thus allowing an auto-answer modem to answer the incoming call.

Group 2 - Data Flow Control.

Circuit CA - Request to Send (CCITT 105)

This circuit is used to ready the DCE for data transmission and, on a half duplex channel, to control the direction of data transmission of the local DCE.

Turning RTS (Request To Send) on instructs the DCE to enter the transmit mode. Once the DCE is ready to transmit, it indicates this by turning CTS (Clear To Send) on. Turning RTS off instructs the DCE to complete transmission of all data passed, and then assume a non-transmit (full duplex DCE) or receive (half duplex DCE) mode as appropriate. The DCE responds to this by turning Clear To Send off.

When RTS is turned off, it should not be turned on again until CTS has been turned off by the DCE.

Circuit CB - Clear to Send (CCITT 106)

CTS (Clear To Send) indicates whether or not the DCE is ready to transmit data.

CTS on, together with RTS (Request To Send), DSR (Data Set Ready) and DTR (Data Terminal Ready) all on, indicates to the DTE that data will be transmitted to the line, whilst CTS indicates to the DTE that it should not pass data on TXD (Transmitted Data).

The RTS/CTS handshake is primarily intended for use with DCE's that are not always capable of transmitting (half duplex or receive only modems).

Full duplex modems can (once the line is established) always transmit and therefore often do not implement the RTS/CTS handshake; instead they ignore RTS and simply turn CTS permanently on.

Half duplex modems cannot by their nature always transmit and therefore the RTS/CTS handshake must be implemented fully. A DTE must not turn RTS on if CTS is already on.

Although both modes of operation are acceptable within the framework of the RS-232-C standard, they are incompatible and it is for this reason that the HP 3787B provides the half/full duplex selection.

Circuit CF - Data Carrier Detect (CCITT 109)

DCD (Data Carrier Detect) indicates whether or not the DCE is receiving a line signal which is suitable for demodulation. If the line signal is lost, DCD will turn off after an appropriate guard delay.

On half duplex channels DCD is held off whenever RTS is on and for a brief interval after RTS turns off. For this reason, if no other, RTS must be monitored by a half duplex modem.

DCD on is used to qualify the reception of data from the DCE; in fact the DCE clamps RXD (Received Data) to the marking state when DCD is off.

Circuit CH/CI - Data Rate Select (CCITT 111/112)

Some modems can operate at two data rates. Normal operation is at the higher rate, say 1200bps, but if the circuit quality is poor and causing errors then the modem can be switched to a "fallback" rate, say 300bps, which, whilst slower, is less error sensitive.

RS-232-C defines two circuits, CH and CI, as data rate selectors. The circuit definitions are identical except that CH is sourced by the DTE, whilst CI is sourced by the DCE. CH is used where the DTE is controlling the transmission speed, for example at the "originate" end of a dial up line. CI is used where the modem is indicating received transmission speed so that the DTE can adapt to it - for example at the "answer" end of a dial up line. The two circuits are functionally mutually exclusive and, probably as a consequence, have both been assigned to pin 23. The decision as to which circuit to implement, i.e. whether the DTE or the DCE is to source the signal, is left to "the supplier". This is a very unsatisfactory arrangement because a dual speed modem that can be used to originate or answer a data transmission ideally needs both circuit CH and circuit CI. The widely adopted solution is to use the normal pin, 23, for circuit CH and to redefine pin 12 (normally Sec Rec's Line signal Detect) as circuit CI. This is the solution adopted by the HP 3787B. The HP 3787B also allows modification to this by means of hardware wire links on the A6 Assembly. For details of modifying the Factory Preset setting see the Installation Section (8) of this manual.

RS-232-C Universal Commands

The HP 3787B will detect a "BREAK" message from a controller and on receipt will set the HP 3787B to a known state without changing the Panel settings. "BREAK" has the same effect via RS-232-C as Device Clear and Selective Device Clear have via HP-IB :-

- All Buffers flushed
- Sets RQS 32 (ERR)
- Clears Error Register
- Clears Status Registers A & B (If the HP 3787B is Gating, GIP Bit 12 of Status Register A is not affected)
- Sets Ready Register to 1
- Sets KEY Register to 0
- Alarm Status Registers 1 & 2 are unchanged

Allow 20milliseconds after a "BREAK" MESSAGE before issuing any other MESSAGE, or an error will result.

General Information 7

Introduction

This manual contains information which allows the user to operate the Hewlett-Packard Model 3787B Digital Data Test Set. The accessories supplied with the HP 3787B and initial inspection information are listed on Page x.

On the title page of this manual is a Microfiche Part Number. This number can be used to order 4 X 6 inch microfilm transparencies of the manual. Each microfiche contains up to 96 photo duplicates of manual pages.

Information required to Adjust, Performance Test and repair the instrument is contained in the HP 3787B Service Manual, HP Part Number 03787-90000.

Specification

Instrument specifications are listed in Table 7-1. These specifications are the performance standards or limits against which the instrument is tested.

Safety Consideration

This product is a Safety Class I instrument (it is provided with a protective earth terminal). The instrument and manual should be reviewed for safety markings and instructions before operation. Also read the Warning on Page ii.

Instruments Covered By Manual

Attached to the instrument is a serial number plate. This serial number is in the form XXXXUXXXXX. It is in two parts; the first four digits and the letter are the serial prefix and the last five are the suffix. The prefix is the same for all identical instruments - it changes only when a change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument. The contents of this manual apply to instruments with the serial number prefix(es) listed under SERIAL NUMBERS on the title page.

An instrument manufactured after the printing of this manual may have a serial number prefix that is not listed on the title page. The unlisted serial number prefix indicates the instrument is different from those described in this manual. The manual for this new instrument is accompanied by a Manual Changes supplement. This supplement contains "change information" that explains how to adapt the manual to the new instrument.

In addition to change information, the supplement may contain information for correcting errors in the manual. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified with the manual print date and part number, both of which appear on the manual title page.

Complementary copies of the supplement are available from Hewlett-Packard. For information concerning a serial number prefix that is not listed on the page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

Equipment Available for use with the HP 3787B

A printer and external controller can be used with this instrument. A typical example of each is listed here:

HP 9816S Model 216S .... Computer with BASIC
HP 2225A... ThinkJet Printer (HP-IB)

Accessories Supplied with the HP 3787B

The accessories supplied with the HP 3787B are:

- An appropriate power cable, see Section 8
- A Service Manual
- An Operating Manual
- An Operating Guide
- RS-232-C Test Plug
- Front Panel Cover kit (HP 15672A) - If the rack mount kit option 908 or 909 is ordered then the Front Panel Cover kit is not supplied.

Options Available

The following options are available on the HP 3787B:

Option 001	- Phase Jitter : permits measurement and display of DS1 Jitter.
Option 002	- DC, Battery Input : permits the HP 3787B to be operated from an external battery in the range -40 to -57 volts.
Option W30	- 3-year Extended Hardware support. Provides 2 additional years of return-to-hp hardware service support (for 2nd and 3rd years).

Accessories Available

Front Panel DDS Clock Cable	: 5-pin DIN (female) to 5-pin DIN (female), 3 meters (10ft) long, part number HP 15668A.
Rear Panel DDS Clock Cable	: 9-pin D-type (male) to 9-pin D-type (male), 3 meters (10ft) long, part number HP 15669A.
Transit Case	: HP part number 9211-2655

Table 7-1 Specifications

Except where otherwise stated, the following parameters are warranted performance specifications. Parameters described as "typical" or "nominal" are supplemental characteristics which provide a useful indication of typical, but non-warranted, performance characteristics.

INTRODUCTION

OPERATING MODES

When interfacing at DS1/DS1C levels, the HP 3787B can operate as a separate Transmitter and Receiver, or in Through (THRU) Mode. In THRU Mode, a DS1/DS1C signal applied to the RX Input is retransmitted from the TX Output. When interfacing at DS0 levels, the HP 3787B operates as a separate Transmitter and Receiver, sharing a common (externally-provided) clock source. Protocol analysis can be performed on channels accessed by the HP 3787B by connecting a protocol analyzer to a rear-panel port.

MEASUREMENT PRESETS

Nine completely independent instrument configurations can be stored in non-volatile memory for later recall. Memory location 0 contains a default instrument configuration. The HP-IB address is not held in the measurement presets.

KEYBOARD LOCK

This feature locks the EXEC and START/STOP keys. The CHANGE keys (PREV and NEXT) are also locked for functions which change the state of the instrument. They are not locked for VIEW functions.

USER CONFIDENCE TESTS

Seventeen independently selectable tests are provided to allow the user to check the functional operation of the instrument.

TRANSMITTER

DS1/DS1C TRANSMITTER

□ Clock Sources

Internal DS1/DS1C TX Clock

Frequency : 1.544 Mbit/s (DS1); 3.152 Mbit/s (DS1C).
Stability : < 25 ppm all causes including 5-year aging and ± 10 ppm temperature 0 to 50 °C.

External DS1 TX Clock

Frequency : 1.544 MHz ± 130 ppm.
Sensitivity : Compatible with TTL level signals.
Connector : BNC (rear panel).
Impedance : 75 Ω unbalanced (nominal).
Termination : GND.
Note : This port accepts inputs only at a DS1 rate. When the TX Output is framed DS1C this input can be used to clock the constituent digroup generators.

Looped DS1 TX Clock

Function : DS1 TX timing is derived from a data signal applied to the DS1/DS1C RX Input. This source is also valid if the RX interface is selected to be DS0, provided a DS1 signal is also connected to the DS1/DS1C RX Input.

□ DS1/DS1C Interface

DS1/DS1C TX Line Code

AMI, B8ZS.

DS1/DS1C TX Output

Connector Type : WECO jack to accept WECO type 310 plug.
Impedance : 100 Ω balanced (nominal).

DS1/DS1C TX Level

DSX-1 (Refs : KS-22332, L-171907, T1X1-4/85-032);
DSX-1C.

Pulse Height :

DS1 : ± 3 V ± 600 mV (at the center of the pulse).

DS1C : ± 3.65 V ± 850 mV (at the center of the pulse).

Pulse Imbalance : Ratio of power in positive and negative pulses nominally 0 ± 0.5 dB.

Pulse Width : (Measured at half amplitude)

DS1 : 324 ± 30 ns.

DS1C : 159 ± 20 ns.

Rise and Decay Time :

DS1 : 50 ns ± 25 ns (10% to 90%).

DS1C : 37.5 ns ± 12.5 ns (20% to 80%).

Waveshape :

DS1 : Meets T1X1.4-85-032 (same as CCITT G.703).

DS1C : Meets T1X1.4-85-032 (not defined in CCITT G.703).

DS1/DS1C Additional TX Output

Signal : Identical to main output signal.

Connector : Rear-panel WECO, identical to front-panel port.

DS1/DS1C TX Signal Format

DS1 : Unframed
Framed Ft only, SF(D4), ESF(Fe), T1DM(DDS).

DS1C : Unframed
Framed.

DS0 TRANSMITTER

▫ Clock Sources

DS0 Clocks

For DDS testing, the DS0 transmitter must always be supplied with bit and byte clocks from the DDS system. These clocks can be connected to the front-panel 5-pin connector or to the rear-panel D-shell, the active source being selected via the CRT. The clocks are shared by the DS0 RX circuitry.

If the output format is clear channel these clocks must still be provided.

Frequency :

Bit Rate : 64 kbit/s (nominal).

Byte Rate : 8 kbit/s (nominal).

Indication : Error message on line 1 of screen if instrument fails to receive either bit or byte clock : "NO DS0 CLOCKS".

DS0 Complementary Clocks

Connector : 5-pin DIN male (front-panel).

Format : Separate bit and byte clocks. Both have complementary TTL inputs.

Levels :

Low Level : 0.0 to 0.8 V.

High Level : 2.0 to 5.5 V.

DS0 Channel Bank DDS Clocks

Connector : 9-pin D-shell (rear-panel).

Format : Separate bit and byte clocks, both TTL.

Levels :

Low Level : 0.0 to 0.8 V.

High Level : 2.0 to 5.5 V.

▫ DS0 Interface

DS0 Bipolar Output

Validity : All DS0.

Connector : WECO Bantam.

Impedance : 100 Ω ± 5%, balanced, DC-isolated at DS0 interface.

Transition Time : 0.5 µs maximum.

Transmitted Zero : < 0.7 V.

Transmitted One : 3.2 V peak ± 10%.

Pulse Width : 15 µs (nominal).

Pulse Shape : The ratio of the amplitudes of positive and negative pulses at the center of the pulse interval is in the range 0.95 to 1.05.

The ratio of the widths of positive and negative pulses at the nominal half-amplitude point is in the range 0.95 to 1.05.

(All measured when terminated with 100 Ω ± 5% resistive load.)

Drive Capability : This output will drive up to 1500 feet of 22 AWG balanced, twisted, shielded 100 Ω cable.

DDS Logic Output

Validity : DS0A.

Direction : Near; Far.

With DS0A interface selected for both TX and RX, the selection of Near or Far is commoned with the receiver.

Connector : WECO Bantam - Tip = Near; Ring = Far.

Output Levels :

TTL High : > 2.4 V (Logic 0).

TTL Low : < 0.4 V (Logic 1).

Drive Capability : Output sink current = 16 mA DC (nominal).

DS0 TX Format

DDS DS0A :

XDDDDDDC for sub-rate services (2.4, 4.8 or 9.6 kbit/s);
DDDDDDDC for 56 kbit/s service
where D is data,
C is control or status
X is don't care.

DDS DS0B :

SDDDDDDC for sub-rate services (multi-customer) (2.4, 4.8 or 9.6 kbit/s);
DDDDDDDC for 56 kbit/s service
where D is data,
C is control or status,
S is sub-rate frame sequence.

Clear Channel : DDDDDDDD where D is data.

TEST SIGNALS

▫ DS1/DS1C TX Data

Patterns

PRBS : 2^{20}-1, (D20+D17+1=0), a 14-zero limit may be selected.

Word : 8-bit fully programmable.

DS1 In-Band Loopback : Latching loopback activated and deactivated by the EXEC key.

Set-up - 8 second burst of "10000" repeated.

Clear-down - 8 second burst of "100" repeated.

Framed or unframed signals.

DS1/DS1C TX Alarms

AIS : Valid with either DS1 or DS1C interface selected. The selection of AIS overrides any prior frame selection.

Yellow Alarm : Yellow alarm can be transmitted for all four DS1 frame formats. Yellow alarm is introduced in the various framing formats as follows :

SF, "Ft only" : Bit 2 of every timeslot zero.

T1DM : Bit 190 of every frame zero.

ESF : 4 kHz datalink carries repetitive 8 zeros/8 ones pattern.

X-Bit : With DS1C framed signals, the X-bit can be set to "0" (alarm) or "1".

▫ DS1 Timeslot Insertion

Available in all DS1 framing modes, all other timeslots filled with a background 2^{20}-1 PRBS.

Timeslot Formats :

Multi-customer DDS (DS0B);

56 kbit/s single-customer DDS;

Dataport single-customer (except 56 kbit/s);

56 kbit/s circuit-switched (PSDC);

64 kbit/s clear channel.

For PSDC the format is DDDDDDDS, where D is data, S is signaling bit (frames 6, 12, etc), (S = 1 in other frames).

For the other formats refer to the DS0 TX Signal Format section. PSDC is available only with SF and ESF. Clear channel is NOT available with T1DM.

Insertion Level : Unless the timeslot is specified to contain DDS multi-customers, the insertion pertains to the complete (single-customer) timeslot.

If the timeslot is specified to be multi-customer DDS, then customer number must be further specified to permit insertion in a particular customer slot. In the TX & RX mode, other customer slots in the chosen timeslot are filled with DDS TEST code. In the THRU mode, they are retransmitted unmodified.

Insertion Data : The data applicable is as specified for the DS0 Transmitter.

With 56 kbit/s PSDC selected, the choice of test patterns is the same. As with clear channel and 56 kbit/s, DDS data received from a protocol analyzer cannot be inserted in a timeslot.

Errors may be added as described in the TX Error Addition section.

Signaling : When 56 kbit/s circuit-switched channels are inserted in a DS1 signal (TX & RX or THRU modes), the signaling bits of the selected channel can be set via the front panel.

SF : A, B bits.

ESF : A, B, C, D bits.

▫ T1 Datalink

Types :

With ESF framing, data may be inserted in the 4 kbit/s datalink.

With "Ft only" framing, data may be inserted in the 4 kbit/s Fs link.

With T1DM framing, data may be inserted in the 8 kbit/s R-channel.

Insertion is available in both TX & RX and THRU modes.

Test Patterns :

511-bit PRBS

2047-bit PRBS

All-ones word

In addition, data may be transmitted as received over the rear-panel serial link.

▫ DS0 TX Data

Patterns :

511-bit (2^9-1) PRBS, (D9+D5+1=0).

2047-bit (2^{11}-1) PRBS, (D11+D9+1=0).

All-ones word
8-bit word, fully programmable } Bits 1 and 8 restricted for DDS; bit 8 restricted for PSDC

Preprogrammed sequence : This can be any length from 1 byte to 256 bytes inclusive. The content can be programmed only remotely (HP-IB or RS-232-C). The following number of bits per byte are programmable :

Clear channel - 8

56 kbit/s CSDC - 7

56 kbit/s DDS - 8 (data + status)

Sub-rate DDS - 7 (data + status)

Note : The pattern choice is restricted in the following cases -

DDS Alternating Loopbacks

DDS Secondary Channel

T1 Data Links

See appropriate section for details.

Protocol : Transmitted data is as received over the rear-panel serial link. This feature is available only for sub-rate DDS and is not available with alternating loopbacks.

Background : When the interface is DDS multi-customer DS0B the other customer slots are filled with TEST code.

DDS Multi-Point Signaling Unit

When testing multi-point DDS circuits, any number of multi-point junction units (MJUs) in tandem may be routed to set up a path by sending control sequences from the HP 3787B. The returned MJU branch number and Hub Office Identification are displayed.

Once the path has been set up the branch may be tested, blocked or an existing block cleared.

Control Sequences : The following table describes the code sequences which are transmitted for the various MJU operations.

Operation	Select	Block	Unblock	Release
1 second TA	•			
20 bytes MA*	•			
20 bytes BRN*	•			
20 bytes UMC*	•			
1 second BLK		•		
1 second CMI		•	•	
1 second RLS				•

where :

TA	Test Alert	S1101100
MA	MJU Alert	S1110010
BRN	Branch Select	S0101XY1
UMC	Unassigned Mux	S0011000
BLK	Block	S0001010
CMI	Idle	S1111110
RLS	Release	S1111000

The branch selected is binary-coded into bits "XY" in the range 0 to 3. These are mapped from the branch range 1 to 4 (1 ➤ 0, 2 ➤ 1, etc).

Note : For the multiple byte transmissions marked by * in the table above, the number of bytes is the number transmitted at DS0A after iteration to 64 kbit/s.

Within a DS0B signal the numbers of MA, BRN and UMC bytes are respectively :

1 each for the 2.4 kbit/s case;
2 each for the 4.8 kbit/s case;
4 each for the 9.6 kbit/s case.

DDS Loopback

Alternating and latching loopbacks may be activated and released.

Alternating

Whenever the loopback is selected the HP 3787B transmits the selected test pattern alternated with the appropriate code.

There are five types of alternating loopback. The following table lists them and details the activation codes :

	D1	D2	D3	D4	D5	D6	D7	C8
DSU	0	0	1	0	1	1	0	0
Channel	0	0	1	0	1	0	0	0
OCU	0	0	1	0	1	0	1	0
56 kbit/s Repeater	0	0	1	0	1	0	0	0
HL96NY	0	0	1	0	1	0	1	0

Column D1 assignment is for 56 kbit/s operation. For sub-rate operation (2.4, 4.8 and 9.6 kbit/s) from a DS0A interface the first bit is a one in all cases. For sub-rate channels when interfacing at DS0B this bit position contains one bit of the sub-rate framing sequence and is designated S.

While testing using alternating loopbacks, test pattern selection is restricted to :

511-bit PRBS (D9+D5+1=0).
2047-bit PRBS (D11+D9+1=0).
Preprogrammed word.

DDS code transmission is not valid during an alternating loopback.

Latching

There are four types of latching loopback.

Control Sequences : The following table describes the code sequences which are transmitted to set up the various latching loopbacks. Note that the number of bytes specified applies to the DS0A interface, ie after iteration.

Operation	DS0DP	OCU	Channel	HL222
40 bytes TIP	•	•	•	•
40 bytes DS0DP	•			
40 bytes OCU		•		
40 bytes CSU			•	
40 bytes HL222				•
120 bytes LBE	•	•	•	•
40 bytes DMI*	•			
120 bytes LBE*	•			
2 seconds FEV	•	•	•	•
120 bytes LBE	•	•	•	•

* This section is transmitted once for every intervening DS0DP unit up to a maximum of 7.

where :

TIP	Transition In Progress	00111010
DS0DP	Dataport LSC	00000101
OCU	Office Channel Unit LSC	01010101
CSU	Channel Unit LSC	00110001
HL222	HP222 LSC	01000111
LBE	Loopback Enable	01010110
DMI	Data Mode Idle	11111111
FEV	Far-End Voice	01011010
(LSC =	Loopback Select Code	0XXXXXX1)

Assignment of the first bit is for 56 kbit/s. For sub-rate operation (2.4, 4.8 and 9.6 kbit/s) from a DS0A interface the first bit is a one in all cases. For sub-rate channels when interfacing at DS0B this bit position contains one bit of the sub-rate framing sequence and is designated S.

▫ Special DDS Codes

When any of these special codes are selected, the EXEC key is required to start the generation. The all-ones byte is transmitted in all cases until EXEC is pressed to activate a code transmission.

Predefined Codes :

	D1	D2	D3	D4	D5	D6	D7	C8
CMI	1	1	1	1	1	1	1	0
OCU L/B	0	0	1	0	1	0	1	0
CHANNEL L/B	0	0	1	0	1	0	0	0
DSU L/B	0	0	1	0	1	1	0	0
TIP	0	0	1	1	1	0	1	0
LBE	0	1	0	1	0	1	1	0
FEV	0	1	0	1	1	0	1	0
TA	0	1	1	0	1	1	0	0
MA	0	1	1	1	0	0	1	0
UMC	0	0	0	1	1	0	0	0
BLOCK	0	0	0	0	1	0	1	0
RLS	0	1	1	1	1	0	0	0
ASC	0	0	0	1	1	1	1	0
TEST	0	0	0	1	1	1	0	0
OOS	0	0	0	1	1	0	1	0

Column D1 assignment is for 56 kbit/s operation. For sub-rate operation (2.4, 4.8 and 9.6 kbit/s) from a DS0A interface, the first bit is a one in all cases. For sub-rate channels when interfacing at DS0B, this bit position contains one bit of the sub-rate framing sequence and is designated S.

Settable Code

In addition to the above codes, any other code can be transmitted by selecting SETTABLE CODE.

Bit 8 is always restricted to "0". For sub-rate operation (2.4, 4.8 and 9.6 kbit/s) from a DS0A interface, the first bit is a one in all cases. For sub-rate channels when interfacing at DS0B, this bit position contains one bit of the sub-rate framing sequence and is designated S. All other bits are selectable.

▫ DDS Secondary Channel

Interleave Factor : DDS secondary channel is transmitted by modifying every 3rd control bit (bit 8).

Test Patterns :

511-bit PRBS

2047-bit PRBS

Note : These both contain the secondary channel training sequence of 6 consecutive zeros.

Protocol : As with primary DDS channels, data can be transmitted as received over the rear-panel serial link.

Note : A preamble of 6 consecutive zeros must be transmitted to initialize secondary channel reception. Transmission of twelve or more consecutive ones will cause the secondary channel receiver to drop out.

Loopback : Only latching loopbacks are used to test a secondary channel.

Primary Data : When a secondary channel is transmitted, the primary channel is filled with random data.

Note : When testing the primary channel, the secondary channel is idle.

ERROR ADDITION

▫ DS1/DS1C Error Add

Error Types

Binary (Logic) Errors : Any DS1/DS1C test pattern.

Any DS1 datalink test pattern.

Bipolar Violation/Code Errors

Frame Errors : T1DM, F-bits and 24th timeslot.

SF, Ft bits and Fs bits.

ESF, Fe bits.

Ft only, Ft bits.

CRC Errors : ESF only.

Insertion

Single : SINGLE ERROR key allows insertion of single logic, BPV, Frame or ESF CRC errors.

Ratio :

Logic and BPV : $M \times 10^{-N}$, where M = 1 to 9 and N = 3 to 8 variable in unit steps.

CRC : 1×10^{-0} to 4.6×10^{-3}, selected by setting corresponding BER in the range 3×10^{-4} to 1×10^{-8}.

Notes :

Frame errors can be added only singly.

Datalink errors (ESF and "Ft only") can be added only singly.

T1DM R-channel errors can be added only singly.

If output framed then logic error ratio is wrt data bits.

Logic error insertion does not cause bipolar violations, CRC or frame errors. Both 0 to 1 and 1 to 0 conversions are included without violating the 15-zero constraint in DS1 signals.

Bipolar violation insertion does not cause logic, CRC or frame errors.

CRC error insertion does not cause bit errors.

Automatic Protection Switch (APS) Test

Based on BPV insertion. Five states are sequenced using the NEXT key :

START	NO RESTORE
NO TRANSFER	RESTORE
TRANSFER	

In the START state no bipolar violations are inserted. For each of the other states, BPV error ratios are independently selectable in the range 1×10^{-8} to 9×10^{-3}. The states are sequenced using the NEXT key. Valid for both AMI and B8ZS. (Selected set common for DS1 and DS1C).

DS0 TX Error Add

Type : Logic bit, byte or sub-rate frame errors. Sub-rate frame errors apply only with sub-rate cases of DDS DS0B. They cannot be added with secondary channel selected. Logic bit or byte errors cannot be added when remote word or protocol analysis is selected.
Single : The SINGLE ERROR key allows insertion of single logic, byte or sub-rate frame errors. With logic selected, each successive press of the SINGLE ERROR key causes the insertion position to rotate through the set of valid data bit locations. (Ratio error add is provided for Dataport testing.)
Insertion Method : With the DDS formats, DS0A and DS0B bit errors are inserted only in the data bits, ie not in the status or sub-rate framing bits.

With DDS interleaved loopbacks, logic bit and byte errors are inserted only in the data bytes, NOT in the code bytes.
Dataport Test : For testing sub-rate Dataport error correction, every twentieth set of byte iterations can be errored in the following ways :

(1) 2 in every 5 bytes inverted (error correction should cope 100%).
(2) 3 in every 5 bytes inverted (error correction should fail 100%).

DS1/DS1C THRU MODE

Function : In this mode, a signal applied to the DS1/DS1C RX Input passes through the instrument and is retransmitted from the DS1/DS1C TX Output. When the interface is DS1, timeslots can be accessed for measurement as described in the Receiver DS1 Timeslot Extraction section, and data can be inserted in timeslots as described in the Transmitter DS1 Timeslot Insertion section. At DS1C interface points, the THRU mode offers only monitoring access. Alarms and loopback codes cannot be transmitted in the THRU mode.
Frame : In the THRU mode the retransmitted frame format is always the same as the received format.

Received frame bits are retransmitted unmodified. Hence frame errors are preserved. The only exception occurs with T1DM framing when the R-channel is being stimulated.

While the receiver is not aligned to the incoming frame the entire received signal is retransmitted unmodified. Hence both frame structure and data present in the received stream are preserved intact.

In DS1 operation where insertion is selected, the insertion commences after frame alignment has been achieved.

Code : In the THRU mode the retransmitted line code is always the same as the received line code.

The retransmitted line code is regenerated. Any received code errors are not retransmitted.
Delay : This depends on the line code as follows :
AMI : ~4 bits.
B8ZS : ~20 bits.
Protection : In the event of a failure of the instrument power source a fail-safe relay provides a metallic connection between the RX and TX ports to provide traffic continuity. Also in the THRU mode protection against traffic corruption is provided by an INSERT field which reverts to OFF on selection of ANY new insert configuration. During insertion only the data may be modified.
ESF CRC : When a DS1 signal with ESF framing is being retransmitted the CRC is recalculated (to take account of any timeslot insertions). However, for every received CRC error an error is inserted in the retransmitted stream to preserve end-to-end CRC-monitoring accuracy.
DDS with Secondary Channel : The insertion of DDS or Dataport primary channel data will corrupt any received secondary channel data pertaining to that customer.

Conversely, the insertion of DDS secondary channel data will corrupt any received primary channel data pertaining to that customer. The received primary channel data will be overwritten with random data.

RECEIVER

DS1/DS1C RECEIVER

DS1/DS1C Input Modes

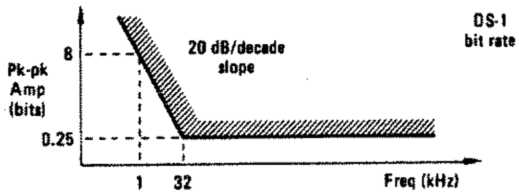
Terminated/monitor.
Bridged.

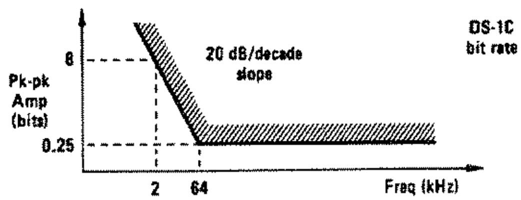
DS1/DS1C RX Input

Connector Type : WECO jack to accept WECO type 310 plug.
Impedance :
Terminated : 100 Ω ± 5% balanced (nominal);
Monitor : 100 Ω ± 5% balanced (nominal);
Bridged : 1 kΩ ± 5% balanced (nominal).

DS1/DS1C RX Rate

DS1 Rate : 1.544 Mbit/s ± 130 ppm.
DS1C Rate : 3.152 Mbit/s ± 30 ppm.
Jitter Tolerance : The input will operate without error in the presence of a signal with a jitter content within the nominal masks shown. These specifications apply for data with maximum zero runs of 14.





DS1/DS1C RX Level

Terminated/Monitor : 80 mV to 5.5 V peak.

Bridged : 800 mV peak (minimum).

Safe operating maximum 10 V peak.

DS1/DS1C Preselectable Levels

DS1 Levels :

- **DSX-1 :** 3.0 V peak ± 600 mV, at pulse center.
- **DSX-MON :** As for DSX-1 less 20 dB.
- **DS-LO :** As for DSX-1 but with loss due to the equivalent of 655 feet (200 m) of ABAM cable.
- **DS-LO-MON :** As for DS-LO less 20 dB.

DS1C Levels :

- **DSX-1C :** 3.65 V peak ± 850 mV, at pulse center.
- **DSX-MON :** As for DSX-1C less 20 dB.
- **DS-LO :** As for DSX-1C but with loss due to the equivalent of 655 feet (200 m) of ABAM cable.
- **DS-LO-MON :** As for DS-LO less 20 dB.

DS1/DS1C RX Level Measurement

The received DS1 or DS1C level can be displayed in peak volts. The positive and negative peaks are displayed simultaneously.

Display Format : X.XX V.

Accuracy : ± 10%

- **DSX :** One LSB = 77 mV.
- **DS-LO :** One LSB = 77 mV.
- **DSX-MON :** One LSB = 39 mV.
- **DS-LO-MON :** One LSB = 39 mV.
- **Bridged Mode :** One LSB = 390 mV.

DS1/DS1C RX Line Code

AMI; B8ZS

Decoding Rules :

- **AMI :** +1 ➤ 1 and -1 ➤ 1.
- **B8ZS :** 0V10V1 ➤ 000000. +1 ➤ 1 and -1 ➤ 1 except in 0V10V1.

DS1/DS1C RX Framing

DS1 Format : SF (D4); Ft only; ESF (Fe); T1DM (DDS); unframed.

DS1C Format : Framed or unframed.

DS1/DS1C Frame Synchronization Criteria

DS1 (T1DM)

- **Reframe :** 5 successive correct timeslot 24 bytes followed by 14 successive correct Ft bits followed by 6 successive correct Fs bits.
- **Frame Loss :** 3 in any 12 successive frames containing errors in either the F bits or timeslot 24.

DS1 (SF)

- **Reframe :** Ft bits - 14 successive error-free.
- **Frame Loss :** Ft bits - 3 in any 7 errored.
- **Multiframe :** Fs bits - 6 successive error-free.
- **Multiframe Loss :** Fs bits - 2 in any 4 errored.

DS1 (ESF)

- **Reframe :** Fe bits - 14 successive error-free.
- **Frame Loss :** Fe bits - 3 in any 7 errored.

DS1 (Ft only)

- **Reframe :** Ft bits - 14 successive error-free.
- **Frame Loss :** Ft bits - 3 in any 7 errored.

DS1C Reframe :

- **F Bits :** 8 error-free, then
- **M Bits :** next "011X" sequence error-free.

DS1C Frame Loss :

- **F Bits :** 3 in error between successive M4 bits, or
- **M Bits :** 3 errors in any 3 consecutive "011" sequences.

Multilevel : If the RX configuration requires synchronization at more than one level the sync processes occur sequentially with the above criteria.

ESF False-Framing Protection : When ESF framing is selected this feature is activated by selecting CRC measurements in result B. A message "FALSE-FRAMING PROTECTION ACTIVE" is displayed in the Results section of the CRT. With this feature active, the complete sync process is :

- 14 successive error-free Fe bits.
- One or more error-free CRC checks in the following decisecond.

DS1/DS1C RX Data

Patterns : PRBS 2^{20}-1, (D20+D17+1=0); a 14-zero limit may be selected.

8-bit word fully programmable.

All-ones word.

Note : If the input signal is DS1C framed, then this signal must be formed by stuffing, multiplexing and scrambling two DS1 digroups.

Traffic : The input signal may be live traffic for all but logic error measurements.

DS1/DS1C Pattern Synchronization Criteria

Sync Loss : Sync loss is deemed to have occurred if the error ratio exceeds ~1/6 as measured over a decisecond.

Sync Gain : Sync is regained after 40 error-free clock periods.

DS1 Timeslot Extraction

DS1 Timeslot Format :

Multi-customer DDS (DS0B).
56 kbit/s single-customer DDS.
Dataport single-customer (except 56 kbit/s).
56 kbit/s circuit-switched (PSDC).
64 kbit/s clear channel.

For 56 kbit/s circuit-switched operation the format is DDDDDDDS where

D is data
S is signaling bit (frames 6, 12 etc) (S = 1 in other frames)

For the other formats refer to the DS0 RX Format section.

Timeslot Data : When demultiplexing of the RX Input to channel or DDS customer level is selected, then the channel or customer data may be selected as for the DS0 Receiver.

With 56 kbit/s PSDC selected, the choice of test patterns is the same. As with clear channel and 56 kbit/s DDS, the data received is not available for protocol analysis.

Data inversion may be selected for the receipt of inverted data from a PSDC loopback. Note that in this case the signaling bits are not inverted.

DS0A Synchronization Criteria :

Sync Gain : Byte 1 = byte 5.

Sync Maintenance : 160 error-free byte comparisons before 20 with errors (byte comparison is byte 1 with byte 5).

Sync Loss : 20 errored byte comparisons before 160 which are error-free.

DS0B Synchronization Criteria : If the RX configuration requires demultiplexing at a lower level (ie DS0B to single-customer), the multi-customer frame sync criteria are as described in the DDS Sub-Rate Frame Synchronization Criteria section.

Error Correction : If the RX configuration requires demultiplexing to a 64 kbit/s channel carrying 2.4, 4.8 or 9.6 kbit/s iterated dataport service (DS0A), error correction can be selected. Note that error correction is not available for a 56 kbit/s dataport channel.

DS0 RECEIVER

DS0 Bipolar Input

Validity : All DS0.

Modes : Terminated; monitor.

Connector : WECO Bantam.

Impedance :

Terminated : 100 Ω balanced (nominal), transformer-coupled.

Monitor : 2 kΩ balanced (nominal), transformer-coupled.

DS0 RX Level : DSX-0. The sampling threshold is set to sample DSX-0 at 1.2 V above or below zero level.

DDS Logic Input

Validity : DS0A.

Direction : Near; Far.

With the DS0A interface selected for both TX and RX, the selection of Near or Far is commoned with the transmitter.

Connector : WECO Bantam - Tip = Near, Ring = Far.

Impedance : 10 kΩ unbalanced (nominal).

Input Levels :

TTL High : > 2.0 V (Logic 0).

TTL Low : < 0.8 V (Logic 1).

DS0 RX Rate

64 kbit/s (nominal).

DS0 RX Clocks

Shared with DS0 TX Clocks - see section in Transmitter specification.

DS0 RX Format

DDS DS0A :

XDDDDDDC for sub-rate services (2.4, 4.8 or 9.6 kbit/s);
DDDDDDDC for 56 kbit/s service
where D is data,
C is control or status
X is don't care.

DDS DS0B :

SDDDDDDC for sub-rate services (multi-customer) (2.4, 4.8 or 9.6 kbit/s);
DDDDDDDC for 56 kbit/s service
where D is data,
C is control or status,
S is sub-rate frame sequence.

Clear Channel : DDDDDDDD where D is data.

DS0 RX Data

Patterns :

511-bit (2^9-1) PRBS. (D9+D5+1=0).
2047-bit (2^{11}-1) PRBS. (D11+D9+1=0).
All-ones word
8-bit word, fully programmable
} Bits 1 and 8 restricted for DDS; bit 8 restricted for PSDC

Protocol Mode : Received data is output over the rear-panel serial datalink but no internal measurements (bit, frame, etc) are available. However, ALARM duration measurements and bit monitor functions are available simultaneously.

This feature is available only for sub-rate DDS and is not available with alternating loopbacks.

Return Code Mode : Used in conjunction with the transmitter for the acknowledgment of MJU routing or the setting up of latching loopbacks.

Alternating Loopback : While testing using alternating loopbacks, test pattern selection is restricted to :

511-bit PRBS (D9+D5+1=0).
2047-bit PRBS (D11+D9+1=0);

For these test patterns a choice of "Continuous" or "From Alternating Loopback" is offered in the receiver. The latter must always be selected when receiving from an alternating DDS loopback.

It is not assumed that the test pattern bytes have maintained their byte identity through the loopback process.

DS0 Pattern Synchronization Criteria

Sync Loss : Sync loss is deemed to have occurred if the error ratio as measured over a decisecond exceeds ~1/5.

Sync Gain : Sync gain is deemed to have occurred if the error ratio as measured over a decisecond is less than ~1/5.

DDS Sub-Rate Frame Synchronization Criteria

Sync Gain : Searches for 20 consecutive correct frame bits in the following sequences according to the service rate :

01100 for 9.6 kbit/s.

0110010100 for 4.8 kbit/s.

01100101001110000100 for 2.4 kbit/s.

Sync Loss : 2 frame errors in any 6 frame bits.

DDS Secondary Channel

Interleave Factor : DDS secondary channel is implemented by modifying every 3rd control bit (bit 8).

Sync Gain : Locks to an initialization sequence of 6 consecutive zeros in the secondary channel.

Sync Loss : Loses sync on detecting 12 consecutive ones in the secondary channel. A search for a following initialization sequence commences automatically.

Test Patterns : 511-bit PRBS; 2047-bit PRBS.

Protocol : As with primary DDS channels, the received data can be transmitted over the rear-panel serial link.

ALARM INDICATORS (front panel)

These indicators are illuminated whenever the alarm condition exists. They are NOT hierarchical.

The indication remains for 500 ms beyond the duration of the alarm condition.

The following alarm conditions are indicated :

Signal Loss
DS1C Frame Loss
DS1 Frame Loss
DS0B Frame Loss
Errors/Hits Detected
Pattern Sync Loss
Yellow Alarm
AIS
X-Bit (set to zero)

ERROR DETECTION

DS1C

BPV/Code, Frame, Test Pattern bit errors.

Digroup : Frame errors :

T1DM : F bits and frame bits in timeslot 24.
SF : Ft and Fs.
ESF : Fe.
Ft only : Ft.
CRC errors (ESF only).
Test pattern bit errors.

Digroup Datalink : Test pattern bit errors (ESF, and "Ft only").

Digroup T1DM R-Channel : Test pattern bit errors.

DS1

BPV/Code, CRC (ESF only), Test Pattern bit errors.

Frame errors -

T1DM : F bits and frame bits in timeslot 24.
SF : Ft and Fs.
ESF : Fe.
Ft only : Ft.

Note : Code Error Rules

AMI : Each BPV = one error.
B8ZS : Each BPV not contained in 0V10V1 = one error.

DS1 Datalink

Test Pattern bit errors.

Datalink types :

ESF framing - 4 kbit/s datalink.
Ft only framing - 4 kbit/s link.
T1DM framing - 8 kbit/s.

DS1 Timeslot Extraction

Test Pattern bit errors.

DDS sub-rate frame errors (2.4, 4.8 and 9.6 kbit/s DS0B).

DS1 Timeslot Format :

Multi-customer DDS (DS0B).
56 kbit/s single-customer DDS (before error correction).
Dataport sub-rate single-customer (before or after error correction).
56 kbit/s circuit-switched (PSDC).
64 kbit/s clear channel.

For 56 kbit/s circuit-switched operation the format is DDDDDDDS where

D is data
S is signaling bit (frames 6, 12 etc) (S = 1 in other frames)

For the other formats refer to the DS0 RX Format section.

DS0

DS0B (DDS) : Sub-rate framing errors (except 56 kbit/s). Customer level test pattern bit errors. Secondary channel test pattern bit errors.

DS0A (DDS) : Test pattern bit errors. Secondary channel test pattern bit errors.

Clear Channel : Test pattern bit errors.

ERROR PERFORMANCE MEASUREMENTS

▫ Real-Time Clock

Fundamental Period : 1 decisecond (nominal).
Settability : ± 50 ppm at 25 °C (nominal).
Stability : Crystal-controlled -0/+50 ppm including 5-year aging.
Display : Displays of time and date are presented on Page 4 of the CRT.
TIME Format : Time 14 hrs 31 mins 12 secs (example).
DATE Format : Date 24 January 1987 (example).
Both can be set at any time (time display resolution 1 second).

Battery Back-Up : The real-time clock and calendar remain operational during line power failures and when the instrument is switched off.

Elapsed Time

Function : The instrument can monitor the time which has elapsed since the start of a gating period. This facility is available in all GATING modes.
Display : In these modes the ELAPSED TIME display can be selected for display.

▫ Gating Periods

Modes

Manual : Controlled by START/STOP key.
Interval : START key controls start of gating period. End of gating period normally controlled by the internal timer but this can be overridden by the START/STOP key.
Minimum Interval : 1 second.
Maximum Interval : 99 days 23 hrs 59 mins 59 secs.
Resolution : 1 second.
Repeat Interval : START/STOP key controls the start of the first gating period. End of gating periods normally controlled by the internal timer but this can be overridden by the START/STOP key. The START/STOP key ends the sequence of gating periods as well as terminating the current gating period.
Minimum Interval : 1 second.
Maximum Interval : 99 days 23 hrs 59 mins 59 secs.
Resolution : 1 second.
Short (repeats) : As for Repeat Interval but with a short period restricted to a choice of 1 second, 15 seconds, 5 minutes or 15 minutes.
Dead Time : In repeat modes there is NO dead time between gating periods.
Power Failure : In the event of a loss of line power to the instrument during a gating period, measurement results and settings are retained in non-volatile memory. When line power returns the instrument automatically continues gating from the point in the period reached at the time of interruption.

▫ Measurement Results

Two error types can be accumulated simultaneously whenever two types of error can be present. These must be chosen prior to the start of a gating period. Two selected results, Result A and Result B, may be displayed simultaneously.

The form of display, eg Async EFS, can be chosen before, during or after a gating period.

Error Results

Error Count :
Display Format : 7-digit display for < 10,000,000 errors; 2-digit mantissa, 2-digit exponent display for ≥ 10,000,000 errors.
For CRC error counts, an incorrect CRC checksum is counted as one error.

Error Ratio :
Display Format : 2-digit mantissa, 2-digit exponent display.
For CRC error ratio results, the number of clocks is used as the base. For all other ratio results, the number of bits sampled is used as a base.
Error Seconds : Both synchronous and asynchronous.
Error-Free Seconds : Asynchronous.
% Error-Free Seconds : The number of error-free seconds expressed as a percentage of the number of seconds in the gating period.
Display Format : XX.XXXX% or 100.00%.
Validity : Valid for all gating modes and error types.

Display Update

Single Modes : Non-exponent format displays update every 100 ms to show the cumulative result.

Exponent format displays update every second to show the cumulative result.
Repeat Modes : The displays update only at the end of each gating period. Consequently no results are displayed during the first gating period.
Result Hold : After a single gating period or set of gating periods (repetitive) the final result is held until a new gating period is initiated. If the configuration is modified in the meantime the previous result remains until the new gating period is initiated.

Error Analysis

These measurements are based on CCITT Recommendation G.821. Analysis is available for all error sources and gating modes.
% Availability : The number of available seconds during a gating period expressed as a percentage of the number of elapsed seconds.

Availability is as defined in CCITT Rec. G.821. A system becomes "available" when the error ratio measured in 1 second intervals is better than 1×10^{-3} for 10 or more consecutive seconds, ie minimum available period is 10 seconds.

A system becomes "unavailable" when the error ratio measured in 1 second intervals is greater than 1×10^{-3} for 10 or more consecutive seconds.

For the purpose of determining availability, pattern loss, frame loss and signal loss seconds are simply considered as seconds with error ratios exceeding the availability threshold. Power loss seconds are discarded.

If CRC errors are being analyzed, the availability criterion is 320 CRC errors in a second. This CRC error rate corresponds to a BER of 1×10^{-3} with randomly distributed bit errors.

% Unavailability : The number of unavailable seconds during a gating period expressed as a percentage of the number of elapsed seconds.

% Severely-Errored Seconds : The number of seconds during the available time in a gating period which have an error ratio worse than the availability threshold expressed as a percentage of the available time expressed in seconds (as per CCITT Rec G.821).

% ES : The number of seconds which contain errors during the available time in a gating period expressed as a percentage of the available time in seconds.

% Degraded Minutes : The number of 60 second (1 minute) intervals (excluding severely-errored seconds) during which the error ratio is worse than a threshold 1×10^{-6} expressed as a percentage of the available time in minutes (excluding severely errored seconds).

Alarm Duration

The following alarm durations are measured in seconds :

- Instrument Power Loss
- Signal Loss (except for DS0 Clear Channel)
- AIS (DS1 and DS1C signals)
- DS1C Frame Sync Loss
- DS1 Frame Sync Loss
- DS0B Frame Sync Loss
- Pattern Sync Loss

DS1 JITTER MEASUREMENTS (Option 001)

Jitter Amplitude Measurement

Range 0.00 to 13.00 UI pk-pk (nominal) in 0.01 UI steps.
Accuracy specified in range 0.00 to 10.00 UI pk-pk.

Intrinsic Jitter : < 0.02 UI pk-pk (typical) at 25°C;
< 0.06 UI pk-pk 0 to 50°C.

Basic Accuracy : 3.0% ± 0.03 UI (typical) + pattern dependency.

Internal Filters :

- **LP :** 2 Hz to 40 kHz.
- **HP1 + LP :** 10 Hz to 40 kHz.
- **HP2 + LP :** 8 kHz to 40 kHz.

Filter Tolerances :

- **Upper Cutoff LP :** 40 kHz ± 10%.
- **Lower Cutoff LP :** 2 Hz ± 70%.
- **Lower Cutoff HP1 :** 10 Hz ± 10%.
- **Lower Cutoff HP2 :** 8 kHz ± 10%.

Jitter Analysis

Hit Threshold : Can be set in the range 0.05 to 10.00 UI pk-pk (resolution 0.01 UI pk-pk).

Hit Count : Totalizes the number of times the measured jitter exceeds the hit threshold during the measurement interval.

Display Format : 7-digit display for < 10,000,000 hits.
2 digit mantissa, 2-digit exponent display for ≥ 10,000,000 hits.

Hit Bit Count : Totalizes the number of DS1 clock periods during which the measured jitter amplitude exceeds the hit threshold during the measurement interval.

Display Format : 7-digit display for < 10,000,000 hit bits.
2 digit mantissa, 2-digit exponent display for ≥ 10,000,000 hit bits.

Jitter Hit Bit Ratio : The ratio of the DS1 hit bit count to the total number of DS1 bits in the measurement interval.

Jitter Hit Seconds : The number of seconds in which the hit threshold has been exceeded at least once during the measurement interval. (Measured asynchronously.)

Jitter Hit-Free Seconds : Converse of Jitter Hit Seconds.

DATA LOGGING

Logging Device

Internal Printer - this is the default device. External HP-IB printer in listen-always mode.

Remote Control : When logging to an external HP-IB printer remote is restricted to RS-232-C since the HP-IB port must be set to talk-only in order to drive the external HP-IB printer.

Note : When using the internal printer, no output is available to external printers and vice versa.

Internal Printer

Type : Impact, 24-column.

Capacity : Approximately 6000 lines per paper roll (19 metres).

Print Modes

Manual : At any time the manual PRINT key can be used to cause the displayed "results" (Results, Analysis, Alarm Durations, RX Level or Monitor Word) to be printed on the selected device.

Note that this is the only case in which the RX Level and Monitor Word are logged.

Log During Gating : Logs time of occurrence and number of errors/jitter hits in the errored seconds/jitter hit seconds measurement selected for Result A. The result may be logged for every error/hit second, or only when the error ratio or hit bit ratio in 1 second exceeds a preset threshold 1×10^{-N}, where N can be set in the range 2 to 7.

Alarms : The printer always prints the occurrence of an alarm change, ie a change in the state of :

- Power Loss
- Signal Loss (DS1 or DS0)
- External Clock Loss (DS1 or DS0)
- Frame Sync Loss (DS1C, Digroup, MFA, DS1 or Sub-rate)
- AIS
- Yellow Alarm
- X-Bit
- Pattern Sync Loss
- RX Level too high or low
- RX Level imbalance

As with normal triggered logging, these alarm printouts are printed in a single line together with a timestamp.

An alarm printout is also given for any alarm which is active at the start of a single gating period or sequence of repetitive gating periods.

Squelch : A print-squelch mechanism is implemented such that error/hit second printouts occur on a maximum of 10 consecutive seconds. On the occurrence of the next trigger-free second, the number of elapsed trigger-seconds is printed together with the total number of errors (or hits) accumulated during the squelched period.

End of Gating Summary : Logs measurement results, error performance analysis and alarm durations always or when Result A exceeds a threshold 1×10^{-N}, where N can be set in the range 2 to 7. The user may choose to log all results or only those selected for display.

PROTOCOL ANALYZER PORT

Application

Permits direct connection of a protocol analyzer such as the HP 4952A. When this mode is selected, the internally-generated test pattern is substituted with the protocol analyzer test pattern. The HP 3787B acts as a DS1 channel access unit allowing the following channels to be accessed :

- DDS sub-rate primary/secondary channels
  - 2.4 kbit/s/133 bit/s, 4.8 kbit/s/266 bit/s, 9.6 kbit/s/533 bit/s.
- DS1 Extended Super-Frame (ESF) 4 kbit/s datalink.
- DS1 Super-Frame (SF) 4 kbit/s Fs bits.
- DS1 T1 Data Multiplexer (T1DM) 8 kbit/s R-channel.

Connector : 24-pin D-shell.

Function : Full duplex, TX and RX clocks supplied, no handshake lines.

GENERAL

REMOTE OPERATION

Type

HP-IB or RS-232-C. Either can be selected and configured on Page 5 of the CRT.

HP-IB

Implementation : SH1; AH1; T5; TE0; L4; LE0; SR1; RL1; PP0; DC1; DT0; C0.

Modes :

ADDRESSABLE : When the HP 3787B is operated with an external controller the addressable mode allows control of front-panel functions except the HP-IB address and the POWER switch. All current results and flags are available and a local lockout facility is provided. There is no remote control of screen paging.

TALK-ONLY : This mode permits the HP 3787B to be used without an external controller. It is intended for the output of results to a peripheral such as a printer. In this mode the format and frequency of results are as set up for the internal printer operation.

RS-232-C

Connection : Hardwired or Modem.

Duplex : Half or Full. Only Full Duplex is available if hardwired is selected.

Handshake : Xon/Xoff (Full Duplex only)

- **RX Only :** HP 3787B paces rate at which it receives data by sending Xon/Xoff.
- **TX Only :** Controller paces rate at which HP 3787B transmits data by sending Xon/Xoff.
- **RX & TX :** As for both above.
- **Enq/Ack :** On/off.
- **DTR On/Off :** For users who require manual control of DTR this field can be brought into the display by selection of an internal DIL switch.

Baud Rate : 300, 600, 1200, 1800, 2400, 4800, 9600, or SELECT.

CI High Rate : 300, 600, 1200, 1800, 2400, 4800, 9600.

CI Low Rate : 300, 600, 1200, 1800, 2400, 4800, 9600.

Parity : Even, Odd, ones or zeros.

Stop Bits : 1 or 2.

POWER SUPPLY

Mains Input

Voltage Ranges : 88 to 127 V AC, nominally 120 V AC; 176 to 254 V AC, nominally 240 V AC.
Line Frequency : 48 to 66 Hz.
Power Consumption : Approx 110 VA (both ranges).

DC Battery Input (Option 002)

Voltage Range : -40 to -57 V DC, nominally -48 V DC.
Power Consumption : Typically 70 Watts.
Earthing : The positive pole of the DC supply will be grounded.

PHYSICAL

Dimensions

130 mm high; 425 mm wide; 420 mm deep (5.12 x 16.73 x 16.54 inches).

Weight

10.4 kg (23 lb).

Environment

Operating Temperature : 0 to 50°C.
Storage Temperature : -40 to 75°C.

ORDERING INFORMATION

STANDARD INSTRUMENT

The HP 3787B is supplied complete with :

- DS1C/DS1/DS0 interfaces
- Internal printer
- HP-IB and RS-232-C remote control
- Protocol analyzer interface
- Front and rear panel DDS external clock interfaces
- DS1 external clock interface
- An extra DS1/DS1C Output on rear panel
- RS-232-C and protocol analyzer port test plug
- Power cord
- Front panel cover
- Front panel handles
- A set of Operating and Service Manuals

OPTIONS

Option 001 - DS1 Jitter Measurement

Adds DS1 jitter measurement and analysis capability to the HP 3787B.

Option 002 - DC Power Supply

Allows the HP 3787B to be powered from a -40 to -57 V DC supply in addition to AC line power operation.

Option 909 - Rackmount Fittings

Allows the HP 3787B to be fitted in a 19-inch wide equipment rack. The instrument front panel cover is not supplied with this Option.

Option 910 - Additional Operating and Service Manuals

One set of Operating and Service Manuals is supplied with the HP 3787B. This Option provides an extra set.

ACCESSORIES AVAILABLE

HP 15668A - Front Panel DDS Clock Cable

5-pin DIN (female) to 5-pin DIN (female), 3 metres (10 feet) long.

HP 15669A - Rear Panel DDS Clock Cable

9-pin D-type (male) to 9-pin D-type (male), 3 metres (10 feet) long.

Transit Case - HP Part Number 9211-2655

Installation 8

Introduction

This section provides installation instructions for the Hewlett-Packard Model HP 3787B Digital Data Test Set and its accessories. This section also includes information about preparation for use, packaging, storage and shipment.

Preparation For Use

WARNING

TO AVOID THE POSSIBILITY OF INJURY OR DEATH. THE FOLLOWING PRECAUTIONS MUST BE FOLLOWED BEFORE THE INSTRUMENT IS SWITCHED ON.

(A) NOTE THAT THE PROTECTION PROVIDED BY GROUNDING THE INSTRUMENT CABINET MAY BE LOST IF ANY POWER CABLE OTHER THAN THE THREE- PRONGED TYPE SUPPLIED IS USED TO COUPLE THE AC LINE VOLTAGE TO THE INSTRUMENT.

(B) IF THIS INSTRUMENT IS TO BE ENERGIZED VIA AN AUTO-TRANSFORMER TO REDUCE OR INCREASE THE LINE VOLTAGE, MAKE SURE THAT THE COMMON TERMINAL IS CONNECTED TO THE NEUTRAL POLE OF THE POWER SOURCE.

(C) THE POWER CABLE PLUG SHALL ONLY BE INSERTED INTO A SOCKET OUTLET PROVIDED WITH A PROTECTIVE EARTH CONTACT. THE PROTECTIVE ACTION MUST NOT BE NEGATED BY THE USE OF AN EXTENSION CORD WITHOUT A PROTECTIVE CONDUCTOR (GROUNDING).

Power Requirements

The instrument requires a power source of 115V AC (+6%, -27%) or 230V AC (+6%, -18%), 48 to 66Hz single phase. Total power consumption is typically 110VA.

Instruments containing Option 002 can also be operated from an external DC power source in the range -40V to -57V DC (see DC Battery Operation on Page 8-2). Power consumption is typically 70W.

Line Voltage Selection and Fuse

The line voltage is selected by the rear panel switch labeled 120V and 240V.

CAUTION

Before connecting the instrument to a power outlet, ensure that the line voltage selector is correctly set and that a fuse of the correct rating is fitted.

Fuse ratings are given in the table below:

Table 8-1. Fuse Ratings

Nominal Line	Fuse Rating	HP Part Number
120V	3AT/250V	2110-0381
240V	1.5AT/250V	2110-0304

Power Cord

This instrument is equipped with a three-wire power cord. When connected to a power outlet, this cord grounds the instrument case. The type of power cord shipped with each instrument depends on the country of destination. Refer to Figure 8-1 for part numbers of the power cord and plug configurations available. The number shown below each plug is the Hewlett-Packard part number of a power cord equipped with that plug. If the appropriate power cord is not included with the instrument, notify the nearest Hewlett-Packard Sales and Service Office and a replacement will be provided.

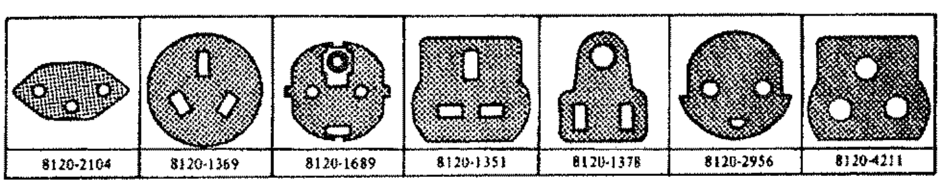


Figure 8-1 Plug Configurations

The color code used in each power cable is given below:

Line : Brown
Neutral : Blue
Ground : Green/Yellow

DC Battery Operation (Option 002 only)

The HP 3787B can be powered from an external DC supply via the BATTERY terminals on the rear panel. For correct operation, the HP 3787B ground terminal should also be connected to ground. The following figure illustrates how the HP 3787B should be connected to a DC supply.

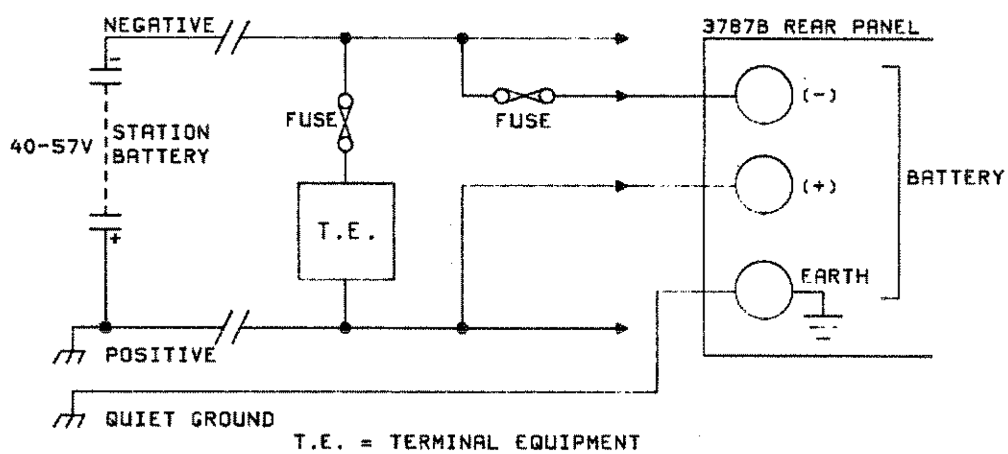


Figure 8-2 Connecting a DC Supply to the HP 3787B (Option 002 Instruments)

Ensure that a 3AT/250V fuse, HP Part Number 2110-0381, is fitted in the fuse holder next to the BATTERY terminals on the HP 3787B rear panel.

WARNING

ENSURE THAT THE SAFETY COVER IS IN POSITION OVER THE AC INPUT SOCKET WHEN THE INSTRUMENT IS WIRED FOR DC OPERATION.

CAUTION

Failure to connect the DC supply to the HP 3787B as shown in Figure 8-2 may result in damage to the instrument.

Operating Environment

Temperature - The instrument may be operated in temperatures from 0 degrees centigrade to +50 degrees centigrade.

Humidity - The instrument may be operated in environments with humidity up to 95% at 40°C. However, the instrument should also be protected from temperature extremes which may cause condensation within the instrument.

Altitude - The instrument may be operated at altitudes up to 4600m (15,000ft).

Air flow - The air intake to the instrument is via a fan mounted on the rear panel. The air exhaust is via the perforated side panels. To provide adequate cooling, an air gap of approximately 3 inches should be maintained around the instrument.

Preventive Maintenance

Internal Batteries

WARNING

DO NOT INCINERATE OR MUTILATE THE BATTERIES. THEY MAY BURST OR RELEASE TOXIC MATERIALS CAUSING PERSONAL INJURY.

The lithium batteries on A5, used as a power supply for the nonvolatile memory and the real time clock, should be checked annually. Life expectancy of the battery is approximately 5 years.

Fan Filter

The fan filter should be removed from the instrument and cleaned in hot soapy water every six months or more frequently if the instrument is operated in a hostile environment.

Mating Connectors

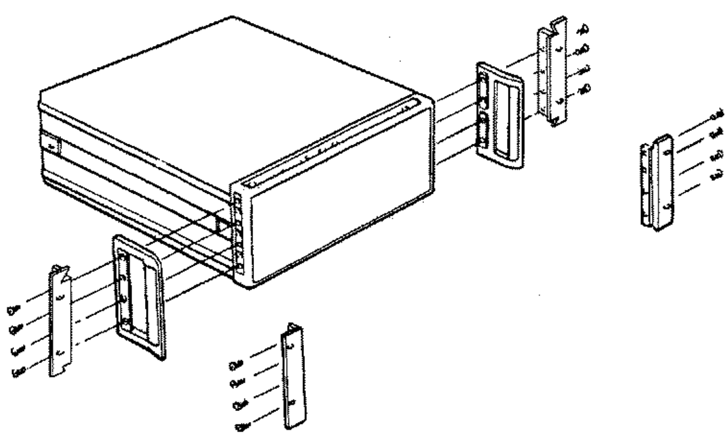
Table 8-2 lists the connectors which mate with the instrument ports.

Table 8-2. Mating Connectors

Connector	Type	Mating Connector Part Number
RX INPUT DS1/1C	WECO 310	HP 1251-0695
RX INPUT DSX-0	BANTAM	HP 1251-3060
TX OUTPUT DSX-1/1C	WECO 310	HP 1251-0695
TX OUTPUT DSX-0	BANTAM	HP 1251-3060
DS0 CLOCKS	5-PIN AUDIO DIN PLUG-F	HP T48733
DDS CLOCK	9 W D SUBMIN	HP 1251-0216 (plug) HP 1251-1551 (hood) HP 1251-0215 (lock)
RS-232-C	25 W D SUBMIN	HP 1251-0063 (plug) HP 1251-1438 (hood)
PROTOCOL ANALYZER	25 W D SUBMIN	HP 1251-0063 (plug) HP 1251-1438 (hood)
HP-IB	AMPHENOL	HP 1251-0293
DS1 CLOCK INPUT	BNC (75Ω)	HP 1250-1448

Rack Mounting

Figure 8-3 illustrates the Rack Mount Kits available for use with the HP 3787B. Refer to the Operating Environment on Page 8-3 regarding the cooling of rack mounted instruments.



The operating instruction tray may prevent rack mounting immediately above another instrument. A standard bottom cover (without tray) HP Part number 5060-9447, may be used.
The original feet should be fitted to the new cover.

Figure 8-3 Rack Mount Kits

Printer Paper Replacement

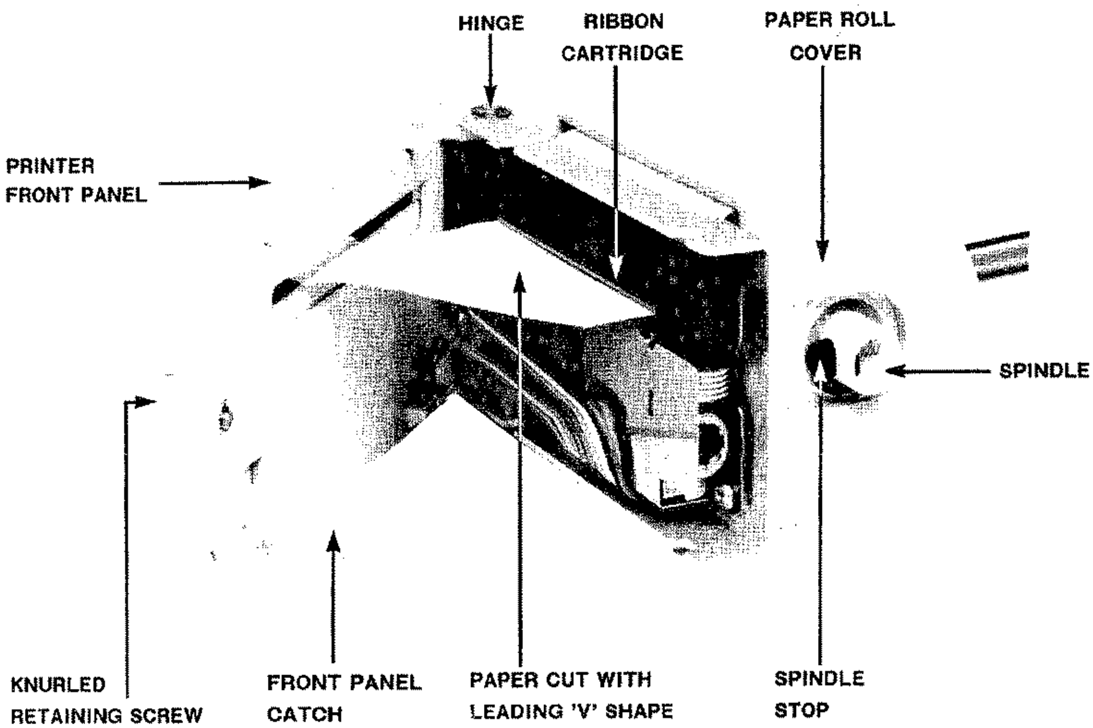


Figure 8-4 Internal Printer

New rolls of paper for the HP 3787B internal printer can be ordered under HP Part Number 9270-1151. These are standard rolls of paper, 2 1/4 inches wide.

Use the following procedure (see Figure 8-4) to fit a new roll.

1. Switch the HP 3787B power off.
2. Unscrew the Knurled Retaining Screw on the left hand side of the printer assembly and withdraw the complete assembly from the instrument.
3. Remove the Paper Roll Cover. This is a friction fit on the printer assembly bracket.
4. Press in the Spindle Stop, remove and discard the spent paper roll.
5. Fit the new paper roll by pressing the Spindle Stop and sliding the new roll onto the Spindle.
6. Ensure that the end of the paper is cut clean and square or in a leading "V" shape (see Figure 8-4).
7. Pass the end of the paper into the printer loading slot.
8. Push the paper into the slot until resistance is felt.

9. Replace the Paper Roll Cover.

10. Switch the HP 3787B on.

11. Press the HP 3787B front panel printer (PAPER) key until paper emerges from the printer assembly front panel slot.

NOTE

If any difficulty is experienced in feeding the paper through the printer assembly, check that the edge of the paper is cut clean and repeat steps 6 to 11.

12. When the paper has been successfully fed through the printer assembly, switch the instrument power off, replace the assembly in the instrument and secure with the Knurled Retaining Screw.

Printer Ribbon Replacement

New ribbons for the HP 3787B internal printer can be ordered under HP Part Number 9282-1005.

Use the following procedure (see Figure 8-4) to fit a new ribbon:

1. Switch the HP 3787B power off.

2. Unscrew the Knurled Retaining Screw on the left hand side of the printer assembly and withdraw the complete assembly from the instrument.

3. Gently push back the printer Front Panel Catch and open up the printer assembly as shown in Figure 8-4.

4. Push the Ribbon Cartridge on the edge to eject as indicated and lift it away from the printer.

5. Place the new Ribbon Cartridge onto the printer assembly and gently push into place (ensure paper is between the ribbon and the metal impact plate).

6. Close the printer assembly, replace it in the instrument and secure using the Knurled Retaining Screw.

Hewlett-Packard Interface Bus (HP-IB)

This section contains information for installing the HP 3787B Digital Data Test Set into a Hewlett-Packard Interface Bus (HP-IB) system.

The HP-IB is Hewlett-Packard's implementation of the IEEE Standard 488-1978 (Digital Interface for Programmable Instrumentation). This standard defines a physical interface and protocol which enables the remote control of instrumentation systems.

Connection to the HP-IB

Logic Levels

The HP-IB logic levels are TTL compatible i.e. the true (1) state is 0 to +0.5V DC and the false (0) state is +2.5 to +5V DC.

Mating Connector

HP1251-0293;
Amphenol 57-302040

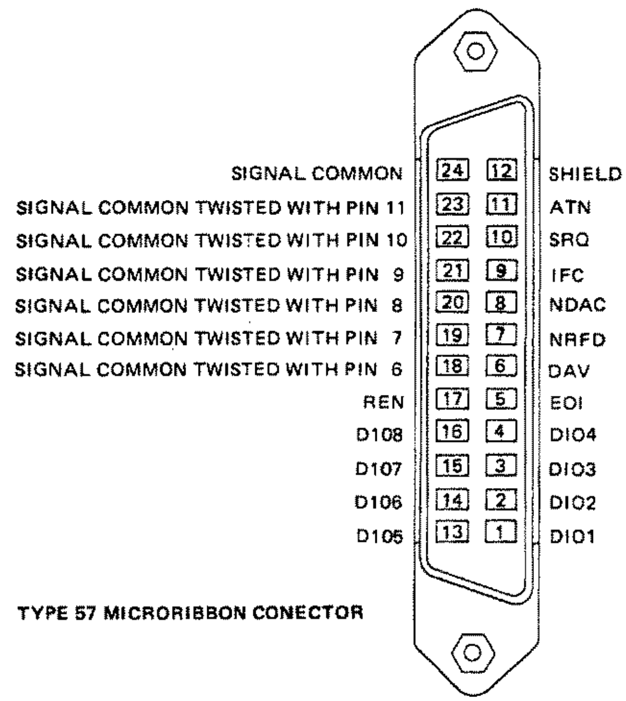


Figure 8-5 HP-IB (rear panel) Connector

The HP-IB connector on the rear panel of the HP 3787B provides the physical interface to connect the HP 3787B into an HP-IB system. The figure above illustrates the connector pin configuration. Devices in the HP-IB system may be interconnected in any suitable arrangement (star, delta, etc) using the HP-IB cables listed in the table below.

Table 8-3. HP-IB Cables

Part Numbers	Cable Lengths
HP 10833A	1m (3.3ft)
HP 10833B	2m (6.6ft)
HP 10833C	4m (13.2ft)
HP 10833D	0.5m (1.6ft)

External Printer Control

(See Section 5 Printing/Logging Results).

The HP 3787B as an Addressable Device.

Setting the HP 3787B to the ADDRESSABLE mode permits the instrument to be controlled remotely via a separate HP-IB controller.

Refer to Connecting the HP 3787B to HP-IB (Section 6) for information on address selection. Each device in the HP-IB system requires a unique address to enable the controller to differentiate between devices. The following table provides the ASCII character equivalents of the HP-IB address codes.

Table 8-4. HP-IB Address Codes

Address	Address Characters	
Decimal	**Talk**	**Listen**
0	@	SP
1	A	!
2	B	"
3	C	#
4	D	$
5	E	%
6	F	&
7	G	'
8	H	(
9	I	)
10	J	*
11	K	+
12	L	,
13	M	-
14	N	.
15	O	/
16	P	0
17	Q	1
18	R	2
19	S	3
20	T	4
21	U	5
22	V	6
23	W	7
24	X	8
25	Y	9
26	Z	:
27	[	;
28	\	<
29	]	=
30	Ø	>

RS-232-C Interface

This section contains information for connecting the HP 3787B to a RS-232-C interface. The HP 3787B is configured as Data Terminal Equipment (DTE).

Connection to the RS-232-C System

Logic Levels

The RS-232-C functions are ON when the voltage at the receiver is more positive than +3V and OFF when more negative that -3V. The function is not defined in the transition region between +3V and -3V.

Mating Connector

HP 1251-0063 (plug)
HP 1251-1438 (hood)

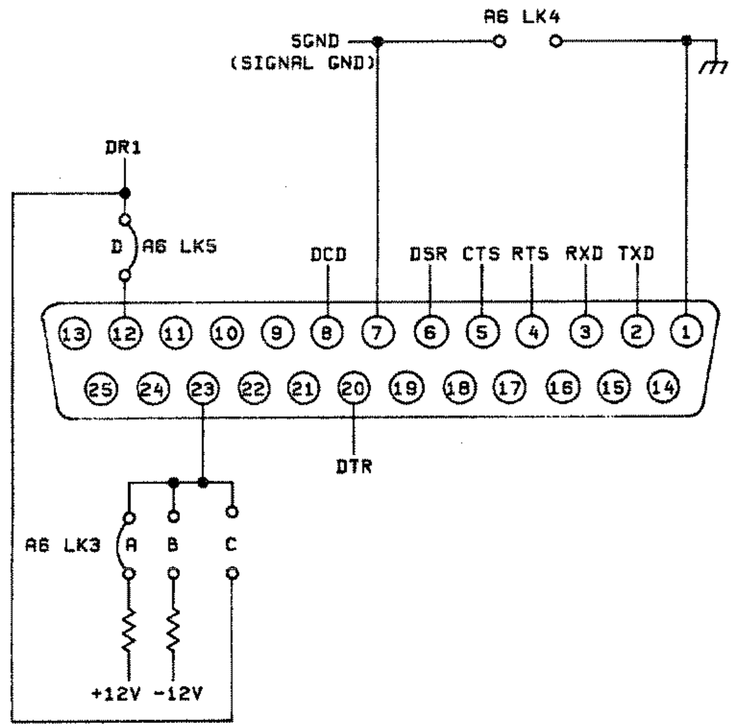


Figure 8-6 RS-232-C (rear panel) Connector

RS-232-C Interface Cables

Refer to Connecting the HP 3787B to RS-232-C (Section 6) for information relating to interface cables.

RS-232-C Remote Control

Refer to Section 6 for all relevant information on preparing the HP 3787B for RS-232-C Remote Control.

Dual Rate Modems (data rate selection)-CH/CI

Some modems can operate at two data rates. Normal operation is at the higher rate, e.g. 1200 bps, but if the circuit quality is poor and causing errors then the modem can be switched to a "fallback" rate, say 300 bps, which, although slower, is less prone to errors.

RS-232-C defines two circuits, CH and CI, as data rate selectors. The circuit definitions are identical except that CH is used by the DTE to control the modem speed, whilst CI is used by the modem to control the DTE. CH is used where the DTE is controlling the transmission speed, for example, at the "originate" end of a dialup line. CI is used where the modem is indicating received transmission speed so that the DTE can adapt to it - for example at the "answer" end of the dialup line.

The two circuits are functionally mutually exclusive and have both been assigned to pin 23 of the RS-232-C. The decision as to which circuit to implement, i.e. whether the DTE or DCE is to source the signal, is left to the modem manufacturer. However, a dual-speed modem that can be used to originate or answer a data transmission ideally needs both circuit CH and circuit CI.

The widely adopted solution is to use the normal pin, 23, for circuit CH and to redefine pin 12 (normally Secondary Received Line Signal Detect) as circuit CI.

A set of links on the Rear Panel Assembly, A6, accommodates different configurations of the data rate CH/CI functions. The instrument is shipped with links in the position shown in "Connection to the RS-232-C System" (Page 8-9) which is compatible with AT & T 212A-type modems.

The following examples show how the links are used to prepare the HP 3787B for connection to a dual rate modem.

Example 1 - Setting the HP 3787B to adapt to the modem speed (e.g. at the "answer" end of a dialup line, or at one end of some leased lines).

The HP 3787B can adapt to the modem speed if the modem provides circuit CI.

	Link Settings			
	A	B	C	D
If CI is on pin 23 If CI is on pin 12*	Open Closed	Open Open	Closed Open	Open Closed

Example 2 - Setting the HP 3787B to control the modem speed (e.g. at the "originate" end of a dialup line, or at one end of some leased lines). The HP 3787B can control the modem speed if the modem has circuit CH on pin 23 of its RS-232-C connector.

	Link Settings			
	A	B	C	D
To select the higher speed To select the lower speed	Closed Open	Open Closed	Open Open	Open Open

*The instrument is shipped with the links in this position.

Manual Control Of DTR

NOTE: Changing A5 S202 causes loss of NVM including stored panels.

Normally, when the HP 3787B is configured for modem connection, it holds DTR (Data Terminal Ready) signal permanently on. However, if switch bit "5" on A5 S202 is set to "1" prior to switching the HP 3787B on, then manual control of DTR is available via an additional selection on the Remote Configuration Page (5). The display will then be as follows with a choice of DTR - OFF or ON:

```
Source  RS232  Status:Local    Error:  0

Connection   Modem      Duplex  Full

   Enq/Ack  On         Xon/Xoff   Off

       DTR  Off

     Speed   1200

(7 Bit Data) Parity  0's   Stop Bits 1
```

DTR (Data Terminal Ready) can be turned on prior to manually originating or answering a call, or it will turn on automatically in response to a signal on Ring Indicate.

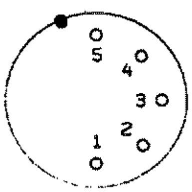
DTR on the display will always reflect the state of the Data Terminal Ready signal at the interface.

During the progress of a call Data Terminal Ready will be on, but can be manually turned off to cause the modem to disconnect.

In all cases, if DSR (Data Set Ready) does not turn on within 60 seconds of DTR (Data Terminal Ready) being turned on then DTR (Data Terminal Ready) will turn off. If Data Set Ready turns off, for example at the end of a call, then Data Terminal Ready will turn off.

As for normal operation, Data Terminal Ready and Data Set Ready must be on before communications can proceed.

DS0 CLOCKS Connector (front panel)



Pin 1	Ground
Pin 2	8 kHz byte clock
Pin 3	8 kHz byte clock (complement of pin 2)
Pin 4	64 kHz bit clock
Pin 5	64 kHz bit clock (complement of pin 4)

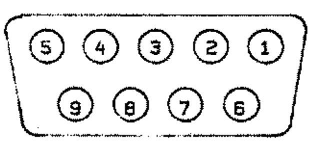
TTL levels

Figure 8-7 DS0 CLOCKS Connector

DDS CLOCK Connector (rear panel)

As an alternative to the front panel DDS CLOCKS input, the DS0 interfaces can be driven by DDS clocks connected to the rear panel 9-pin, D-Type, DDS CLOCK input. The rear panel DDS clocks are normally supplied from D4 Channel Banks.

Pin designations for the rear panel connector are shown in Figure 8-8.



Pin 1	Power supply, +5V DC (terminated but not used by HP 3787B)
Pin 2	Ground
Pin 3	64 kHz clock (TTL)
Pin 4	8 kHz clock (TTL)

Figure 8-8 DDS CLOCK Connector

NOTE

The two screws securing the D-type connector to the rear panel can be replaced by hexagonal lock connectors (HP Part Number 1250-2942) which will enable D-type mating connectors with securing screws to be fixed to the rear panel.

Storage And Shipment

Environment

The instrument may be stored or shipped in environments within the following limits:

Temperature.......................... -40 degrees centigrade to +75 degrees centigrade
Humidity.. up to 90% at 65°C
Altitude.. 15,300m (50,000ft)

The instrument should also be protected from temperature extremes which may cause condensation within the instrument.

Packaging

Tagging for Service - If the instrument is being returned to Hewlett-Packard for service, please complete one of the blue repair tags located at the front of the service manual and attach it to the instrument.

Original Packaging - Containers and material identical to those used in the factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number and full serial number. Also mark the container "FRAGILE" to ensure careful handling.

Other Packaging - The following general instructions should be used for repacking with commercially available materials:

(a) Wrap the instrument in heavy paper or plastic. (If shipping to Hewlett-Packard office or service center, attach a tag indicating type of service required, return address, model number and full serial number.)

(b) Use a strong shipping container. A double-walled carton of 350 pound test material is adequate.

(c) Use a layer of shock absorbing material 70 to 100mm (3 to 4 inch) thick around all sides of the instrument to provide firm cushioning and prevent movement inside the container. Protect the control panel with cardboard.

(d) Seal the shipping container securely.

(e) Mark the shipping container "FRAGILE" to ensure careful handling.

(f) In any correspondence, refer to instrument by model number and full serial number.

Glossary of Terms

AIS
Alarm Indication Signal, normally all 1's on a DS1 signal.

ALTERNATING LOOPBACK
Loopback which requires frequent transmission of code (alternating with data) to hold the loop. The HP 3787B transmits alternate 1 second periods of code and data.

AMI
Alternate Mark Inversion. Line code used at 1.544Mbit/s T1.

APS
Automatic Protection Switch. Automatically switches between primary and standby lines depending on error ratio.

AVAILABILITY
Percentage of time that satisfactory data communication service is available. The term "satisfactory" implies that terminal equipment and cables are in working order. CCITT define availability in terms of error ratios - a system becomes "available" when the error ratio measured in 1 second intervals is better than 10^{-3} for 10 or more consecutive seconds (ie the minimum available period is 10 seconds).

AUTO
When the receiver DS1/DS1C level selection is set to Auto, the receiver input will accept signals over the whole range of DSX/DSX-LO-MON.

B8ZS
Binary 8 Zeros Substitution. One of the line codes used at the 1.544Mbit/s T1 rate. A code is transmitted when 8 consecutive zeros occur to ensure that there are sufficient transitions for clock recovery.

BASEBAND
In the Digital Data System, baseband refers to a digital stream designated to contain data for only one customer station, that is, not multiplexed. For example, data on a customer's loop and at the DS0A level is at baseband.

BIPOLAR RZ (BPRZ)
Bipolar return-to-zero - a three-level code in which alternate "ones" change in sign (for example, 1011 becomes +1, 0, -1, +1) and transitions between adjacent "ones" pause at the zero voltage level.

BIPOLAR NRZ (BPNRZ)
Bipolar non-return-to-zero - same as bipolar RZ except transitions between adjacent "ones" do not stop at the zero level.

BPV
Bipolar Violation - a violation of the alternating +1, -1 pattern in a ternary (three-level) code.

BYTE
In the Digital Data System, a byte refers to a group of eight consecutive binary digits associated with a single user.

BYTE STUFFING
In DDS, the technique by which the speed of a digital stream is increased by repeating bytes and transmitting them at a faster rate. The information content of the stream is not increased.

C-BIT
Bit 8 of customer bytes. Set to 1 when data is transmitted to ensure at least one 1 per byte. Set to 0 when control codes are transmitted.

CLEAR CHANNEL
All 8 bits of each byte are data.

CONTROL SIGNALS
Signals in byte format used for synchronization, status and remote testing.

CP
Circuit Pack - a unit that contains part of the DDS circuitry and can be inserted into equipment shelves where required.

CRC
Cyclic Redundancy Code. A code used with extended superframe which is calculated on the transmitted data, transmitted itself, and compared

with an identical calculation performed on the received data. The CRC check is used as a method of performance monitoring.

CROSS-CONNECT
A piece of hardware used to interconnect multiplexers with line terminating equipment and other multiplexers. Access to signals is often available through jacks associated with a testboard located near the cross-connect.

CSU
Channel Service Unit - a unit located on the customer premises that provides a DDS channel for use with the customer's logic and timing recovery circuitry. (also see T1CSU)

DATA MODE
A condition of the DSU with respect to the transmitter in which its Data Set Ready and Request to Send circuits are ON and it is presumably sending data.

DATAPORT
A unit which allows direct digital access to channels in a D4 bank. This gives the bank a voice/data sharing capability.

DDS
Digital Data System.

DIGINET
A data transmission service similar to the DDS but cross connected at the End Office rather than being back hauled to a Hub Office.

DIGROUP
One of the two DS1 signals multiplexed to form a DS1C signal.

DOWN-TIME
Time during which data communication is not available or unsatisfactory (see "availability") due to malfunction. Time required for preventive maintenance is not included.

DS0
Digital Signal at the 0 level - a bipolar non-return-to-zero signal at the 64 kbit/s rate.

DS0A
Single customer subrate data, reiterated or byte stuffed up to the 64kbit/s rate.

DS0B
Multi customer subrate data multiplexed up to the 64kbit/s rate.

DS1
Digital Signal at the first level - a bipolar return-to-zero T1 signal at the 1.544 Mbit/s rate.

DSA
Digital Serving Area - the geographic area covered by all DDS customer stations that home on a single DDS hub office.

DSU
Data Service Unit - a terminal located on the customer premises for the purpose of accessing the Digital Data System through a standard EIA or CCITT interface.

DSX-0
Digital Cross-Connect used to interconnect equipment at the DS0 level. Note that no cross-connects are used in local DDS offices.

DSX-0A
The DS0 digital cross-connect at a DDS hub office where individual customer circuits are properly routed and where test access (the STC) is available.

DSX-0B
The DS0 digital cross-connect at a DDS hub office used to connect T1DM and T1WB4 ports with SUBMUXs and to connect T1DM and/or T1WB4 ports together for through or bypass circuits.

DSX-1,2,3
Digital Cross-Connect used to interconnect equipment, provide patch capability, and provide test access at the DS1, DS2, or DS3 level respectively.

DT BOARD
Driver/Terminator Board - used in an OCU shelf when individual OCU outputs are required for the shelf.

DTSS
Digital Transmission Surveillance System. A system based in Chicago to remotely monitor DDS DS1 facilities.

DUPLEX
A facility which permits transmission in both

directions simultaneously (sometimes referred to as full duplex).

DUTY CYCLE
The percent of a single pulse period (for a "1") during which the voltage is non-zero.

EFFICIENCY OF DATA COMMUNICATIONS
Percentage of one-second intervals in which data is delivered free of error.

EFS
Error Free Seconds.

END OFFICE
In a DDS local area, a local office that passes on toward the hub only circuits that entered the office over local loops.

ERROR SECONDS
Seconds during which an error occurs.

ESF
Extended Super Frame. The ESF format "extends" the DS-1 superframe structure from 12 to 24 frames (4632 bits) and divides the 8kbit/s framing bit position pattern previously used for basic frame and robbed-bit- signaling synchronization into a 2kbit/s channel for basic frame and robbed-bit-signaling synchronization, a 2kbit/s channel for a cyclic redundancy code check code (CRC-6) and a 4kbit/s channel for a terminal to terminal data link.

FDM
Frequency Division Multiplexing - the process of combining a number of analog signals into a single analog signal by an orderly assignment of frequency bands.

FOUR-WIRE CIRCUIT
A facility which provides two full-time, independent channels for transmission in opposite directions. Historically associated with two wires for transmission and two wires for reception.

FRAME
On a T1 line a frame refers to 193 binary digits. 24 customer bytes plus one network framing bit.

Fs
Framing signaling used in Superframe (SF) format. The 193rd bit of even numbered frames.

Ft
Framing terminal used in Superframe (SF) format. The 193rd bit of odd numbered frames.

HIT
Any disruption of service that persists for less than one second.

HL-222 HL-96NY
Interface packs providing bipolar/unipolar conversion of NRZ data for an integrated sub rate multiplexer or driver terminator. HL-96NY responds to alternating loopback and HL-222 responds to latching loopback.

HUB
An office in the Digital Data System that combines the T1 data streams for a number of local offices into signals suitable for transmission over DDS facilities, and/or provides test access by means of an STC.

IDLE CODE
A bipolar violation sequence transmitted by the DSU to indicate no data is being sent over the loop.

IDLE MODE
A condition of the DSU with respect to the transmitter in which its Data Set Ready circuit is ON but its Request to Send circuit is OFF and it is sending idle code.

ISMX
Integrated Subrate Multiplexer - an arrangement used only in end offices in which the subrate multiplexing function is contained within the OCU shelves. Up to ten subrate channels of uniform speed can be grouped onto a single 64 kbit/s T1DM or T1WB4 port with this arrangement.

LATCHING LOOPBACK
Type of loopback which is set with a transmitted code and is maintained until released with another transmitted code.

LOCAL LOOP
The cable pairs between a DDS office and customer premises.

LOGIC NEAR/FAR
For testing an unbalanced unipolar DS0A signal

with balanced type test jacks connected across the line. The tips of the transmit and receive jacks are connected to the NEAR (customer) side and the rings to the FAR (network) side.

LOOPED DS1 CLOCK
The clock extracted from the DS1 data, received by the instrument is used as the instrument transmitter clock.

LOOPING (LOOPBACK)
A testing procedure that causes a received signal to be returned to the source.

MAP CODE
A code which is provided by a latching loopback device to indicate when it is looped. The map code is displayed on the HP 3787B Transmitting display when the Receiving display Pattern is set to Return Codes.

MJU
Multi-Point Junction Unit - a unit employed at a DDS hub office to link together three or more segments of a multi-point circuit.

MSU
Multi-Point Signaling Unit - a device used in conjunction with the DDS test equipment to isolate and test various segments of a DDS multi-point circuit.

MULTIPLEX CROSS-CONNECT
See DSX-0B.

MULTI-POINT
A customer circuit with more than two end points. Usually one end point is designated as the "control" station.

OCU
Office Channel Unit - a terminal located in the Central Office for the purpose of accessing the data transmissions.

PCM
Pulse Code Modulation - the process in which analog signals are sampled, quantized, and coded into a digital bit stream.

PRBS
Pseudo Random Binary Sequence. A known reproducible sequence which has many of the characteristics of a truly random sequence.

PSDC
Public Switched Digital Capability - a dedicated, stand alone, 56kbit/s digital network.

R-CHANNEL
Remote channel at 8kbit/s which uses 1 bit (channel 24 bit 7) per frame for the DDS Digital Transmission Surveillance System.

RETURN CODES
An HP 3787B receiving mode which causes returned transmission operation codes (e.g. MJU selection) to be decoded and displayed with the transmission information.

S-BIT
The subrate framing bit inserted in bit 1 of the customers 8 bit byte.

SF
Super Frame format (also known as D4 or multiframe format) comprises 12 frames and has one framing bit per frame. The least significant bit from each timeslot in frames 6 and 12 is used for "robbed bit signaling". The framing bits comprise 6 Fs bits used to synchronize the the robbed bit signaling, and 6 Ft bits used for basic frame synchronization.

SHORT-HAUL
Referring to transmission distances typically less than 50 miles.

SQUELCH
Printer squelch inhibits print out when the logging trigger occurs on ten consecutive seconds.

SRDM
Subrate Data Multiplexer - a unit that combines a number of data streams at or below some basic rate (2.4, 4.8, 9.6 kbit/s) into a single 64 kbit/s time division multiplexed signal.

STATION
A point on a customer's premises at which a digital access line is terminated.

STC
Serving Test Center - a test location established to control and maintain circuit layout records (CRL), receive customer trouble reports, assist in the

checkout of newly-installed stations, perform trouble localization, and coordinate service restorals.

STRAIGHT-AWAY TEST
A test procedure in which a test signal is transmitted from one point to a receiver at a different point.

SUBRATE
In DDS, this refers to a data speed of 9.6, 4.8 or 2.4 kbit/s.

T1
The digital 1.544Mbit 24 channel transmission which carries both voice and data.

T1ASU
T1 Automatic Switching Unit - monitors the line code bipolar violation error rate of the regular T1 line and switches service automatically to a standby line when the bipolar violation error rate exceeds a preset threshold. The threshold for DDS is normally 1×10^{-6}

T1CSU
T1 Channel Service Unit - a unit which provides an interface between customer premises data equipment and telephone company T1 transmission lines.

T1 LINE
A digital transmission line that carries data at the 1.544 Mbit/s rate (DS1 level); in DDS it is used primarily for short-haul links.

T1DM
T1 Data Multiplexer - a multiplexer that is capable of time division multiplexing up to twenty three 64 kbit/s channels and synchronizing information into a DS1 signal. T1DM uses a specific frame format, see Appendix C.

T1WB4
A voice-data multiplexer capable of combining up to twelve data channels at the 64 kbit/s rate with PCM encoded voice channels from a D-type channel bank. The resultant TDM format is a DS1 signal. Now obsolete.

T1WB5
A voice-data multiplexer similar to the T1WB4 except all 24 channels can be used to carry data.

TDM
Time Division Multiplexing - the process of combining a number of digital signals into a single digital stream by an orderly assignment of time slots.

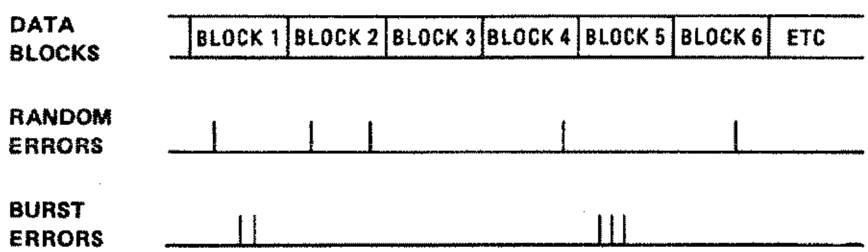
TEST MODE
A condition of the DSU in which its transmitter and receiver are inoperative due to a test in progress on the line.

THRU MODE
An HP 3787B mode which provides retransmission of the received signal with monitoring and data insertion facilities.

CCITT G.821 Error Analysis

ERROR DISTRIBUTION

DATA THROUGHPUT IS ASSESSED BY THE DATA BLOCK RETRANSMISSION RATE. RANDOM ERROR DISTRIBUTION HAS A MORE DISRUPTIVE INFLUENCE ON DATA THROUGHPUT THAN BURST ERRORS.



Introduction

In general, information in a communication system is transmitted in data blocks. To guarantee an error-free path, most communication systems use an error correction system which retransmits a block containing one or more errors (normally called error correction by retransmission). Data throughput on these systems is measured in terms of block retransmissions.

In a transmission system using error correction by retransmission, randomly distributed single bit errors present a more disruptive influence than an equal number of bit errors occurring in short bursts since a single error in a block will require a retransmission of the entire block.

For some time, long-term mean error ratio was used to provide a measure of the error performance of a digital communication path. This technique, commonly referred to as Bit Error Rate (BER), assumed that errors occurring in a network resulted from randomly distributed events. In practice, however, it has been found that the majority of errors within a network occur in bursts. Since data block retransmission is dependent on the error distribution, long-term BER results cannot be used to give an indication of the path data throughput rate.

CCITT G.821 analysis provides a true characteristic error performance of a digital communication path. The basic error performance is based on the number of error-free seconds (or error-free second blocks) that occur during the test period.

CCITT G.821 ERROR ANALYSIS

THE HP 3787B PROVIDES ERROR ANALYSIS AS RECOMMENDED BY CCITT G.821.

ERROR ANALYSIS IS DEFINED BY CCITT IN TERMS OF THE PERFORMANCE OBJECTIVES FOR AN INTERNATIONAL 64 kbit/s CIRCUIT. THE MEASUREMENT PARAMETERS ARE:

% AVAILABILITY

% UNAVAILABILITY

% SEVERELY-ERRORED SECONDS

% ERROR SECONDS

% DEGRADED MINUTES

CCITT G.821 Measurement Parameter Definitions

CCITT G.821 analysis divides the total test period into segments called "available" and "unavailable" time. The error performance measurements refer to available time only. During unavailable time, the error performance measurements remain unaltered. Error performance is evaluated by determining the percentage error-free seconds that occur during the available time of the test period.

% Availability

The number of available seconds during a gating period expressed as a percentage of the number of elapsed seconds.

A system becomes "available" when the error ratio measured in 1 second intervals is better than 1×10^{-3} for 10 or more consecutive seconds (ie minimum available period is 10 seconds).

A system becomes "unavailable" when the error ratio measured in 1 second intervals is greater than 1×10^{-3} for 10 or more consecutive seconds.

For the purpose of determining availability - pattern loss, frame loss and signal loss are simply considered as seconds with error ratios exceeding the availability threshold. Power loss seconds are not included in the analysis.

If CRC errors are being analyzed, the availability criterion is different since the CRC is a block error check. Here the availability threshold for CRC errors is 320 CRC errors in a second, implying a BER of 1×10^{-3} with the bit errors randomly distributed. For CRC error counts, an incorrect CRC checksum is counted as one error. The CRC error ratio uses the number of clocks as the base (eg 320 CRCs errored in one second gives an error ratio of 320/1.544 M). All other ratio results use the number of bits sampled as a base.

% Unavailability

The number of unavailable seconds during a gating period expressed as a percentage of the number of elapsed seconds.

A system becomes "unavailable" when the error ratio measured in 1 second intervals is greater than 1×10^{-3} for 10 or more consecutive seconds.

% Severely-Errored Seconds

The number of seconds during the available time in a gating period which have an error ratio worse than the availability threshold, expressed as a percentage of the available time expressed in seconds.

% Error Seconds

The number of seconds which contain errors during the available time in a gating period expressed as a percentage of the available time in seconds.

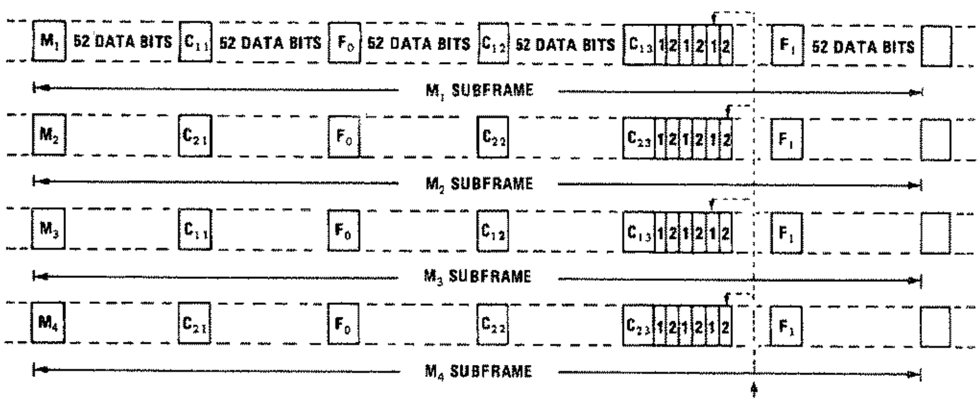
Note : The HP 3787B also provides % Error-Free Seconds over total time as defined in AT&T Pub 62411 and BSTR Pub 41451.

% Degraded Minutes

The number of 1 minute intervals (excluding severely-errored seconds) during which the error ratio is worse than a threshold 1×10^{-6} expressed as a percentage of the available time in minutes (excluding severely-errored seconds).

DS1C, DS1 and DS0 Frame Formats

DS1C (3.152 Mbit/s) FRAME FORMAT



$F_0 = 0$ $F_1 = 1$ *Time slots available for stuffed bits (see Note)*

M_1, M_2, M_3, M_4 = 011X where X is an alarm service digit, and is set to 1 for no alarm (X-Bit).
M_1 to M_4 are subframes which constitute a multi-frame.

C_{11}, C_{12}, C_{13} = 000 when no stuffing has occurred. 111 when stuffing has taken place in input 1.

Note: The timeslot available for stuffing input 1 is the third slot for input 1, following C_{13}

DS1C Frame Format

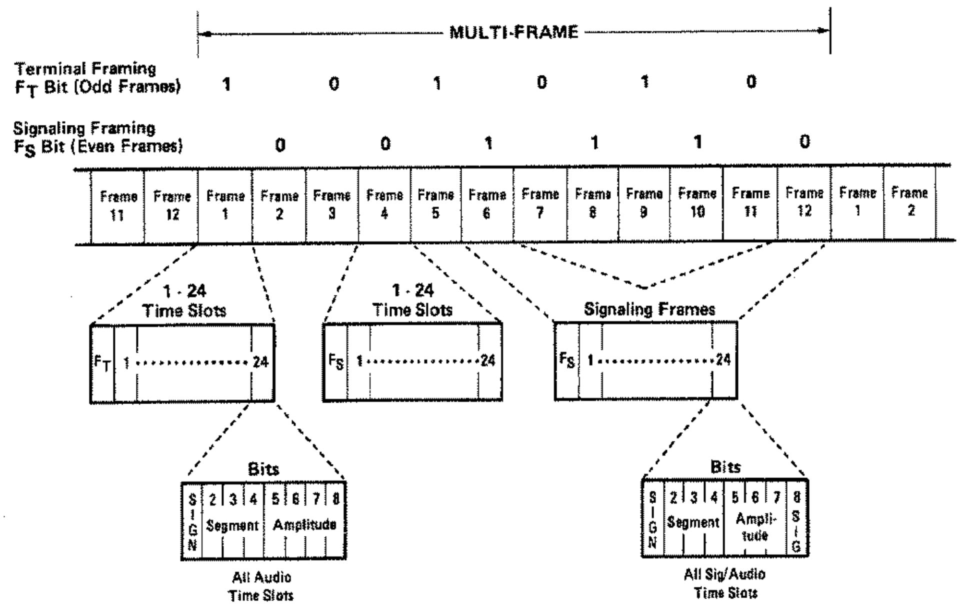
The DS1C (3.152 Mbit/s) signal is achieved by time division multiplexing two DS1 (1.544 Mbit/s) data streams. Pulse stuffing is required because the frequency of the two DS1 streams (digroups) may not be the same. The DS1C format consists of one control bit followed by 52 data bits. The data block is composed of alternating or interleaved bits from the two digroups. The control bits consist of :

1. The F-bit sequence which allows the demultiplexer receiver to separate the data from the control bits (frame alignment signal).

2. The M-bits allow the demultiplexer receiver to identify the stuffed bit positions in the bit sequence (multi-frame alignment).

3. The C-bits indicate pulse stuffing has taken place (stuffing control indicator word).

DS1 SUPER-FRAME (SF) FORMAT



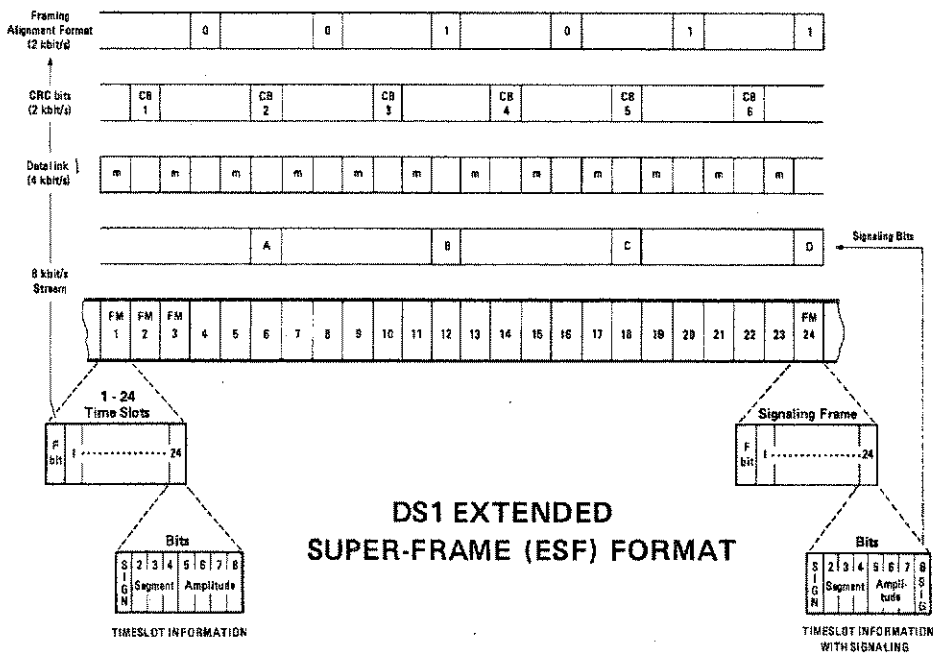
DS1 Super-Frame (SF) Format

The SF format combines 24 timeslots using 8000 Hz sampling and 8-bits/timeslot. When carrying PCM voice, signaling information is incorporated by using the least significant bit from each timeslot in frame 6 (A-bits) and frame 12 (B-bits), (sometimes called bit stealing). Framing is achieved using 1 bit per 24 timeslots.

24 x 8-bit/timeslot	=	192 bits
1 x 1-bit framing/24 timeslots	=	1 bit
Therefore, 1 frame	=	193 bits

The 193rd framing bit is alternated between Framing Terminal (Ft) bits (odd frame numbers) and Framing Signaling (Fs) bits (even frame numbers). The Ft bit pattern is 101010 and is used to gain frame alignment. The Fs pattern is 001110 and is used for signaling bit alignment. A total of 12 frames are required to maintain frame alignment and carry the Fs bits - this is known as a Superframe (SF) or multi-frame.

The system bit rate is 8000 frames/sec x 193 bits/frame = 1.544 Mbit/s.



DS1 Extended Super-Frame (ESF) Format

The ESF format combines 24 timeslots using 8000 Hz sampling and 8-bits/timeslot. When carrying PCM voice, signaling information is incorporated by using the least significant bit from each timeslot in frames 6 (A-bits), 12 (B-bits), 18 (C-bits) and 24 (D-bits). One bit is added every 24th timeslot to provide frame alignment, CRC bits and a 4 kbit/s datalink.

24 x 8-bit/timeslot	=	192 bits
1 x 1-bit	=	1 bit
Therefore, 1 frame	=	193 bits

The system bit rate is 8000 frames/sec x 193 bits/frame = 1.544 Mbit/s.

The 193rd bit is used to carry the 2 kbit/s framing word, the Cyclic Redundancy Check (CRC) code and the 4 kbit/s Datalink (DL). A total of 24 frames are required to insert the 193rd bit information. The position of these bits within the 24-frame Extended Superframe (ESF) is as shown above.

The CRC is a 6-bit (CRC-6) polynomial check code calculated using the contents of each 24-frame ESF. The CRC calculated within a given ESF are always transmitted in the CRC-6 bit positions of the following ESF (ie ESFn+1) so that each transmitted ESF contains the CRC that was generated for the preceding ESF. At the receiver, the CRC is calculated for the ESFn as described, then compared to the CRC that has been extracted from ESFn+1. In the absence of transmission errors, the CRCs will be identical.

The CRC has the ability to detect most errors that occur on the T1 signal and can be used in various applications :

1. False framing protection (see note).

2. Automatic Protection Switching.
3. Terminal-to-Terminal performance monitoring.
4. Line verification after repair.

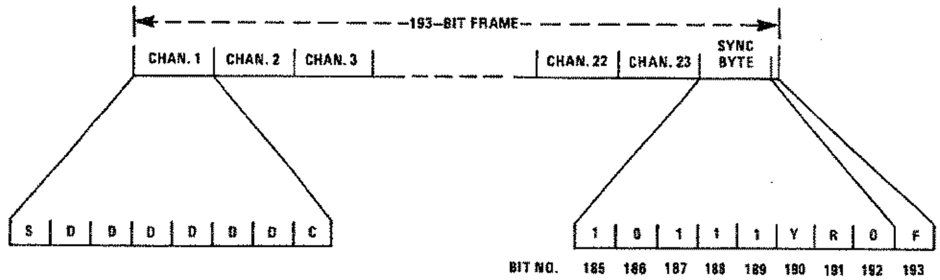
Note : Under certain conditions, it is possible for data to mimic the framing pattern. If a T1 terminal aligns to this false pattern then all data contained within a T1 will be corrupted. Since the CRC is also corrupted, checking the CRC once frame alignment is gained can be used to determine the validity of the framing candidate. The HP 3787B can use this technique to provide false frame protection (false frame protection is selectable).

The 4 kbit/s datalink has various applications :

1. Alarms and T1 CSU loopbacks.
2. Supervisory signaling.
3. Network configuration information.
4. Line performance channel.

The HP 3787B can drop and insert test patterns to the 4 kbit/s datalink or mux/demux the datalink to the protocol analyzer interface.

DS1 T1 DATA MULTIPLEXER (T1DM) FRAME FORMAT



D = INFORMATION BIT
C = NETWORK CONTROL BIT
F = BIT PATTERN = 100011011100
S = SUB-RATE FRAMING
Y = YELLOW ALARM – Set to '0' in alarm condition
R = 8 k REMOTE CHANNEL

DS1 T1 Data Multiplexer (T1DM) Format

In a T1 Data Multiplexer framed system, 24 channels are multiplexed, using 8000 Hz sampling. Each channel sample is grouped into 8-bit bytes. Framing is achieved using channel 24 and one extra bit (193rd bit) per frame. No signaling capability is required.

23 x 8-bit channels	=	184 bits
1 x 8-bit fast framing channel	=	8 bits
1 x 1-bit framing channel	=	1 bit
Therefore, 1 frame ($1/8000 = 125\mu s$)	=	193 bits

From this the system bit rate is derived as 8000 x 193 = 1.544 Mbit/s.

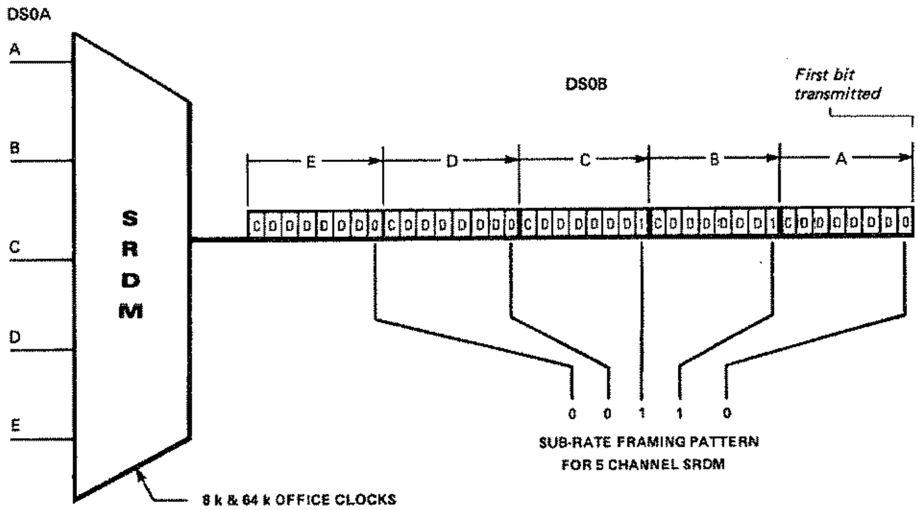
Timeslot 24 is used primarily for fast framing. The fast framing pattern in channel 24 is 101110. This pattern is inserted in bits 185, 186, 187, 188, 189 and 192 respectively of each frame. The remaining bits in timeslot 24 (ie bits 190 and 191) are used to transmit the Yellow alarm and provide an 8 kbit/s R-channel used for the DDS Digital Transmission Surveillance System (DTSS).

Yellow alarm is used to inform an upstream T1DM that the downstream T1DM cannot align to its transmitted DS1.

The DDS Digital Transmission Surveillance System (DTSS) is centered in Chicago and is used to remotely monitor the performance of the DDS DS1 facilities.

Bit 193 frame pattern is compatible with standard D4 channel bank framing.

DS0B SUB-RATE DATA MULTIPLEXER (SRDM) FRAME FORMAT



FRAMING FOR 10 CHANNEL SRDM = 0110010100
FRAMING FOR 20 CHANNEL SRDM = 01100101001110000100

DS0B Sub-Rate Data Multiplexer (SRDM) Frame Format

In a DS0B framed system, up to twenty 2.4 kbit/s, ten 4.8 kbit/s and five 9.6 kbit/s customer channels are multiplexed to 64 kbit/s. Each channel sample is grouped into 8-bit bytes. One bit is used for subrate (S-bit) framing, one bit is used as a network control bit (C-bit) and six bits are allocated for customer data.

20-channel SRDM	(6+2)/6 x 2.4 kbit/s	=	3.2 kbit/s
	3.2 kbit/s x 20	=	64 kbit/s
10-channel SRDM	(6+2)/6 x 4.8 kbit/s	=	6.4 kbit/s
	6.4 kbit/s x 10	=	64 kbit/s
5-channel SRDM	(6+2)/6 x 9.6 kbit/s	=	12.8 kbit/s
	12.8 kbit/s x 5	=	64 kbit/s

The framing pattern is always inserted in bit 1 of the customers 8-bit bytes (S-bit). The patterns for 5-, 10- and 20-channel DS0Bs are as follows :

5-channel	0 1 1 0 0
10-channel	0 1 1 0 0 1 0 1 0 0
20-channel	0 1 1 0 0 1 0 1 0 0 1 1 1 0 0 0 0 1 0 0

To maintain the 1/8 ones density on the T1 carrier, the C-bit is always set to a logic "1" when customer data is being transmitted. When a network control code is being transmitted (eg loopback), the C-bit is set to "0". Control codes always have at least one logic "1" present.

DDS SECONDARY CHANNEL – (DDS-2)

PRIMARY CHANNEL RATE	SECONDARY CHANNEL RATE
2400	133 1/3
4800	266 2/3
9600	533 1/3
56000	2666 2/3

Sub-rate Byte Format	=	C	D	D	D	D	D	D	S
56 k Byte Format	=	C	D	D	D	D	D	D	D

First bit transmitted

EVERY 3rd C-BIT IS USED FOR SECONDARY CHANNEL –

IE C C S C C S C C S C C S ETC

DDS Secondary Channel (DDS-2) Frame Format

The DDS secondary channel (DDS-2) is a companion digital transmission channel independent of the primary channel and at a lower bit rate.

The secondary channel is derived by replacing every 3rd C-bit with an encoded Secondary channel (S) bit.

The secondary channel rate can be calculated by dividing the primary channel rate by the number of primary channel data bits/byte (this is the data byte rate and also the C-bit rate), then dividing this by 3 (eg 2.4 k/6 = 400, 400/3 = 133 1/3).

To maintain the minimum 1/8 ones density on the T1 carrier, only customer channels with the subrate framing bit (S-bit) set to "1" are allowed secondary channels (ie 40% of DDS customers).

Displayed Messages and Remote Control Error Codes — D

Displayed Messages

The messages which can occur on the top line of the display are listed below with some additional notes. Only one message can be displayed at any one time. When more than one condition is active, a priority scheme determines which message is displayed.

DISPLAYED MESSAGE	NOTES
CLOCK RESET - BATT?	The internal clock was reset at power-up. The internal battery may have failed. The message will be cleared on the first keystroke.
COLD START	Nonvolatile Memory has been lost. The display settings and the stored panels will be set to their defaults. The message will be cleared on the first keystroke.
GATING IN PROGRESS	The operation attempted is not allowed while the instrument is making a measurement. The message is displayed for two seconds after the keystroke.
HIGH RX SIGNAL LEVEL	The receiver input level is higher than the upper limit for the level selected e.g. >3.6V with DSX-1 selected. The message appears only if the Normal Operation Receiving page is displayed with DS1 or DS1C interface levels.
KEYBOARD LOCKED	The operation attempted is not allowed while the keyboard lock is active. The keyboard lock On/Off selection is on display page 2. The message is displayed for two seconds after the keystroke.
LOOPBACK FAILED	When the receiver is set to look for DDS Return Codes, this message, displayed for two seconds, indicates failure to receive a mapcode after a DDS loopback operation. The message appears only if the Normal Operation Transmitting page is displayed.
LOW RX SIGNAL LEVEL	The receiver input level is lower than the lower limit for the interface selected e.g. <2.4V with DSX-1 selected. The message appears only if the Normal Operation Receiving page is displayed with DS1 or DS1C interface levels.
MJU BLOCK SUCCESSFUL	When the receiver is set to look for DDS Return Codes, this message displayed for two seconds, confirms an MJU blocking operation. The message appears only if the Normal Operation Transmitting page is displayed

MJU BLOCKING FAILED	When the receiver is set to look for DDS Return Codes, this message, displayed for two seconds, indicates failure of an MJU blocking operation. The message appears only if the Normal Operation Transmitting page is displayed
MJU ROUTING FAILED	When the receiver is set to look for DDS Return Codes, this message, displayed for two seconds, indicates failure to receive a valid HUB-ID and BRANCH SELECT CODE after an MJU routing operation. The message appears only if the Normal Operation Transmitting page is displayed.
MULTIFRAME SYNC LOSS	The multiframe sync loss message appears only when the Normal Operation Receiving page is displayed.
NO DSO CLOCKS	There is no DS0 clock signal at the Front/Rear port selected on the Normal Operation display.
NO DS1 INPUT TO LOOP	When the DS1 Clock is set to Looped a DS1 signal must be connected at the Receiver input. This message appears only when the Normal Operation Transmitting page is displayed.
NO EXTERNAL CLOCK	When the DS1 Clock is set to EXT, a DS1 clock signal must be supplied to the rear panel clock input. This message appears only when the Normal Operation Transmitting page is displayed.
POWER HAS CYCLED	This is the normal message at power switch-on or on power regain after a power loss. The message will be cleared on the first keystroke.
PRINTER DOWN	This message is displayed for 5 seconds.
RX SIGNAL IMBALANCE	There is >20% difference between the positive and negative peak input amplitudes. The message appears only if the Normal Operation Receiving page is displayed with DS1 or DS1C interface levels.
UNDER REMOTE CONTROL	The local operation attempted is only allowed when the instrument is in the Local mode. This message is displayed for two seconds.

Fatal Errors

When the instrument detects an internal malfunction, ! ! ! FATAL ERROR nnn DETECTED, is displayed. The numbers nnn are for fault location by the service engineer. Pressing any key twice (as instructed on the display) will cause the instrument to attempt a COLD START, i.e. attempt to restart with default settings.

Remote Control Error Codes

The remote control error codes are the codes which are returned to the controller in response to an ERR? command. These codes also appear on the Remote Control display (display page 5)

The codes apply to both HP-IB and RS-232-C control. and are grouped to give an indication type of error encountered.

Codes -100 to -199	Parse time errors (including, -160 to -163 RS 232 link errors).
Codes -200 to -299	Execution time errors.
Code 100	Self Test error.
Code 600	Jitter option not fitted.
Code -400 to -402	Instrument fault.

ERROR CODE TABLE

CODE	DEFINITION
-100	Command not recognized.
-101	Invalid character received.
-110	Command header error
-111	Header delimiter error
-120	Numeric argument error
-121	Wrong data type, numeric data expected
-122	Precision error; rounding occurred
-123	Numeric overflow
-129	Missing numeric argument.
-130	Mnemonic not recognized.
-131	Wrong data type, character expected.
-132	Wrong data type, string expected.
-133	Wrong data type, block type #A required.
-134	Data overflow, string or block too long.
-135	Error in #H block.
-139	Missing non-numeric argument.

-141	Command buffer overflow.
-142	Too many arguments.
-143	Argument delimiter error.
-144	Invalid message unit delimiter.
-150	Unexpected EOI.
-151	CR found without following LF.
-160	RS 232 link parity error.
-161	RS 232 link framing error.
-162	RS 232 link overrun error.
-163	RS232 link receiver buffer overflow.
-200	Unable to perform, generic execute error.
-201	Not executable in local mode.
-202	Settings lost due to RTL or PON.
-203	Trigger ignored.
-211	Legal command but settings conflict.
-212	Argument out of range.
-221	Busy at execution time.
-222	Insufficient capability or configuration.
-231	Input buffer full or overflowing.
-232	Output buffer full or overflowing.
-240	Command provided thru meta-message only.
-241	Command not implemented.
-250	Command illegal during gating.
-251	Command illegal when not gating.
-252	Commands in incorrect sequence.
-253	Command executable over HP-IB only.
-254	Command executable over RS 232 only.

-400 to -402	Instrument fault, code provides service information.
100	Self test failed
600	Jitter option not fitted

Alphabetical List of Remote Control Messages with Default Settings E

This Appendix contains an alphabetically arranged list of HP 3787B Remote Control Messages and the Default Settings associated with these Messages where applicable.

Regardless of the current set up the following Message sets the HP 3787B to the Default Settings and clears all HP-IB input and output buffers.

- RST : Reset HP-IB and RS-232-C.

Table E-1 Remote Control Messages

Command Description	Mnemonic	Page Reference	Default Setting
Alarm Duration Result	"ALD? n" n = PATTERN or 1 n = SUBR_FRAME or 2 n = DS1_FRAME or 3 n = DIGR_FRAME or 4 n = DS1C_FRAME or 5 n = AIS_SECS or 6 n = INST_POWER or 7 n = SIGNAL or 8	6-46	N/A
Alarm Duration Type	"ADT n" n = PATTERN or 1 n = SUBR_FRAME or 2 n = DS1_FRAME or 3 n = DIGR_FRAME or 4 n = DS1C_FRAME or 5 n = AIS_SECS or 6 n = INST_POWER or 7 n = SIGNAL or 8 "ADT?"	6-40	PATTERN
Actuate Loopback	"ALB"	6-21	N/A
TX Alarm Type DS1/DS1C	"ALT n" n = OFF or 0 n = YELLOW or 1 n = X_BIT or 2 n = AIS or 3 "ALT?"	6-29	OFF

Table E-1 Remote Control Messages

Alarm Status Register 1	"AL1?"	6-44	N/A
Alarm Status Register 2	"AL2?"	6-44	N/A
Alarm Mask Register 1	"AM1 n" n = NONE or Ø n = PAT or 1 n = SL1 or 2 n = SLØ or 4 n = CL1 or 8 n = CLØ or 16 n = FLC or 32 n = MFA or 64 n = FL1 or 128 n = FLB or 256 n = AIS or 512 n = XBT or 1Ø24 n = YAL or 2Ø48 n = ERR or 4Ø96 "AM1?"	6-43	8191
Alarm Mask Register 2	"AM2 n" n = NONE or Ø n = SLH or 1 n = SLL or 2 n = SLI or 4 "AM2?"	6-43	7
Output Analysis Result	"ANR? n" n = AVAIL or 1 n = UNAVAIL or 2 n = SEVERE_ES or 3 n = ERROR_SEC or 4 n = MINUTES or 5	6-46	N/A
Analysis Source	"ANS n" n = A or 1 n = B or 2 "ANS?"	6-40	A
TX APS Test Mode	"APM n" n = START or 1 n = NO_TRANSFER or 2 n = TRANSFER or 3 n = NO_RESTORE or 4 n = RESTORE or 5 "APM?"	6-28	START

Table E-1 Remote Control Messages

TX APS Error Rate	"APR r1,r2,r3,r4" r1 = 1.ØE-8 to 9.ØE-3 r2 = 1.ØE-8 to 9.ØE-3 r3 = 1.ØE-8 to 9.ØE-3 r4 = 1.ØE-8 to 9.ØE-3 "APR?"	6-28	All 1.ØE-8
Analysis Type	"ATY n" n = AVAIL or 1 n = UNAVAIL or 2 n = SEVERE_ES or 3 n = ERROR_SEC or 4 n = MINUTES or 5 "ATY?"	6-40	AVAIL
Audio Control	"AUD n" n = OFF or Ø n = ON or 1 "AUD?"	6-50	OFF
Output MJU Branch Select Code	"BSC?"	6-47	N/A
Error Add Rate (ESF_CRC Errors)	"CAR n" n = 1.ØE-8 to 3.ØE-4 "CAR?"	6-27	1.0E-8
Clear (Common Capability)	"CLR"	6-52	N/A
Configuration (Common Capability)	"CON" "CON?"	6-52	N/A
Date	"DAT y,m,d" y = 1987 to 2Ø5Ø m = 1 to 12 d = 1 to 31 "DAT?"	6-15	N/A
DS0 Clock Source	"DCS n" n = FRONT or 1 n = REAR or 2 "DCS?"	6-16, 6-30	FRONT
RX Dataport Error Correction	"DEC n" n = OFF or Ø n = ON or 1 "DEC?"	6-33	OFF
TX Dataport Error Rate	"DER n" n = OFF or Ø n = LOW or 1 n = HIGH or 2 "DER?"	6-28	OFF

Table E-1 Remote Control Messages

TX DDS Link Type	"DLT n" n = SINGLE or 1 n = MULTI or 2 "DLT?"	6-20	SINGLE
TX Error Add Method	"EAD n" n = SINGLE or 1 n = RATE or 2 "EAD?"	6-27	SINGLE
TX Error Add Rate (Logic, BPV/Code)	"EAR n" n = 1.ØE-8 to 9.ØE-3 "EAR?"	6-27	1.ØE-8
TX Error Add Type	"EAT n" n = OFF or Ø n = LOGIC or 1 n = BPV or CODE or 2 n = FRAME or 3 n = SUBFRAME or 4 n = ESF_CRC or 5 n = DATAPORT or 6 n = BYTE or 7 n = APS or 8 "EAT?"	6-27	OFF
Output Elapsed Time	"ELP?"	6-47	N/A
Error Code (Common Capability)	"ERR?"	6-52	N/A
Gating Period	"GPR d,h,m,s" d = Ø to 99 h = Ø to 23 m = Ø to 59 s = Ø to 59 "GPR?"	6-42	00.00.00.01
Gating Type	"GTY n" n = MANUAL or 1 n = SINGLE or 2 n = REPEAT or 3 n = SHORT_1S or 4 n = SHORT_15S or 5 "GTY?"	6-42	MANUAL
TX HL96NY Presence	"HLP n" n = NO or Ø n = YES or 1 "HLP?"	6-21	NO

Table E-1 Remote Control Messages

Output Hub ID	"HUB? n" n = PRESENT or 1 n = PREVIOUS or 2	6-47	N/A
RX DS0 Termination	"I0T n" n = TERMINATED or 1 n = MONITOR or 2 "I0T?"	6-31	TERMINATED
RX DS1/DS1C Input Level	"I1L n" n = AUTO or 1 n = DSX or 2 n = DSX_MON or 3 n = DS_LO or 4 n = DS_LO_MON or 5 n = BRIDGED or 6 "I1L?"	6-30	AUTO
RX DS0A Termination	"IAT n" n = TERMINATED or 1 n = MONITOR or 2 n = LOGIC_NEAR or 3 n = LOGIC_FAR or 4 "IAT?"	6-31	TERMINATED
RX DS0B Termination	"IBT n" n = TERMINATED or 1 n = MONITOR or 2 "IBT?"	6-31	TERMINATED
Identification (Common Capability)	"ID?"	6-52	N/A
TX Timeslot Insertion	"INS n" n = OFF or 0 n = ON or 1 "INS?"	6-19	OFF
RX Jitter Filter (Option 001 only)	"JFL n" n = LP or 1 n = LP_HP1 or 2 n = LP_HP2 or 3 "JFL?"	6-40	LP
RX Jitter Filter Threshold (Option 001 only)	"JFT n" n = 0.05 to 10.00 UI "JFT?"	6-40	00.05
Key Query (Common Capability)	"KEY?"	6-53	N/A

Table E-1 Remote Control Messages

TX Loopback Type	"LBT n" n = NONE or Ø n = DS1 or 1 n = ALT_DSU or 2 n = ALT_CHAN or 3 n = ALT_OCU or 4 n = ALT_RPT or 5 n = ALT_HL96 or 6 n = DSØDP or 7 n = OCU or 8 n = CSU or 9 n = HL222 or 1Ø "LBT?"	6-21	NONE
Return To Local (Common Capability)	"LCL"	6-53	N/A
Log During Gating	"LDG n" n = OFF or Ø n = ERR_SEC or HIT_SEC or 1 n = RATIO or 2 "LDG?"	6-49	OFF
Log During Gating Threshold	"LDT n" n = 2 to 7 LDT?	6-49	1.ØE-2 (2)
Logging Device	"LDV n" n = HP3787B or 1 n = HP-IB or 2 "LDV?"	6-48	HP3787B
End of Gating Summary Contents	"LEC x,y,z" x = OFF or Ø x = SELECTED or 1 x = ALL or 2 y = OFF or Ø y = SELECTED or 1 y = ALL or 2 z = OFF or Ø z = SELECTED or 1 z = ALL or 2 "LEC?"	6-48	OFF,OFF,OFF
Log at End of Gating	"LEG n" n = OFF or Ø n = ALWAYS or 1 n = RATIO or 2 "LEG?"	6-48	OFF
Log at End of Gating Threshold	"LET n" n = 2 to 7 "LET?"	6-48	1.ØE-2 (2)

Table E-1 Remote Control Messages

Log On Demand	"LOD"	6-49	N/A
Logging ON/OFF	"LOG n" n = OFF or Ø n = ON or 1 "LOG?"	6-48	OFF
Output Latching Loopback Mapcode	"MAP?"	6-47	N/A
RX Measurement Source A	"MAS n" n = SEC_CHAN or 1 n = CUST or 2 n = SUBRATE or 3 "MAS?"	6-36	N/A
Measurement Source B	"MBS n" n = OFF or Ø n = SEC_CHAN or 1 n = CUST or 2 n = SUBRATE or 3 n = TIMESLOT or 4 n = DSØ or 5 n = DSØA or 6 n = PSDC or 7 n = DATALINK or 8 n = DIGROUP or 9 n = DS1 or 1Ø n = DS1C or 11 n = R_CHAN or 12 "MBS?"	6-38	OFF
Measurement Display	"MDS n" n = RESULTS or 1 n = ALARMS or 2 n = BIT_MON or 3 n = INP_LEV or 4 n = ANALYSIS or 5 "MDS?"	6-51	RESULTS
TX Multipoint Junction Unit Operations	"MJU n" n = SELECT or 1 n = TEST or 2 n = END_TEST or 3 n = BLOCK or 4 n = UNBLOCK or 5 n = RELEASE or 6 "MJU?"	6-20	N/A
Instrument Mode	"MOD n" n = TX&RX or 1 n = THRU or 2 MOD?	6-16, 6-30	TX&RX

Table E-1 Remote Control Messages

Output Monitor Word Result	"MON?"	6-46	N/A
RX Measurement Type A	"MTA n" n = LOGIC or 1 n = BPV or CODE or 2 n = FRAMING or 3 n = ESF_CRC or 4 n = JITTER or 5 "MTA?"	6-36	LOGIC
RX Measurement Type B	"MTB n" n = LOGIC or 1 n = BPV or CODE or 2 n = FRAMING or 3 n = ESF_CRC or 4 n = JITTER or 5 "MTB?"	6-38	LOGIC
Option Query (Common Capability)	"OPT?"	6-53	N/A
Protect Panel	"PRP n" n = OFF or Ø n = ON or 1 "PRP?"	6-50	ON
RX DSØA/DSØB Data Rate	"RØR n" n = 1 to 4 "RØR?"	6-31, 6-32	2.4 kbits (1)
RX DS1/DS1C Coding	"R1C n" n = AMI or 1 n = B8ZS or 2 "R1C?"	6-30	AMI
RX DS1/Digroup Framing	"R1F n" n = OFF or Ø n = T1DM or 1 n = SF or D4 or 2 n = FT or 3 n = ESF or FE or 4 "R1F?"	6-31	SF

Table E-1 Remote Control Messages

RX Pattern Type	"RCD n" n = PRBS_20 or 1 n = ALL_ONES or 2 n = SETTABLE or 3 n = PRBS_2047 or 4 n = PRBS_511 or 5 n = TRAFFIC or 6 n = CODES or 7 "RCD?"	6-34	PRBS_20
RX DS1C Framing	"RCF n" n = OFF or Ø n = ON or 1 "RCF?"	6-30	ON
Recall Panel	"RCL n" n = Ø to 9	6-50	N/A
RX DSØB Customer Rate	"RCR n" n = 1 to 3 "RCR?"	6-33	2.4 kbits (1)
RX DSØB Customer Number	"RCU n" n = 1 to 20 "RCU?"	6-33	1
RX DDS Channel Type	"RDC n" n = PRIMARY or 1 n = SECONDARY or 2 "RDC?"	6-33	PRIMARY
RX Digroup Number	"RDN n" n = 1 or 2 "RDN?"	6-32	1
RX Data Type	"RDT n" n = PATTERN or 1 n = PROTOCOL or 2 "RDT?"	6-34	PATTERN
Ready Code (Common Capability)	"RDY?"	6-53	N/A
Revision Date (Common Capability)	"REV?"	6-53	N/A

Table E-1 Remote Control Messages

RX Interface Level	"RIN n" n = DS1C or 1 n = DS1 or 2 n = DSØB or 3 n = DSØA or 4 n = DSØ or 5 "RIN?"	6-30	DS1
Output Jitter Result A (Option 001 only)	"RJA? n" n = HIT_COUNT or 1 n = HB_COUNT or 2 n = HB_RATIO or 3 n = HIT_SECS or 4 n = HITF_SECS or 5 n = PK_TO_PK or 6	6-45	N/A
Output Jitter Result B (Option 001 only)	"RJB? n" n = HIT_COUNT or 1 n = HB_COUNT or 2 n = HB_RATIO or 3 n = HIT_SECS or 4 n = HITF_SECS or 5 n = PK_TO_PK or 6	6-45	N/A
Release Loopback	"RLB"	6-21	N/A
RX Loopback Data	"RLD n" n = NO_LOOP or Ø n = LOOP or 1 "RLD?"	6-34	NO_LOOP
RX Measurement Select	"RMS n" n = OFF or Ø n = DS1C or 1 n = DIGROUP or 2 n = DS1 or 3 n = DSØB or 4 n = DSØA or 5 n = PSDC or 6 n = DSØ or 7 N = DATALINK or 8 n = FS_CHAN or 9 n = R_CHAN or 1Ø "RMS?"	6-32	DS1
Remote (Common Capability)	"RMT"	6-54	N/A

Table E-1 Remote Control Messages

RX PSDC Pattern Inversion	"RPI n" n - OFF or Ø n = ON or 1 "RPI?"	6-33	OFF
Request Service (Common Capability)	"RQS n" n = NONE or Ø n = RQC or 1 n = PWR or 2 n = FPS or 4 n = LCL or 8 n = RDY or 16 n = ERR or 32 n = RQS or 64 n = MSG or 128 n = EOG or 256 n = AL1 or 512 n = AL2 or 1Ø24 n = LOG or 2Ø48 n = GIP or 4Ø96 n = OFF n = ON "RQS?"	6-54	ERR (32)
Output Result A	"RSA? n" n = COUNT or 1 n = RATIO or 2 n = SYNC_ES or 3 n = ASYNC_ES or 4 n = ASYNC_EFS or 5 n = PER_EFS or 6	6-45	N/A
Output Result B	"RSB? n" n = COUNT or 1 n = RATIO or 2 n = SYNC_ES or 3 n = ASYNC_ES or 4 n = ASYNC_EFS or 5 n = PER_EFS or 6	6-45	N/A
Reset (Common Capability)	"RST"	6-55	N/A
RX Settable Word	"RSW ′bbbbbbbb′" b = Ø or 1 or f or s "RSW?"	6-35	1Ø1Ø1Ø1Ø
RX Timeslot Number	"RTS n" n = 1 to 24 "RTS?"	6-32	1

Table E-1 Remote Control Messages

Output, Input Voltage Result	"RXL? n" n = POSITIVE or 1 n = NEGATIVE or 2	6-46	N/A
RX PRBS Zero-Limit	"RZL"	6-34	ON
Save Panel	"SAV n" n = 1 to 9	6-50	N/A
TX Select MJU Branch	"SBR n" n = 1 to 4 'SBR?"	6-20	1
Single Error Add	"SEA"	6-27	N/A
Output Signaling Bits Result	"SGR?"	6-47	N/A
TX Signaling Bits	"SIG xxyy" x = Ø or 1 y = Ø or 1 "SIG?"	6-26	"11 "
Status Register A (Common Capability)	"STA?"	6-55	N/A
Status Register B (Common Capability)	"STB?"	6-55	N/A
TX Stop DDS Codes	"STC"	6-25	N/A
Stop Gating	"STP"	6-42	N/A
Start Gating	"STR"	6-42	N/A
TX DSØA/DSØB Data Rate	"TØR n" n = 1 to 4 "TØR?"	6-17,6-18	2.4 kbits(1)
TX DS1 Framing	"T1F n" n = OFF or Ø n = T1DM or 1 n = SF or D4 or 2 n = FT or 3 n = ESF or FE or 4 "T1F?"	6-16	SF
TX DSØA Interface Mode	"TAM n" n = DSX or 1 n = LOGIC_NEAR or 2 n = LOGIC_FAR or 3 "TAM?"	6-17	DSX

Table E-1 Remote Control Messages

TX DS1/DS1C Coding	"TCD n" n = AMI or 1 n = B8ZS or 2 "TCD?"	6-16	AMI
TX DS1C Framing	"TCF n" n = OFF or Ø n = ON or 1 "TCF?"	6-16	ON
TX DS1 Clock	"TCL n" n = INTERNAL or 1 n = EXTERNAL or 2 n = LOOPED or 3 "TCL?"	6-17	INTERNAL
TX DSØA/DSØB Customer Rate	"TCR n" n = 1 to 3 "TCR?"	6-18	2.4 kbits(1)
TX DSØA/DSØB Customer Number	"TCU n" n = 1 to 20 "TCU?"	6-18	1
TX DDS Channel Type	"TDC n" n = PRIMARY or 1 n = SECONDARY or 2 "TDC?"	6-20	PRIMARY
TX Data Type	"TDT n" n = PATTERN or 1 n = CODE or 2 n = PROTOCOL or 3 "TDT?"	6-23	PATTERN
Time	"TIM h,m,s" h = Ø to 23 m = Ø to 59 s = Ø to 59 "TIM?"	6-15	N/A
TX Interface Level	"TIN n" n = DS1C or 1 n = DS1 or 2 n = DSØB or 3 n = DSØA or 4 n = DSØ or 5 "TIN?"	6-16	DS1

Table E-1 Remote Control Messages

TX Number Of Intermediate Repeaters (CSU Loopback)	"TIR n" n = 0 to 2 "TIR?"	6-22	Ø
TX Tandem Number (DS0DP Loopback)	"TNU n" n = 1 to 8 "TNU?"	6-22	1
TX DDS Code	"TRC n" n = CMI or 1 n = OCU_LB or 2 n = CHAN_LB or 3 n = DSU_LB or 4 n = TIP or 5 n = LBF or 6 n = FEV or 7 n = TA or 8 n = MA or 9 n = UMC or 1Ø n = BLOCK or 11 n = RLS or 12 n = ASC or 13 n = TEST or 14 n = OOS or 15 n = SETTABLE or 16 "TRC?"	6-25	CMI
TX Pattern Type	"TRD n" n = PRBS_20 or 1 n = ALL_ONES or 2 n = SETTABLE or 3 n = PRBS_2047 or 4 m = PRBS_511 or 5 n = PREPROG or 6 "TRD?"	6-23	PRBS_20
TX Repeater Number	"TRN n" n = 1 to 2 "TRN?"	6-21	1

TX User Defined Pattern	"TRP #H(data)"
	data = 1 to 256 bytes of data.
	1 byte = 2 Hex Characters
	"TRP?"
		6-24	100 x FF(Hex) &
			100 x ØØ(Hex)

TX/RX Display Select	"TRS n" n = TX or 1 n = RX or 2 "TRS?"	6-51	RX

Table E-1 Remote Control Messages

TX DDS Settable Code	"TSC 'bbbbbbbb'" b = Ø or 1 or s "TSC?"	6-26	SØ1Ø1Ø1Ø
TX Select Level	"TSL n" n = DS1 or 1 n = DSØB or 2 n = DSØA or 3 n = PSDC or 4 n = DSØ or 5 n = DATALINK or 6 n = FS_CHAN or 7 n = R_CHAN or 8 "TSL?"	6-18	DS1
TX Signaling Mode	"TSM n" n = SET or 1 n = RETRANSMIT or 2 "TSM?"	6-26	SET
SELF TEST (Common Capability)	"TST"	6-56	N/A
TX Settable Word	"TSW 'bbbbbbbb'" b = Ø or 1 or f or s "TSW?"	6-24	1Ø1Ø1Ø1Ø
TX Timeslot Number	"TTS n" n = 1 to 24 "TTS?"	6-19	1
TX Start DDS Code	"TXC"	6-25	N/A
TX PRBS_20 Zero Limit	"TZL n" n = OFF or Ø n = ON or 1 "TZL?"	6-23	ON

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SPECIAL CHARACTERS

MANUAL CHANGES

MANUAL IDENTIFICATION	
Model Number:	3787B
Date Printed:	June 87
Part Number:	03787-90001

Operating Manual

This supplement contains important information for correcting manual errors and for adapting the manual to instruments containing improvements made after the printing of the manual.

To use this supplement:

Make all ERRATA corrections.

Make all appropriate serial number related changes indicated in the tables below.

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
2703U	No Change		
2814U	Change 1		
2840U	1/2		
2917U	Change 3		
2939U00790	Change 4*		

* NEW ITEM

NOTE

Manual change supplements are revised as often as necessary to keep manuals as current and accurate as possible. Hewlett-Packard recommends that you periodically request the latest edition of the supplement. Free copies are available from all HP offices. When requesting copies quote the manual identification information from your supplement or the model number and print date from the title page of the manual.

11 Oct 1989

HEWLETT PACKARD

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CHANGE 1

Prefix 2814U

Use package 03787-80001U0388 to update your Manual.

CHANGE 2

Prefix 2814U

Use package 03787-80001U0388 to update your Manual.

Prefix 2840U

Use packages 03787-80001U0388 and 03787-80001U0988 to update your Manual.

CHANGE TO HP 3787B OPERATING MANUAL UPDATE PACKAGES:

On Package 1

ERRATA

Change the references to software version 2822 to 2822/2830 as follows:

1. On the yellow cover sheet.
2. On the Title Page in the "SERIAL NUMBERS/SOFTWARE REVISIONS" information.
3. On Page 6-2 in the "FIRMWARE/SOFTWARE HISTORY" information (2 changes in the text and 1 in the table headings).

On Package 2

ERRATA

Change the references to software version 2839 to 2839/2905 as follows:

1. On the yellow cover sheet.
2. On the Title Page in the "SERIAL NUMBERS/SOFTWARE REVISIONS" information.
3. On Page 6-1 (2 references in the text) and Pages 6-2/6-2A (reference in column 3 in the table).

CHANGE 3

This change applies to operating manuals which have already been updated with packages 1 and 2.

Change the software version references from 2839 to 2919 as follows:

1. On the Title Page in the "SERIAL NUMBERS/SOFTWARE REVISIONS" information.

2. On Page 6-1 (two references in the text) and Pages 6-2/6-2A (reference in column 3 in the table).

Page 2-18, at the end of "Application"
Page 2-27, at the end of "Application"
Page 3-13, bottom left hand column after "Select the type of latching loopback required"
Page 3-14, after the third paragraph of "Multipoint Circuits"
Add the following information:

Check that the "Standard/Extended" DDS control sequence length on the Instrument ID display page (INDEX Page.....6) is set to the required sequence length (see Page 3-37).

Page 3-37, Instrument Identification:
Add to the display illustration after "Options fitted":

```
DDS Control Sequences Standard
                          |
                      Extended
```

Add the following information to the text is the left hand column:

The Standard/Extended selection of the DDS control sequence length affects the number of repeats of the latching loopback and MJU codes.

Standard provides the minimum number of repeats required for conformance testing specification. Extended provides 20 times the minimum number of repeats for those sequences or parts of sequences which are specified in terms of numbers of bytes. The selection of Extended may be necessary to achieve latching loopback and MJU operations on some manufacturers equipment which does not operate on the minimum sequences.

Example for OCU latching loopback comprising TIP, OCU, LBE, FEV and LBE bytes:

	TIP	OCU	LBE	FEV	LBE
Standard	40 bytes	40 bytes	120 bytes	2 seconds	200 bytes
Extended	800 bytes	800 bytes	2400 bytes	2 seconds	4000 bytes

The default sequence length is Standard.

CHANGE 3 (continued)

Page 6-21, Remove Control (Loopback):
Add:

Function	Mnemonic Code	Description
DDS Latching Loopback /MJU Operation Sequence Length	"CSL n"	Always valid
	n = Standard or 1	Standard sequence length
	n = Extended or 2	Extended sequence length
	"CSL?"	Returns state of CSL, 1 or 2

Appendix E, Page E-2:
Add:

DDS Control Sequences	"CSL n"	6-21	Standard
	n = Standard or 1		
	n = Extended or 2		
	"CSL?"		

Page 7-6 DDS Multi-point Signalling Unit, Control Sequences Table,
Page 7-7 DDS Loopback, Latching, Control Sequences Table:
Add the following NOTE to the Specifications:

NOTE: If extended sequences are selected, the byte counts specified in this table are multiplied by 20.

*CHANGE 4

Changes for Serial Prefix 2939U Software Rev 2936.

After completing all previous updating procedures replace corresponding pages in your manual with the following updated pages.

PAGES

Title/Warning
1-3/1-4
1-19/1-20
1-21/1-22
3-29/3-30
3-31/3-32
6-1/6-2
6-2A/Blank
6-49/6-50
E7/E8