HP 37702A Digital Data Tester
Operating and Calibration Manual

HP 37702A
Reorder P/N
37702-90005
Edition 1, 12/93

WARNING

READ THE FOLLOWING NOTES BEFORE INSTALLING OR SERVICING ANY INSTRUMENT.

1. IF THIS INSTRUMENT IS TO BE ENERGIZED 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 POWER CORD PROVIDED. IF THIS IS NOT SUITABLE, CONTACT YOUR NEAREST HP SERVICE OFFICE. THE LINE POWER PLUG SHALL ONLY BE INSERTED IN A SOCKET OUTLET PROVIDED WITH A PROTECTIVE GROUND 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 ground.
   c. Ensure that the line power plug is connected to a three-conductor line power outlet that has a protective ground. (Grounding one conductor of a two-conductor outlet is not sufficient).
   d. Check correct type and rating of the instrument fuse(s).

WARNINGS

Warning: Risk of electric shock

Ensure repeater power is switched off before connecting or disconnecting connectors. Voltages of up to ±130V dc may be present on telephone lines.

Avertissement: Risque de choc electrique

Toujours couper l'alimentation du repetiteur avant de brancher ou de debrancher des connecteurs. La tension de la ligne telephonique peut atteindre ±130V cc.

Warning

The instrument must be connected to the protective ground via the power cord or the ground terminal provided at any time that there is a connection to the instrument front panel.

WARRANTY

This Hewlett-Packard product is warranted against defects in materials and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environment specifications for the products, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility and to the calibration facilities or other International Standards Organization members.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

Notice

The information contained in this document is subject to change without notice.

Hewlett-Packard shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance or use of this material.

EMC COMPLIANCE

This product has been tested and complies with FTZ 1046 when used with the following cables:

Cable	HP Part Number
Weco 310	15513A E01
15 pin D	15707A E01
RS-232/V.24	15714A E01

PRINTING HISTORY

Edition 1 (37702-90000)	September 1992
Edition 1 (37702-90002)	March 1993
Edition 1 (37702-90005)	December 1993

Contents

Tables

What the Digital Data Tester Gives You

- Fast and easy, installation and maintenance of your T1, Fractional T1, DDS and VF measurements in one portable tester.
  - Out-of-service testing for installation and commissioning.
  - In-service testing for maintenance and troubleshooting.
- Option datacom testing at V.35, RS-449 and RS-232 interfaces.
- Correlation of error bursts and alarm conditions - graphic presentation of errors and alarms simultaneously.
- One test to find out what's wrong - "trouble scan" looks for bit, code, CRC and frame errors.
- Mux/demux VF or data signals in any timeslot - with built-in VF channel access.
  - Plug in a TIMS or protocol analyzer.
  - DTMF/pulse signaling and dialing.
- Easy circuit identification with built-in VF channel access. Listen to a channel with the built-in speaker or display the signaling bits to check if it is idle.
- Rapid distinction of marginal pulse failures from gross failures, and simple detection of badly set equipment with graphic, on screen presentation of T1 pulse shape.
- Quickly check timeslot integrity, including wideband nx56 and nx64 kbit/s circuits. Drop and insert your own test into timeslots (up to 6).
- No need to buy and carry field printers to record test results. Sets of results, including graphs, may be displayed and printed back at the office using internal results storage.
- Faster and more positive identification of timing problems on T1 networks using high resolution clock slips measurement with graphic presentation.
- Lasting value and protection of your investment in test equipment with Hewlett-Packard's upgradability.

New Features:

- SLC-96 monitoring and stimulation of the RTU.
- Addressable T1 loopbacks for Westell and Teltrend Intelligent Repeaters.
- Multi-pattern tests, including bridge tap tests and user-definable tests.
- V.54 loopbacks on VF (Switch-56) and DDS (HP 37702A only).
- MF dialing (HP 37702A only).

1

Getting Started

This chapter tells you about the basic features of the instrument and shows you how to use them. The items covered are:

- Switching on
- Setting the Tester to a known state
- Returning to the basic measurement display
- Making a measurement
- Displaying all error types together
- Adding transmit errors
- Observing alarm indications
- Displaying an alarm record
- Displaying basic results and full results
- Adding transmit errors at a fixed rate
- Displaying received signal details
- Displaying a time related alarm record
- Displaying results as graphs
- Displaying the results store contents list
- Displaying tabulated stored results
- Sending T1 line (CSU) loopcodes

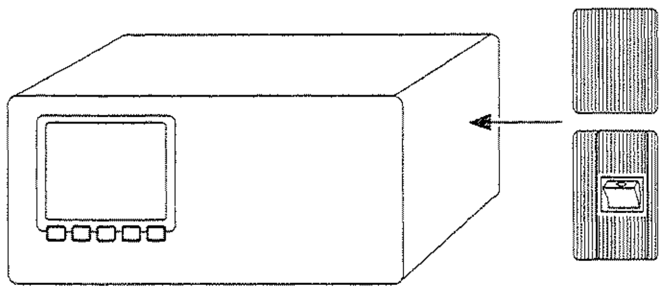
Before Getting Started

Ensure that there are no cables connected to the instrument front panel. Connect the instrument to a power supply of between 85 V ac and 264 V ac. If in doubt see "Installation" in chapter 7.

Getting Started

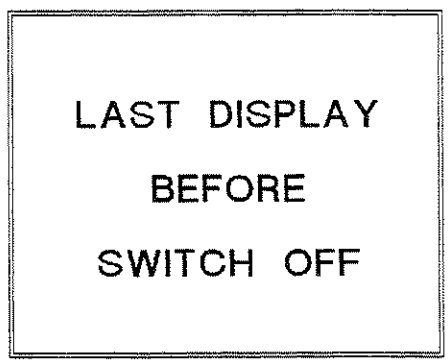
Switch On

Switch on.



You should see a title page.

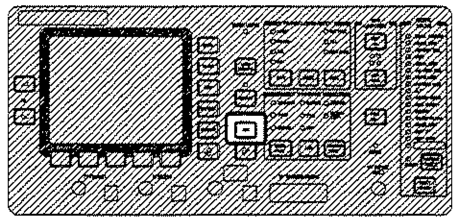
Followed by.

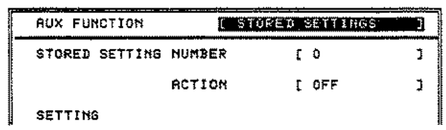


If the Tester has the Datacom test accessory in the lid, set the Datacom module TEST SELECT to T1.

To Set the Tester to a Known State

The Tester can store 1 fixed and 5 user selectable test set-ups.
You are going to recall the fixed set-up.
Press (AUX)

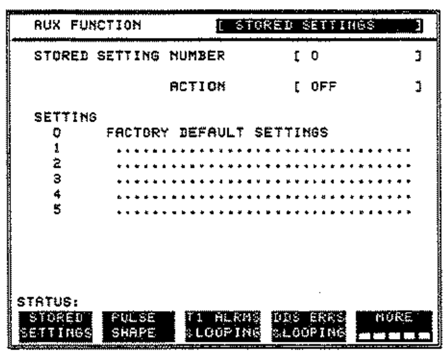




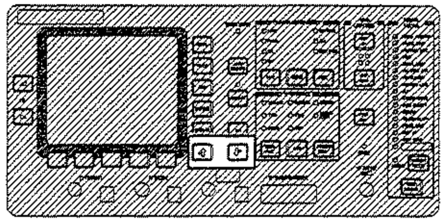
You should see one of the AUX FUNCTION displays with AUX FUNCTION highlighted.

Select STORED SETTINGS

NOTE :
The instrument starts up in the "last used" state. Some of the settings in this procedure may already be selected.

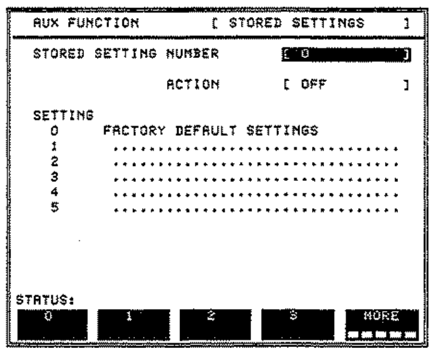


Use ↓ and ↑ to highlight
STORED SETTING NUMBER [ ]

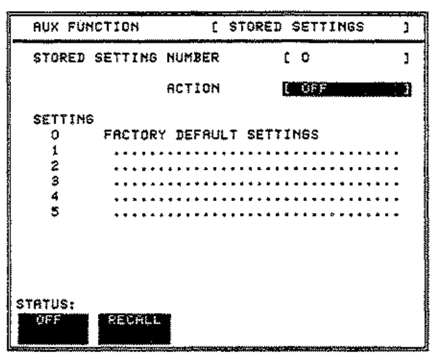


Select 0.

0 is the fixed stored setting.

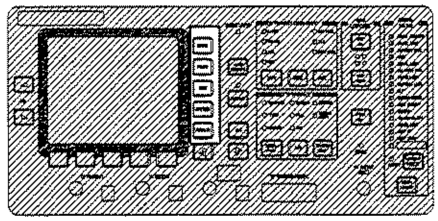


Highlight ACTION [ ].
Select RECALL.



To Return to the Basic Measurement Display

Any measurement set-up key will get you to the basic measurement display. In this case, Press (RESULTS).



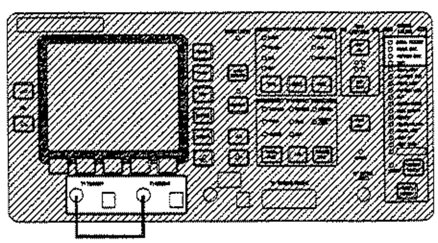
You should see.

```
[FULL-T1] FRAME[ D4  ] CODE [B8ZS] THRU (OFF)
[PATTERN] [ QRSS           ]

TEST PERIOD [ CONTINUOUS    ]
DISPLAY      [ ERROR RESULTS ] [ LOGIC      ]
```

To Loop Transmit/Receive and Make a Measurement

Connect

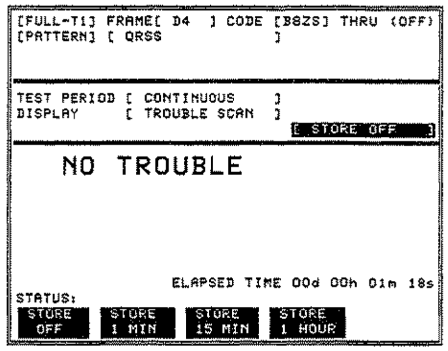
T1 TRANSMIT to T1 RECEIVE with a WECO 310 cable. Check that received data is correct (green indicators on).



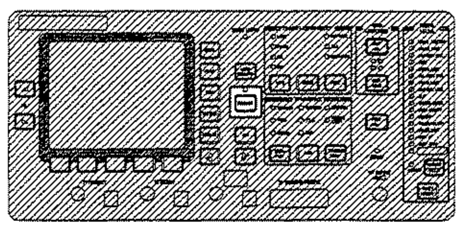
To See All Error Types on One Display

Select TROUBLE SCAN.
As you will want to see a graph of the results.

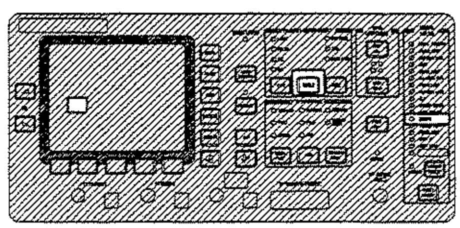
Highlight STORE OFF
and select STORE 1 MIN



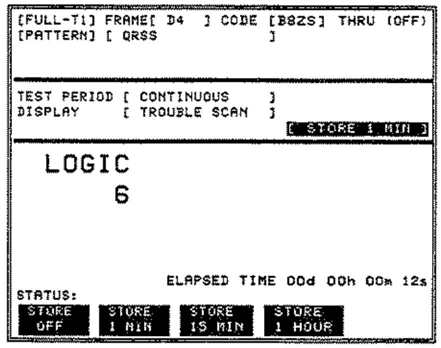
Press (RESTART) to start a test



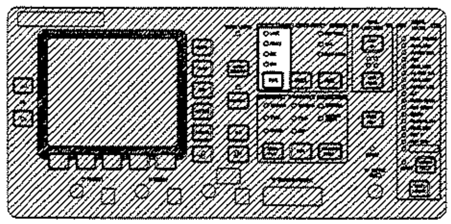
Watch the ERRORS indicator flash and the results display accumulate errors when you press TRANSMIT ERROR INSERT (SINGLE) a few times.



The display should show the logic errors that you have inserted.

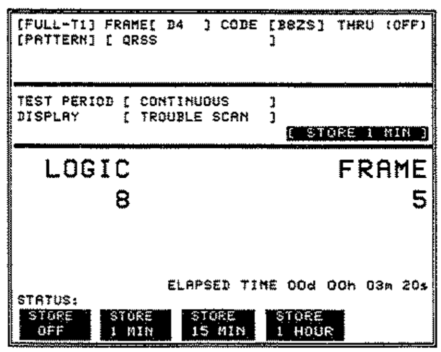


Use (TYPE) to select FRAME.



Press (SINGLE) a few times.

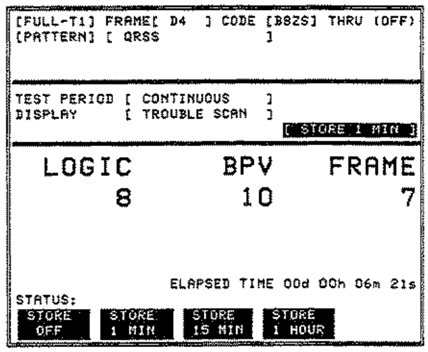
You should see.



Use (TYPE) to select BPV.

Press (SINGLE) a few times.

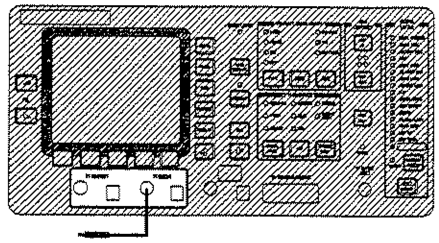
You should see.



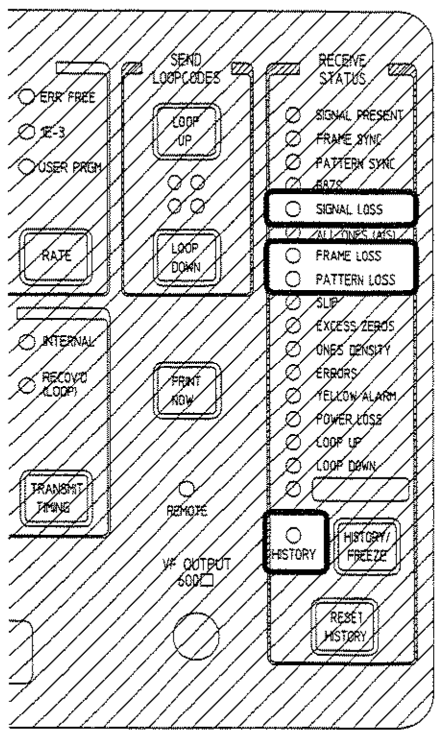
Use (TYPE) to select LOGIC

To See Alarm Indicator Operation

Break the signal path.



You should see the alarm indication for the current situation.



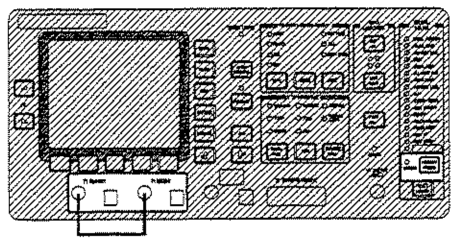
To See an Alarm Record

Reconnect the signal path.

As alarms have occurred in the current test, you should see the HISTORY indicator on.

Press (HISTORY/FREEZE) to see what they were.

You can use this to check for the occurrence of alarms on unattended tests.

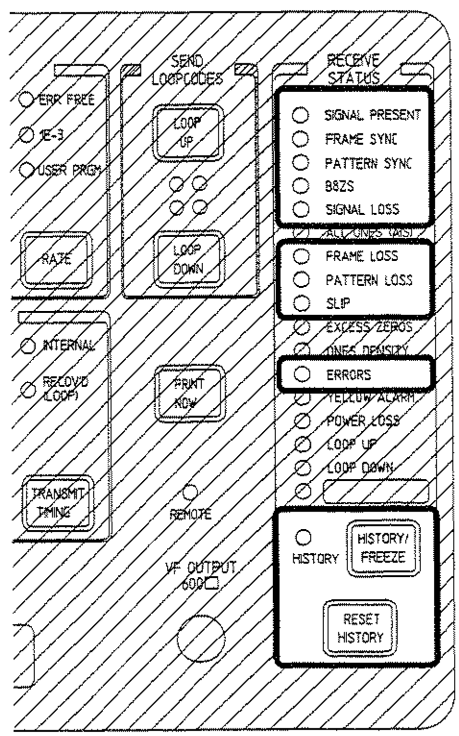


The display is frozen but the test is still running.

Press (HISTORY/FREEZE) again to unfreeze the display.

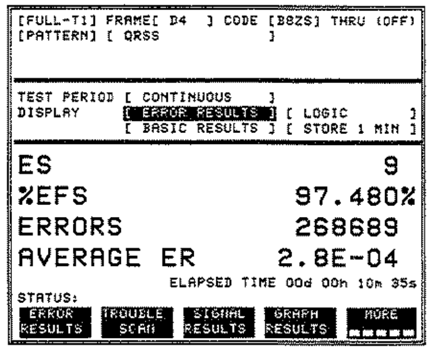
Press (RESET HISTORY).

You should see the HISTORY indicator go off.



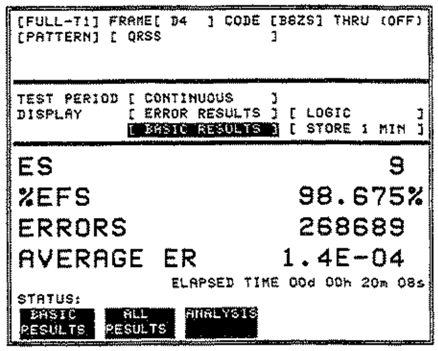
To See Error Results

Highlight
DISPLAY [TROUBLE SCAN]
Select ERROR RESULTS .

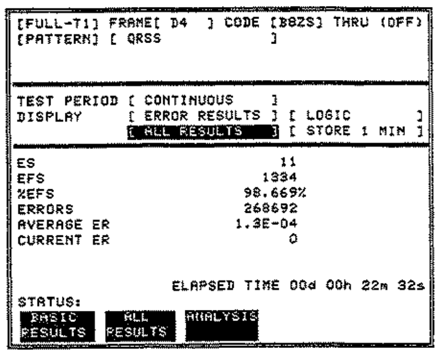


To See More Results

Highlight
[ERROR RESULTS] [LOGIC]
BASIC RESULTS .
Select ALL RESULTS .

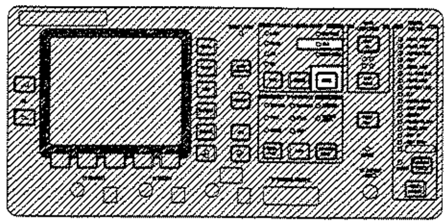


You should see.

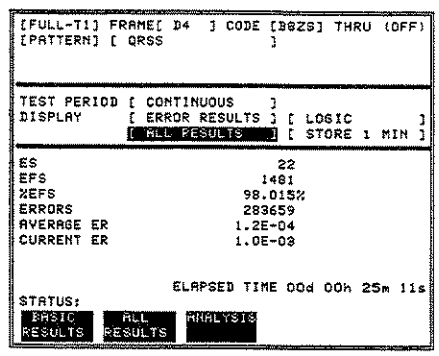


To Add Transmit Errors at a Fixed Rate

Use (RATE) to set TRANSMIT ERROR INSERT to 1E-3.



You should see CURRENT ER . . . 1.0E - 0.3.



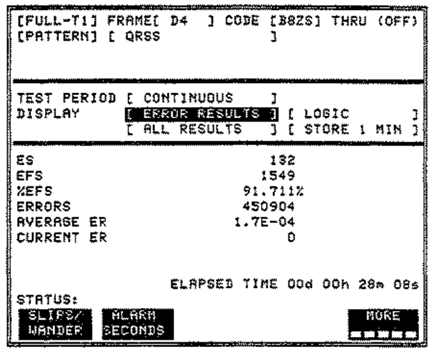
Use (RATE) to set TRANSMIT ERROR INSERT to ERR FREE.

To See a Time Related Alarm Record

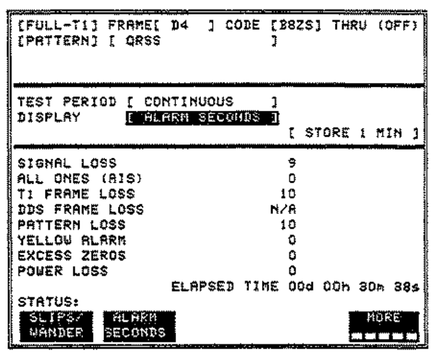
Highlight DISPLAY [ ].

Use MORE to change the selections available.

Select ALARM SECONDS .

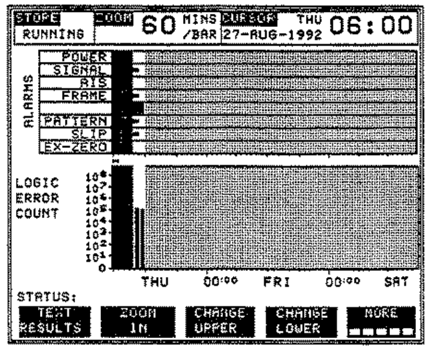


You should see the alarm durations caused by breaking the signal path



To See Results as Graphs

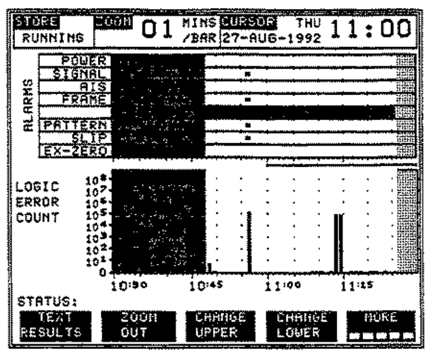
Highlight DISPLAY [ ].
Use MORE to change the selections available.
Select GRAPH RESULTS .



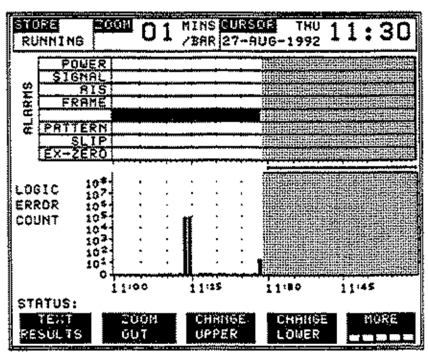
You will see two graphs of the current test.

Use ZOOM IN , and if necessary, to display 1 minute resolution.

Use CHANGE UPPER and CHANGE LOWER to display the range of graphs.

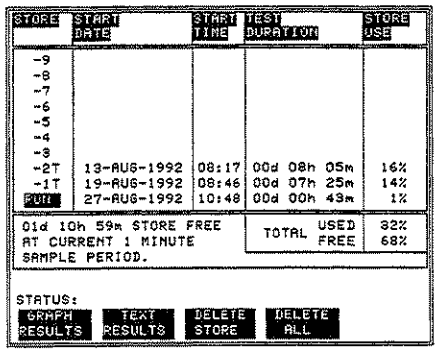


Display the graph of LOGIC ERROR COUNT and see errors recorded when you add SINGLE logic errors.



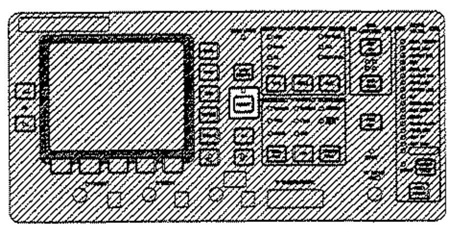
To See Results Store Contents List

Use TEXT RESULTS , STORE STATUS to see details of stored results.



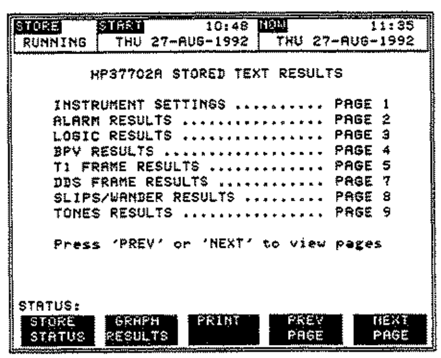
To See Tabulated Stored Results

The tabulated results are not calculated until the test has been completed.



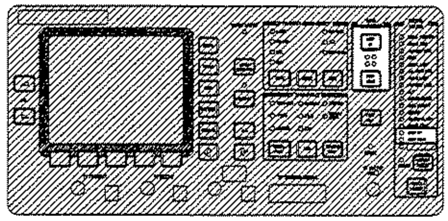
Press (RESTART) to stop the test. The results storage will be switched off and the test will stop.

Use TEXT RESULTS then NEXT PAGE to see tabular details of stored results on pages 1 thru 7.



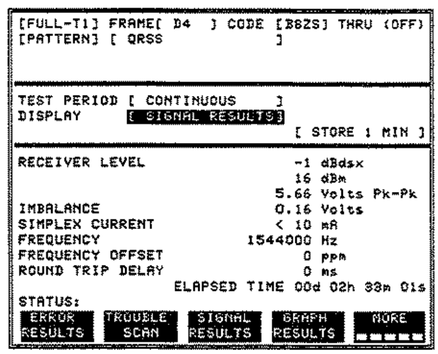
To Send T1 Line Loopcodes

Watch the LOOP UP indicator come on briefly when you press (LOOP UP), then, watch the LOOP DOWN indicator come on for 8 seconds when you press (LOOP DOWN).



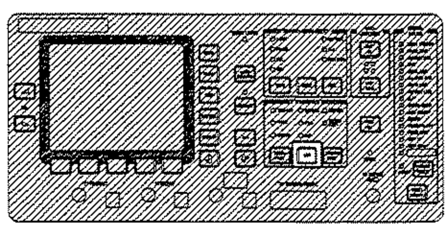
To See Received Signal Details

Press (RESULTS).
Select SIGNAL RESULTS .



Watch the RECEIVER LEVEL change as you change the transmit level with (LBO) (Line Build Out).

NOTE: The change of a measurement parameter will cause RESTART.



After Getting Started

Now that you are familiar with the operation of the instrument and are able to make the basic measurements, it's time to explore.

Press (AUX) and have a look at some of the other things that you can do.

Select the printer/remote control set-up display PRINTER/REM CTL. RS-232 MODE lets you select the function of the RS-232 connector.

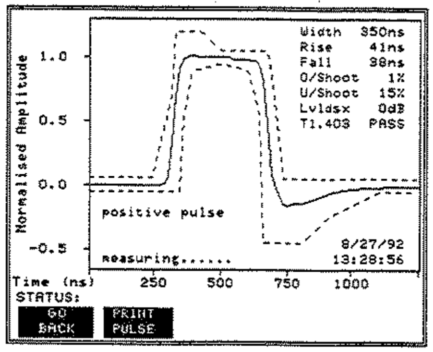
Select PRINTER OUTPUT and set up an AUTO TRIGGERED PRINT.

Select VF ACCESS and switch the AUDIO MONITOR ON and OFF.

Select T1 ALARMS & LOOPING. You can change the USER PROGRAM ERROR RATE and set the tester to transmit an alarm here. You can also select LOOPCODES, set the tester to respond to that loopcode, or force the tester to loop up or down.

Select DDS ERRS & LOOPING. You can also change the USER PROGRAM ERROR RATE from here. You can select alternating loopback type, latching loopback type or MJU operation.

Select `PULSE SHAPE`, ACTION `MEASURE` if you have the tester with the pulse shape display option. You will need to press `GO BACK` to get back to the other AUXILIARY selections, press a test set-up key or (RESULTS) to get back to the set-up / results display.



2

Getting Ready For Telecom Testing

This chapter tells you how to set features which apply to more than one telecom test. Check to see if you want to do any of the things in the following list. If not go on to Chapter 3 Telecom Testing.

- Selecting Telecom on combined Telecom/Datacom Test Sets.
- Fast Set up.
- Recalling stored set-ups.
- Storing results.
- Setting long user words.
- Setting the date and time.
- Storing test set-ups.
- Setting the user programmable error rate.
- Generating T1 alarms.
- Setting T1 loopcodes.
- Setting DDS loopcodes.
- Setting VF channel signaling.
- Switching the speaker on and off.

To Select Telecom on Combined Telecom/Datacom Test Sets

If the Tester is part of a combined Telecom/Datacom Test Set, set the Datacom module TEST SELECT to T1.

Fast Set Up

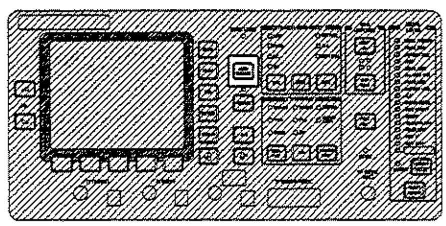
There are five ways to set up the tester :

1. Automatically setting Frame, Code and Pattern to the incoming signal.
2. Recalling stored set-ups.
3. Recalling stored set-ups and modifying them.
4. Manually from the front panel (see Chapter 3 Telecom Testing).
5. Over an RS-232 link (see Chapter 10 Remote Control).

To Automatically Set Frame, Code and Pattern To The Incoming Signal

Press AUTO RESTART

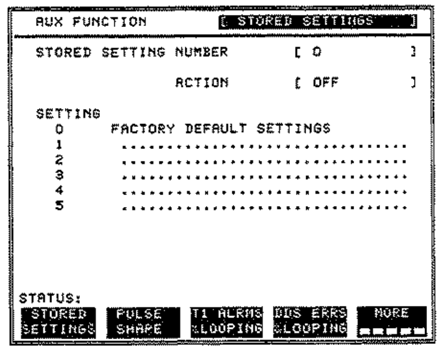
This will also start a new test.



To Recall a Stored Set-Up

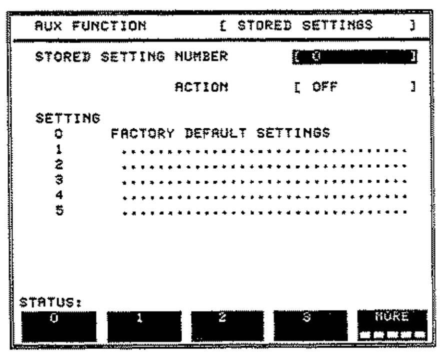
Press (AUX).

Select STORED SETTINGS.



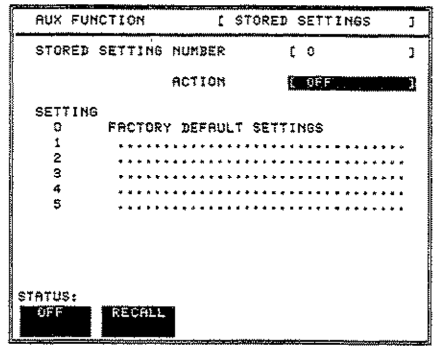
Highlight STORED SETTING NUMBER [ ]

and select the set-up you want.



Highlight ACTION [ ].

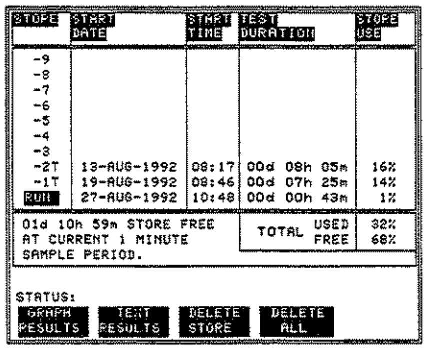
Select RECALL.



To Set Up For Storage of Results

To see the storage space available before overwriting occurs.

Use (RESULTS), **GRAPH RESULTS**, **TEXT RESULTS** **STORE STATUS**



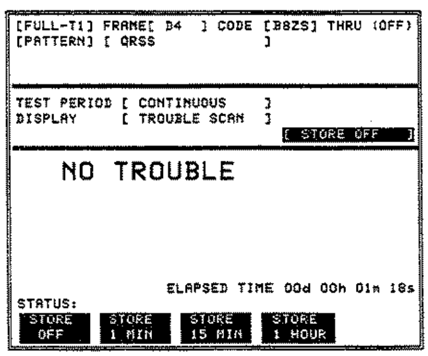
Press (RESULTS).

Set up the test.

Highlight **[STORE . . . .]**.

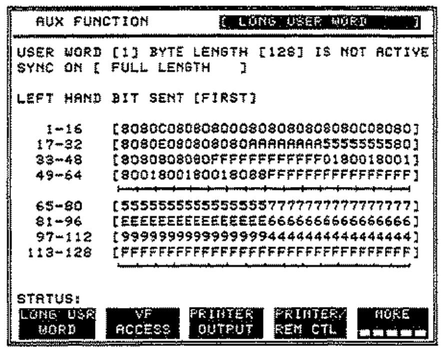
Select the storage resolution you want.

Start the test by pressing the (AUTO/RESTART) key.



To Set Up Long User Words

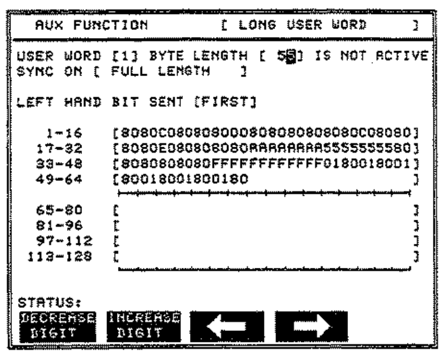
You may select and store up to four words of up to 128 bytes. For high error conditions you may select sync on any number of bytes.



Press (AUX).

Select LONG USR WORD.

Highlight BYTE LENGTH [ ] and select the number of bytes you want in the pattern.



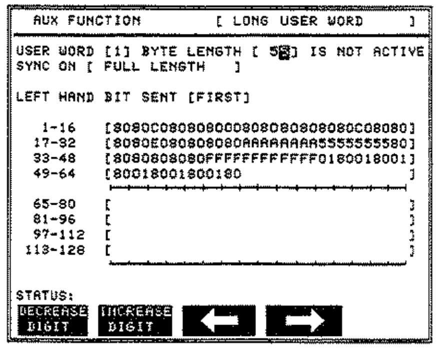
Highlight SYNC ON [ ] and select the number of error free bytes you want the Tester to sync on.

The bits of each byte are shown at the bottom of the display when the hexadecimal code for that byte is highlighted. To select the order of transmission of the bits:

Highlight LEFT HAND BIT SENT [ ] and select FIRST to transmit bits as shown ,or LAST to transmit bits in the reverse order.

To change a byte

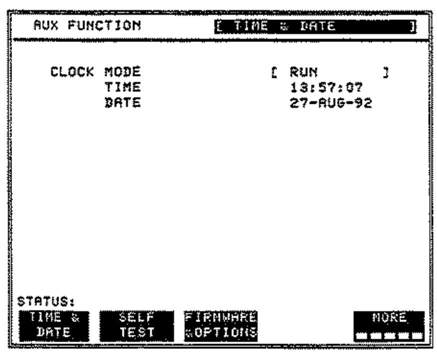
Highlight each of the two hexadecimal characters for that byte and select the byte you want.



To Set the Date and Time

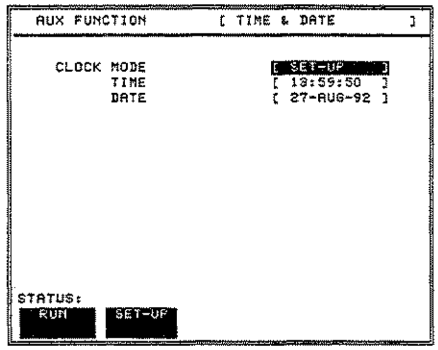
Press (AUX).

Select TIME & DATE.

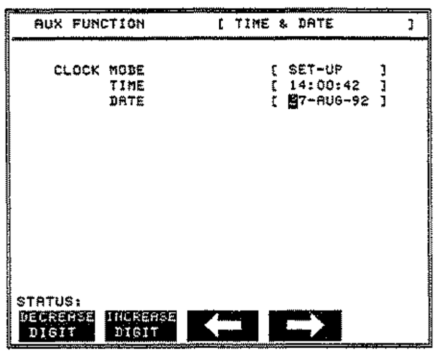


Highlight CLOCK MODE [ ].

Select SET-UP.

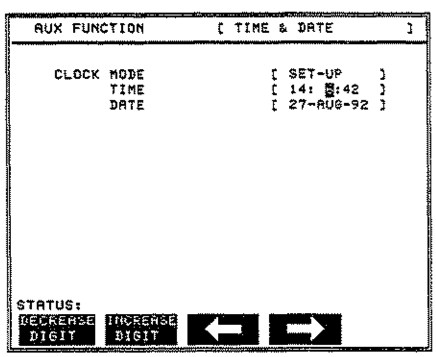


Highlight DATE [ ].
Use ←– and –→,
INCREASE DIGIT / DECREASE DIGIT and
PREVIOUS MONTH / NEXT MONTH
to set the date.



Highlight TIME [ ].

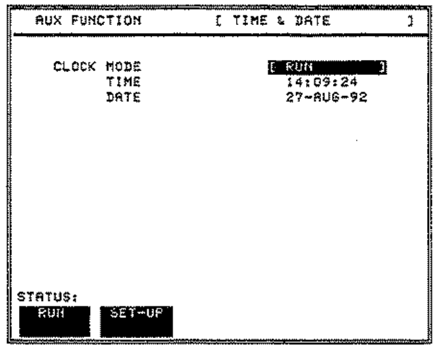
Use ←– and –→, and INCREASE DIGIT / DECREASE DIGIT, to set the time.



To Start the Clock at the Selected Time

Highlight CLOCK MODE [ ].

Select RUN.

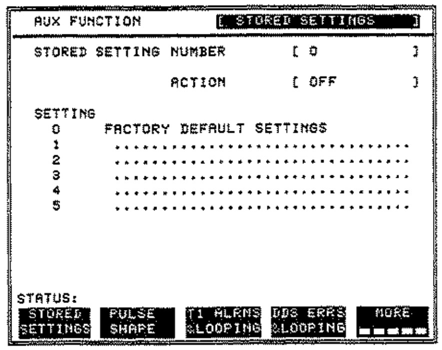


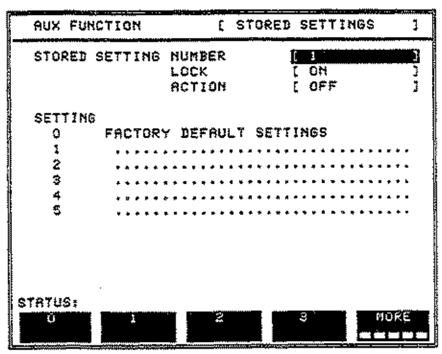
To Store Test Set-Ups

Set up the Tester with the settings you want to store.

Press (AUX).

Select STORED SETTINGS .

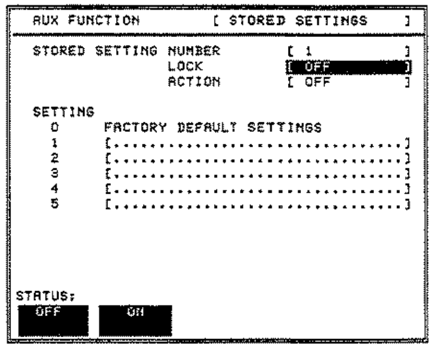




Highlight STORED SETTING NUMBER [ ] and select the number of the store you want to use.

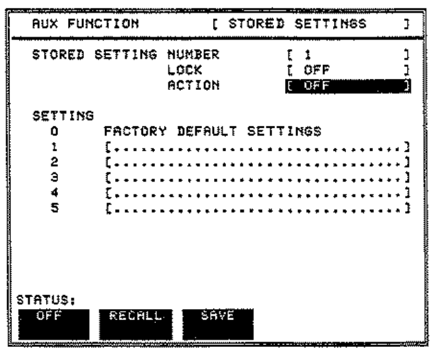
Highlight LOCK [ ].

Select OFF.



Highlight ACTION [ ].

Select SAVE.

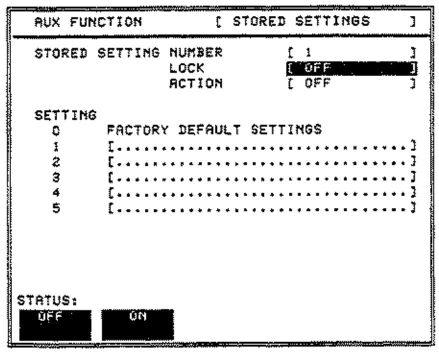


To Indicate Stored Set-Up Content

The display area beside the setting number may be used to give the set-up a title or to leave a message for a future user. The title / message may be set remotely using a terminal connected to the RS-232 connector (see the "Remote Operation" chapter) or manually as follows :

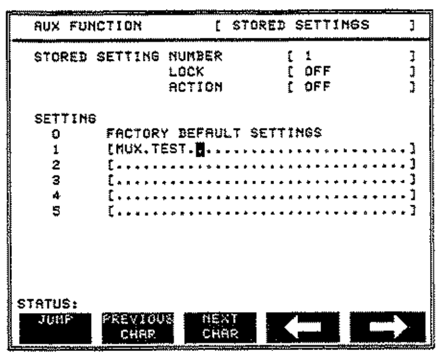
Highlight LOCK [ ].

Select OFF.



Highlight the SETTING description line N [..........].

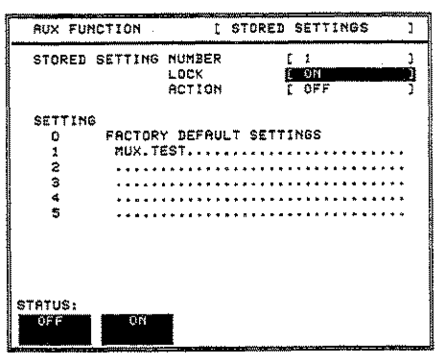
Use JUMP PREVIOUS CHAR NEXT CHAR and ←– and –→ to select characters.



To prevent overwriting without changing LOCK.

Highlight LOCK [ ].

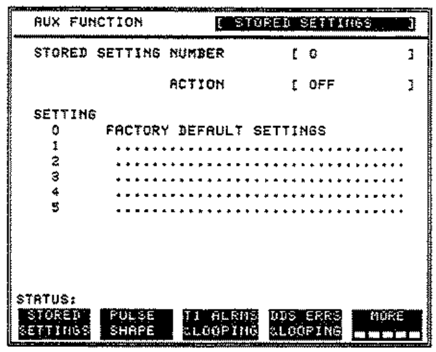
Select ON.



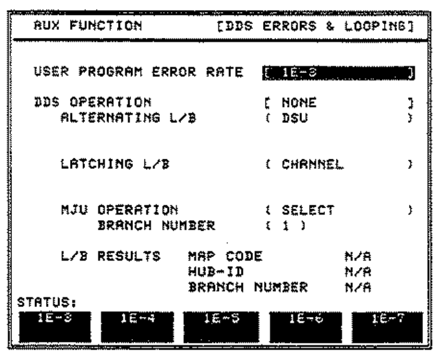
To Set a User Programable Error Rate

To set the error rate inserted when TRANSMIT ERROR INSERT is set to USER PRGM with (RATE).

Press (AUX).



Select DDS ERRS &LOOPING.



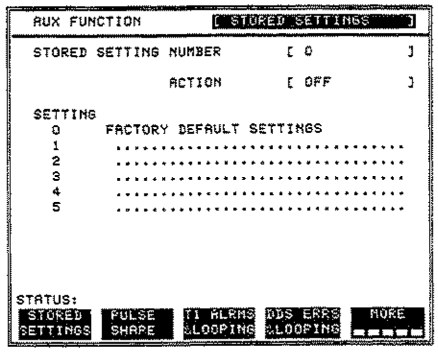
Highlight USER PROGRAM ERROR RATE [ ].

Select the rate you want.

To Generate T1 Alarms

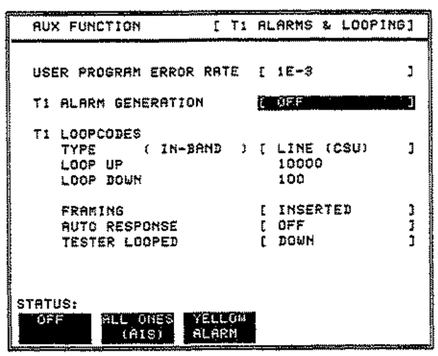
Press (AUX).

Select T1 ALRMS &LOOPING.



Highlight
T1 ALARM GENERATION [ ].

Select the alarm you want.



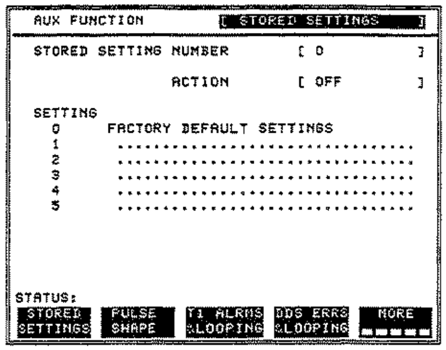
To Select T1 Loopcodes

Select (AUX) T1 ALRMS &LOOPING for T1 loopcode selection. With ESF framing selected, you can select in or out of band loop loopcode types. However, with FDL selected, only out of band loopcodes are offered, the choice is duplicated on the main page.You can set the tester to respond to the displayed codes, AUTO RESPONSE ON or force loop manually, TESTER LOOPED UP.

A T1 **and** a DDS loopcode may both be selected. The loopcode transmitted when (LOOP UP) or (LOOP DOWN) is pressed will depend on the configuration selected with (CONFIG). DDS loopcodes are transmitted if T1-DDS or DS0-DDS are selected. T1 loopcodes are transmitted if FULL-T1, N×56k, N×64k or FDL are selected.

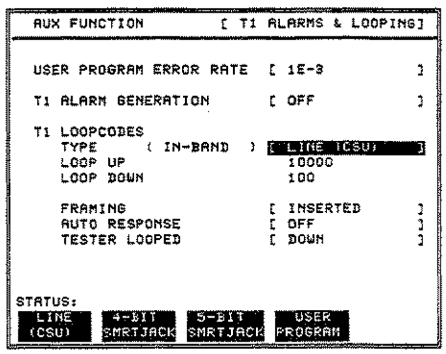
Press (AUX).

Select T1 ALRMS &LOOPING.

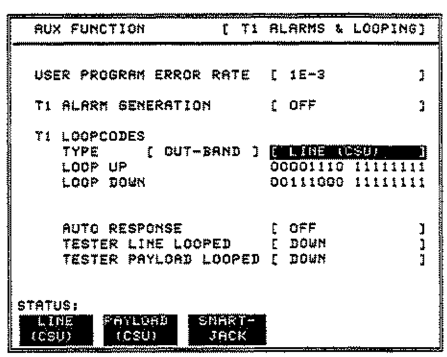


Highlight
T1 LOOPCODES
TYPE (IN-BAND) [ ].

Select the type of loopcode you want. For user program loopcodes, select the length and content.

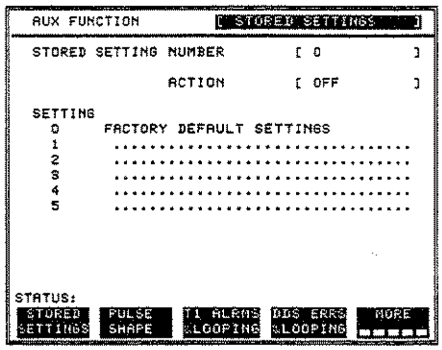


With ESF framing select in-band or out-of-band and then the type of loopback you want. For user program loopcodes, select the length and content.



To Select DDS Loopcodes.

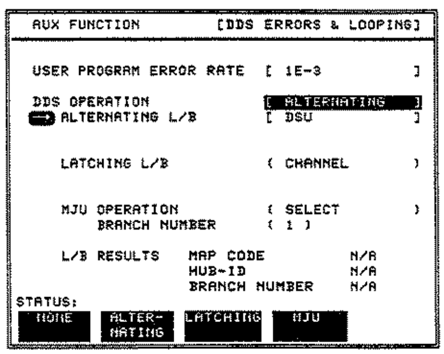
Press (AUX).



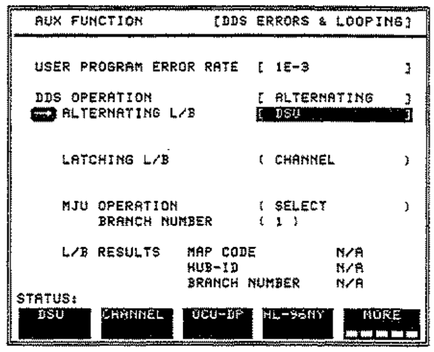
Select DDS ERRS &LOOPING.

Highlight
DDS OPERATION [ ].

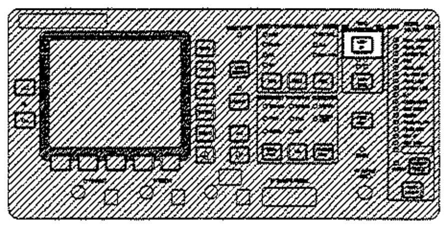
select ALTERNATING or LATCHING.



Highlight
ALTERNATING L/B [ ].
or
LATCHING L/B [ ].
whichever has been selected.
and select the type of loopback you want.

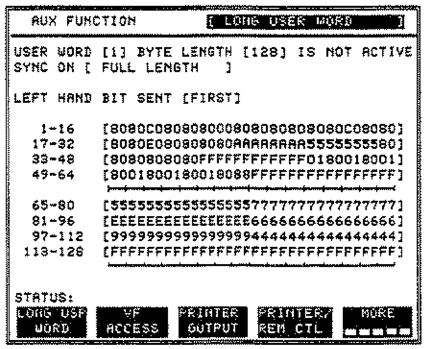


Press (LOOP UP) to perform the function selected.



To Select VF Channel Signaling

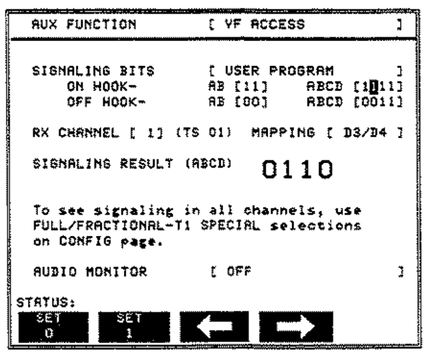
Press (AUX).



Select VF ACCESS.

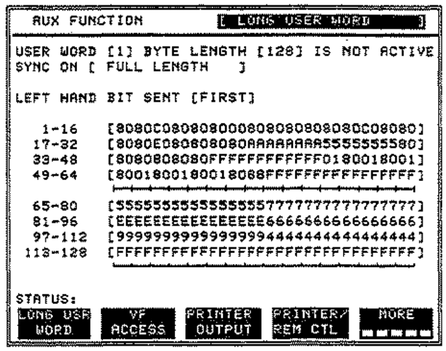
Highlight
SIGNALING BITS [ ].

select USER PROGRAM
highlight and select the bits you want to set.



To Monitor a VF Channel

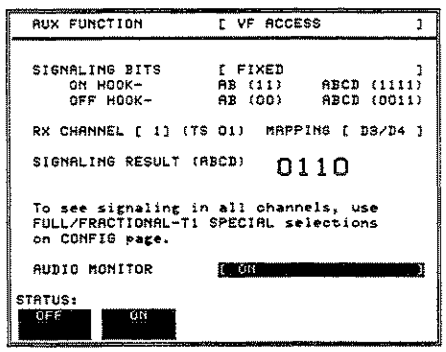
Press AUX.



Select VF ACCESS.

Highlight
AUDIO MONITOR [ ].

select ON.

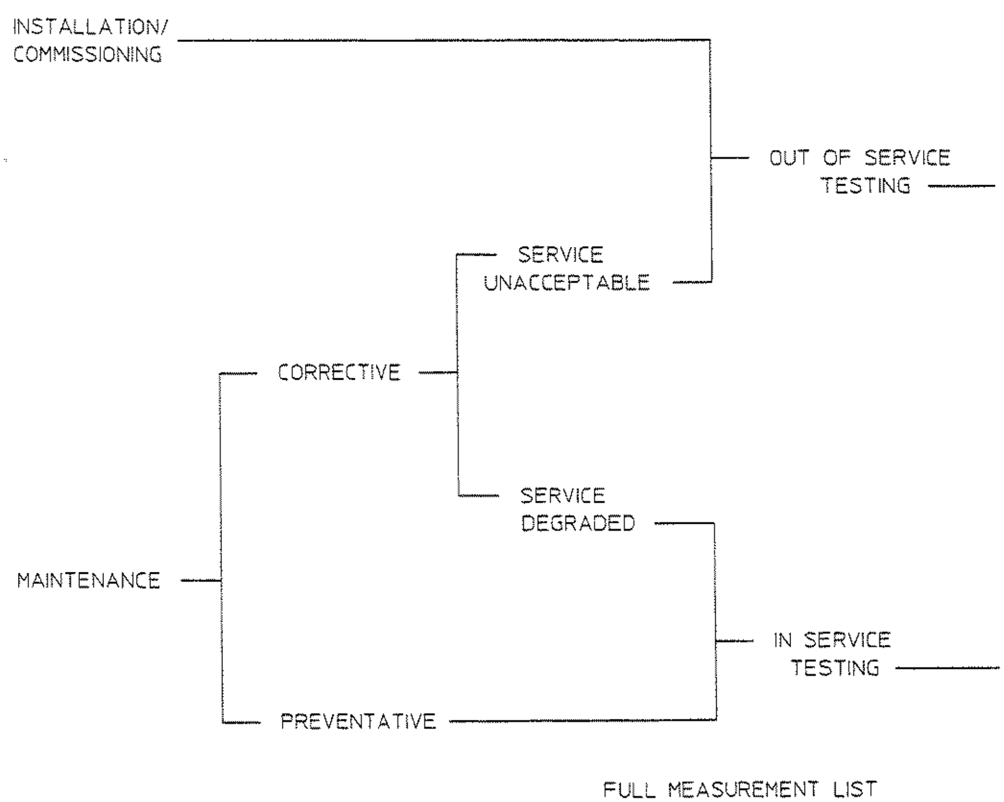


3

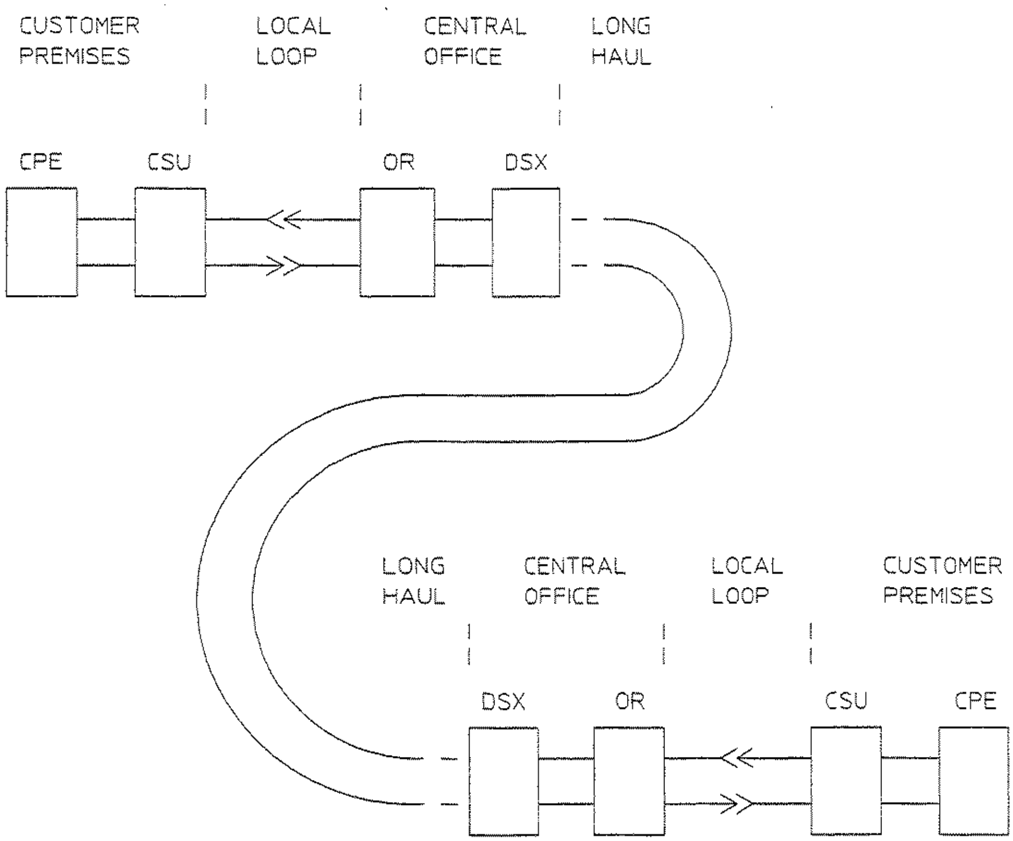
Telecom Testing

How to Find Set-Up Examples

The diagram below shows the organization of the information in this chapter. The page numbers lead you to set-up examples.



How a T1 System is Shown in This Manual



Key

CPE = Customer Premises Equipment

CSU = Channel Service Unit

<< = Repeatered, metallic, local loop showing direction of path

OR = Office Repeater

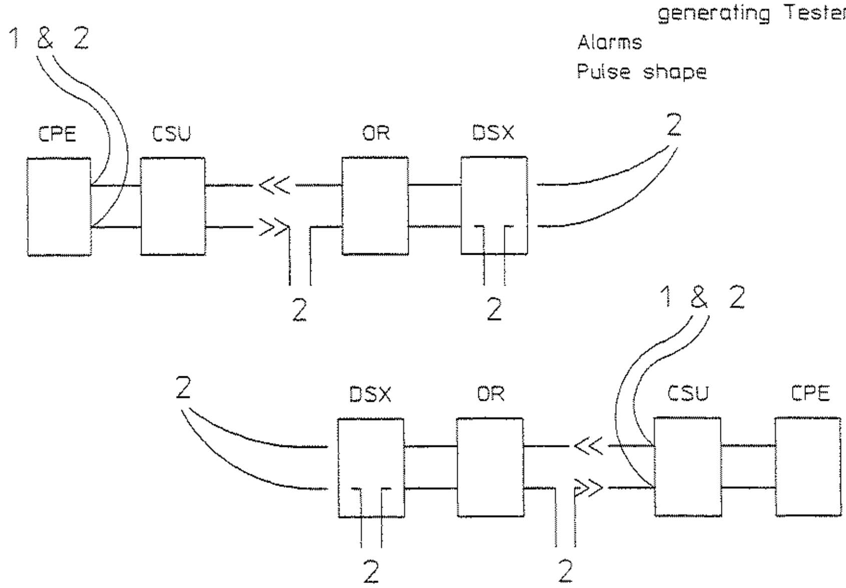
DSX = Cross Connect

Out Of Service Testing

1 Here you can :

Use the instrument as a CSU.

Measure : Frequency
- Simplex Current
- Level (to set LBO)
- Errors (part of loop from generating Tester)
- Alarms
- Pulse shape



2 Here you can :

Loop up remote CSUs

Generate the test pattern

Measure : Errors (both paths)
- Delay (round loop)
- Alarms
- Pulse shape

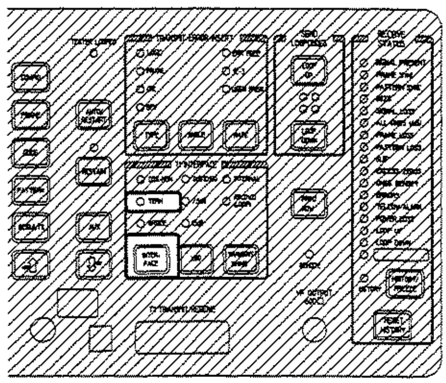
Loop down remote CSUs

To Set the Terminated (TERM) T1 Line Interface

Out-of-service tests, including use as a portable CSU, usually require the tester to terminate the T1 line. The TERM interface provides a 100Ω termination at the receiver input. The **Loopback** facility may be used to complete the signal path if required.

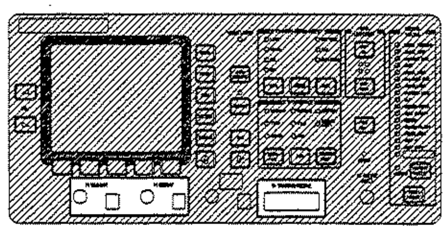
Warning **T1 Line voltages are capable of supplying dangerous currents. Power should be removed from the local loop while the tester is being connected or disconnected.**

Use (INTERFACE) to set T1 INTERFACE to TERM.

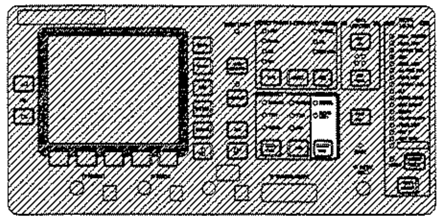


To Connect the Tester for Out-of-service T1 Testing

Have the line power disconnected,
Connect the tester to the T1 interface and have the power reconnected.



To Set The Transmit Timing



Use T1 INTERFACE [TRANSMIT TIMING]
To select the transmit timing.

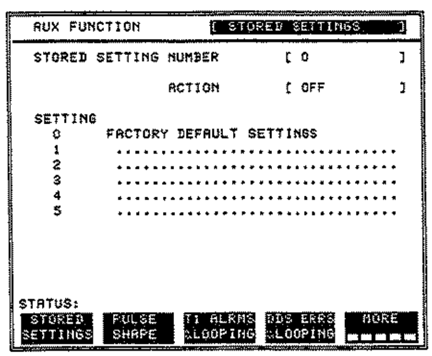
If you have to be the source of timing select INTERNAL, otherwise select RECOV'D (LOOP).

To Use As A Portable CSU / Network Interface

You can make tests on the received data while you are using the tester as a CSU / network interface.

You can loop the tester manually (FULL-T1, FRACTIONAL-T1, FDL and T1 DDS configurations) OR set it to loop when it receives a loopcode.

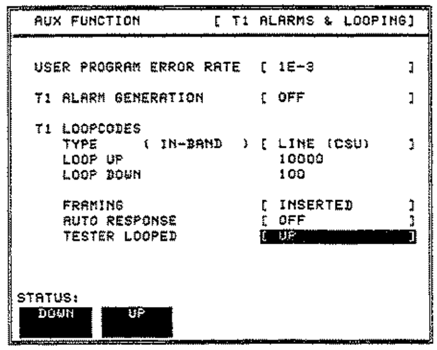
To Loop the Tester Manually



Press [AUX].

Select T1 ALARMS & LOOPING.

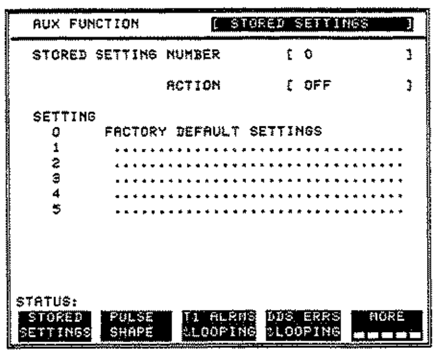
Highlight TESTER LOOPED [ ].
Select UP.



To Set the Tester to Respond to a T1 Loopcode (In-Band)

Press (AUX).

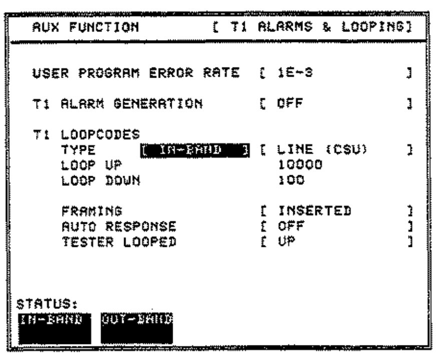
Select T1 ALARMS & LOOPING.



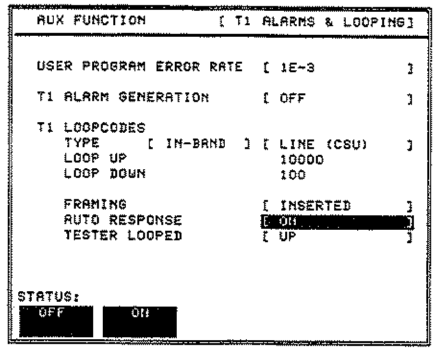
Highlight T1 LOOPCODES TYPE [ ], and select what you want the Tester to respond to.

If you choose USER PROGRAM you can select the length (3 to 8 bits) and the content.

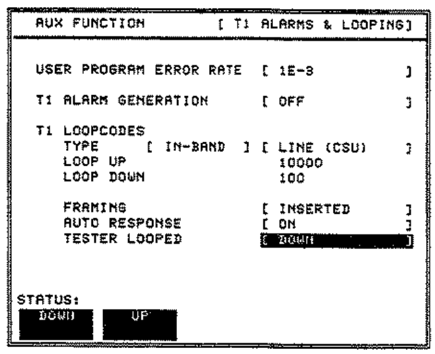
If ESF framing is being used, ensure that [IN-BAND] is selected.



Highlight AUTO RESPONSE [ ].
Select ON.



Highlight TESTER LOOPED [ ].
Select DOWN.

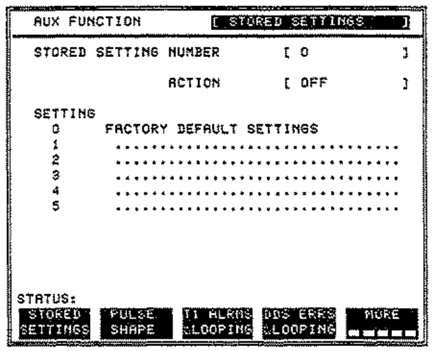


To Set the Tester to Respond to a T1 Loopcode (Out-of-Band)

Out-of-band loopcodes are only available with ESF framing, and are carried in the Facilities Datalink (FDL).

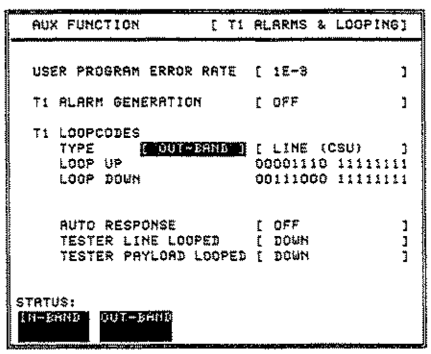
Press (AUX).

Select T1 ALARMS & LOOPING .

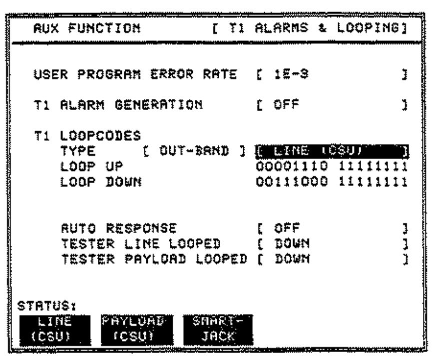


Highlight LOOPCODES TYPE [ ] .

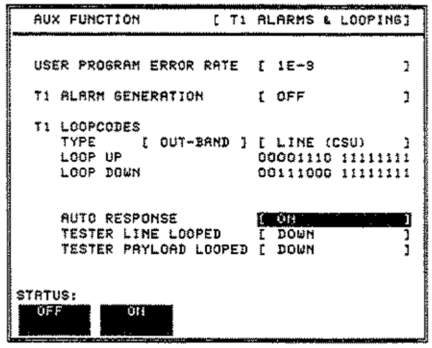
Select [OUT-BAND] .



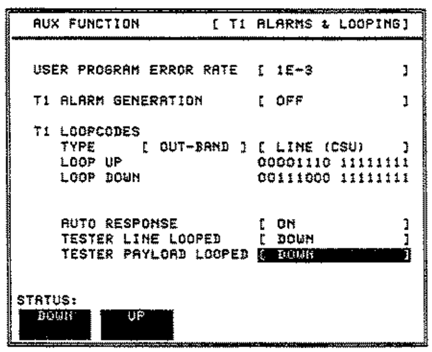
Select the code you want the Tester to respond to: [LINE (CSU)] , [PAYLOAD (CSU)] , [SMARTJACK] or [USER PROGRAM] .



Highlight AUTO RESPONSE [ ].
Select ON.

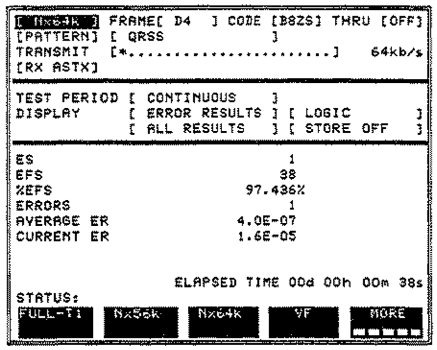


Highlight TESTER LINE LOOPED [ ] and TESTER PAYLOAD LOOPED [ ].
Select DOWN for each.



To Make Fractional T1 (n × 56 / n × 64 kBit/s) Tests

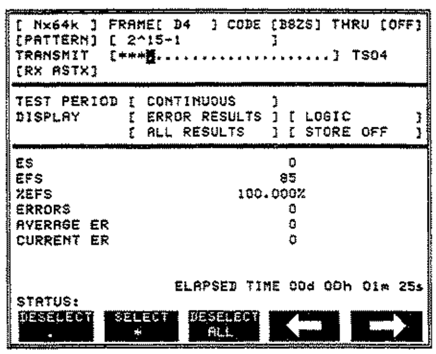
Press (CONFIG).
Select N × 56k or N × 64k.



Select the frame,code and pattern you want.

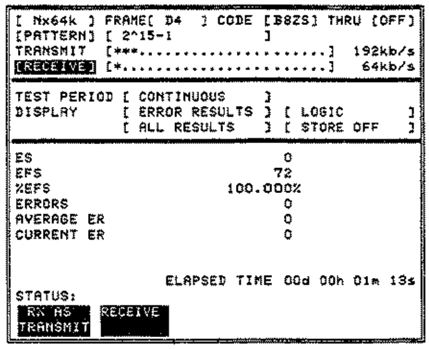
Highlight TRANSMIT [ ], and select the timeslots over which you want to spread the selected pattern.

The example shows a 2^15−1 PRBS transmitted in a 192 kbit/s Intermediate Bit Rate (IBR) in timeslots 1, 2, and 3.



To set the receive timeslots for 1:1 mapping select RX ASTX .

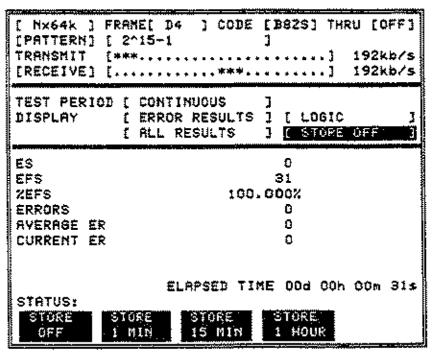
To define your own receive timeslots select RECEIVE .



Highlight RECEIVE [ ], and select the timeslots that contain the incoming IBR.

The example shows the selection of timeslots 13, 14, and 15.

If results storage or graphs of results are required, start the test by selecting the storage resolution and press (RESTART).



To Transmit Errors and Alarms

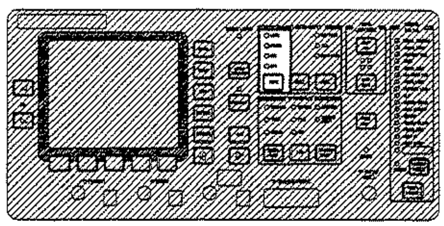
You may insert errors by introducing changes into the transmitted pattern.
You may introduce the yellow alarm into the transmitted pattern.
You may replace the transmitted pattern with unframed all 1's.

To Transmit Errors

You may choose the type of error and the error rate.

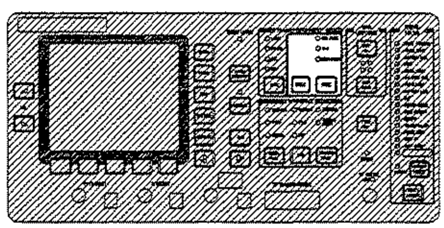
To Choose the Type of Error

Use (TYPE) to set the type of error you want to introduce.



To Choose the Error Rate

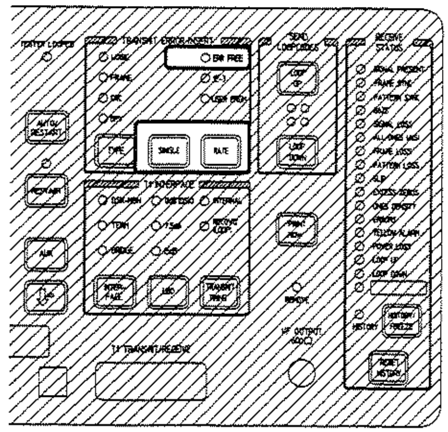
You may choose:
To add errors singly .
To add errors at a fixed rate of 1E − 3.
To select the error rate.



To Add Errors Singly

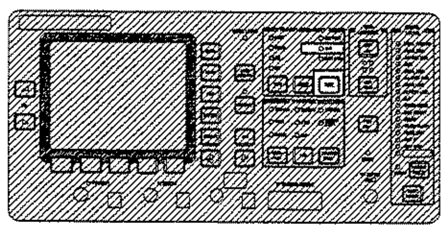
Use (RATE) to select ERR FREE.

Press (SINGLE) to insert an error.



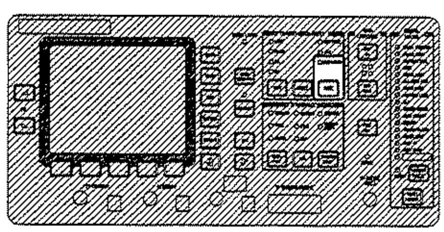
To Add Errors at a Fixed Rate of 1E − 3

Use (RATE) to select 1E − 3.



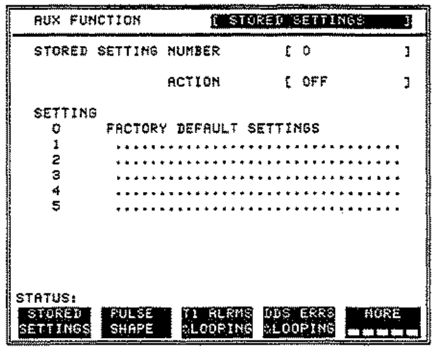
To Select an Error Rate

Use (RATE) to select USER PRGM.



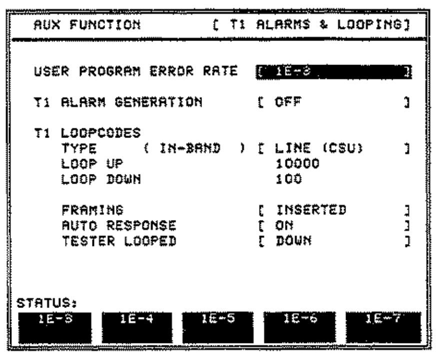
Press (AUX).

Select T1 ALARMS & LOOPING.



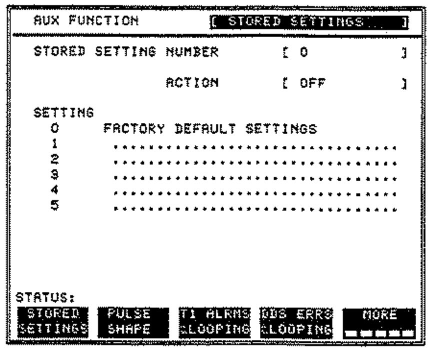
Highlight USER PROGRAM ERROR RATE [ ].

Select the rate 1E − 3, 1E − 4, 1E − 5, 1E − 6 or 1E − 7.

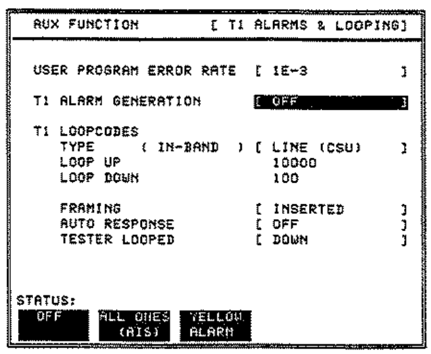


To Transmit T1 Alarms

Press (AUX).
Select T1 ALARMS & LOOPING.

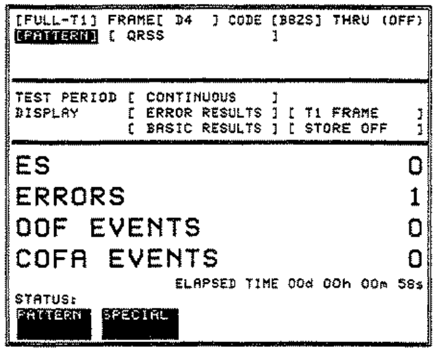


Highlight
T1 ALARM GENERATION [ ].
Select the type of alarm you want.



To Transmit and Monitor Signaling Bits

Press (PATTERN).

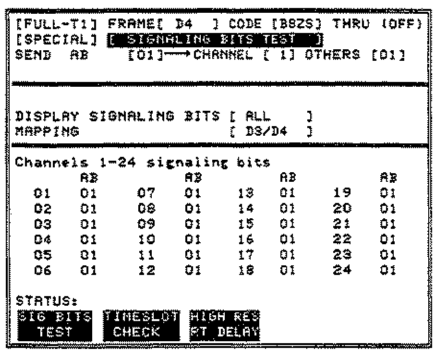


Highlight [PATTERN]

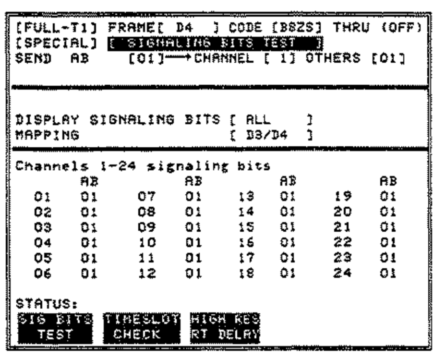
Select SPECIAL.

Highlight [SPECIAL] [ ]

Select SIG BITS TEST.

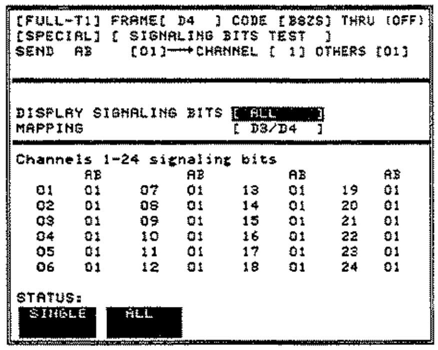


Select the test signaling bits A B (A B C D with ESF),the CHANNEL you want to send them in and the signalling bits to go in the OTHER channels.



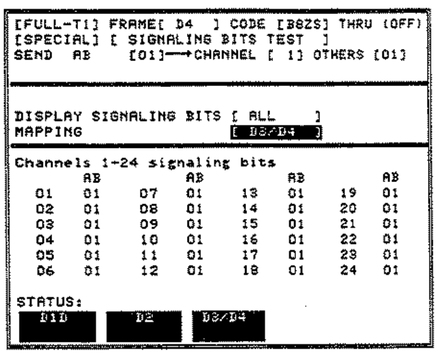
Highlight DISPLAY SIGNALING BITS [ ]

To display signaling bits from one channel select SINGLE.
To display signaling bits from all channels select ALL.



Highlight MAPPING [ ]

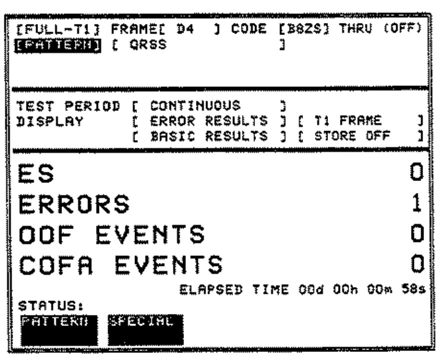
Select the channel / timeslot mapping for the system being tested.



To return to the error measurement display.

Highlight [SPECIAL]

Select PATTERN.



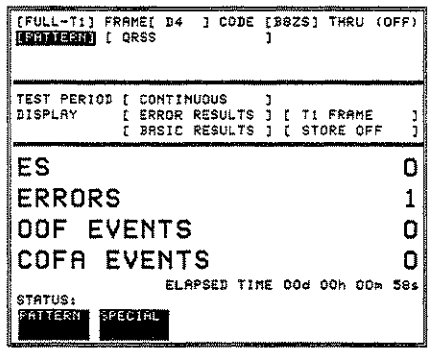
To Trace Timeslots

The instrument transmits a binary code of the timeslot number in bits 3 to 7 of each timeslot (bits 1,2 and 8 are 1's). When a SINGLE timeslot is selected the binary code is displayed. When ALL timeslots are selected, decoded timeslot numbers are displayed for all timeslots.

Press (PATTERN).

Highlight [PATTERN]

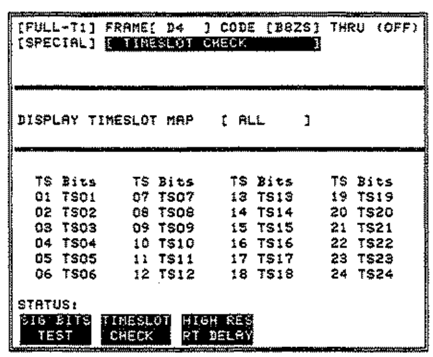
Select SPECIAL.



Highlight [SPECIAL] [ ]

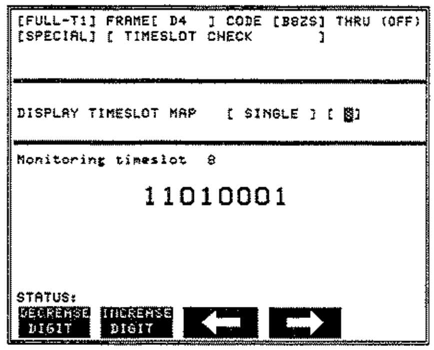
Select TIMESLOT CHECK.

In this case the timeslots are not being cross connected and so do not change positions.

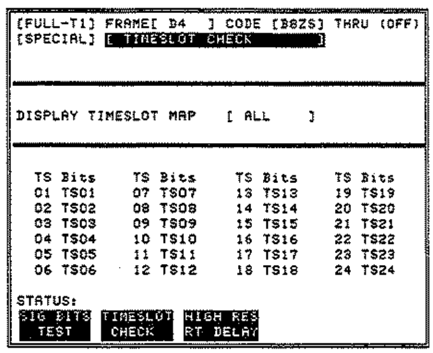


Highlight
DISPLAY TIMESLOT MAP [ ]

To display the timeslot code for one channel select SINGLE.



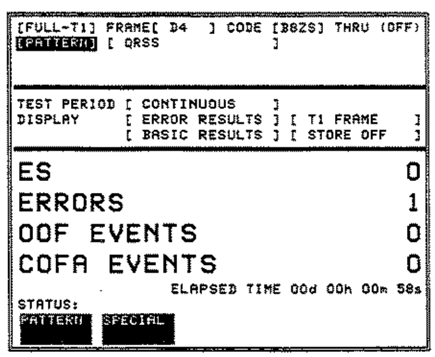
To display the decoded timeslot numbers for all channels select ALL.



To return to the error measurement display.

Highlight [SPECIAL]

Select PATTERN.

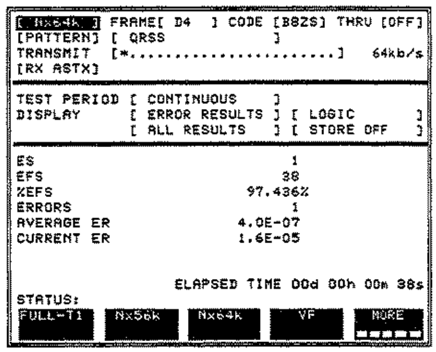


To Make Out-of-Service Tests at the Customer Premises

T1 and Fractional T1, Level (for LBO setting), Current, Frequency and Pulse Shape

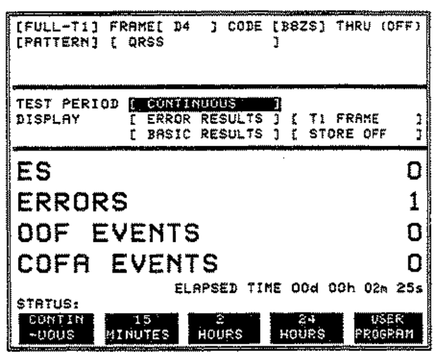
Press (CONFIG).

Select FULL T1, N x 56k or N x 64k.



Highlight TEST PERIOD [ ].

Select CONTINUOUS.

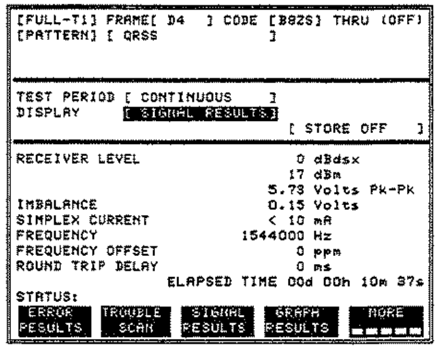


Press (AUTO/RESTART) to set FRAME, CODE and PATTERN to the incoming signal and start an error test.
Highlight DISPLAY [ ].
Select SIGNAL RESULTS.

Use the measured RECEIVER LEVEL to set the Tester transmit LBO.

For round trip delay measurement use the QRSS test pattern.

For high resolution round trip delay change [PATTERN] to [SPECIAL].



You can now check SIMPLEX CURRENT and FREQUENCY readings. Current is best checked with an all 1's (max current) pattern. Low current might indicate bad PSU's, bad wiring or a bad repeater.
When the CSU or network interface is replaced or installed, its transmit output LBO should be set to the value you set on the Tester to get the correct RECEIVER LEVEL.

Pulse Shape.

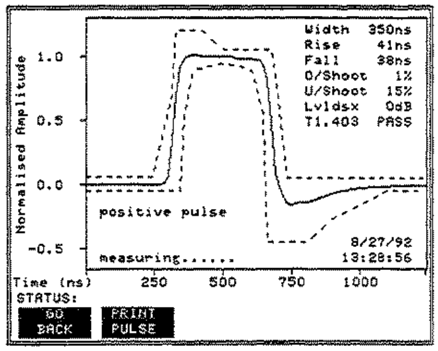
If the Tester has the optional Pulse Shape display facility

Press (AUX).

Select PULSE SHAPE.

Highlight ACTION [ ].

Select MEASURE.



If you want to store the displayed pulse shape select GO BACK.

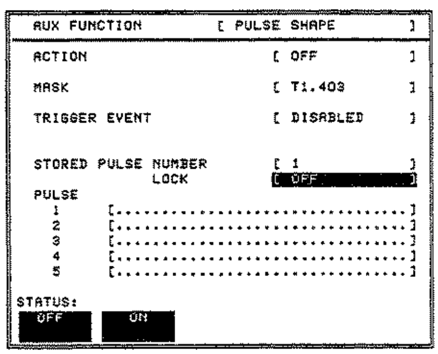
Before you run the measurement

Highlight STORED PULSE NUMBER [ ] and select the number of the store that you want to use.

Highlight LOCK [ ].

Select OFF.

To name the store see "To Indicate Stored Setup Content" in chapter 2.



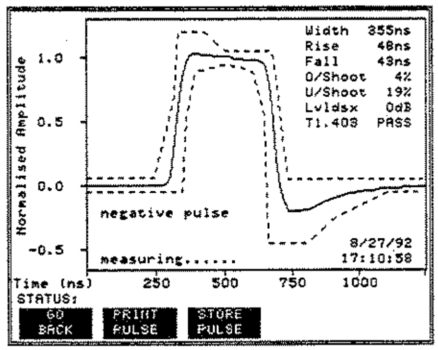
To display the pulse shape

Highlight ACTION [ ].

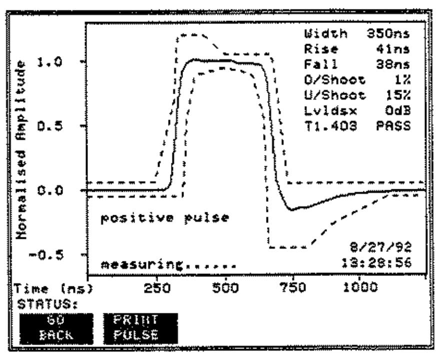
Select MEASURE.

To store the display

Select STORE PULSE.



You can check that the received pulse meets the specified mask.



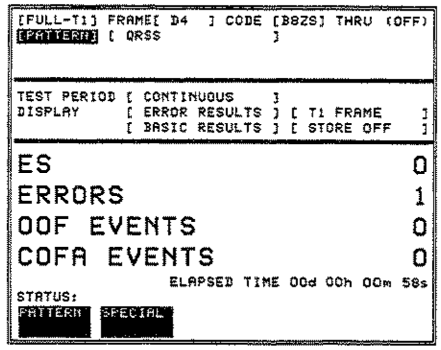
To Measure Round Trip Delay with Higher Resolution

Round trip delay is displayed as part of the signal test. A higher resolution display of round trip delay may be obtained as follows:

Press (PATTERN).

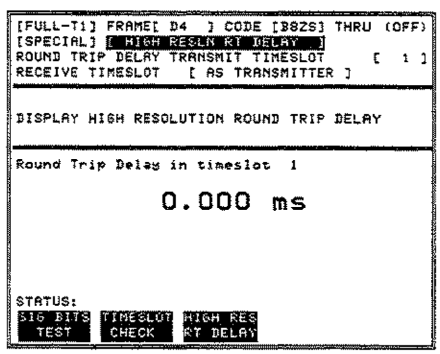
Highlight [PATTERN].

Select SPECIAL.

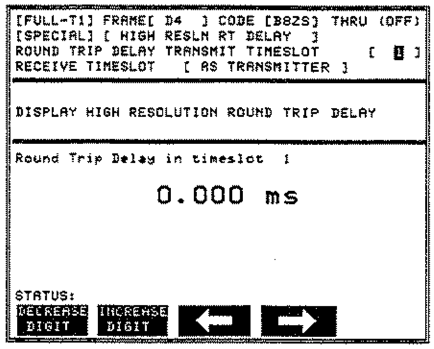


Highlight [SPECIAL] [ ]

Select HIGH RESLN RT DELAY.



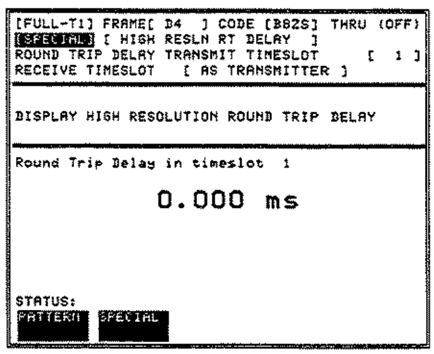
Select the transmit and receive timeslots .



To return to the error measurement display.

Highlight [SPECIAL]

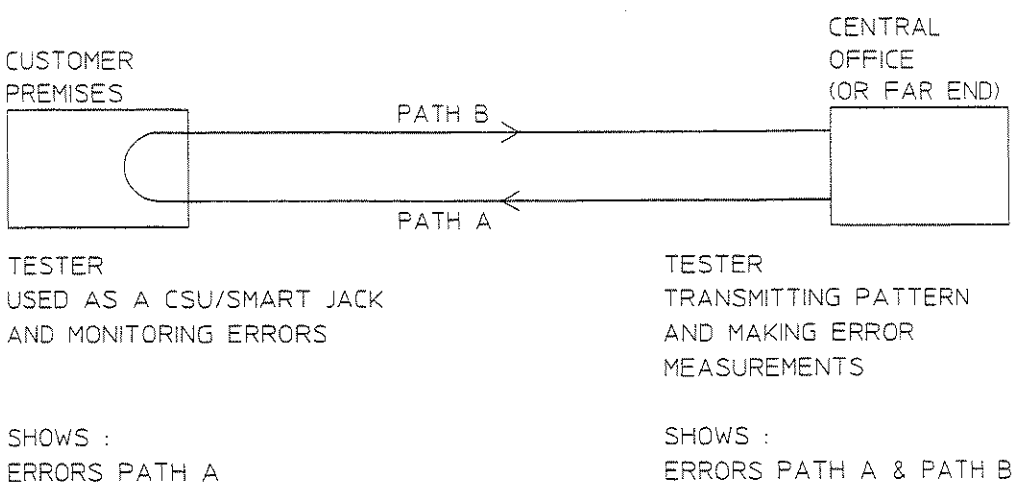
Select PATTERN.



To Monitor Errors at the Customer Premises.

The tester measures and stores all error types simultaneously. The display shows one selected type in "real time". The other types can be displayed at any time, during and after the test, up to the start of the next test. Results may also be stored for later reference.
Single path error tests are most useful as an aid to trouble location when making a looped test from the Central Office or the far end of the circuit with another Tester.
With the Tester at the customer premises looped and set up for the Level,Current and Frequency test (with SIGNAL RESULTS selected) the other results : ERROR RESULTS (ALL RESULTS or BASIC RESULTS), TROUBLE SCAN, ALARM SECONDS and SLIPS AND WANDER, apply to the path being received at the Customer Premises.
Just select a TEST PERIOD, press RESTART and select the error type that you want to DISPLAY in "real time".

Local loop Tests



Out of Service Tests From the Central Office

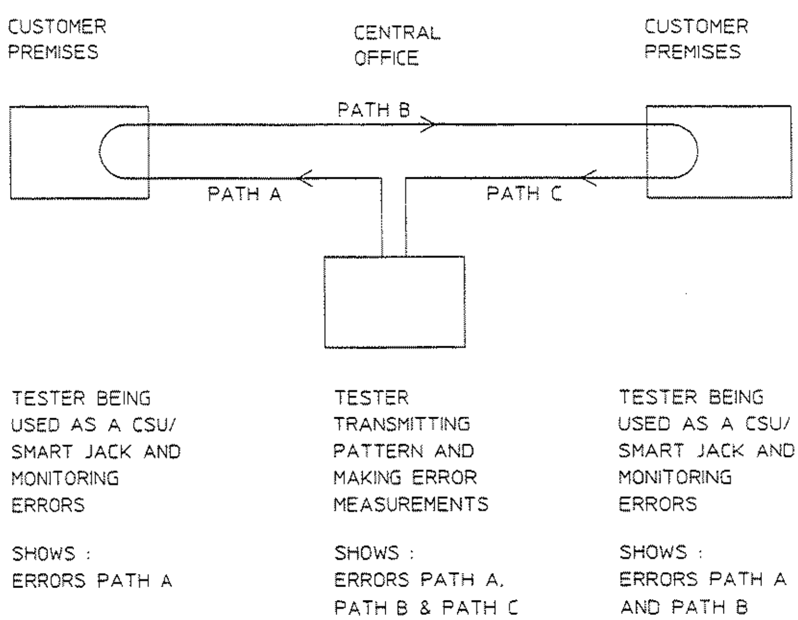
You can make local loop, end to end and round trip loopback tests. Local loop tests are as shown with customer premises tests on page 3-30.

Two kinds of loopback are available when testing devices with ESF framing and out-of-band loopback.

1. LINE (CSU) Loopback - all bits in the T1 signal are retransmitted.
2. PAYLOAD (CSU) Loopback - only the customer data bits are retransmitted, framing and CRC bits are recalculated before being transmitted back to the Tester.

Using both loopbacks help isolate the fault to either the *go* or *return* path of the T1 circuit.

End-to-End and Round Trip Loopback Tests

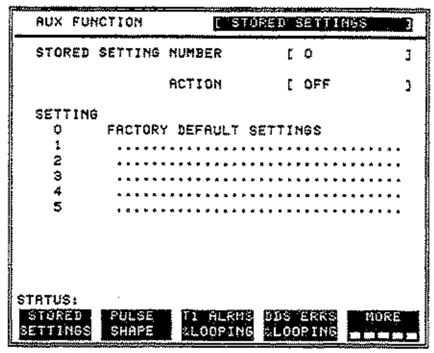


To Loop the CSU, Network Interface, or Tester at the Customer Premises using a T1 In-Band Loopcode

The loop can be set manually at the customer premises. Alternatively, the loopcode can be sent from the tester at the Central Office using the following procedure.

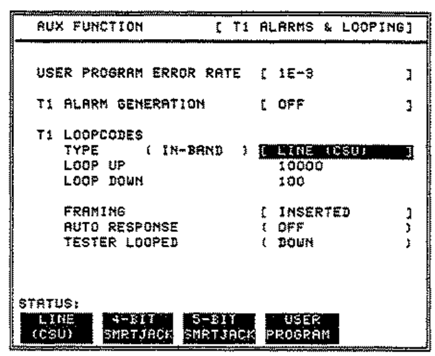
Press (AUX).

Select T1 ALARMS & LOOPING.



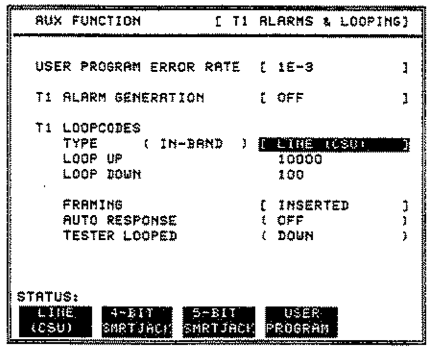
Highlight TYPE (IN-BAND) [ ]. Select the loopcode that the far end CSU, Smartjack or tester will respond to.

If ESF framing is being used, ensure the LOOPCODE TYPE is set to [IN-BAND].

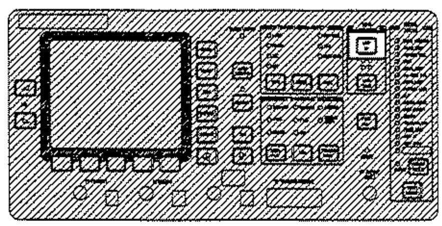


Highlight AUTO RESPONSE [ ].
Select OFF.

Highlight TESTER LOOPED [ ].
Select DOWN.



To send the loop code.
Press (LOOP UP).
For round trip loopback tests you may need to press (LOOP UP) twice.



To Loop the CSU, Network Interface, or Tester at the Customer Premises using an Out-of-Band T1 Loopcode

Out-of-band loopcodes are only available with ESF framing.

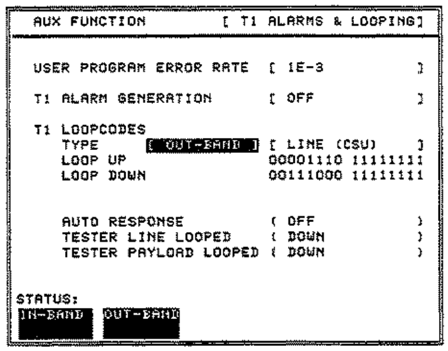
The loop can be set manually at the customer premises. Alternatively, the loopcode can be sent from the tester at the Central Office using the following procedure.

Press (AUX).

Select T1 ALARMS & LOOPING.

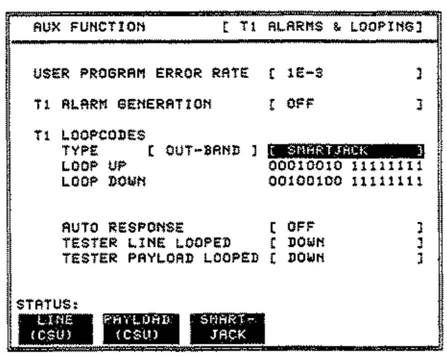
Highlight TYPE [ ].

Select [OUT-BAND].



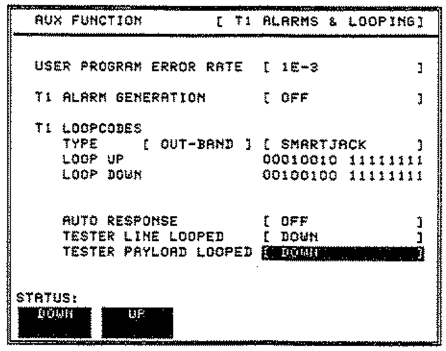
Select which loopback you want: [LINE (CSU)], [PAYLOAD (CSU)], [SMARTJACK] or [USER PROGRAM].

The LOOP UP and LOOP DOWN codes are shown on the display.

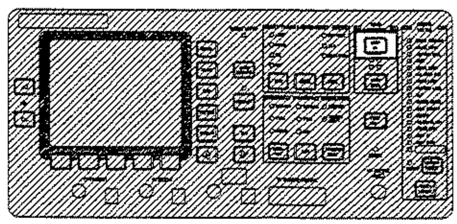


Highlight AUTO RESPONSE [ ].
Select OFF.

Highlight TESTER LINE LOOPED [ ] and TESTER PAYLOAD LOOPED [ ].
Select DOWN for each.



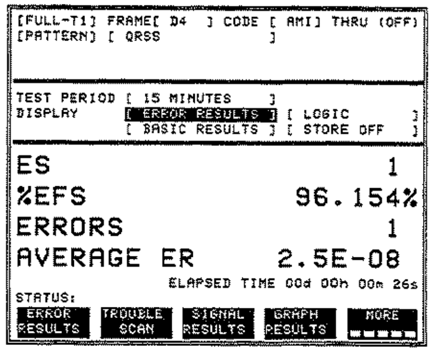
To send the loop code.
Press (LOOP UP).
For round trip loopback tests you may need to press (LOOP UP) twice.



To Set-Up the Tester for a Looped 15 Minute, QRSS, T1, Logic Error Test

Press (FRAME).
Select ESF, D4, SLC96 or UNFRAMED.

Press (CODE).
Select AMI or B8ZS.
Press (PATTERN).
Select QRSS.
Highlight TEST PERIOD [ ]
Select 15 MINUTES.
Press (RESULTS).
Select DISPLAY.
ERROR RESULTS LOGIC
BASIC RESULTS.



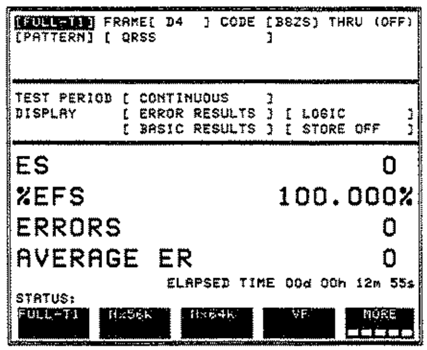
To Run the Test

A test will have started when you changed parameters. To start a new test press (RESTART).
The Tester at the central office will display go and return path errors. If a tester is used as a CSU / network interface at the customer premises, use (RESTART) on that tester to display the single path (central office to customer premises) errors.
You can display the other results either during or after the test. The alternatives are : Frame Errors, BPVs and ESF CRC errors (individually or together in Trouble Scan), All (Error) Results, Signal Results, Alarm Seconds, Slips and Wander or Pulse Shape.

To Test, to Arm and Loop Westell or Teltrend Intelligent Addressable Repeaters.

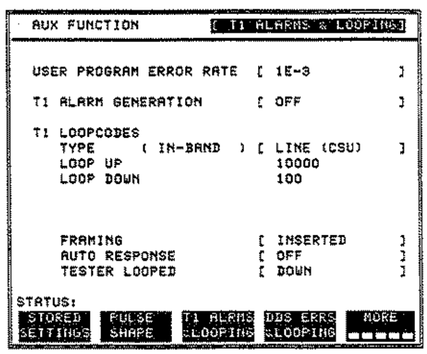
Press (CONFIG).

Select FULL-T1.



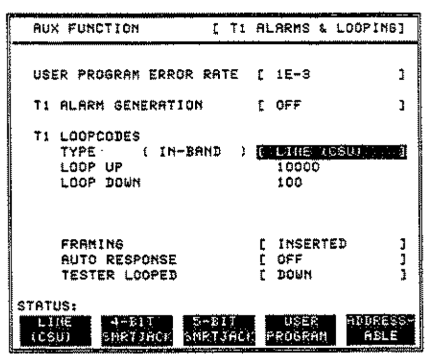
Press (AUX).

Select T1 ALARMS & LOOPING.



Highlight TYPE (IN-BAND) [ ].

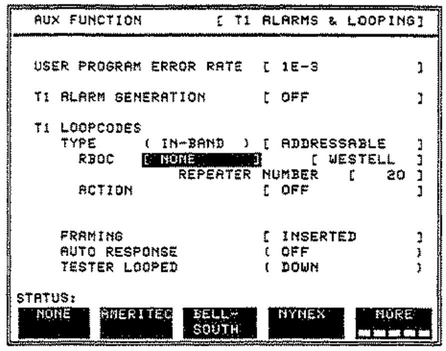
Select ADDRESSABLE.



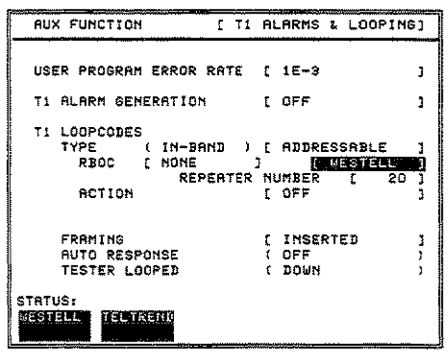
Highlight RBOC [ ].

For a Regional Bell Operating Company Type, select the RBOC, or to choose Westell or Teltrend, select NONE.

The tester has built-in firmware for each RBOC depending on whether they are Westell or Teltrend.



Select WESTELL or TELTREND.



Multi Pattern Testing

Three multi pattern tests are available:
Bridge tap test with selectable seconds / pattern.
Fixed program (all 1's, 1:8, 2:8, 3:24 and QRSS) with selectable minutes / pattern.
User program with selectable pattern and selectable time / pattern.

If long user word 1 or user program are required as patterns:
Select long user word with (AUX) LONG USR WORD .
Select user program with (RESULTS) PATTERN USER PROGRAM

To run a multi pattern test, use (AUX) MULTI PATTERN to set up the time / pattern and user program patterns.

Press (RESULTS)

Set [PATTERN] / [MULTI PATTERN] / [SPECIAL] to MULTI PATTERN

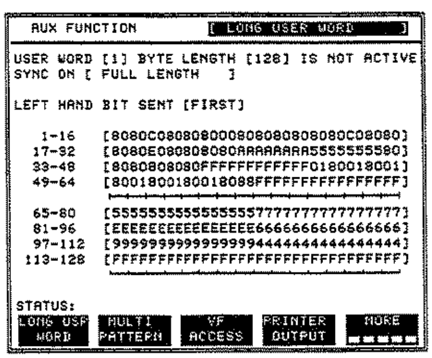
Set DISPLAY [ ] to MULTI PATTERN

The following example of a multi pattern test is for a bridge tap test.

To Run a Bridge Tap Test

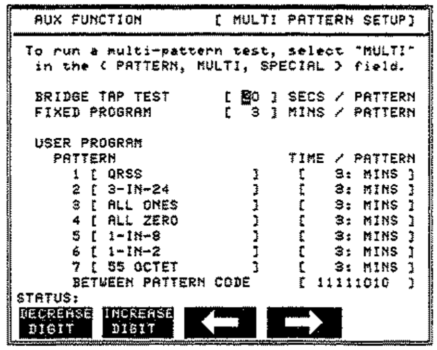
Press (AUX).

Select MULTI PATTERN.



For bridge tap or fixed program tests, select the time/pattern.

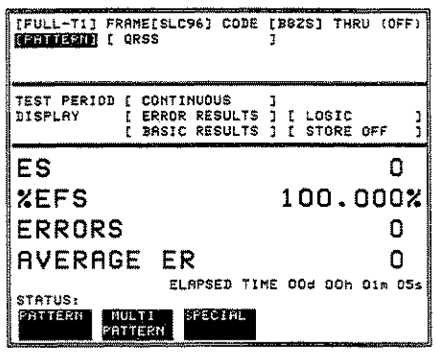
For user program, select the patterns and time/pattern.



Press (PATTERN).

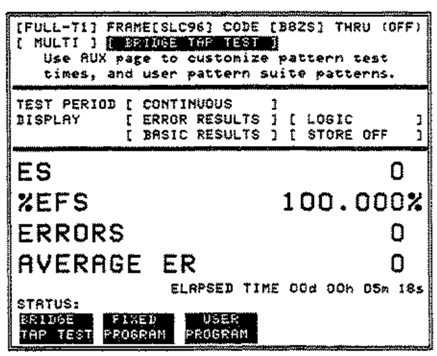
Select MULTI PATTERN.

Cursor up to (PATTERN) and select MULTI PATTERN.



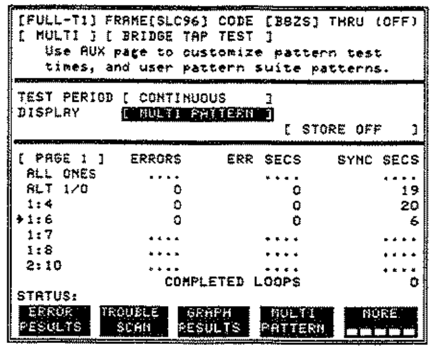
Highlight MULTI [ ].

Select BRIDGE TAP TEST.



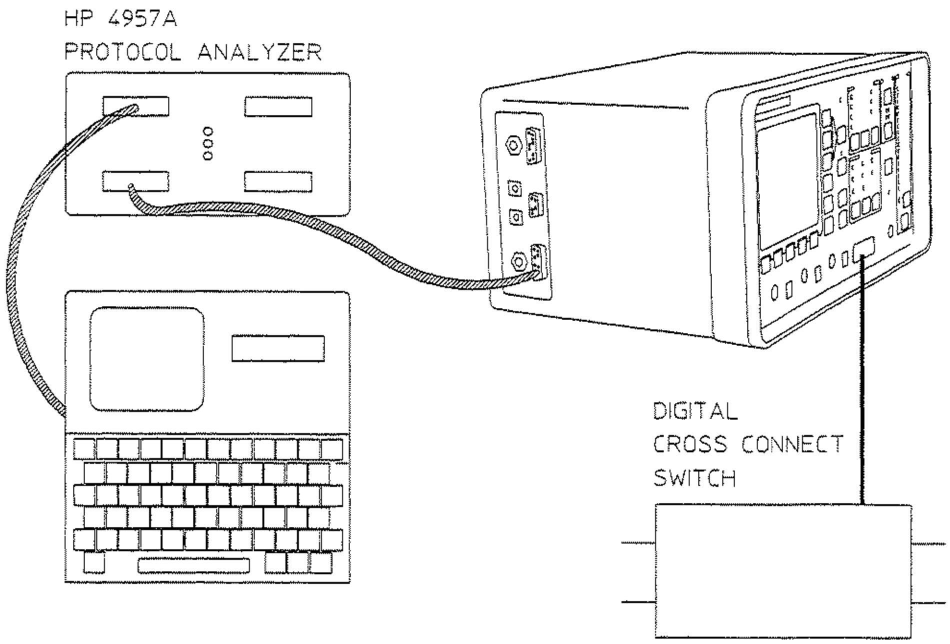
Press (RESULTS) to highlight DISPLAY [ ].

Select MULTI PATTERN.

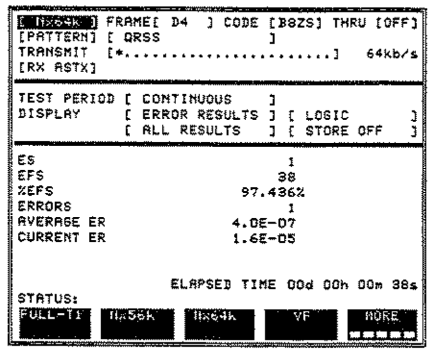


To Test Using a Customer Protocol

You may use the instrument as an interface between a protocol analyzer and a T1 circuit. You may drop and insert up to 6 T1 timeslots or the ESF or SLC-96 facilities datalinks.

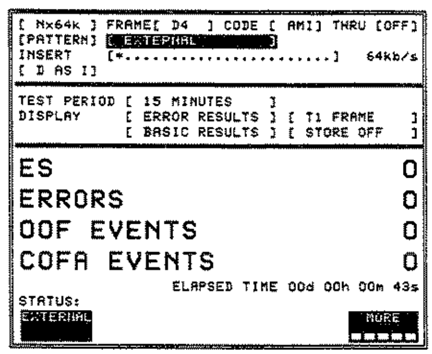


Press (CONFIG).



Select Nx56k, nx64k, T1-DDS or DS0-DDS.

Highlight PATTERN [ ].



Select EXTERNAL.

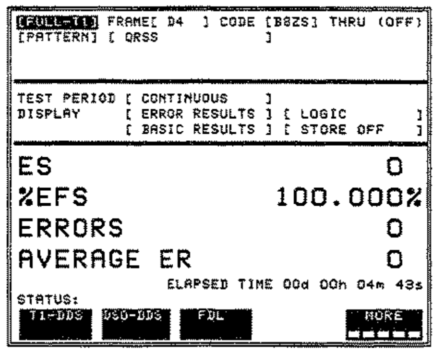
For FDL Highlight PROTOCOL [ ].

Select EXTERNAL.

To See A Complete Decode of Information Carried in the SLC-96 or ESF Facilities Datalink

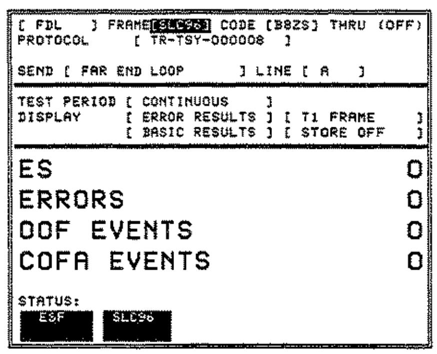
Press (CONFIG).

Select FDL.



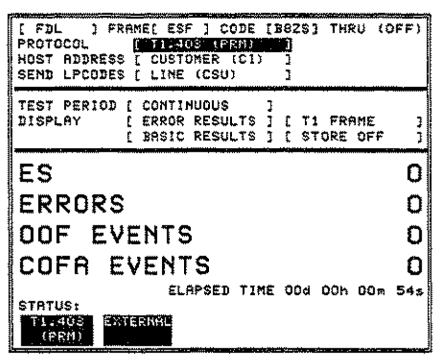
Highlight FRAME [ ].

Select [ESF].



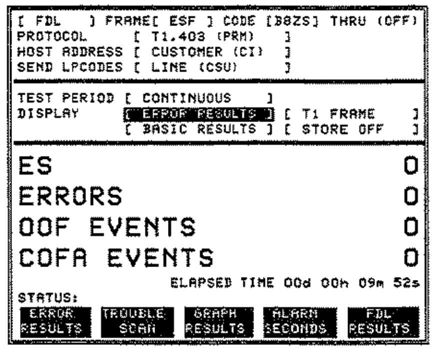
Highlight PROTOCOL [ ].

Select T1.403 (PRM)



Press (RESULTS)

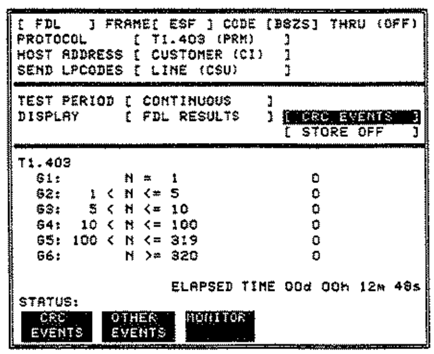
Select [FDL RESULTS].



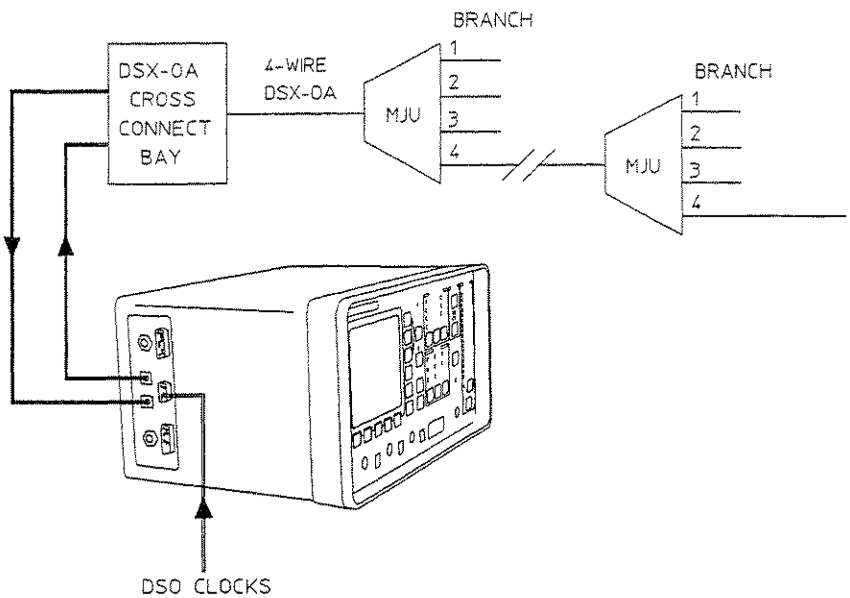
Highlight DISPLAY [FDL RESULTS] [ ].

To monitor error performance information carried in the FDL PRM (Performance Report Message), Select CRC EVENTS or OTHER EVENTS.

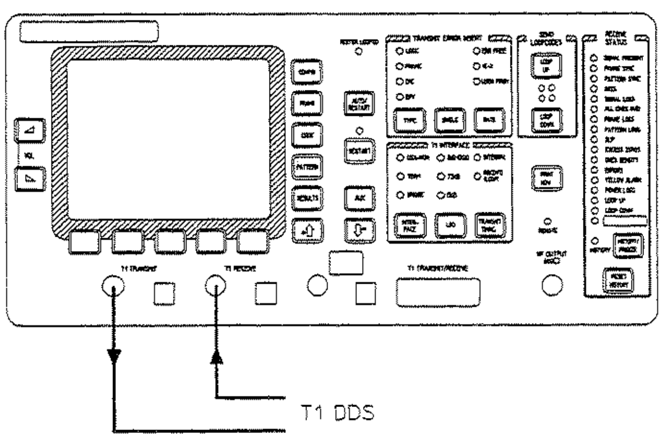
To see all of the bits within the FDL, Select MONITOR



To Select a DDS Route, Loopback and Make a Measurement



OR



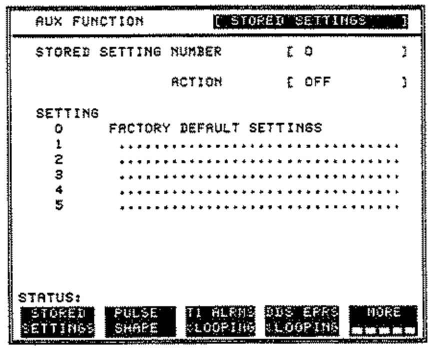
Selecting the Route

Press (CONFIG).

Select T1-DDS.

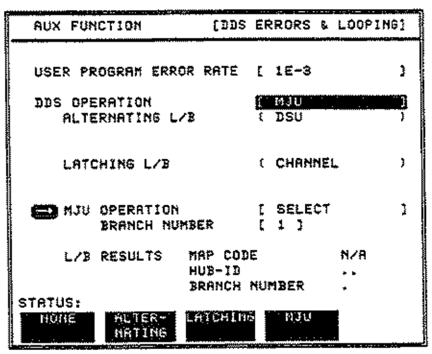
Press (AUX).

Select DDS ERRS &LOOPING.



Highlight
DDS OPERATION [ ].

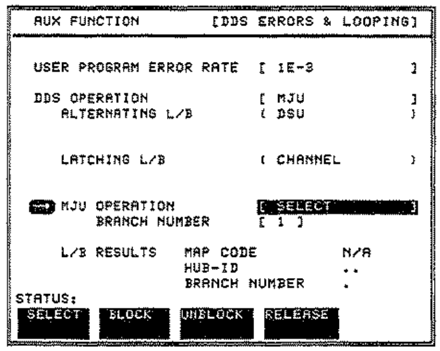
Select MJU.



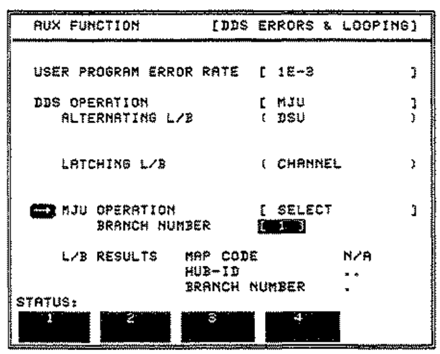
To Select an MJU Branch

Highlight
MJU OPERATION [ ].

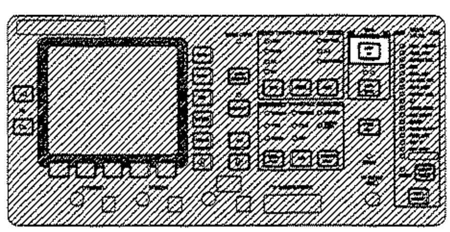
Select SELECT.



Highlight
BRANCH NUMBER [ ].
and select the branch you want.



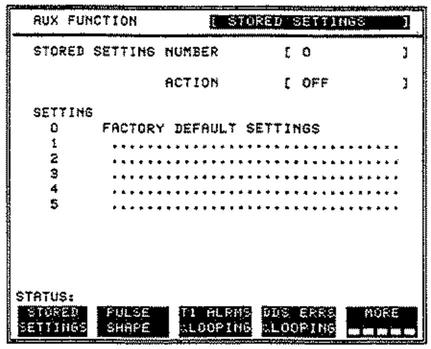
Press (LOOP UP) to select the branch. The response will appear as a HUB-ID and BRANCH NUMBER.



Selecting the loopback

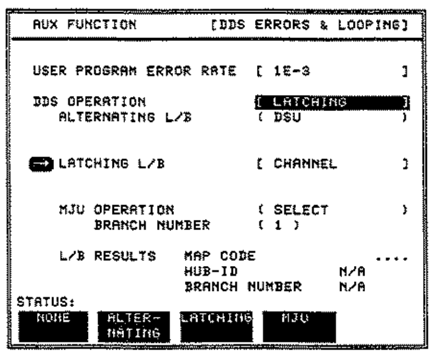
Press (AUX).

Select DDS ERRS &LOOPING.

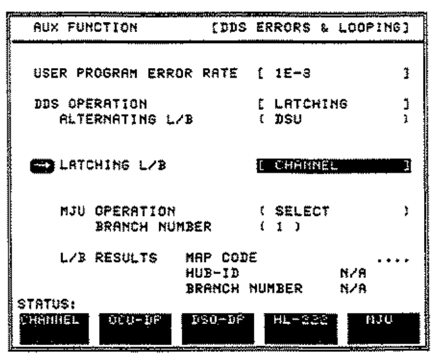


Highlight
DDS OPERATION [ ].

Select ALTERNATING or LATCHING.



Highlight
ALTERNATING L/B [ ].
or
LATCHING L/B [ ].
whichever has been selected.
and select the type of loopback you want.
The response will appear as a MAP CODE.



Selecting MJU Loopback

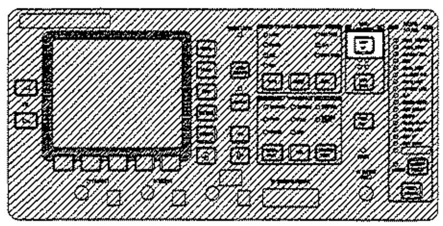
Use DDS OPERATION LATCHING

LATCHING L/B MJU

Actuating the loopback

NOTE: When LOOP UP or LOOP DOWN are used the type of loopcode sent, T1 or DDS, depends on the CONFIG selected. For DDS looping, CONFIG must be T1-DDS or DS0-DDS.

Press LOOP UP to perform the function selected.



Making the Measurement

DDS measurements are run in the same way as T1 measurements. All error types are measured simultaneously during a test. To choose how you want to display them, press (RESULTS) and select what you want.

T1-DDS tests use the front panel T1 TRANSMIT and T1 RECEIVE connectors.

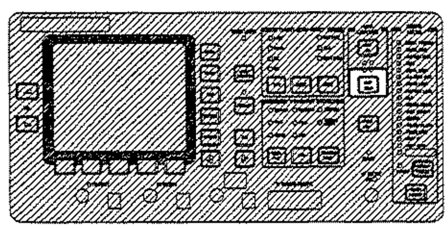
DSO-DDS tests use the side panel DSO RECEIVE, TRANSMIT and CLOCK connectors.

If you want to store the results for later analysis, the test should be started by selecting a storage resolution.

Looping Down

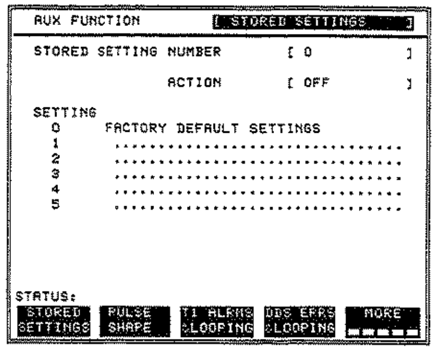
NOTE: When (LOOP UP) or (LOOP DOWN) are used the type of loopcode sent, T1 or DDS, depends on the CONFIG selected. For DDS looping, CONFIG must be T1-DDS or DS0-DDS.

Press (LOOP DOWN) to perform the function selected.



Blocking, Unblocking and Releasing (all) MJU Branches.

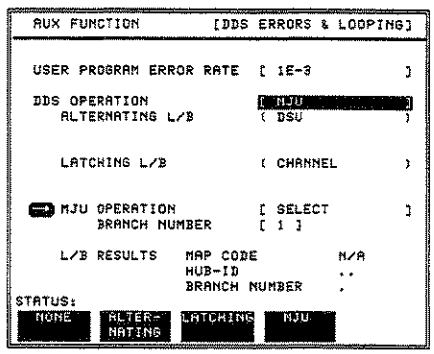
Press (AUX).



Select DDS ERRS &LOOPING.

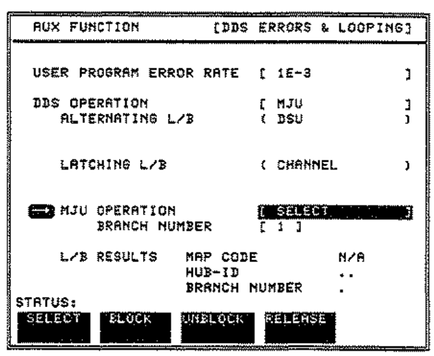
Highlight
DDS OPERATION [ ].

Select MJU

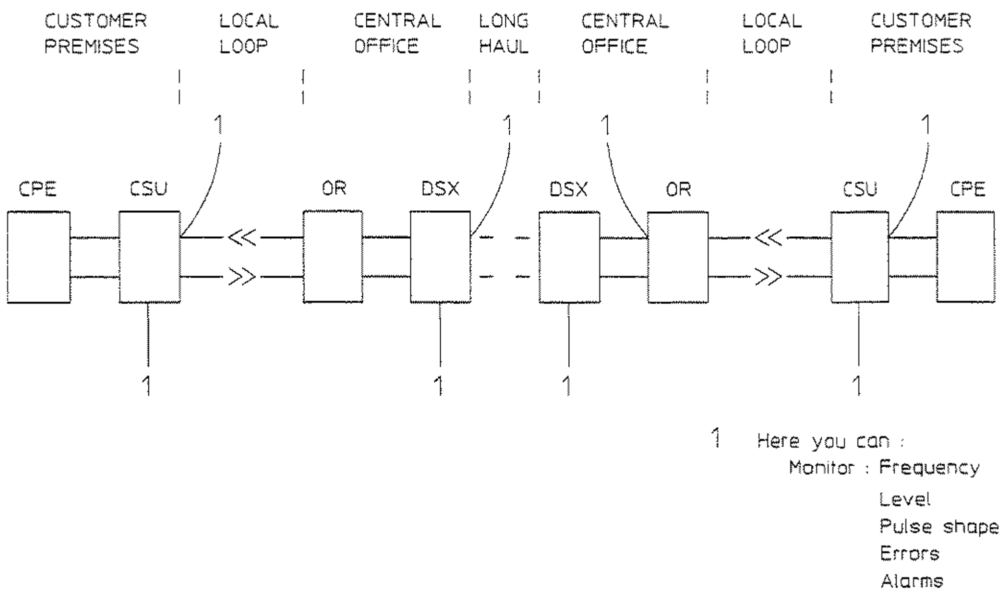


Highlight
MJU OPERATION [ ].

and select the operation you want to perform and press (LOOP UP) to actuate it.



In-Service Testing

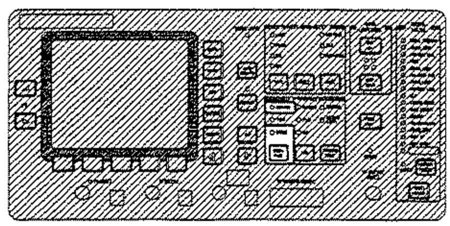


To Set the Monitor Interface

You can set up to monitor at a protected monitor point (DSX-MON) or at an unprotected point (BRIDGE).

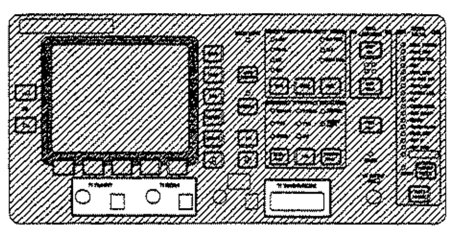
Warning **T1 Line voltages are capable of supplying dangerous currents. Power should be removed from the local loop while the tester is being connected or disconnected. It is recommended that the tester should be connected at a DSX-1 MON for in-service testing.**

Use (INTERFACE) to set T1 INTERFACE to DSX-MON or BRIDGE.



To Connect the Tester for In-service T1 Testing

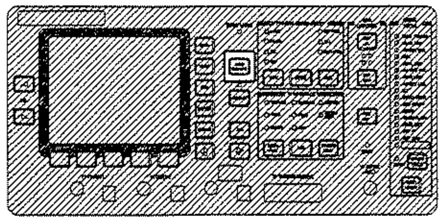
Connect the tester to the monitor point. As the signal is only being received for in-service tests, Transmitter timing selection is not necessary.



To Use the Tester for T1 Line Identification

The least intrusive method of line identification is to look for a known signal in one VF channel. Select either FULL-T1, FRACTIONAL-T1, T1-DDS or FDL.

Press (AUTO/RESTART) to set the T1 tester to the incoming Frame, Code and Pattern and start an error test.

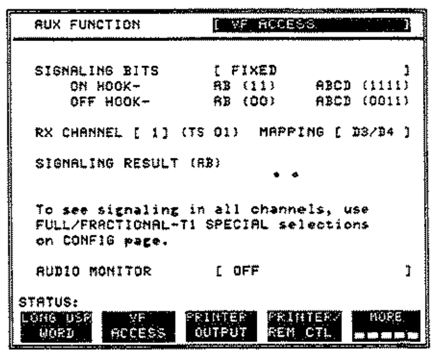


Press (AUX) and select VF ACCESS.

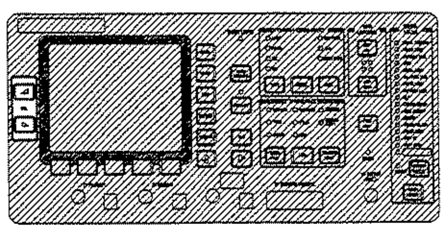
Highlight MAPPING and select [D1D], [D2] or [D3/D4].

Highlight AUDIO MONITOR [ ]. Select ON.

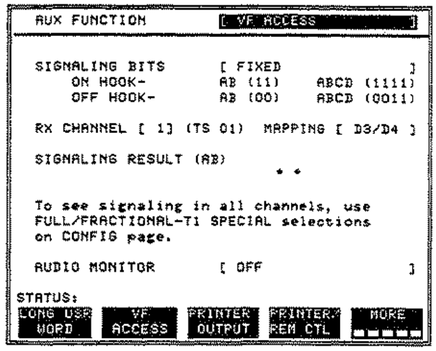
N.B. This is necessary for the signal to appear at the VF OUTPUT port.



Use (◢) and (◣) to adjust the volume.



Highlight RX CHANNEL [ ].
Select channels using ◀ ▶ and
INCREASE DIGIT or DECREASE DIGIT
until the known VF signal is heard.



Mapping is automatic, as the channel setting is changed the timeslot reading on the display is automatically updated - you can see at a glance the channel-to-timeslot relationship.

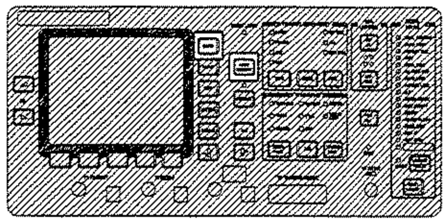
To Monitor Circuit Performance

Level, Frequency and Pulse Shape

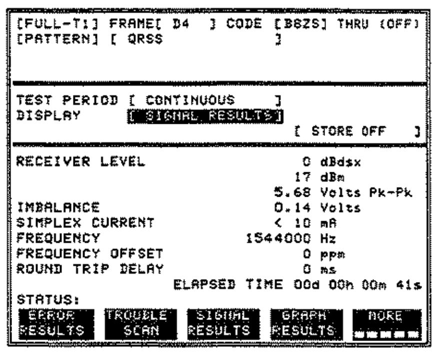
Press (CONFIG) to recall the results display.

Highlight TEST PERIOD [ ].
Select CONTINUOUS.

Press (AUTO/RESTART) to set FRAME, CODE and PATTERN to the incoming signal and start an error test.



Highlight DISPLAY [ ].
Select SIGNAL RESULTS.

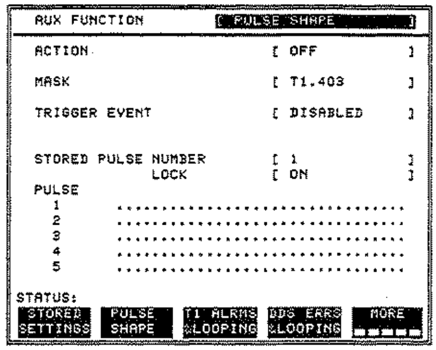


You can now check LEVEL, and FREQUENCY.
Level outside the expected range might indicate a wrongly set LBO, bad wiring, bad splices or a double terminated circuit.
High frequency offset might indicate serious equipment or configuration problems. For example, A faulty clock oscillator, or the terminals at each end of the circuit loop timed from each other.

If the Tester has the optional Pulse Shape display facility

Press (AUX).

Select PULSE SHAPE.

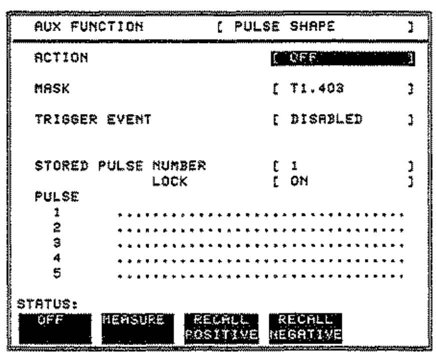


You can now look for gross distortions of the pulse shape.
Remember that the pulse may be slightly distorted by :
The termination of the line.
The monitor point itself.

For testing against a mask, the Tester has to terminate the T1 line directly to avoid these distortions.

Highlight ACTION [ ].

Select MEASURE



To Set-Up the Tester to Monitor T1 Errors

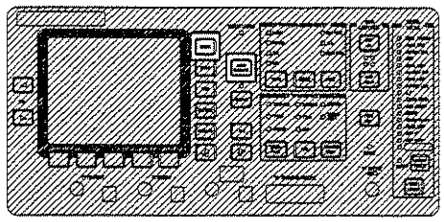
The tester measures and stores all error types simultaneously. The display shows one selected type in "real time". The other types can be displayed at any time, either during or after the test, up to the start of the next test. Results may also be stored for later reference.

Example, to Measure All Errors With Real Time Display of ESF CRC Errors.

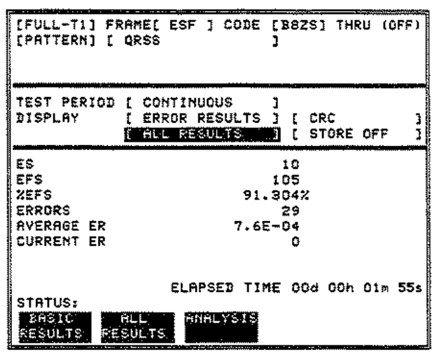
Press (CONFIG) to recall the results display.

Highlight TEST PERIOD [ ].
Select CONTINUOUS.

Press (AUTO/RESTART) to set FRAME, CODE and PATTERN to the incoming signal and start an error test.



Highlight DISPLAY [ ].
Select ERROR RESULTS CRC.
Highlight
[ERROR RESULTS] [CRC].
[ ]
Select ALL RESULTS.

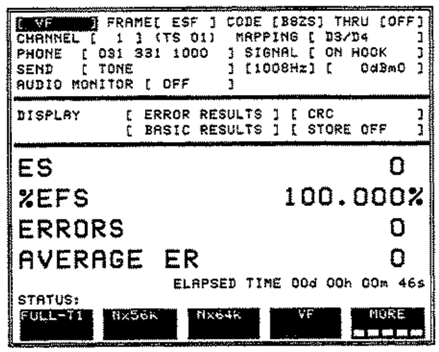


To Check Audio Line Response Within a T1 Signal

Tests may be looped back or end to end. The remaining timeslots may be kept in service by selecting THRU ON.

Press (CONFIG).

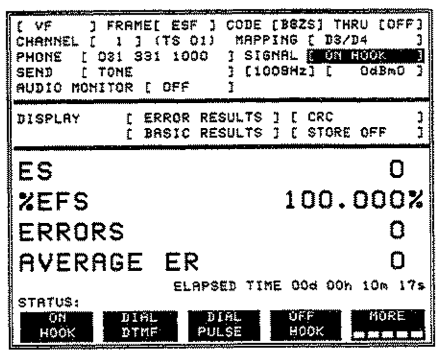
Select VF.



Select the parameters for the system being tested.

Highlight PHONE [ ].

Select the number of the line to be tested.



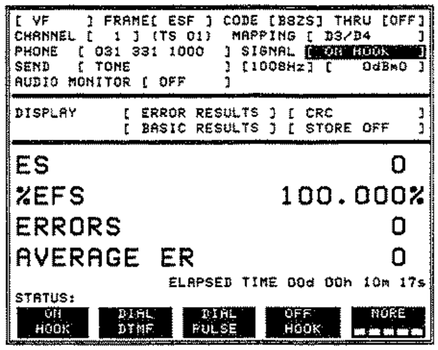
Highlight SIGNAL [ ].

Select the type of dialling you want.

The signals sent will be "on hook", "off hook" and then the selected number in the type of dialling selected.

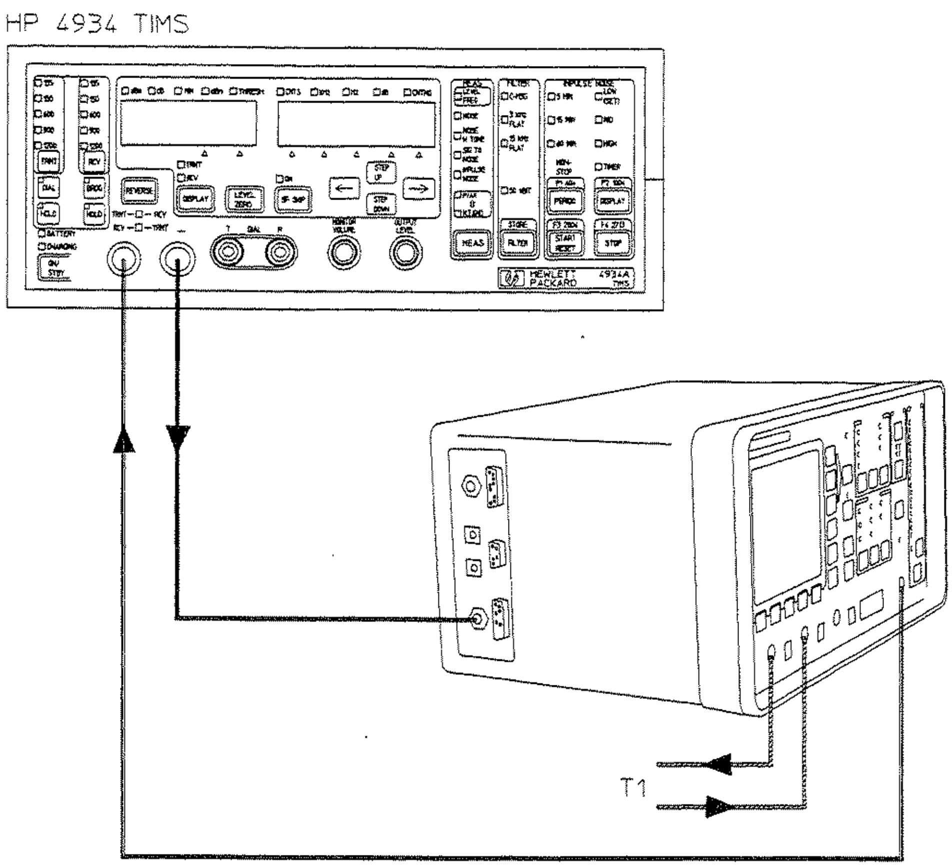
The signaling bits are as defined under (AUX) VF ACCESS.

To send on hook or off hook only, select ON HOOK or OFF HOOK.

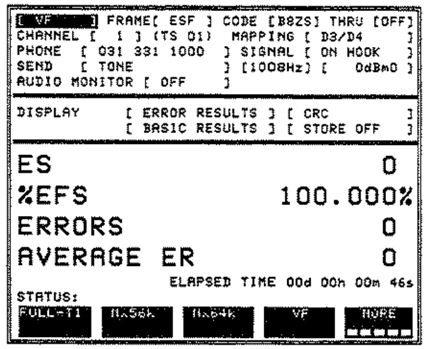


To Interface a TIMS Tester

You may use the instrument as an interface between a TIMS tester and a T1 circuit. The TIMS test signal may be inserted into a timeslot and dropped to the same or another TIMS tester.

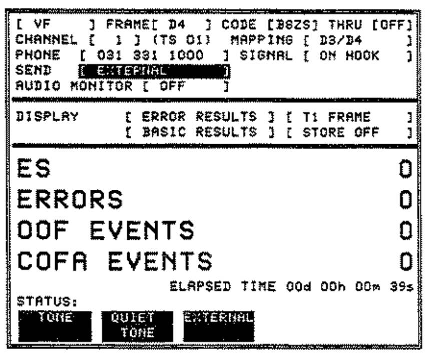


Press (CONFIG).



Select VF.

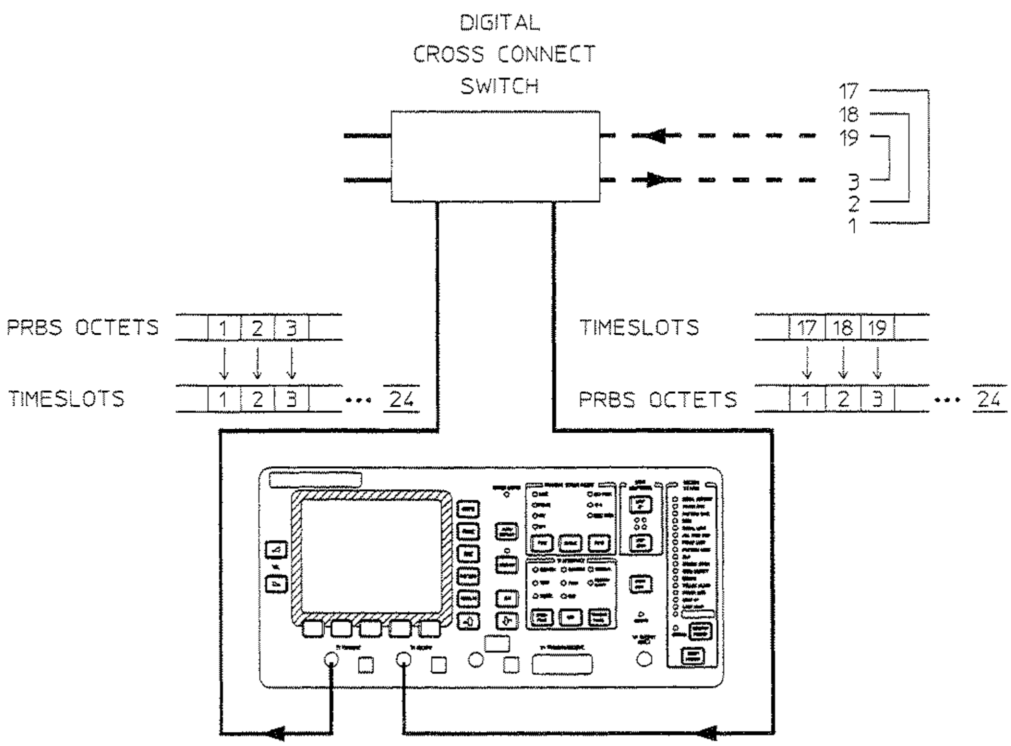
Highlight SEND [ ].



Select EXTERNAL.

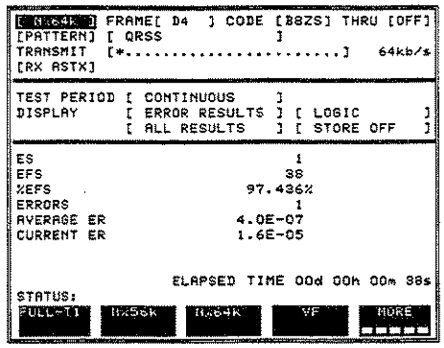
To Test IBR or Suitability for DDS Within a T1 Signal

This is the type of test which may be used to select a suitable group of timeslots for allocation to a new DDS service. It may also be used as a single instrument test in each direction from a cross connect to discover on which side a source of errors is located. The error source may be further isolated by looping the timeslots at intermediate points on the bad side.



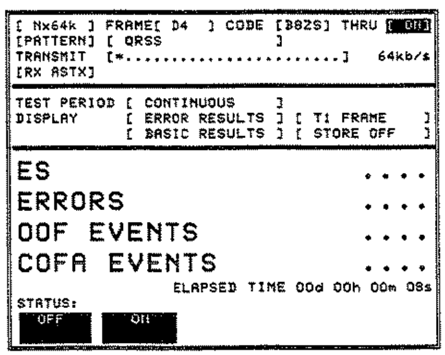
Press (CONFIG).

Select Nx56k or nx64k.



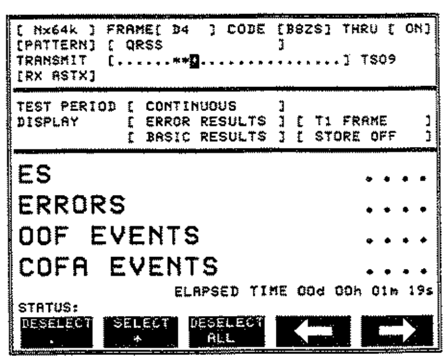
Highlight THRU [ ].

Select ON.



Highlight TRANSMIT [ ].

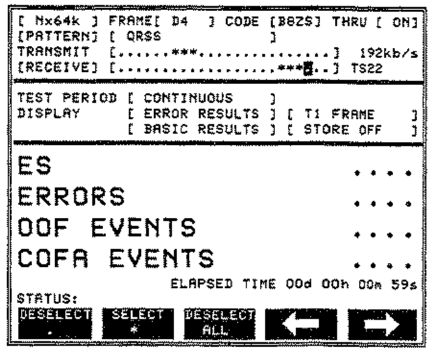
Select the timeslots that you want to spread the test pattern over.



If you are looping back the timeslots of interest:

Highlight RECEIVE [ ].

Select the timeslots that contain the returned test pattern.



Stress Testing

With FULL T1, a number of fixed stress patterns are selectable using (PATTERN) STRESS.

With FULL T1, N×56K and N×64k, stress patterns may be created using the 4 long user words. Instructions for setting the long user words are given in chapter 2.

NOTE: The long user words retained in the instrument memory are those selected by the user. If any are changed, the changed version is retained and the original is lost.

The instrument is initially supplied with the first 55 bytes of each of the long user words set to :
80 80 C0 80 80 80 00 80 80 80 80 80 80 C0 80 80
80 80 E0 80 80 80 80 AA AA AA AA 55 55 55 55 80
80 80 80 80 80 FF FF FF FF FF FF 01 80 01 80 01
80 01 80 01 80 01 80

The binary equivalents of the hexadecimal pairs used in the original long user word are:

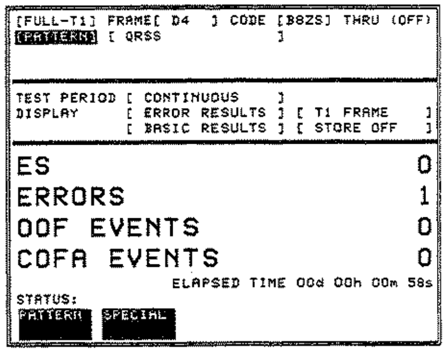
80	10000000
C0	11000000
E0	11100000
AA	10101010
55	01010101
FF	11111111
01	00000001
77	01110111
EE	11101110
66	01100110
99	10011001
44	01000100

To Monitor Timeslot Map/Content

Press (CONFIG)

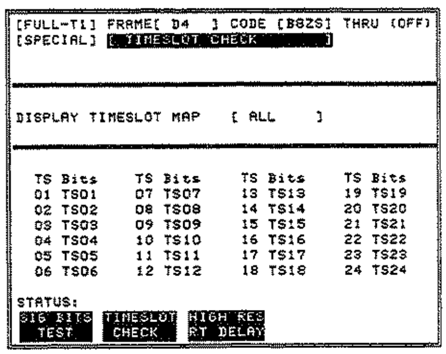
Highlight [PATTERN]

Select SPECIAL.



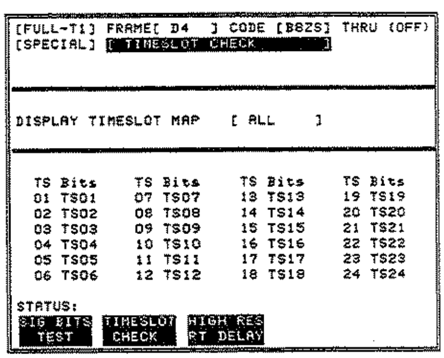
Highlight [SPECIAL] [ ]

Select TIMESLOT CHECK.

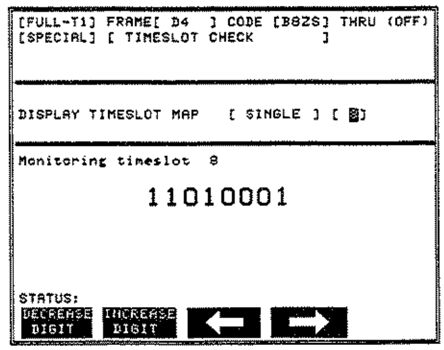


Highlight TIMESLOT MAP [ ]

For a timeslot map select ALL.



To monitor the content of a single timeslot select SINGLE
highlight TIMESLOT MAP [SINGLE] [ ]
and select the timeslot number.



Full Measurement List.

Error Measurements	Logic	BPV	T1 Frame	CRC (ESF)	DDS Frame
Error count	*	*	*	*	*
Error ratio, average	*	*	*	*	*
Error ratio, current	*	*		*	
Error seconds	*	*	*	*	*
Error free seconds	*	*		*	*
% error free seconds	*	*		*	*
Out of frame events			*		
Change of frame alignment events			*		
Frame loss seconds			*		
Loss of frame events			*		
Severely errored framing events			*		
Unavailable seconds	*		*	*	
% availability (unavailability)	*		*	*	
Error seconds	*			*	
Severely errored seconds	*		*	*	
Degraded minutes	*			*	
Consecutive severely errored seconds	*		*	*	

(Columns Logic through DDS Frame: Type Of Error)

Alarm Seconds

Power loss
Alarm indication seconds (<3 zeros in two consecutive frames)
T1 Frame loss
DDS Frame loss
Signal loss (175 consecutive zeros) (For DS0 - either bit clk, byte clk or data loss).
Yellow Alarm
(D4 / SLC-96, zero in bit 2 of every timeslot)
(ESF, data link contains repeated 1111111100000000)
Pattern loss
Ones density / Excess zeros (>15 zeros)

Signal Results

Frequency, absolute and offset from 1544000Hz
Received level, dBm , dBdsx and V pk-pk

Simplex current, mA
Imbalance
Round trip delay
Tones Results
FDL Results
DDS Bit Monitor

Slips and Wander (optional)

Out of service slips (pattern slips)
Clock slips

Display formats

Tabular results during measurement: Alarms, errors, signal results, slips/wander
Graphical results during measurement: Alarms,logic errors, BPV errors, Frame errors, pulse shape, slips
Tabular and graphical stored results after measurement: Alarms,logic errors, BPV errors, Frame errors, pulse shape, slips (tabular only)

Pulse Shape (optional) access via AUX

Pulse storage for 5 pulses
Title/message user selectable

FDL Results

ESF: decode to ANSI T1.403
SLC-96: decode

Test Patterns

2^15−1 PRBS, 2^20−1 PRBS, 2^23−1 PRBS, PRBS 2047, PRBS 511, QRSS, 3 in 24, ALL ONES, ALL ZEROS, 1 in 8, 1 in 2, 72-octet - for ALBO testing, 96-octet, 54-octet (ball buster), 20-octet (Trip test), 53-octet, 55 octet DALY, 55-octet - version-2, 55-octet-version-3, user program, Long user word, live, external, DDS stress, special (see below).

SPECIAL TESTS : Signaling bit test, Timeslot check, High resolution round trip delay.

MULTIPATTERN TESTS : BRIDGE, TOP, Multipattern user suite.

TEST TONES (VF config) 404Hz, 1008Hz, 2100Hz, 2804Hz and user programmable 100Hz to 3900Hz in 1 Hz steps. Levels −55dBm0 to 0dBm0.

Auxiliary Functions

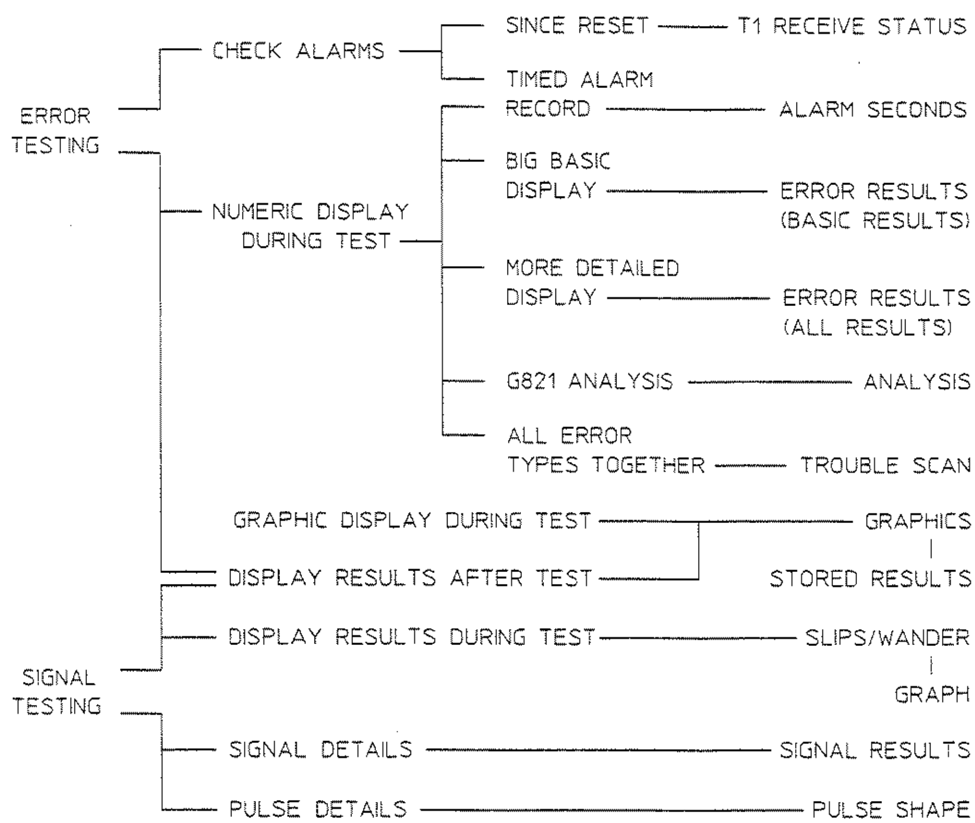
Function	Selections
Transmit functions	
Error insertion rate	10E-2, 10E-3, 10E-4, 10E-5, 10E-6, 10E-7
Alarm generation type	Off, Yellow, All ones (AIS)
Dialing (VF config)	DTMF, MF or pulse, normal or chain, continuous on hook and continuous off hook.
T1 In band Loopcode	
Types	Line , 4-bit network interface 5-bit network interface User programmable (3 to 8 bits selectable)
Intelligent Repeaters	Westell and Teltrend
Auto response	On, off
Tester looped	Up, down
Framing	Inserted, overwritten
T1 Out of band Loopcode	
Types	Line, Payload, smartjack, user programmable
Auto response	On, off
Tester line looped	Up, down
Tester payload looped	Up, down
DDS Loopcodes	
Alternating	DSU, channel, OCU-DP, HL-96NY, repeater, DS0-DP
Latching	channel, OCU-DP, DS0-DP, HL-222, MJU, V.54
MJU operations	Select (branch), block, unblock, release (all)

Function	Selections
Printer output	
Squelch	On, off
Print on demand	Current settings, results snapshot
Auto triggered print	Off, event results, every 15 minutes, every 2 hours, end of test, messages only
Stored settings	
Setting number	User selectable 1 to 5
Fixed setting	0
Title/message	User selectable
Remote control	
RS-232 mode	Computer control, Terminal control, Hewlett-Packard printer, Alternative printer (80 col or Condensed)
ENQ ACK	On, off
X on/X off	Off, Rx only, Tx only, Rx and Tx
Speed	300, 600, 1200, 1800, 2400. 4800, 9600 baud
7 bit data + parity	0's, 1's, even, odd
Stop bits	1, 2
Time / date	
Real time clock	Run, set-up
Set-up	23 hours 59 minutes 59 seconds
Date	Day month year
VF access	
Channel	01 to 24
Signaling	A B C D (on hook and off hook)
Audio monitor	On, off
Pulse shape (optional)	T1.403, PUB 62411, CB119 old, T1.102 / 119 new, G.703 / 7790-B
Pulse shape/wander results	
	Rise time, fall time, width, overshoot, undershoot, pass/fail
	Instantaneous wander, positive wander, negative wander, pk-pk wander

4

Displaying Test Results

The result display choices available are shown on the diagram below.
The page numbers lead you to set-up examples.



To Display Alarms

The current alarm conditions are always displayed when the tester is connected to a line.

One or more occurrences of an alarm during a test, since the last history reset, may be displayed at any time until the start of the next test.

A record of total alarm durations may be displayed during or after a test at any time until the start of the next test.

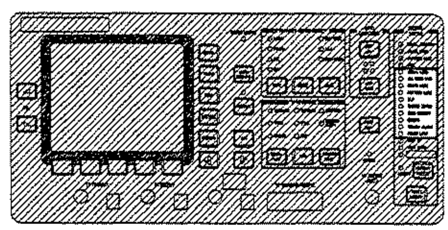
A graphic representation of alarms may be displayed (see *To Display Alarm And Error Graphs*).

All alarm displays for previously stored results may be recalled (see *To Display Stored Results*).

A timed record of alarms may be obtained by triggering a printer output (see *PRINTING*).

To See the Current Alarm Conditions.

The current alarm conditions are always displayed on the RECEIVE STATUS INDICATORS.

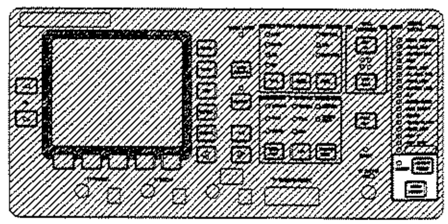


To See the Alarm History

You can run an unattended test and use alarm history to see if any alarms occurred while you were away.

The occurrence of alarms since the start of a test with (RESTART)/(AUTO/RESTART) or since a history reset during a test, is shown when (HISTORY/FREEZE) is pressed.

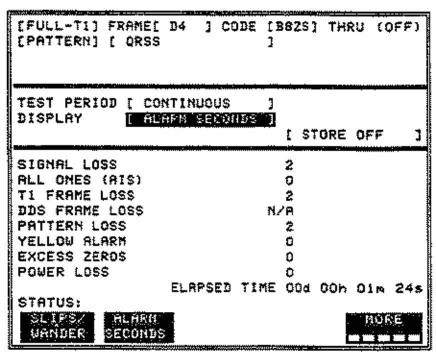
To clear this record press (HISTORY RESET).



To See the Record of Total Alarm Durations.

This record is the total of each type of alarm since the start of the test. The record is reset at the start of each test. The results of up to ten tests may be stored (see *To Display Alarm and Error, Graphs* and *To Display Stored Results*).

Press (RESULTS).
Select ALARM SECONDS.



To Display Errors

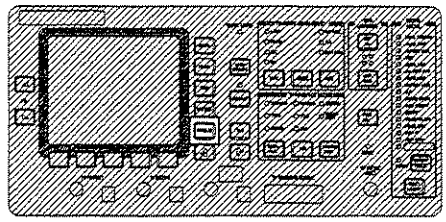
When you run a test, all errors are measured and recorded. You chose how you want to display them. The display can be changed, at any time, during and after the test. The record is reset at the start of each test.
The results of ten tests may be stored .
A timed record of result displays may be obtained by triggering a printer output (see *PRINTING*).

The choice of display at any one time is :

1. A display of the error count of each error type TROUBLE SCAN:
   a. Logic Error Count.
   b. BPV Count.
   c. T1 Frame Error Count.
   d. CRC Error Count.
   e. DDS Frame Error Count.
2. A display of the basic results of one error type in large characters (Logic, T1 Frame, BPV, CRC or DDS Frame Error Count) BASIC RESULTS
   a. Error Seconds.
   b. %Error Free Seconds.
   c. Error Count.
   d. Average Error Rate.
3. A more detailed display of the results of one error type (Logic, Frame, BPV or CRC or DDS Frame Error Count) ALL RESULTS **This shows the basic results plus :**
   a. Synchronous Error Seconds.
   b. Error Free Seconds.
   c. Current Error Rate.
4. The G821 analysis of one error type (Logic, Frame or CRC) ANALYSIS.
5. Bar charts of error count updated at selected intervals during the test GRAPH RESULTS (see *To Display Alarm and Error Graphs*).
6. A complete set of results for the previous ten tests in graphic and numeric form including G821 analysis (see *To Display Stored Results*).

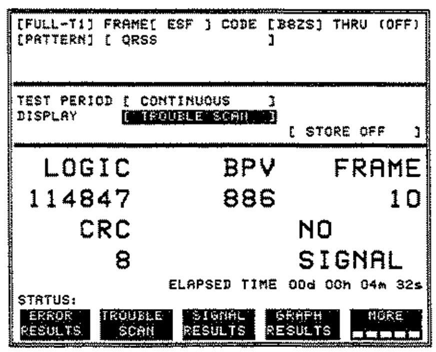
To Select One of the Error Displays

Press (RESULTS).



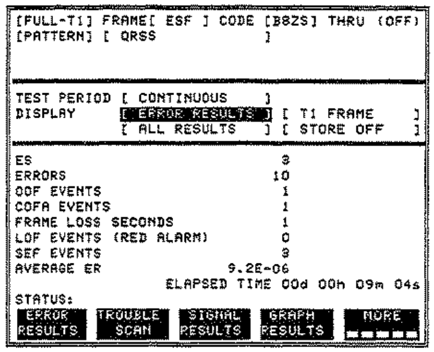
To Display the Error Count of Each Error Type

Select TROUBLE SCAN .

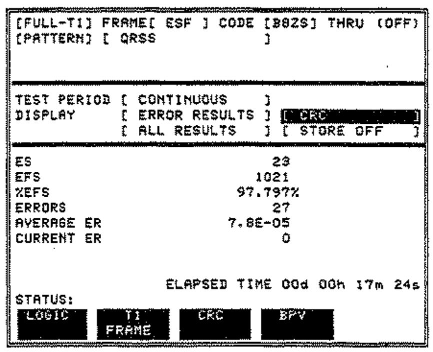


To Display Details of One Error Type

Select ERROR RESULTS.



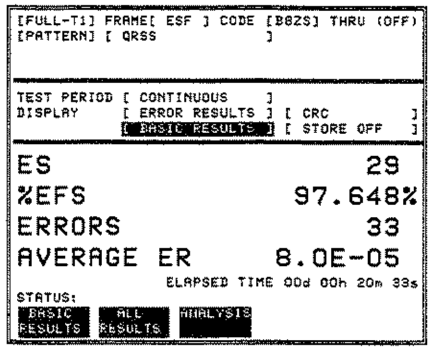
Highlight the Error Type and select the type of error you want to display.



For a Display of Basic Errors in Large Characters

Highlight
DISPLAY [ERROR RESULTS] [ ]
[ ].

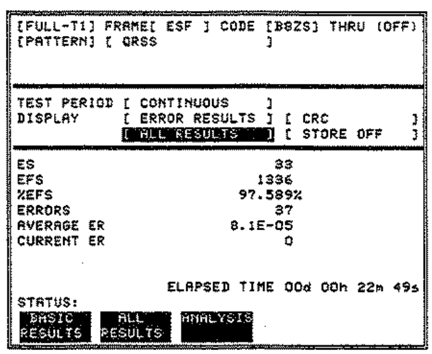
Select BASIC RESULTS.



For a More Detailed Display of One Type Of Error

Highlight
DISPLAY [ERROR RESULTS] [ ]
[ ].

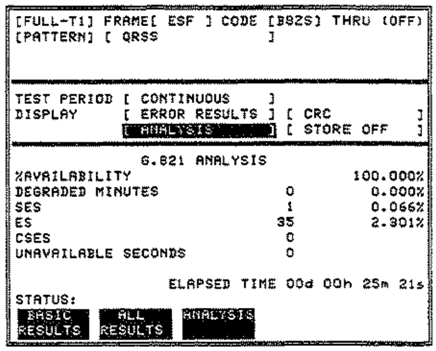
Select ALL RESULTS.



For a G821 Analysis Display of One Type Of Error

Highlight
DISPLAY
[ERROR RESULTS] [ ]
[ ].

Select ANALYSIS.



To Display Alarm and Error Graphs

During and after a test you can display :

- A graphic representation of all alarms (in two sections) simultaneously, with a timescale.
- A graphic representation of all FDL bits (in two sections) simultaneously, with a timescale.
- A graphic representation of all types of error count, any two simultaneously, with a timescale.
- Any combination of the above : one section of the alarm display with the count of one error type simultaneously.

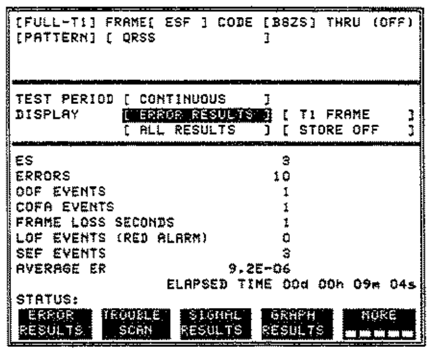
The graphs make it easy to see how errors and alarms relate to each other and to time of day. Knowing the time pattern of errors often helps point to their cause.

The graphs are constructed from results stored at intervals selected before the test (1, 15 or 60 minutes). The displayed resolution is limited to the storage resolution.

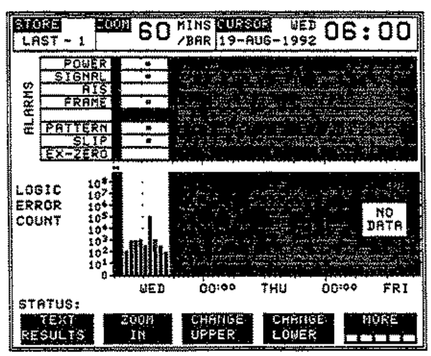
To Select One of the Graphic Displays

To display results as graphs, the test must be started by selecting a storage resolution and pressing (RESTART).

Press (RESULTS).
Select GRAPH RESULTS.

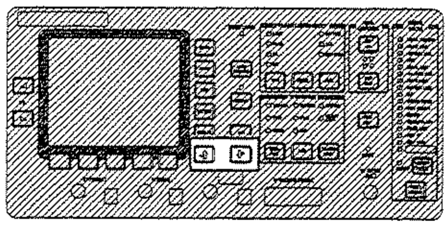


Select each of the two simultaneous displays with CHANGE UPPER and CHANGE LOWER.

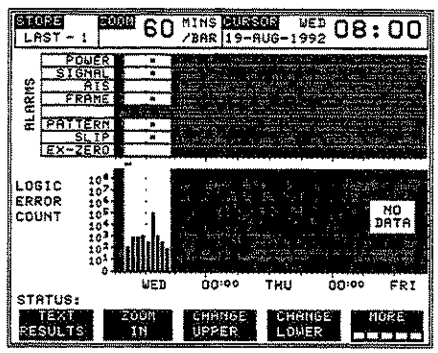


To Select the Time "Window" and Resolution of the Graphic Display

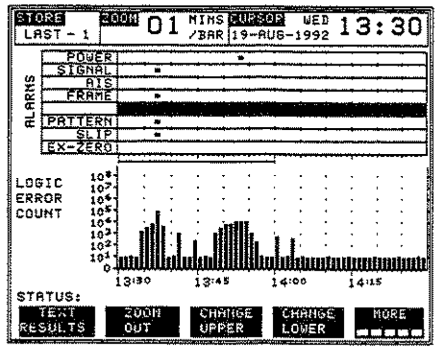
Select the time "window" with and



The start time of the cursor is shown in the CURSOR box.



Select the resolution with ZOOM IN ZOOM OUT.



To Return to the Normal Measurement Display

Press (RESULTS).

To Display Stored Results

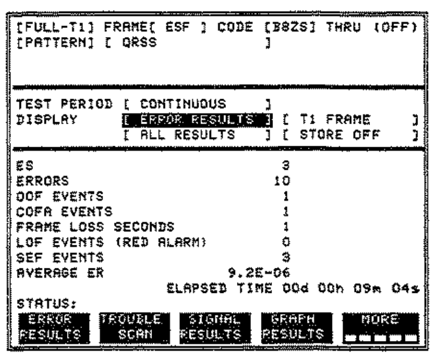
To display stored results, the test must must have been started by selecting a storage resolution and pressing (RESTART).
You can display the following details of previously stored tests :

The settings used.
The alarms.
The errors and G821 analysis.
The DDS trapped control code.
The tones results.
The FDL results.
The slips and wander.
The alarms and error counts in graphical form.
The test date and time.

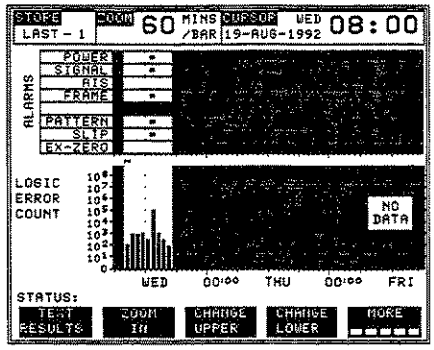
You do not need to carry a printer a printer around. You can store the results and process them later.

To Display One of the Stored Results.

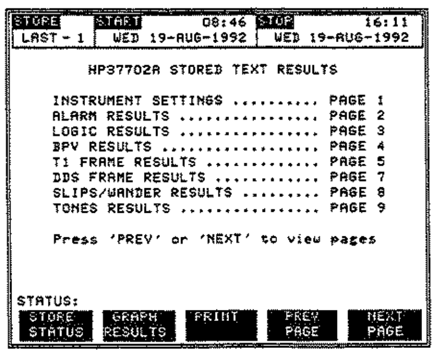
Press (RESULTS).
Select GRAPH RESULTS.



Select TEXT RESULTS .

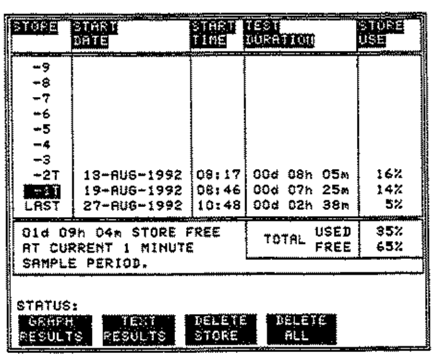


Select STORE STATUS .



Use ⇧ and ⇩ to highlight the test result you want to display.

Select GRAPH RESULT or TEXT RESULT .

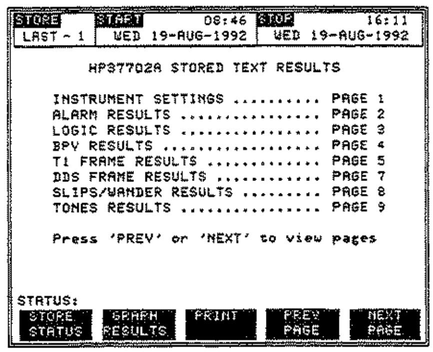


Graphic Display - to Select Error Type or Alarms

see Page 4-9

Numeric Display - to Select Error Type, Alarms or Slips/Wander

Use PREV PAGE / NEXT PAGE to scroll through the displays.



To Return to the Normal Measurement Display

Press (RESULTS).

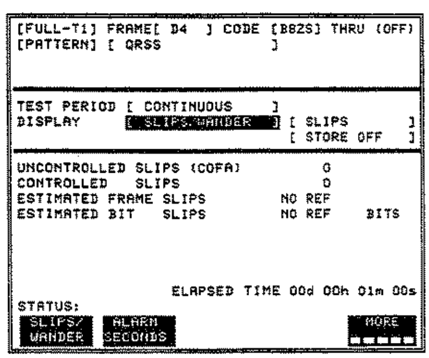
To Display Pattern Slips, Clock Slips and Wander

The tester with the optional clock slips/wander facility is required for display of T1 and fractional T1 clock slips and wander.
The tester needs a reference at the front panel TIMING REF DS1 INPUT for any clock slips/wander test.

You can display CLOCK SLIPS in graphical form at any time when the tester is connected to the T1 line and has a timing reference.
PATTERN SLIPS and CLOCK SLIPS counts may be displayed, during or after a test at any time until the start of the next test.
WANDER analysis may be displayed, during or after a test at any time until the start of the next test.
The recorded total PATTERN SLIPS counts, CLOCK SLIPS counts and WANDER analysis, for each of the previous ten stored test results, may be displayed if a tester with the optional clock slips/wander facility is used (see *To Display Stored Results*).

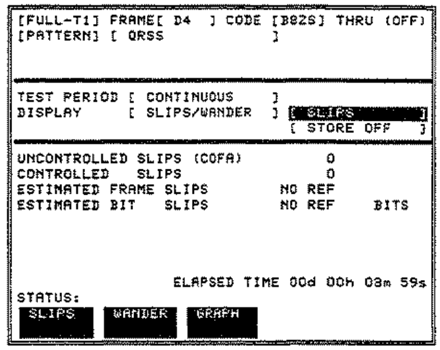
To Select One of the Slips/Wander Displays

Press (RESULTS).
Select SLIPS or SLIPS/WANDER depending on facilities available.



For Testers with the Clock Slips/Wander Facility.

Highlight
[SLIPS /WANDER] [ ] .
Select SLIPS WANDER or GRAPH.

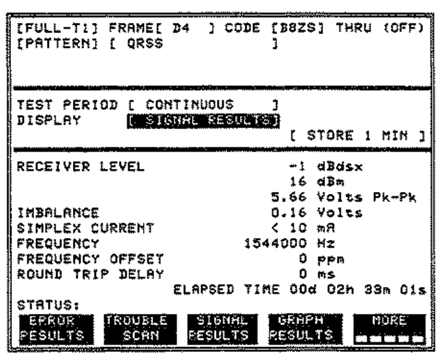


You can quickly see timing differences between two T1 signals with the high resolution of the slips graph feature.

To Display Signal Results

Signal results may be displayed at any time when the tester is connected to a T1 line and either FULL or FRACTIONAL-T1 is selected. Round trip delay is only displayed when the FULL-T1, QRSS pattern is selected. For high resolution round trip delay see chapter 3.

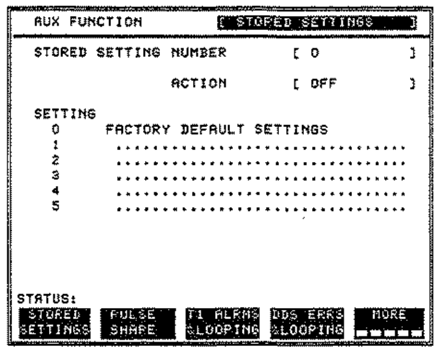
Press (RESULTS).
Select SIGNAL RESULTS.



To Display Pulse Shape

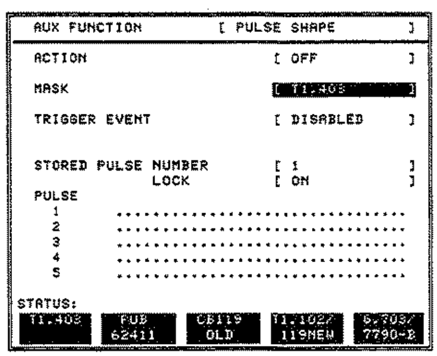
The tester with the optional pulse shape facility is required.
Pulse Shape may be displayed at any time when the tester is connected to a T1 line.

Press (AUX).
Select PULSE SHAPE.



To Change the Pulse Mask

Select T1.403, PUB 62411, CB119 OLD T1.102/119 NEW or G.703/7790-B.



To Return to the Normal Measurement Display

Press (RESULTS).

5

Preparing To Print Results.

Printing is enabled by selecting the one of the printing functions of the RS- 232 connector.
The tester can be set to provide an RS-232 output to any one of three types of printer:

1. Any Hewlett-Packard 80 column printer (recommended type HP2225D).
2. An alternative type which may be:
   a. Any other 80 column printer.
   b. A 40 column printer which is capable of handling 80 column condensed format.

Cabling information is given in the Installation chapter of this manual.

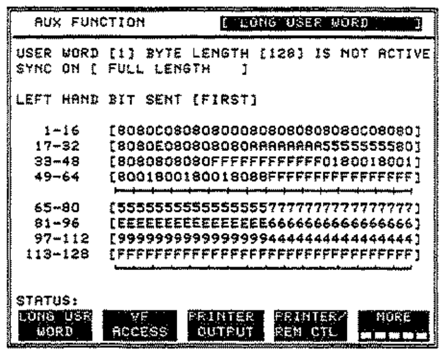
To Select a Printer Output.

An output suitable for the printer being used, must be selected before any print operation can be performed.

To Select an Output Suitable for a Hewlett - Packard 80 Column Printer.

Press (AUX).

Select PRINTER REM CTL.



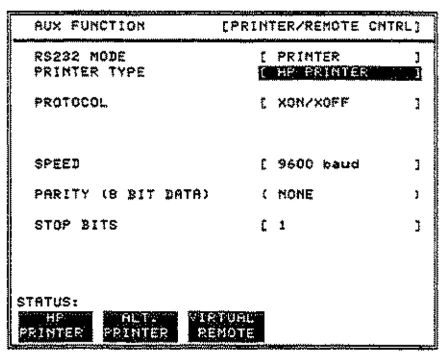
Highlight RS-232 MODE [ ].

Select PRINTER.

Highlight

PRINTER TYPE [ ].

Select HP PRINTER

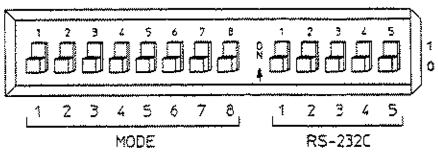


Example Set-Up Using a Hewlett-Packard Thinkjet Printer, Model 2225D.

To make the printer and tester compatible, the switches on the rear panel of the printer, MODE and RS-232, and the settings on the tester AUX, PRINTER / REMOTE CONTROL display must be compatible.
The following example gives one set of compatible settings and the information necessary to select alternatives.

Printer

Printer MODE and RS-232 Settings

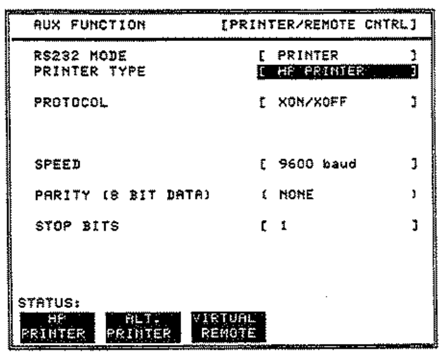


The MODE switches :
1,2 and 5 = 0 : for all interfaces.
3 = 0 : no perforation skip.
4 = 0 : 11 inch paper length.
4 = 1 for 12 inch.
6, 7 and 8 = 0 : ROMAN characters.

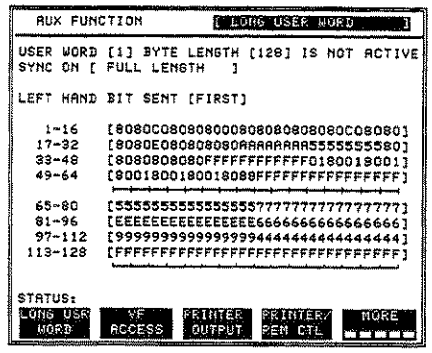
The RS-232 switches :
1 = 0 : XON/XOFF.
1 = 1 for DTR set.
2,3 = 0 : parity none / 8 bit data .
2,3 = 0,1 odd / 7 bit data,
2,3 = 1,0 even / 7 bit data,
2,3 = 1,1 one / 7 bit data.
4,5 = 0 : 9600 baud.
4,5 = 0,1 19200 baud,
4,5 = 1,0 2400 baud,
4,5 = 1,1 1200 baud.

Tester

Compatible Tester AUX PRINTER / REM CTL display.

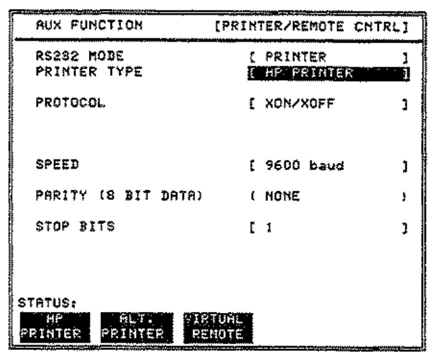


To Select an Output Suitable for an Alternative Printer.



Press (AUX).

Select PRINTER REM CTL.



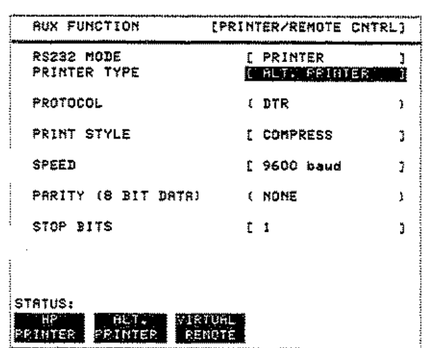
Highlight
RS-232 MODE [ ].

Select PRINTER.

Highlight

PRINTER TYPE [ ].

Select ALT. PRINTER.



Highlight PRINT STYLE [ ].

For an 80 column printer select NORMAL.

For a 40 column Printer select COMPRESS.

Set the SPEED, PARITY and STOP BITS to be compatible with the printer being used. The PROTOCOL is fixed as DTR.

6

Printing Results

Before printing results, an RS-232 output, suitable for the printer being used, must be selected (AUX - PRINTER REM CTL). Selection details are given in Chapter 5, *Preparing to Print Results*.

The following printer outputs are available:

Print	Availability
Major alarms only.	Automatically triggered
Alarms and Error count.	Automatically triggered. For previous tests as graphs.
Signal details.	The existing signal details at any time.
Full results.	Automatically triggered. At any time up to the start of the next test. For previous tests in tabular form.
Pulse shape.	The existing pulse shape at any time *.
Full tester settings.	The existing settings at any time.

* Availability depends on tester option.
Selections may be changed during a test.
PRINT NOW is unavailable while auto triggered print is in use.

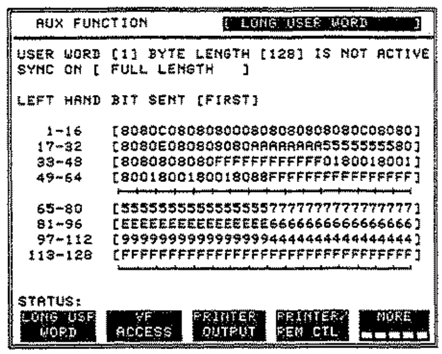
To Print Only the Occurrence of Major Alarms.

The date, time and state of the following alarms are printed when any of them occur or clear:

- Power loss
- Signal loss
- All ones
- T1 Frame loss
- Pattern loss

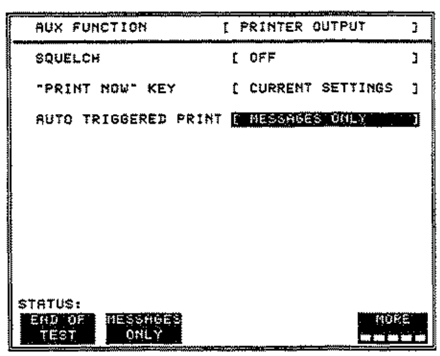
Press (AUX).

Select PRINTER OUTPUT.



Highlight
AUTO TRIGGERED PRINT [ ].

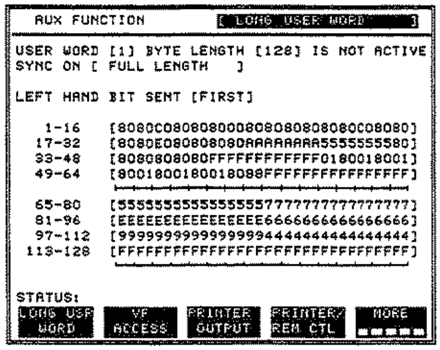
Select MESSAGES ONLY.



To Suppress Printing After 10 Consecutive Seconds with Major Alarms.

Press (AUX).

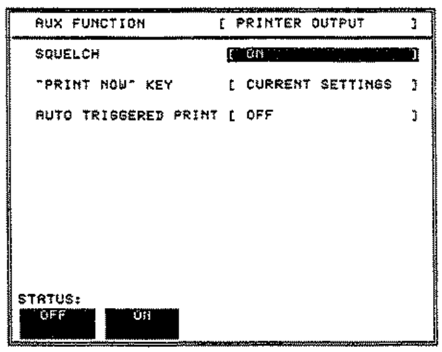
Select PRINTER OUTPUT.



Highlight SQUELCH [ ].

Select ON.

Printing is restored after 2 error free seconds.



To Print Only Alarms and Error Count

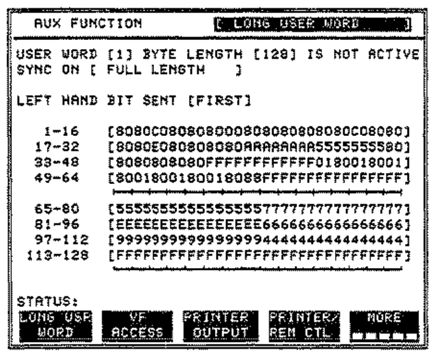
The following choices are available:

1. An automatically triggered print of the test being run.
2. A print in graphical form of a stored result.
   a. Between the end of a test and the start of the next test.
   b. For any of the previously stored test results.

To Automatically Trigger a Print of Alarms and Error Count.

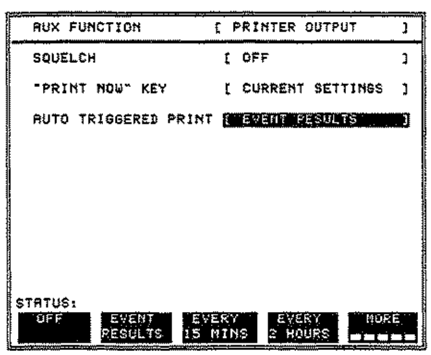
Press (AUX).

Select PRINTER OUTPUT.



Highlight
AUTO TRIGGERED PRINT [ ].

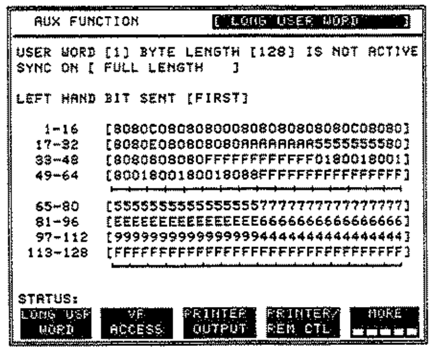
Select EVENT RESULTS.



To Suppress Printing After 10 Consecutive Seconds with EVENT Results

Press (AUX).

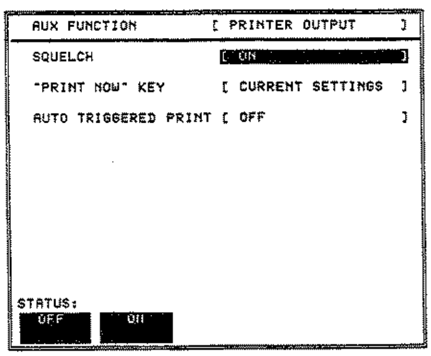
Select PRINTER OUTPUT.



Highlight SQUELCH [ ].

Select ON.

Printing is restored after 2 error free seconds.



To Print Graphs of Alarms and Error Count.

What you get is what you see plus alarms.

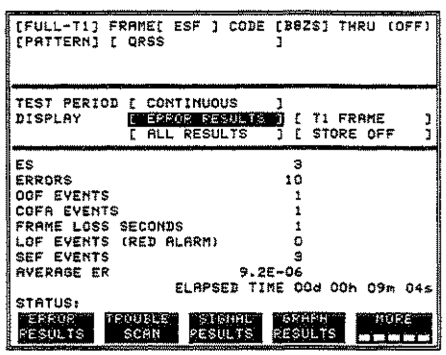
The general procedure is:
Get the result of the test as a graphic display.
Select the pair of error result graphs to be printed.
Select the time period and resolution.
Press PRINT.

Three graphs are printed. The two selected plus a graph of ten alarms (all except Loop up / loop down).
If alarms are displayed an additional graph will be printed.
Results of live traffic, frame off, tests produce only the two valid graphs, BPV errors and alarms.

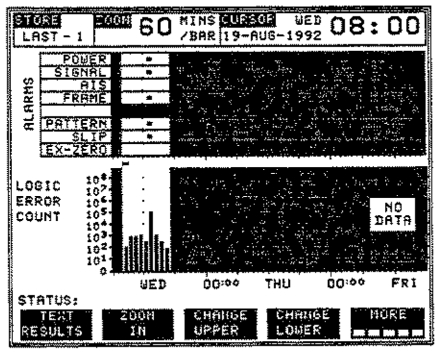
NOTE: The test must have been started by selecting a storage resolution and pressing (RESTART).

Press (RESULTS).

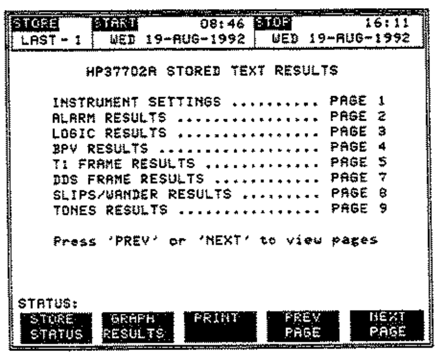
Select GRAPH RESULTS.



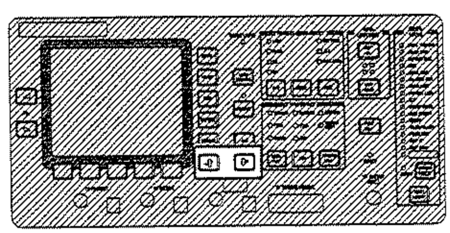
Select TEXT RESULTS.



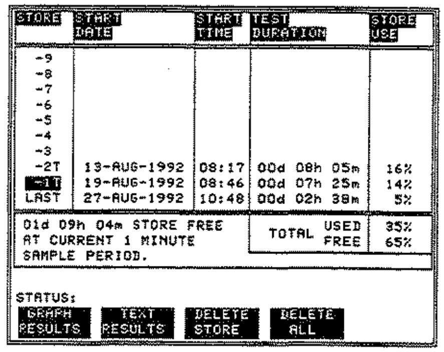
Select STORE STATUS.



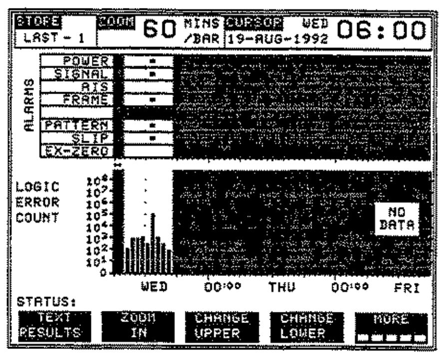
Use and to highlight the test result to be printed.



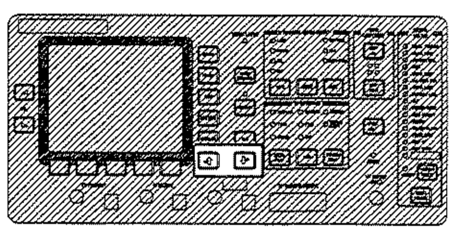
Select GRAPH RESULTS.



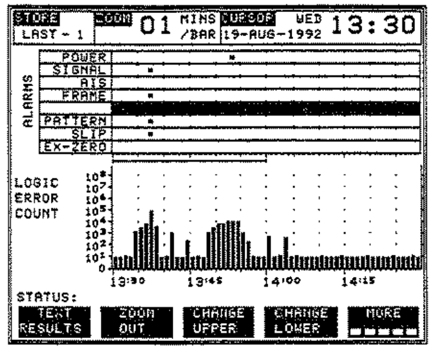
Display the graphs to be printed by selecting CHANGE UPPER and CHANGE LOWER.



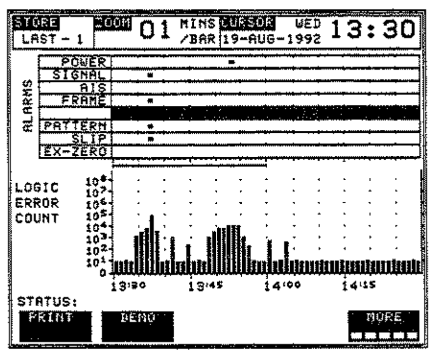
Select the time "window" with and .



Select the resolution with ZOOM IN ZOOM OUT.



Select PRINT.



To Print Signal Details

Signal details may be printed on demand during a test.

The signal details are printed as part of a full results print, see the following information on "To Print Full Results".

To Print Full Results

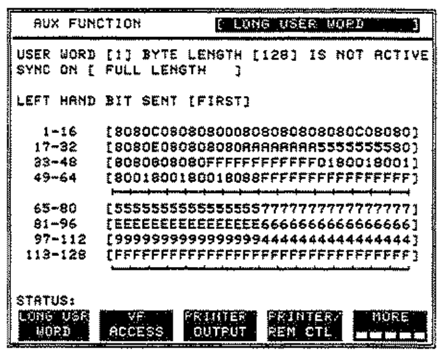
The following choices are available:

1. An automatically triggered print at time intervals or at the end of the test.
2. A print on demand during or after a test, up to the start of the next test.
3. A print in tabular form of a stored result.

To Automatically Trigger a Print of Full Results.

Press (AUX).

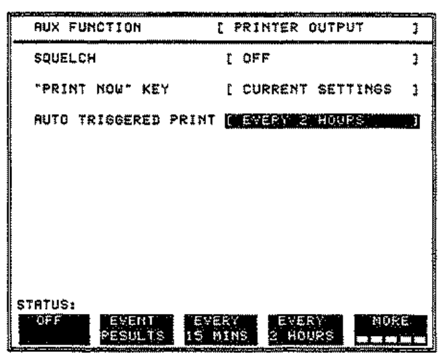
Select PRINTER OUTPUT .



Highlight
AUTO TRIGGERED PRINT [ ] .

Select how often you want to print.
The following choices are available:

- Every 15 minutes EVERY 15 MIN .
- Every 2 hours EVERY 2 HOURS.
- At the end of the test END OF TEST .
- Press (RESTART).

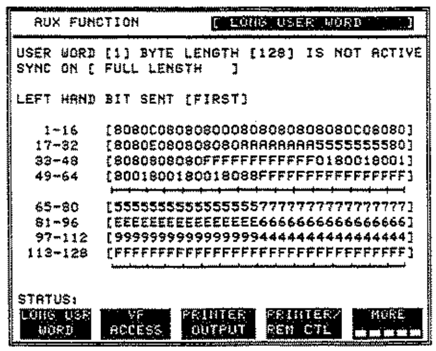


To Print Full Results On Demand

The present state of the test may be printed during a test. In this case the analysis, although printed, may not be meaningful.
The full results may be printed at any time after a test up to the start of the next test.

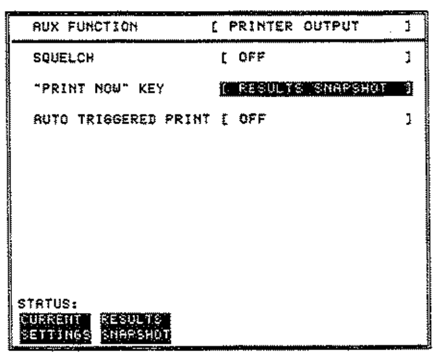
Press (AUX).

Select PRINTER OUTPUT.

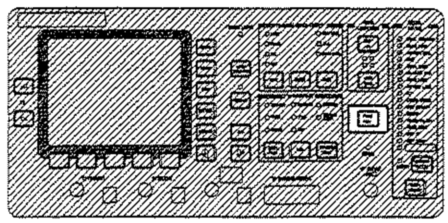


Highlight "PRINT NOW" KEY [ ].

Select RESULTS SNAPSHOT.



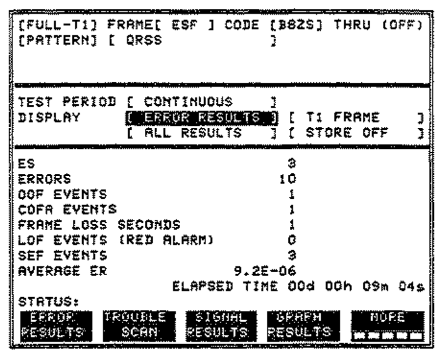
Press (PRINT NOW).



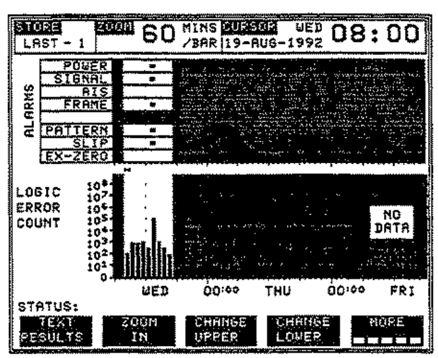
To Print the Stored Results of a Previous Test

Press (RESULTS).

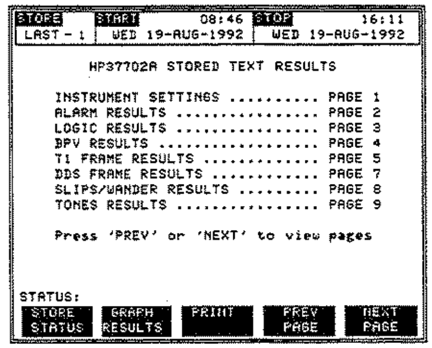
Select GRAPH RESULTS.



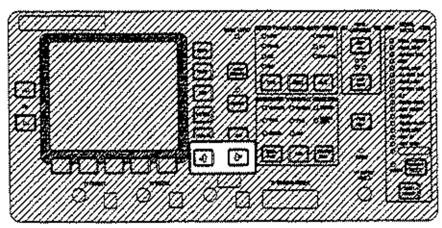
Select TEXT RESULTS.



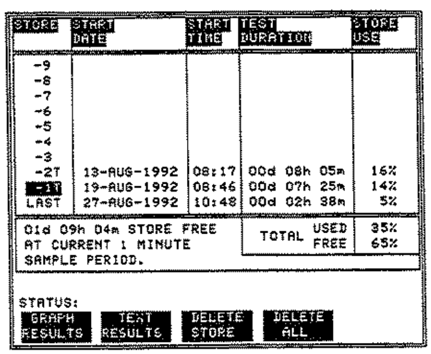
Select STORE STATUS.



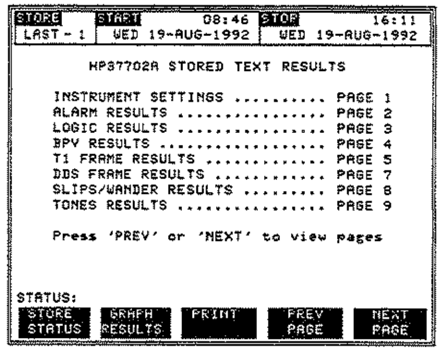
Use ⇧ and ⇩ to highlight the test result to be printed.



Select TEXT RESULTS.



Select PRINT.



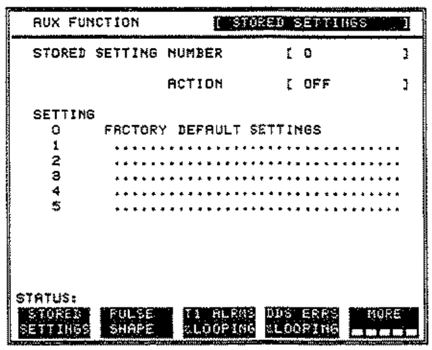
To Print the Pulse Shape

The tester with the pulse shape option is required

The displayed pulse shape may be printed and stored pulse shapes may be recalled and printed.

Press (AUX).

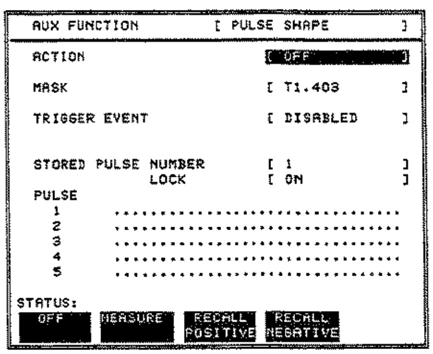
Select PULSE SHAPE.



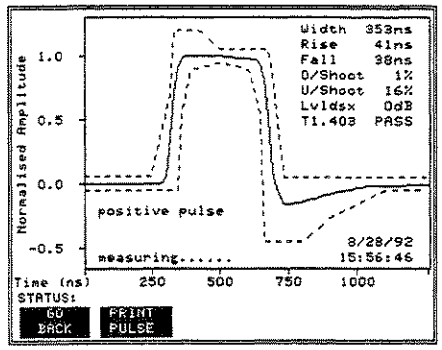
For stored pulse shapes, select the stored pulse number.

Highlight ACTION [ ].

Select MEASURE, RECALL POSITIVE or RECALL NEGATIVE.



Select **PRINT PULSE**.

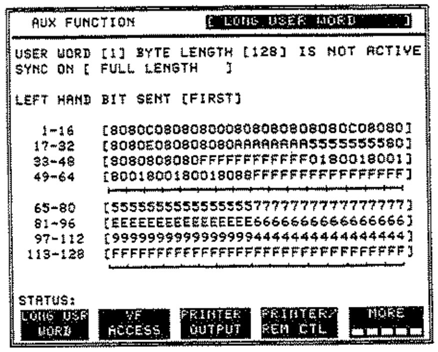


To Print the Full Tester Settings.

The full tester settings may be printed at any time outwith an auto triggered print period.

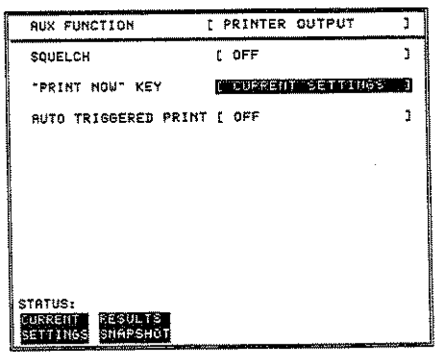
Press (AUX).

Select PRINTER OUTPUT.

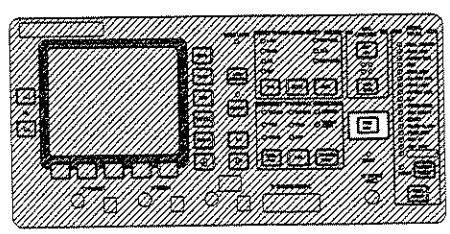


Highlight
"PRINT NOW" KEY [ ].

Select CURRENT SETTINGS.



Press (PRINT NOW).



7

General Information

Introduction

This manual contains information which allows the user to operate and calibrate the Hewlett-Packard Model 37702A Digital Data Tester. The instrument may have a Datacom accessory in the lid. Operating information for the Datacom accessory is given in a separate manual.

On the title page of this manual is a Microfiche Part Number. This number can be used to order 4 × 6 inch microfilm transparencies of the manual.

Each microfiche contains up to 96 photo duplicates of the manual pages.

Instrument memory

The instrument non-volatile memory is powered from an internal battery. The replacement and disposal of this battery requires the observation of special safety precautions as detailed in the instrument service manual. In the event of memory failure, the battery should be replaced only by a qualified engineer who is aware of the hazards involved and the precautions necessary.

Safety Considerations

This product is a Safety Class 1 instrument (provided with a protective earth terminal). The instrument and manual should be reviewed for safety markings and instructions before operation. Also read the Warning page at the front of this manual.

Options Available

The following options are available and may have been ordered with the instrument:

Option 001	Pulse Shape, Clock Slips and Wander Measurement.
Option 002	Datacom accessory fitted in the instrument lid.
Option 004	DS0B testing at DDS
Option H02	HP-IB remote control instead of RS-232.
Option V01	Virtual remote operation (needs HP 15800A or 15801A virtual remote software).

To See a Display of Options Fitted to your instrument.

Press (AUX) and select FIRMWARE & OPTIONS

Accessories Supplied

The accessories supplied with the instrument are:

Accessories Supplied	*Part Number*
Power Cord	See Installation
Operating and Calibration Manual	HP 37702-90000
Protective Front Cover *	HP 37701-00002

* Unless ordered with Option 002

Accessories Available

The following accessories are available and may have been ordered with the Tester:

HP 15901A	Datacom Module.
HP 15513A	Test Cord, WECO 310 - WECO 310, length 1m (3 feet).
HP 15513A H02	Test Cord, WECO 310 - WECO 310, length 3m (10 feet).
HP 18182A	Test Cord, WECO 310 - Alligator clips.
HP 15670A	Test Cord, Bantam - Bantam, length 3m (10 feet).
HP 15707A	Test Cord, DB15 male - modular RJ48, length 3m (10 feet).
HP 15753A	DDS clock cable, 9-pin D male to 5-pin DIN female, length 3m (10 feet).
HP 15751A	DDS clock cable, 9-pin D male to 9-pin D male, length 3m (10 feet).
HP 5060-4461	Cable, RS-232, instrument (DCE) - Terminal / Computer (DTE), Gnd,Tx,Rx only.
HP 92219H	Cable, RS-232, instrument (DCE) - Modem (DCE), Gnd,Tx,Rx only.
HP 37701-60050	19-inch rack mount kit

HP 15710A	Carrying Case.
HP 2225D	Printer, ThinkJet RS-232.
HP 15714A	Cable, instrument - HP 2225D Printer.
HP 15730A	230V, Printer, Thermal RS-232.
HP 15733A	110V, Printer, Thermal RS-232.
HP 15746A	25 way RS-232 cable, 25-pin male D type for connection to a HP 15730A/33A thermal printer.
HP 5060-4462	RS-232 Test plug.

Specification

The following specifications are the performance standards or limits against which the instrument is tested.

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 the typical, but non-warranted, performance characteristics.

T1 and Fractional T1 Transmitter and Receiver

Framing: D4, ESF, SLC-96 (see below), Unframed

Notes on SLC-96 Framing mode.

The precise operation of the SLC-96 frame format depends how the instrument is set up. The following table describes how the transmitter and receiver behave when SLC-96 is selected for various instrument set-ups.

Instrument set-up	SLC-96 Transmitter	SLC-96 Receiver
Sig bits test	Sends Ft bits and SIMULATED SLC-96 Fs (see note 1). The Fs framing is sent because sig bits are sent in this mode.	Syncs on Ft and Fs with SHORT REFRAME ALGORITHM (see note 2).
VF mode	Sends Ft and Fs framing continuously. The Fs framing is sent because sig bits are sent in this mode.	Syncs on Ft and Fs with SHORT REFRAME ALGORITHM (see note 2).
All other modes	Sends Ft framing ONLY. No sig bits are sent.	Sync on Ft ONLY with the LONG REFRAME ALGORITHM (see note 2).
FDL SLC-96 mode.	Meets TR-TSY-000008. A field format (13vs16) as per Rx.	Meets TR-TSY-000008. Auto configure to a field format.

note 1: SIMULATED SLC-96 Fs: the Fs bit channel will contain bursts of Fs framing interspersed with all-ones to simulate the operation of real SLC-96 equipment.

note 2: SHORT REFRAME ALGORITHM: 10 consecutive valid framing bits required to gain frame sync.

LONG REFRAME ALGORITHM: 24 consecutive valid framing bits required to gain frame sync.

Line Code: AMI, B8ZS

Test Patterns

QRSS: 2^20−1 PRBS:	D20+D17+1=0 with 14 zero limit
2^15−1 PRBS:	D15+D14+1=0
2^20−1 PRBS:	D20+D17+1=0
2^23−1 PRBS:	D23+D18+1=0
All ones	
All zeros	
1:1	(101010 ...)
1:7	(01000000 ...)
3 in 24	(01000100 00000000 00000100 ...)

User programmable word, length 3 to 24 bits
Four long user-programmable patterns, length 8 to 1024 bits in 8 bit intervals.

Pattern programmed in hexadecimal from the front panel or over remote control. The order of bit transmission is selectable.
Live (for use when monitoring live traffic)

Notes: Framing bits are inserted into these patterns in D4, SLC-96, and ESF modes. For any user pattern with a pattern length which is a sub-multiple of the frame length (192 bits), the pattern is synchronized to the frame such that the F-bit always occurs at the start of the pattern. This helps to prevent excess zeros caused by framing.

Octet Stress Patterns (Hex)

72-octet - for ALBO testing

80	80	80	80	01	00	01	01
01	03	80	01	80	01	01	80
01	22	00	20	22	00	20	AA
AA	AA	AA	AA	55	55	55	55
AA	AA	AA	AA	55	AA	AA	55
55	55	80	80	FF	FF	FF	FF
FF	FF	FF	FE	FF	FF	24	49
92	88	88	88	10	42	08	21
84	20	08	82	40	20	10	80

96-octet

FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
AA	AA	AA	AA	80	01	80	01
80	01	80	01	80	01	80	01
80	01	80	01	80	01	80	01
AA	AA	AA	AA	80	01	80	01
80	01	80	01	80	01	80	01
80	01	80	01	80	01	80	01

54-octet - known as “Ball Buster”

01	01	01	01	01	01	00	01
01	01	01	01	01	03	01	01
01	01	07	01	01	01	01	55
55	55	55	AA	AA	AA	AA	01
01	01	01	01	01	FF	FF	FF
FF	FF	FF	80	01	80	01	80
01	80	01	80	01	80		

120-octet - known as “Trip Test”

FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
AA	AA	AA	AA	10	10	10	10
10	10	10	10	10	10	10	10
10	10	10	10	10	10	10	10
AA	AA	AA	AA	10	10	10	10
10	10	10	10	10	10	10	10
10	10	10	10	10	10	10	10

53-octet

80	01	80	01	80	01	80	01
80	01	80	01	80	01	80	01
80	01	80	01	80	01	80	01
80	01	80	01	80	01	01	AF
AA	AF	01	01	01	01	FF	FF
FF	FF	01	01	01	01	FF	FF
FF	FF	FF	FF	CB.			

55-octet - DALY from T1M1.3/92-006R2

01	01	01	01	01	01	80	01
01	01	01	01	01	03	01	01
01	01	07	01	01	01	01	55
55	55	55	AA	AA	AA	AA	01
01	01	01	01	01	FF	FF	FF
FF	FF	FF	80	01	80	01	80
01	80	01	80	01	80	01	

55-octet - version-2, Byte 7 changes from 10 to 00

01	01	01	01	01	01	00	01
01	01	01	01	01	03	01	01
01	01	07	01	01	01	01	55
55	55	55	AA	AA	AA	AA	01
01	01	01	01	01	FF	FF	FF
FF	FF	FF	80	01	80	01	80
01	80	01	80	01	80	01	

55-octet-version-3, Byte 3 changes from 10 to 03 and byte 7 changes from 80 to 00

01	01	03	01	01	01	00	01
01	01	01	01	01	03	01	01
01	01	07	01	01	01	01	55
55	55	55	AA	AA	AA	AA	01
01	01	01	01	01	FF	FF	FF
FF	FF	FF	80	01	80	01	80
01	80	01	80	01	80	01	

Multi-pattern tests: Bridge Tap, Quick Test and User Suite

Meets: T1.M1.3/92-006R3

Results: all error types and counts, also logic error counts (EC), logic error seconds (ES) and logic pattern sync seconds (SS) are displayed for each sub-pattern that makes up the multipattern. Loop number of sub-tests, displayed.

During configuration changes counts of frame (and CRC) counts are suppressed. Logic errors are only counted during the sub-test periods and not during sending of the inter-pattern sync code.

Bridge Tap Tests

Test patterns

1-in-1	F 1..
1-in-2	F 01..
1-in-4	F 0100 ..
1-in-6	F 0100 00..
1-in-7	F 0100 000..
1-in-8	F 0100 0000..
2-in-10	F 1100 0000 00..
2-in-11	F 1100 0000 000..
2-in-12	F 1100 0000 0000..
2-in-13	F 1100 0000 0000 0..
2-in-14	F 1100 0000 0000 00..
2-in-15	F 1100 0000 0000 000..
2-in-16	F 1100 0000 0000 0000..
3-in-18	F 1101 0000 0000 0000 00..
3-in-19	F 1101 0000 0000 0000 000..
3-in-20	F 1100 0100 0000 0000 0000..
3-in-21	F 0100 0100 0000 0000 0000 1..
3-in-22	F 0100 0100 0000 0000 0000 10..
3-in-23	F 0100 0100 0000 0000 0000 100..
3-in-24	F 0100 0100 0000 0000 0000 0100..
QRSS	
Inter pattern byte:	F 1111 1010
Test period range:	10 to 60 seconds (nominal)
default:	20 (nominal)

Quick test

Test patterns

all-1s	F 1111 1111
1-in-8	F 0100 0000
2-in-8	F 0100 1000
3-in-24	F 0100 0100 0000 0000 0000 0100
QRSS	
Inter pattern byte:	F 1110 1110
Test period range:	1 to 60 minutes (nominal)
default:	3 minutes (nominal)
accuracy:	nominal

User Suite

Number of patterns:	2 to 7
Selectable patterns:	QRSS, 3 in 24, all ones, all zeros, 1 in 8, 1 in 2 55 Octet (Daly), user word, long user word 1 PRBS: 2^15-1, 2^20-1, 2^23-1
Test Period:	10 to 60 seconds or 1 to 60 minutes, default 3 minutes
Inter pattern byte:	8 bit user-definable (must not occur in test patterns)
Number of pattern loops:	user-definable

All Signaling Bits Display

Used to display the signaling bits for all receive channels. The transmit signaling bits can be set in all signaling channels.

Monitor Mode

Monitor mode is for use on live traffic where no known test pattern exists. No pattern synchronization is attempted and pattern error results and pattern slips are not presented. Monitor Mode is selected by setting the test pattern to "Live". It is automatically set on pressing Auto/Restart if no recognizable pattern is found.

Thru mode

The non-selected timeslots are passed through from receiver to transmitter, the receiver drops out the selected timeslot(s) for measurement, and the transmitter inserts data into the selected timeslot(s). The drop/insert may be to/from the D-type-15 (balanced) connector by selecting EXTERNAL pattern, or to/from internal circuits.

Note: In thru mode,the HP 37702A recalculates the CRC for ESF. The facility data link (FDL) and framing bits are not changed.

Digital Drop and Insert (D&I)

The signal for drop or insert may be one of:

n x 64 kbit/s from within a T1, n = 1 to 6
n x 56 kbit/s from within a T1, n = 1 to 6
DDS circuit from a timeslot within T1 at 2.4, 4.8, 9.6, 38.4 and 56 kb/s.
DDS circuit from a 64 kbit/s DS0A or with Option 004, DS0B.
FDL PRM with either SLC-96 or ESF framing.

Tone generation

Single tones of settable frequency and level generated within a selected single 64 kbit/s channel, using μ-law encoding. Channel numbering in accordance with TR-TSY-000476.

Tone measurements

Measurement is made within a single 64 kbit/s timeslot for true RMS power, frequency, DC offset, peak (positive and negative) codes, and of timeslot sample display.

Analog drop and insert

A selected timeslot (containing PCM encoded voice) may be dropped to the analog output port. Voice at the analog input port may be inserted into a selected timeslot.

Switched-56kb/s

Switched-56 is a 56kb/s dial up and digital data service. User traffic is carried in bits c1 through c7; bit c8 is padded with a "1" and is overwritten by signaling every sixth frame.

Switched-56kb/s is performed by generating a test pattern and inserting it into the selected channel. On the receive side, BER measurements are performed on the switched-56 signal. The test patterns used are a subset of those used in DDS signals which are detailed later.

Signaling/dialing

For analog insert and tone generation, the AB (CD) bits are manipulated for line seizure. Dialing (of the number) is selectable between either DTMF, MF or pulse dialing.

Signaling Bits Control

The signaling bits associated with the dial-up features under CONFIGURATION VF are set up here. Signaling bits (AB or ABCD) may be either fixed or user programmable. The fixed (default) values are:

	AB	ABCD
On Hook	11	1111
Off Hook	00	0011

Timeslot Check.

Shows digital content of one or all timeslots. Transmitter sends varying identification in all timeslots simultaneously. The origin timeslot number is displayed for any received timeslot containing an identification code, enabling detection of swapped timeslots.

Timeslot Delay Measurement.

High resolution round trip delay measurement in any timeslot. Range 10 μs to 0.6 s, resolution 10 μs.

Transmitter

Transmitter timing. The transmitter can be timed from the clock recovered at the receiver (loop timed) or from the internal clock.

Internal Tx Clock.

Frequency:	1.544 MHz
Stability:	±5 ppm 0 to 40°C (nominal).
	±10 ppm 0 to 50°C
Ageing:	±2 ppm per year typical

Tx Error Add.

Types:	Logic, BPV, Frame or CRC (ESF only)
Rates:	Selectable 10^−3, 10^−4, 10^−5, 10^−6 or 10^−7, or SINGLE

Notes: Logic errors are inserted only in test patterns, not in framing bits. They include both 0 to 1 and 1 to 0 conversions without violating the 15-zero constraint in the case of QRSS. With ESF they are inserted before CRC calculation and so do not result in CRC errors. Pattern error insertion never causes bipolar violations, CRC or frame errors. Bipolar violations are inserted across both data bits and F-bits. They include both + to − and − to + conversions with equal probability. Other conversions are excluded since they would result also in logic errors. BPV insertion does not cause logic, CRC or frame errors nor affects B8ZS coding. Frame errors are only added to those F-bits which are used for framing. A CRC error is added by inverting one of the 6 CRC bits in a CRC block (an ESF multiframe). An error injection rate of 10^−n corresponds to one errored CRC block in 10^n CRC BLOCKS.

Tx Alarms.

AIS:	Unframed All Ones.
Yellow Alarm:	bit 2 of each timeslot = 0 (D4 and SLC-96), 8 ones/8 zeros pattern in facility data link (ESF)
Validity:	Alarms can be generated with any test pattern. They are disabled when loop codes are being generated. Yellow alarm is not available in unframed mode.

Tx loopback codes (in-band).

Loopback	Loop-up code	Loop-down code
Line loopback	10000	100
4-bit "smartjack" (NI)	1100	1110
5-bit "smartjack" (NI)	11000	11100
User	xxxxxxxx	xxxxxxxx

The loopback codes may be sent with or without framing. With framing, the default state is that the framing bits temporarily overwrite the loopcode. The user can select framing to be inserted in loopcodes. The loop-up code is sent for at least 6 seconds, after 6 seconds it will stop when loop-up is detected at the receiver or it will continue for an additional 2 seconds. If loop-up is detected within the first second, a "Pre- exist loop" will be flagged. The loop-down code will be sent for at least 8 seconds.
Accuracy of loopcode intervals: ± 1 Second.

Westell and Teltrend Intelligent Addressable Repeaters

By RBOCs:
Ameritech, South West Bell, PacBell, Bell Atlantic, NYNEX and
US West: Teltrend
Bell South: Westell

	Westell	Teltrend IOR	Teltrend ILR	Result	How to action
arm & loop-up	YES	YES	YES	YES	LOOP-UP KEY
loop-down & disarm	YES	YES	YES	NO	LOOP-DOWN KEY
arm	YES	NO	NO	NO	action field
arm (DSX⟶NI)	NO	YES	YES	NO	action field
arm (NI⟶DSX)	NO	YES	YES	NO	action field
dis-arm	YES	YES	YES	NO	action field
loop-up	YES	YES	YES	YES	action field
loop-down	YES	YES	YES	NO	action field
loopback query	NO	YES	YES	YES	action field
timeout defeat	YES	YES	YES	NO	action field
timeout defeat	YES	YES	YES	NO	action field
power query	NO	NO	YES	YES	action field
span power cut	NO	NO	YES	YES	action field
power down	NO	YES	NO	YES	action field

NOTE: IOR = Intelligent Office Repeater
ILR = Intelligent Line Repeater

WESTELL

Address range: 1 to 1999

Arming and Disarming

Arm	SF	11000	8 ± 1 second
	ESF	1111 1111 0100 1000	>15 repetitions
Disarm	SF	11100	8 ± 1 second
	ESF	1111 1111 0010 0100	>15 repetitions

Loop-up: success or failure indicated on status line. Loop-up sequence consists of two parts: an arming word which instructs the repeater to look for the repeater address, and an instruction containing the address itself. In ESF, the arming codes is carried in the FDL.

Loop-up 1100 0AAA AAAA AAAA
Repeater return 0011 0AAA AAAA AAAA

The 16-bit address of the repeater (range 1 thru 1999) is binary coded into the "A to A" field and is carried "in-band".

Loop-down: success or failure is indicated on status line. Loop-down is accomplished by "disarming".

Loopback Query: It is assumed that the path is in an "armed" state.

	Interpretation		
send	No Loop	NIU Loop	repeater
11010101	pattern loss	pattern sync	<=200 errors # errors = ADDR * 10

Power Query

-40 units

	Interpretation		
send	No Loop	NIU Loop	repeater
01011011	pattern loss	pattern sync	<=210 errors # errors = ADDR * 10

Loopback Timeout Disabling: Loopback Timeout is performed using control codes after arming.

Disable 1001 0101 1110 0010
Enable 1001 0101 1110 0001

Other functions: other repeaters may be actioned using the 16-bit user word.

TELTREND

Address range: 1 to 20

ILR Loop-up:	generates the complete sequence of arming and addressing with success or failure indication on the status line and address updating on the AUX page.

In ESF the arming code may be either "in-band" or "out-of-band".

Address 1100 0111 010A AAAA for 15 seconds

The 16-bit repeater address (range 1 thru 20) is binary coded into the "A to A" field and is carried "in-band".

The Teltrend repeater returns its address in the form of logic errors: 10 errors represents address 1; 20 errors represents address 2; etc. Repeaters which support both metallic and logic (payload) loopback, add an extra five errors when in metallic loopback.

Loopdown:	generates the complete disarming sequence complete with success or failure indication on the status line.

SF	11100	8 $\pm$ 1 second
ESF	11111111 00100100	>15 repetitions

Arming and Disarming:	loop-up and loop-down functions include necessary arming and dis-arming.

Arm	SF	11000	8 $\pm$ 1 second
	ESF	11111111 01001000	>15 repetitions
Disarm	SF	11100	8 $\pm$ 1 second
	ESF	11111111 00100100	>15 repetitions

Arming:	The span is first armed using the appropriate "SMARTJACK" code. Then the IOR/IHR/ILRs are armed using the following in-band codes.

SMARTJACK	SF	11000	8 ± 1 second
	ESF	11111111 01001000	> 15 reps
DSX⟶NI	ALL	11000	> 5 seconds
NI⟶DSX	NYNEX	10 0000	> 5 seconds
	B-ATLANTIC	0101 0010	> 5 seconds
	OTHER-RBOCs	0101 0111 1011 0111	> 5 seconds

IOR Loop-up:	to loop an armed IOR. 11000111 010AAAAA > 5 seconds
Loopback Query:	It is assumed that the path is in an "armed" state. Processing of information returned from the ILR is as per the loop-up sequence and the address result on the AUX page is similarly updated. Code: 1101 0101 for 5 seconds (nominal)
Power Query:	It is assumed that the path is in an "armed" state. Processing of information returned from the ILR is as per the loop-up sequence and the address result on the AUX page is similarly updated. Code: 0101 1011 for 11 seconds (nominal)
Timeout Disable:	It is assumed that the path is in an "armed" state. The addressed repeater powers down the span for a long as the code is sent, so the <ACTION> field does not return to OFF. Code: Bell Atlantic: 0101 0100 for user-defined seconds (nominal) All other RBOCs: 1101 0101 1101 0110 for user-defined seconds (nominal)
Span Power Cut Thru:	Issued after power loop query. Acknowledgement of span restoration is by logic error count, failure is loss of pattern synchronization. Code: Bell Atlantic: 1101 1000 for 11 seconds (nominal) All other RBOCs: 0101 1011 0110 1011 for 11 seconds (nominal)

Power Down: An armed IOR/IHR can power down the span if primed. The span remains powered down for as long as the "power down" field is active and no other configuration changes are made.

Code: 0110 0111 11 seconds (nominal)

Repeater in power loop An armed span will return the address of the repeater in power loop.

Code: 0101 1011 11 seconds (nominal)

Tx loopback codes (out-of band)

Out-of-band loopback is only available with ESF framing or SLC-96 framing. Loopcodes (16-bit message) are sent in the ESF 4 kbit/s data link in the format:

Loopback	Loop-up code	Loop-down code
Line loopback	00001110 11111111	00111000 11111111
Payload loopback	00010100 11111111	00110010 11111111
Smartjack loopback	00010010 11111111	00100100 11111111
User	0xxxxxx0 11111111	0xxxxxx0 11111111

Out–of–band loopcode repetition: 15 repetitions of the message are sent.

Idle code

When not transmitting loopcodes, the transmitter sends idle code (repeated 01111110) in the data link.

Output

Impedance: 100 ohm balanced (nominal)
Pulse Shape: meets ANSI Standard T1.403-1989
Pulse Height: ±3V ±600mv (at the center)
Pulse Imbalance: Ratio of voltage in +ve and −ve pulses; 0 ± 100 mV
LBO: 7.5dB and 15dB nominal

Receiver

DSX-MON. For connection to protected monitor points. Automatic gain control (AGC) between 0 and +30dB compensates for the flat loss at these points, no specific frequency dependent gain is provided except ±6db DSX is allowed for cross connect cabling.

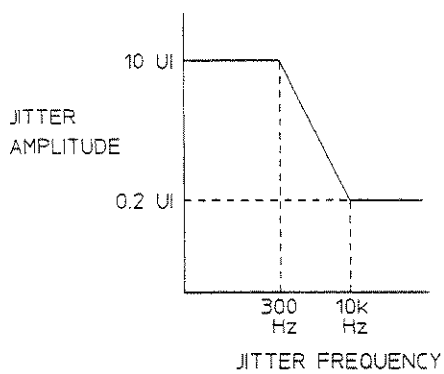
Rate:	1.544 Mb/s ± 130 ppm
Pulse shape:	DSX-1 compatible per ANSI Std T1.102-1987
Input Impedance:	100 ohms nominal
Dynamic Range:	+6 to −30dB relative to DSX-1 level

Terminated. For terminating unprotected DSX-1 points or line terminations up to −36db caused by lines of approx 6000 feet of cable. Frequency dependent gain is provided.

Input Impedance:	100 ohms nominal
Dynamic Range:	6V pk-pk to 95mV pk-pk or 0 to +36db equalization @ 772kHz

Bridge. For use where the circuit is already terminated. Specification as TERMINATED, except input impedance is 1kohm (nominal).

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



Alarm LEDs (red)

The indication remains for 100 ms beyond the duration of the alarm condition. The history function shows any alarm which occurred during the last measurement period.

Signal Loss:	triggered by 175 or more consecutive zeros at the receiver (nominal)(TR-TSY-000475)
All ones (AIS):	triggered when any two consecutive frames contain less than 3 zeroes
Frame Loss:	see Frame Loss Criteria. LED also used for DDS frame loss
Pattern Loss:	triggered by loss of synchronization to the selected test pattern
Slip:	triggered by controlled or uncontrolled slips (out-of-service testing only)
Excess Zeros:	triggered by >15 consecutive zeros
Ones Density:	triggered by a received ones density <12.5% over a 100ms period
Errors:	triggered by an error from any of the available sources in any 1 Second period
Yellow Alarm:	triggered by bit 2 of every timeslot set to zero (D4 and SLC-96) or facility data link contains repeated 1111111100000000 (ESF)
Power loss:	triggered when power is removed from the instrument during a measurement period
Loop up:	triggered when the instrument detects a loop up code (as defined on the AUX TX/RX page) for at least 100ms
Loop Down:	triggered when the instrument detects a loop down code (as defined on the AUX TX/RX page) for at least 100ms

Excess Wander (Optional):	triggered when greater than 5 UI of wander is exceeded in any 15 minute period or 28 UI in any 24 hour period
Status LEDs (green):	Signal present, Frame Sync, Pattern Sync, B8ZS

Signal Indication. This is indicated when 1) A 1544 kHz clock ± 500ppm (nominal) is recovered, and 2) Peak levels (nominal) are between +6 and −30 dBdsx (DSX-MON) or 0 and −36db at 772 kHz (TERM or BRIDGE).

Frame Sync Criteria.

D4:	24 consecutive error-free Ft and Fs bits (nominal)
ESF:	24 consecutive error-free Fe bits and then 3 CRC error-free multiframes (nominal)
SLC-96:	24 consecutive error-free Ft bits (nominal)

Frame Loss Criteria.

D4:	2 in 4 Ft bits in error
ESF:	2 in 4 Fe bits in error
SLC-96:	2 in 4 Ft bits in error

Pattern sync.

Sync Loss:	Sync loss is deemed to have occurred if the error ratio exceeds 4% as measured over a decisecond
Sync Gain:	Sync is regained after 32 error-free clock periods

Test Period.

Range:	1 second to 100 days or continuous
Resolution:	1 second/1 minute/1 hour/1 day
Fixed intervals:	15 min, 2 hours, 24 hours
Indicator:	Green LED above RESTART key is illuminated while measurement is in progress

Fractional T1 Testing

Modes:	n × 56 kbit/s, n × 64 kbit/s contiguous or non−contiguous. Background timeslots filled with idle code 01111111.
Test patterns:	QRSS, user defined word 1 to 8 bits, user defined pattern 8 to 1024 bits, 2^15−1 PRBS, 2^20−1 PRBS, 2^23−1 PRBS.

ESF Facilities Datalink Generation and Decode

Meets ANSI T1.403 performance messages for ESF framing and TR-TSY-000008 for SLC-96. Digital drop and insert allows FDL (ESF or SLC-96) to be dropped to/inserted from a protocol analyzer or other external source via an X.21-leased connector.

Transmit Message:

PRMs 1 per second (nominal) while instrument is gating.

Timeslot data: When not looped, 192 bits/frame of timeslots are filled with QRSS. When looped, data passed thru from receiver.

FDL contents

Background: When not sending a message: all-1s

OR:

Out-of-band loopcode generation

Loopback	Loop-up code	Loop-down code
Line loopback	00001110 11111111	00111000 11111111
Payload loopback	00010100 11111111	00110010 11111111
Network loopback	00010010 11111111	00100100 11111111
User	0xxxxxx0 11111111	0xxxxxx0 11111111

OR:

Performance messages: A 14-byte message packet describing received T1 performance (CRC, BPV, frame errors and loop-back status) is sent back once per second (nominal). The instrument must be running a test period for this to happen correctly.

Bit-messages: As previously described, the instrument will generate "out-of-band" loopback instructions as defined under T1 Loopbacks. These will overwrite performance messages when active.

ESF FDL PRM Analysis to ANSI T1.403

The FDL message is decoded in accordance with ANSI-T1.403. The following message bits are counted and displayed:

CRC Events: G1, G2, G3, G4, G5, G6

Other Events: SE, FE, LV, SL, LB, U1, U2

Note

1. The instrument test period is asynchronous with the FDL data stream, hence the number of FDL messages received has an error of ±1 relative to the instrument test period second.
2. The instrument does not accommodate FDL messages that are discarded due to errored frame check sequences (FCS), i.e. if at the end of a test period, the FCS indicates an errored message, the message will be lost and will not be interpolated from the information repeated in the next post test period received packet.

A message monitor display is provided to view the real time FDL packet contents as they arrive. For T1.403, octets numbered 2, 3, 5-12 are displayed in binary. For convenience, the C/R bit is also decoded as either Customer (CI) or Carrier (NI).

SLC-96 monitoring and stimulation of the RTU. Meets: TR-TSY-000008.

3ms 36-bit F(s) sequence:

`0 0 0 1 1 1 0 0 0 1 1 1 C C C C C C C C C C C 0 1 0 M M M A A S S S S 1`

C1 to C11 concentrator field

M1 to M3 maintenance field

A1, A2 alarm field

S1 to S4 protection switch field.

TX Messages

C field: used in Type-2 SLC's to achieve concentration; arbitration between competing sources for limited transmission bandwidth. The C field will contain idle: C1 to C11 = 11111110000.

Messages decoded

Message	Format		
Idle	7f0	7f0	7f0
No Alarm	0ff	0ff	0ff
Activity Update Request	736	736	736
Activity Update	738	CMESS1	MESS1
Looping Test	738	033	7cc
Activity	MESS1	MESS1	MESS1

S field: enables PROTECTION switching; (Switch and Restore).

RTU response time

range: 0.000 to 10.000s

resolution: ±100ms

accuracy: ±100ms (nominal)

failure: no response within 1 second

Message Values

Idle, Switch A line RX, Switch B line TX, Switch C line TX, Switch D line TX, Switch B line TX & RX, Switch C line TX & RX, Switch D line TX & RX.

User Interface

Action	Key
Switch	Loop-Up
Restore	Loop-Down

Time to respond measured: range 0.000 to 10.000s ±100ms. The alarm field carries either 13 or 16 multi-frame message:

The tester automatically adjusts its send alarm field message size (i.e. 16 vs 13) to be the same as the incoming frame size.

Far end loop: forced by inserting the relevant patterns into the Alarm field; use the "Loop up" and "Loop down" keys. A successful loop is the return of the same pattern.

Measurements in FDL mode

TR-TSY-00008

Frame errors, frame loss, bit monitor

Bit monitor: display of the current SLC-96 frame, current alarms: 1 second (nominal)

T1.403 results.

Loopbacks:	In FDL mode, the instrument responds to out-of-band loopcodes
Error counts:	BPV, frame, CRC

FDL message decoded to ANSI T1.403
All message bits counted, i.e. G1..G6, SE, FE, LV, SL, LB, U1, U2 and may be stored in graphical format as "alarm" bars.
Binary display of the last received (with correct FCS) FDL message

T1 and fractional T1 Measurements

Error Measurements

All appropriate error types are measured during a test.

Error types:	Logic errors, BPVs, Frame errors (Ft & Fs bits for D4 mode, Fe bits for ESF mode, Ft bits for SLC-96 mode), CRC errors (ESF only)
	For B8ZS the zero replacement code (0V10V1) will not be reported as a BPV error.

Recovered Clock Frequency Measurement

Resolution:	1 Hz
Accuracy:	± 5ppm 0 to 40°C (nominal)
	± 10ppm 0 to 50°C
Ageing:	±2ppm per year,typical
Result Presentation:	Absolute frequency (Hz) and frequency offset in ppm from 1544000Hz.

Pattern Slip Measurements

Valid for all PRBS patterns. If framing is present, then CONTROLLED and UNCONTROLLED slips can be distinguished. For unframed modes it is meaningless to use these terms, and a single measurement of SLIPS is made.

Slip Criteria:	A slip occurs when one or more bits are added to or deleted from the received pattern.
Uncontrolled Slip:	If a pattern slip is accompanied by a COFA (change of frame alignment) then it is an uncontrolled slip.
Controlled Slip:	If a pattern slip is not accompanied by a COFA then it is a controlled slip (or frame slip).

Simplex Current Measurement

Volt Drop:	Nominal 8 Volts drop @ 60mA
Range:	from ± 10 to ± 200 mA (Unsigned)
Accuracy:	5% ± 1mA
Resolution:	1 mA

Simplex current measurements are possible on all front panel Tx/Rx connectors.

Caution

Span Power Measurements
Extreme care should be taken when operating with hazardous voltages. Span power can generate voltages of up to ± 130V dc.

A dc connection is provided between the receiver and the transmitter paths for operation on wet lines. Ensure span power is removed before connecting or disconnecting the test set.

Signal Level Measurement

Presentation:	Volts, dBdsx and dBm (the dBm result is the dBdsx result plus 17dB, correct for an all-ones signal)
Range:	+6dBdsx to −36 dBdsx (12 Volts to 100mV peak to peak)
Voltage Accuracy:	± 10% (2V to 12V), ± 30% (100mV to 2V)
Voltage Resolution:	50mV (2V to 12V), 10mV (60mV to 2V)
Level Accuracy:	± 1dB (−9dBdsx to +6dBdsx) ± 2dB (−19dBdsx to −10dBdsx) ± 3dB (−36dBdsx to −20dBdsx)
Level Resolution:	1dB

Round Trip Delay Measurement

Only valid for QRSS, but available simultaneously with error results.

Range:	1ms to 670ms
Resolution:	1ms (for 10μs see High resolution round trip delay)
Accuracy:	3% (nominal)

Results

Error Results

Error Count. Errors are counted for all sources over total elapsed time. Counting is not inhibited during alarm conditions, except during pattern sync loss for 300ms (nominal) following instrument power restoration and during signal loss.

Elapsed time starts after a signal has been detected at the input. BPV results are available at this time. Frame and CRC results are available only after frame sync has been achieved during a measurement. Pattern (logic) results are available after pattern sync has been achieved.

Error Seconds. Asynchronous error seconds are counted for all error sources

Error Count and Error Second. 6-digit display for < 1,000,000 errors, X.XXXE+YY display for >= 1,000,000 errors. For CRC error counts, an incorrect CRC checksum is counted as one error.

Ave. Error Ratio. Average error ratio over total elapsed time

Cur. Error Ratio. Current error ratio, measured over the last second

Error Ratio Format. X.XE+YY display

Error Free Seconds. The number of error free seconds expressed as a count

% Error-free Secs. The number of error free seconds expressed as a percentage of the number of seconds in the measurement period

Percentage format. XX.XXX% or 100.000%

SEF Event. Count of Severely Errored Framing events (SEFs) within the measurement period. An SEF event occurs if 2 or more errors are detected in the framing pattern within a 3 ms period. Consecutive 3 ms periods are examined. Valid in ESF mode only.

OOF Count. Count of Out Of Frame events (OOFs) within the measurement period. An OOF event occurs if 2 or more errors are detected in any 4 consecutive frame bits. Valid in all framed modes.

LOF Count. A count of the number of times a frame loss occurs for >3 seconds, also known as RED ALARM

Frame Loss Seconds. Count of the number of Frame Loss Seconds.

Alarm Seconds

Display Format:	9-Digit display for < 1,000,000,000 seconds
Alarms presented:	Yellow Alarm, Pattern Loss, T1 Frame Loss, Signal Loss, AIS, Excess Zeros, Power Loss, DDS Frame Loss

Trouble Scan

Displays any non-zero error count (in "large" characters) for the five error types LOGIC, T1 FRAME, DDS FRAME, BPV and CRC. Alarm conditions are also displayed. If the results are all zero then "No Trouble Found" is displayed.

Pattern slips

Uncontrolled (COFAs) and controlled (no COFA). Count of both types with no direction indication.

Results storage and graphic presentation

Internal electronic result storage

Automatic storage for up to 10 periods with a maximum of 99 days total capacity. Once all the store capacity has been used, the oldest test data will be discarded. Storage can be switched on or off. Data is retained when the instrument is switched off.

Stored Text Results

At the end of a test period where the STORE was enabled, a summary of the current settings and end of test results is stored in textual format alongside the stored graphics results. The following list is not exhaustive.

Stored Settings:

- Configuration, Framing, Linecode, Thru.
- Electrical interface (T1 parameters or DS0 parameters (HP 37702A)).
- Pattern including any user defined elements.
- Timeslot information.
- DDS mode, payload rate and customer number (HP 37702A).
- VF mode, tone parameters
- FDL mode, protocol
- Test Period.

Stored Results:

- All alarm seconds results
- Logic: All basic results and all G.821 analysis results.
- BPV: All basic results.
- T1 Frame: All basic results and all G.821 analysis results.
- CRC: All basic results and all G.821 analysis results.
- DDS Frame: All basic results and all G.821 analysis results.
- DDS trapped control code and timestamp (HP 37702A).
- All slips results.
- Option 001: Additional slips results and all wander results.
- VF Tones: All VF tones results.
- FDL: All T1.403 results.

Graphic result presentation

Histogram display or printout versus time-of-day of two error sources and alarms, based on current or stored measurement period.

Error Sources. Logic, BPV, T1 Frame, DDS Frame, CRC, Alarms, PRM contents.

Display Format.

Width:	60 bars
Bar resolution:	1 minute, 15 minutes, 60 minutes
Error count scale:	Pseudo-logarithmic range of more than 8 decades, each decade represented linearly.

CSU Emulation

Status Messages

Loop codes are as set for the transmitter. If a set loop code is detected the presence of LOOP UP or LOOP DOWN will be indicated on the Receive Status LED's.

Autoresponse Mode

In-Band — If Autoresponse is ON, the instrument performs a line loopback if the LOOP UP code is present > 5 seconds. If the LOOP DOWN code is detected and Autoresponse is ON, the instrument removes the line loopback if the LOOP DOWN code is present > 5 seconds (nominal). The line loopback can be set ON/OFF manually. Tx error injection and alarm generation are disabled in Line loopback mode.

Out-of-Band — If autoresponse is on, the instrument will respond to line, payload or smartjack received out-of-band loopcodes. At least 4 repetitions of these loopcodes are required. Line and payload loops may be selected manually, if both are selected the line is looped.

The current status of the two loopbacks is indicated on the LOOPCODES display (AUX, T1 ALARMS & LOOPING), these can be manually overridden at any time by the user. The instrument TESTER LOOPED LED lights when either loopback is enabled.

Loopcode Detection

Out-of-Band The receiver constantly monitors for a valid 16-bit message on the ESF data link. Valid messages will remain for at least 10 repetitions and each takes 4 ms. The instrument samples the messages every 5 ms, and a valid loopcode will be flagged whenever 3 out of the last 5 ms samples have contained the same valid loopcode.
Loopcodes are not detected in T1 SPECIAL measurements.

Loopback	Loop-up code	Loop-down code
Line loopback	00001110 11111111	00111000 11111111
Payload loopback	00010100 11111111	00110010 11111111
Smartjack loopback	00010010 11111111	00100100 11111111
User	0xxxxxx0 11111111	0xxxxxx0 11111111

Line Loopback

When line loopback is selected or set by the LOOP UP code, loop timing is forced and the instrument retransmits the recovered receive data. BPVs, T1 frame errors, CRC errors and logic errors are all preserved.

When payload loopback is selected or set by the LOOP UP code, loop timing is forced and the instrument retransmits the recovered receive data. BPVs, T1 frame errors and CRC errors are corrected and retransmitted.

Digital Drop and Insert (selected via PATTERN EXTERNAL)

Rates: n x 64 kbit/s, n x 56 kbit/s: ($1 \leq n \leq 6$), DDS primary channel (56, 38.4, 19.2, 9.6, 4.8, 2.4 kbit/s).

Connector: 15-pin "D" type connector using RS-422A electrical signals (i.e. X.21-leased). The common clock is derived from the transmit clock. Pin assignment:

Name	A	B	Comments
Common clock	6	13	
Receive data	4	11	data dropped by HP 37702A
Transmit data	2	9	data inserted by HP 37702A
Indication	5	12	
Control	3	10	
ground		8	
shield		1	
n/c		7,14,15	

Notes:

Either the HP 37702A or the equipment under test should be loop timed. The HP 37702A is the DCE.

For insert only applications, it is required that the HP 37702A's transmitter be configured with recovered clock.

The drop and insert control lines are not "no-connection".

Voice Frequency Mode

Voice frequency access allows manipulation of data within a single timeslot. The PCM data may be either generated internally (a single tone) or inserted from the VF port. The PCM data may be measured (for level and frequency) and dropped to the VF port. The VF access incorporates facilities to generate a call, using either pulse or DTMF dialing.

Signaling and Dialing

Pulse dialing:. Off/On hook AB(CD) signaling conditions are selectable.

Line condition	D4	ESF	
Off-hook	11	1111	default
On-hook	00	0011	default
Break-time	60ms		nominal
Make-time	40ms		nominal
Inter-digit	>800ms		
Post seizure delay		2s	nominal

DTMF dialing.

	1209Hz	1336Hz	1447Hz	1633Hz
697Hz	1	2	3	A
770Hz	4	5	6	B
852Hz	7	8	9	C
941Hz	*	0	#	D

On	100ms	nominal
Off	100ms	nominal
Level	0.0dBm	nominal

Chain dialing:. does not involve releasing and re-seizing the line in the way that normal dialing does; it maintains the line in the off-hook state.

MF dialing

Meets: CCITT Recs. Q.320, Q.321

Tones

ms		Hz					
		700	900	1100	1300	1500	1700
1	68	*	*				
2	68	*		*			
3	68		*	*			
4	68	*			*		
5	68		*		*		
6	68			*	*		
7	68	*				*	
8	68		*			*	
9	68			*		*	
0	68				*	*	
'	68	*					*
Start prime (ST1)							
"	68		*				*
Start double prime (ST2)							
K	100			*			*
Start pulsing (KP)							
#	68				*		*
Start treble prime (ST3)							
S	68					*	*
Start (ST)							
Inter-digit interval: 68 ms ± 7 ms (nominal)							
Level: -7 ± 1 dBm0 per tone (nominal)							

User-selectable phone digits: 1 thru 9, A thru D, #, *, (space), ', "

MF dialing string: KP, 0 thru 9, *, ST or ST1 or ST2 or ST3

Tone Generation:

in a single timeslot within a T1.

Code: μlaw

Level: 0 dBm0 to – 55 dBm0 in 5dB steps

Frequencies:

Fixed: 404, 1008, 2100, 2804 Hz ± 1 Hz

Variable: 100 Hz to 3.9 kHz in 1 Hz steps

Tone Measurement

in selected 64 kbit/s timeslot in a T1

Code: μlaw

Code word:

Results range: 0 to ± 127

Offset range: 0 to ± 16

Signal level:

Results range: −60 to +3dBm0

Resolution: 0.1 dB

Accuracy: ± .1 dB (−40 dBm0 to +3 dBm0)

± .5 dB (−55 dBm0 to −40 dBm0)

Switched-56kb/s

Switched-56 is a 56kb/s dial up and digital data service. User traffic is carried in bits c1 through c7; bit c8 is padded with a "1" and is overwritten by signaling every sixth frame.

Switched-56kb/s is performed by generating a test pattern and inserting it into the selected channel. On the receive side, BER measurements are performed on the switched-56 signal. In this mode the V.54 latching loopback is available. In VF mode - Switched-56 testing, i.e. PRBS, DDS-stress-patterns

Switched-56kb/s test patterns

PRBS: 2047 and 511, DDS-stress patterns 1 thrus, All-1s, All-0s.

VF Channel Access

The user selects a single channel (1..24) to be demultiplexed from the incoming T1 stream and μlaw decoded D1D, D2 or D3/D4 channel assignment mapping is selectable. The VF signal can be monitored on a loudspeaker mounted behind the instrument front panel or can be fed to an external instrument. The signaling bits associated with the selected channel are displayed.

Audio Monitor

When EXTERNAL VF (drop and insert) is selected, the audio monitor controls whether or not the VF drop signal is dropped to the VF Output port.

Channel Mapping

Channel selection from 1 to 24 is offered which translates into a particular timeslot based on the numbering sequences of Table 6-4 of TR-TSY-000476.

Time	D3/D4	D1D	D2
1	1	1	12
2	2	13	13
3	3	2	1
4	4	14	17
5	5	3	5
6	6	15	21
7	7	4	9
8	8	16	15
9	9	5	3
10	10	17	19
11	11	6	7
12	12	18	23
13	13	7	11
14	14	19	14
15	15	8	2
16	16	20	18
17	17	9	6
18	18	21	22
19	19	10	10
20	20	22	16
21	21	11	4
22	22	23	20
23	23	12	8
24	24	24	24

Channel frequency:

Range:	100 Hz to 3.9 kHz
Resolution:	1 Hz
Accuracy:	± 1 Hz
Minimum input level:	−55 dBm0

600 ohm Audio Access

VF Input.

Code:	μ-law	
Connector:	Weco-310 side panel.	
Impedance:	600 ohms balanced (nominal)	
TLP:	0.0dB nominal	
Level:	+3dBm0 to −50dBm0 nominal.	
Gain Tracking:	1020 Hz level	Reference −10dBm0
	+3dBm to −10dBm	±0.2dB (nominal)
Noise level	Reference −10dBm	
	−10dBm to −40dBm	±0.2dB (nominal)
	−40dBm to −50dBm	±0.3dB (nominal)
Intrinsic Noise:	< 24 dBrnCo	(nominal) (−66dBm0p).

VF Output. The output is available at the front panel.

Coding:	μ11-law	
Connector:	Weco-310	front panel.
Impedance:	600 ohms balanced	nominal.
TLP:	0.0dB	nominal.
Level:	+3dBm to −50dBm	nominal.
Gain Tracking:	1020 Hz level	Reference −10dBm
	+3dBm to −10dBm	±0.2dB (nominal)
	Noise level	Reference −10dBm
	−10dBm to −40dBm	±0.2dB (nominal)
	−40dBm to −50dBm	±0.3dB (nominal)
Intrinsic Noise:	< 15 dBrnCo	(nominal) (−75dBm0p).

DDS Testing

DDS: Complete DS0A and DS0B (Option 004 only) coverage (56, 38.4, 19.2, 9.6, 4.8, 2.4kbit/s) accessing either at DS0 (64 kbit/s) or from within a timeslot from a T1.

Testing functions in accordance with TR-TSY-000439; eg PRBS, word, stress patterns, alternating and latching loopbacks, MJU functions.

Access point

Signal	"Format"	Where	Connectors
T1	SF ESF SLC-96	Front Panel	Weco 310 bantam
DS0A	Logic Near Logic Far Bipolar	Side Panel	bantam

DS0 timing: from one of 2 sources. Connectors for both are mounted on the side panel:

Bit/byte clocks on a 9-pin "D" type, on the side panel.

Composite clock: Weco-310 connector, on the side panel.

DS0 Bipolar output: level conforms to TA-NPL-000458 DDS in THRU mode: only available when the interface is T1. All timeslots, except the timeslot carrying the DDS signal, are copied from the receiver port to the transmitter port. The time order of the DDS timeslot relative to the other timeslots may be disturbed. For ESF format the CRC will be recalculated.

DDS payload

In accordance with TR-TSY-000439, a number of different test patterns are available for stimulating the circuit under test. The test pattern can be errored; either singly or at preset rates. The test pattern can be interrupted to effect a number of network control functions; MJU routing and loopbacks, both alternating and latching.

Test patterns. PRBS-511 (2^9−1, TR-TSY-000476.), PRBS-2047 (2^11−1, TR-TSY-000476.), all ones, all zeros ,user programmable word (8 bits byte-aligned), all bits except sub-rate frame bit, user programmable; i.e. c/s bit is user-programmable (see following table), datacoms port (D.type-15), known as "External", DDS stress patterns (ANSI T1A1.4/92-002R4 Annex B).

DDS-stress-1 '(FFH, 00)'

Repeating pattern 100 octets of '11111111' followed by 100 octets of 00000000.

DDS-stress-2 '(7EH, 00)'

Repeating pattern 100 octets of '01111110' followed by 100 octets of 00000000.

DDS-stress-3 '(32H)'

Continuous octets of '00110010'.

DDS-stress-4 '(40H)'

Continuous octets of '01000000'.

DDS-stress-5 '(1 THRU 4)'

A combination of stress patterns 1 to 4 as follows:

800 bytes of DDS-stress-1 ff/ 00 (i.e. 4 repeats)
800 bytes of DDS-stress-2 7e/ 00 (i.e. 4 repeats)
200 bytes of DDS-stress-3 32
200 bytes of DDS-stress-4 40

Six bit segments (7 @56kbit/s) from the sequence is taken and framed at the customer rate.

Secondary channel patterns

PRBS-2047 and PRBS-511, known as "2C PRBS 2047" and "2C PRBS 511". Both patterns include the secondary channel training sequence of six-0's, and neither contains the secondary channel idle sequence of twelve-1's.

User-programmable Word

	56kbits		< 56kbits	
pattern	bits	alignment 12345678	bits	alignment 12345678
prbs	7	ddddddc	6	fddddddc
word	8	ddddddc	7	fddddddc
external	7	dddddd1	6	fdddddd1

where:

	Settable	Measured	Comment
d	Yes	Yes	data
1	No	No	
f	No	Yes	sub-rate frame bit (usually 1)
c	No	No	network control bit (c/s)

Error add. single, rates: 1E–n where 2 < = n < = 6.

Control functions.

Alternating loopbacks:

DSU, Channel (56 kbit/s only), repeater (56 kbit/s only), OCUDP, HL96NY, DS0-DP.

When in the "loop-down" state, the HP 37702A will not alternate the pattern with loop code; it will only do so after the "loop-up" sequence has completed. Loop-up and loop-down sequences are detailed below:-

Note

1. While looped-down, the instrument will not alternate the pattern with the loop code. It will only do so after the loop-up sequence has completed.
2. For alternating loopbacks, pattern selection should be limited to PRBS-2047 and PRBS-511 and DDS-stress.
3. The receiver is unable to align to bit-wise rotated patterns.
4. Pattern EXTERNAL (Drop and Insert) will not accommodate half rate clocking.

Loop UP

Code	DS0DP	HL96NY	OCU	Repeater (56kbit/s)	Channel	DSU
DS0DP	*	*	*			
Channel				*	*	
DSU						*
OCU/PRBS	1		2			
OCU/DMI	1		2			
Channel/PRBS				3	4	
Channel/DMI				3	4	

Loop DOWN

Code	DS0DP	HL96NY	OCU	Repeater	Channel	DSU
PRBS	*	*	*	*	*	*

In the above table "OCU/DMI", "Channel/PRBS", "Channel/DMI" means 1 OCU code alternated with Data Mode Idle, etc. Such sequences are sent under the following circumstances:-

1. For DS0-DP circuits, 1 second of "DS0DP/PRBS" followed by 1 second of "DS0DP/DMI" once for each intermediate DS0-DP between the tester and the target DS0-DP; up to a maximum of 7 times, supporting 8 tandem DS0-DPs.

2. When a HL-96NY is the path between the HP37702A and the OCU-DP, 1 second of "OCU/PRBS" followed by 1 second of "OCU/DMI" is sent.

3. On a 56kbit/s line with repeaters, 1 second of "Channel/PRBS" followed 1 second of "Channel/DMI" for each repeater (2 maximum) between the OCU and the target repeater.

4. On a 56kbit/s line with repeaters, 1 second of "Channel/PRBS" followed 1 second of "Channel/DMI" for each repeater (2 maximum) between the OCU and the Channel unit.

Latching loopbacks:

DS0-DPs, OCU-DPs, Channel-loopback, HL222s and MJU as detailed below, together with the appropriate loop-down sequences. The HP 37702A will report the success of the loopback by displaying the returned "map-code" (MAP-0 or MAP-1) and (for OCUs) the secondary channel capability. If the circuit fails to return the expected "map-code", then a "Loop-up failed" status message is displayed. The HP 37702A also reports failure to take down a latching loopback.

The byte counts in the table below detailing the loopback sequences are at the customer rate, not the DS0A rate.

Loop UP

Code	Count	DS0-DP	OCU-DP	Channel	HL222	MJU
TA	40					*
MA	20					*
MJU	20					*
UMC	20					*
TIP	40	*	*	*	*	
DS0DP	40	*				
OCU	40		*			
CSU	40			*		
HL222	40				*	
LBE	120	*	*	*	*	
DMI	40	*				
LBE	120	*				
FEV	2 seconds	*	*	*	*	
LBE	200	*	*	*	*	

Notes:

The counts are at the payload rate; i.e. before byte stuffing.

The 4 DMI, 12 LBE phase is repeated once for each intermediate DS0-DP in the path (0 times for the first DS0-DP).

V.54 Latching loopbacks

For DDS and VF testing (switched 56 kbit/s).

Test pattern: PRBS-7 (2048 bits)

Loop-up

preparatory phase: NORMAL PRBS-7 2048 ($\pm$100) bits
acknowledge phase: far end returns INVERTED PRBS (1948 bits)
success: returned PRBS received
failure: no returned PRBS received

Loop-down

1st: 8196 ($\pm$ 100) bits INVERTED PRBS-7.
2nd: 64 ($\pm$8) bits All-1s

Loop DOWN

Code	Count	DS0-DP	OCU-DP	Channel	HL222	MJU
TIP	2 seconds	*	*	*	*	
CMI	2 seconds					*

The secondary channel capability is determined by the value returned when the OCU receives FEV bytes.

MJU functions:

MJUs may be routed thru (i.e. branch selected.) When a path has been selected it may be tested, or a branch may be blocked or unblocked. The path may be released, upon completion of the test.

When a branch is selected the instrument will display the MJUs ID and branch selected; failure to receive the expected MJU acknowledgement will result in a "MJU operation failed" status message. Similarly, the HP 37702A will show acknowledgement of a branch block.

The control sequences are detailed below; the byte numbers are at the customer rate; i.e. before byte stuffing.

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

DDS Results, alarms and counts

DDS Frame loss event:

Indicated on LED as an "OR" of T1 frame loss and DDS frame loss and flashing as a status message: at 38.4 and 19.2 kb/s and also 9.6kb/s, 4.8kb/s and 2.4kb/s with error correction.

DDS Control code alarm:

A control-code event is an occurrence of a network byte with the C/S bit=0; i.e. a DDS control code. Each event is displayed and latched on the "BIT-MONITOR" display. This display will be cleared at the start of the measurement period. Such events that have recognized DDS-control codes will display the relevant mnemonic as shown below: This results in a DDS control code second which may be stored and printed to an external printer. This feature is not available when using alternating loopbacks.

Mnemonic	Code Word
ASC	f0011110
BLK	f0001010
CSU	f0101000
DSU	f0101100
FEV	f1011010
CMI	f1111110
LBE	f1010110
MA	f1110010
OOS	f0011010
OCU	f0101010
RLS	f1111000
TEST	f0011100
TA	f1101100
TIP	f0111010
UMC	f0011000

DDS logic error count

Pattern loss: error rate exceeds 4%, in 100ms.

Pattern resynchronisation automatically started on pattern loss.

DDS frame error count:

In DS0A and DS0B (Option 004 only), for rates less than 56kbit/s sub-rate frame error count will be made.

Frame loss: 5 successive frames which have a subrate frame error.

DDS Payload Formats. 56kbit/s: The bits within a 64kbit/s DS0A signal byte are proportioned as follows:- 7data bits (d) and 1 network control bit (c/s).

```
1 2 3 4 5 6 7 8
d d d d d d d c/s
```

56 kbit/s error correction by BCH coding in a second timeslot is not offered.

38.4 kbit/s: To INC-CB-101.

DDS Formats to ANSI T1.107

	T1 access	DS0 access	
56kb/s	*	*	
56kb/s E/C			
38.4kb/s	*	*	INC-CB-101
19.2kb/s	*	*	
19.2kb/s E/C	*		TA-TSY-000077
9.6, 4.8 and 2.4kb/s	*	*	
9.6, 4.8 and 2.4kb/s E/C	*		

Autosetup

Autosetup depends on the selected configuration. The following table lists which fields may be autosetup and also which fields must be manually set up for autosetup to work properly.

Configuration	Autosetup Fields	Manually Set Up Fields
FULL-T1	LINE CODE	
	FRAMING	
	PATTERN (1)(2)	
Nx56k	LINE CODE	TX & RX TIMESLOTS
	FRAMING (3)	
	PATTERN (1)(4)	
Nx64k	LINE CODE	TX & RX TIMESLOTS
	FRAMING (3)	
	PATTERN (1)(4)	
VF	LINE CODE	
	FRAMING (3)	
T1-DDS	LINE CODE	TIMESLOT
	FRAMING (3)	PAYLOAD
	PATTERN (5)	
DS0-DDS	CLOCKS (6)	PAYLOAD
	DS0 INTERFACE (7)	ERROR CORRECTION
	PATTERN (5)	
FDL	LINE CODE	PROTOCOL
	FRAMING (ESF,SLC-96)	

Notes:

(1) Pattern autoconfigure is not attempted if one of the "special" measurements is active.

(2) If no pattern can be found, the pattern reverts to LIVE.

(3) If no framing can be found, the application reverts to FULL-T1 with UNFRAMED data.

(4) If no pattern can be found, the application reverts to FULL-T1 and the pattern search is repeated.

(5) If no pattern can be found, the pattern reverts to its original value.

(6) If no clocks can be found, the clocks revert to their original value.

(7) If no interface can be found, the interface reverts to its original value.

NOTE: THRU mode must be OFF before any autoconfigure is attempted. Failure to do so will result in the status message "No autosetup in THRU mode" being displayed on the screen.

For each of the autoconfigurable fields, the choices are tried in a predetermined order:

LINE CODE	B8ZS, AMI
FRAMING	ESF, D4, SLC-96, Unframed
(T1) PATTERN	QRSS, 2^20-1, 2^15-1, 2^23-1, 3 in 24, All Ones, All Zeros, 1 in 8, 1 in 2, 53, 54, 55, 72, 96, 120 Octet, 55 Octet, User Word, Long User Word
(DDS) PATTERN	PRBS 2047, PRBS 511, All Ones, All Zeros, User Word, DDS Stress
(DS0) CLOCKS	Bit & Byte, Composite
DS0 INTERFACE	Bipolar, Logic Near, Logic Far

Data Logging

Logging to external printer

External printer data logging provides output of results and instrument control settings via the RS-232 serial port. The recommended printer is an HP Thinkjet. A selectable printer type supports other common printers e.g. Epson and Seiko.

Data logging printouts are produced by pressing (PRINT NOW) or automatically when a preselected trigger occurs.

PRINT NOW Key. Pressing (PRINT NOW) prints out a full list of current instrument settings or a time stamped results snapshot.

Auto Triggered Prints

The following type of printout is only valid during tests. See the section under GENERAL - RUN ALWAYS OPERATION for details of how this field choice operates with instrument test periods.

Off:	No automatic printing is performed.
Event Results:	At the start of testing, a short settings summary, followed by a table header for events, will be printed for column fashion event information if any of the following criteria are met in the preceding second. 1. Errors occurred on any valid basic error type. 2. An alarm change occurred. 3. A DDS control code was detected.
Every 15 Minutes & Every 2 Hours:	At the start of testing, a short settings summary followed by a results summary every 15 minutes or 2 hours will be printed. The format of the results is identical to that of the results snapshot.
End of Test:	At the start of testing, a short settings summary will be printed, followed by a results summary at the end of the test. There will be no end of test summary if the test is restarted via a change to a field which causes a restart.

Messages Only:	At the start of testing, a short settings summary will be printed, followed by messages for changes of state for each major alarm condition shown below.

- Signal Loss
- AIS (All Ones)
- T1 Frame Loss
- Pattern Loss
- Power Loss

Squelch Control

If the SQUELCH selection is OFF, then no control is applied to the output and any existing squelch is revoked. If the selection is ON, then a control is applied to the output in the case of EVENTS RESULTS, and all major alarm conditions.

If events or major alarms are printed for ten consecutive seconds and the squelch is ON, then the print output will stop and a squelch message will be printed. If two consecutive error free seconds occur, then the print output is re-enabled and an unsquelch message is printed.

Printer and Remote Control Port

This dual purpose port is a full duplex RS-232 serial interface configured as a DCE. Direct connection may be made to DTEs, such as printers and terminals. An adaptor (crossover) cable is required for connection to modems, or other DCEs. The port can be assigned either to printing or remote control, but not both together.

Printer output

Baud rate:	300, 600, 1200, 1800, 2400, 4800, 9600
Data bits:	8
Parity:	None
Stop bits:	1 or 2

HP Printer Type.

Pacing: Off, ENQ/ACK, Xon/Xoff or DTR

Alternate Printer Type.

Print Style Normal (80 columns on 80 column printer)
Compress (80 columns on 40 column printer)

Pacing: DTR

Remote control

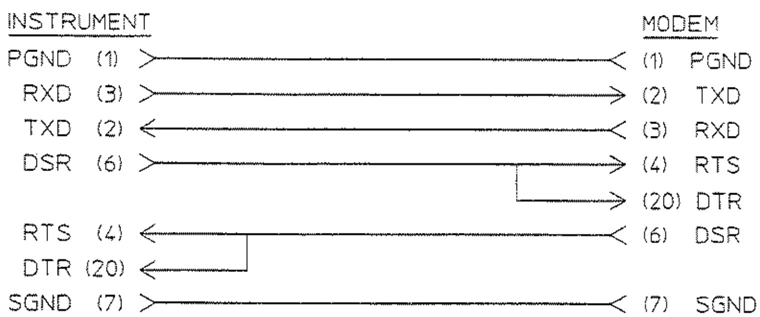
Baud rate: 300, 600, 1200, 1800, 2400, 4800, 9600
Data bits: 7
Parity: ODD, EVEN, ZEROS, ONES
Stop bits: 1 or 2
Pacing: ENQ/ACK, Xon/Xoff (Rx only, Tx only or Rx & Tx) or DTR (Tx only)

In addition to Xon/Xoff and ENQ/ACK character handshake flow control, the instrument can provide a COMMAND PROMPT to facilitate remote control via a "dumb" terminal. When this feature is in use, the remote control device waits after sending a command until a string is returned by the instrument to signify that it is ready to accept a new command.

RS-232 connector configuration

Pin	Mnemonic	Description
1	PGND	Connected to chassis ground
2	TXD	Instrument data input
3	RXD	Instrument data output
4	RTS	Internally connected to CTS in the instrument
5	CTS	Internally connected to RTS in the instrument
6	DSR	Set "ON" by instrument when powered
7	SGND	Signal ground
8	DCD	Set "ON" by instrument when powered
20	DTR	When DTR transmit pacing is selected, data output from the instrument is inhibited if DTR is held "OFF" by receiving device.

Modem operation. Remote control via a modem link requires a pair of full duplex modems. Connection between the instrument and the modem should be by means of a cable configured as shown below:



General

Size: 340mm (13.4in) wide, 190mm (7.5in) high, 275mm (10.8in) deep (including front panel cover).
Weight: 5.5kg (12.1lbs). Datacom module (option 002) adds 0.6kg (1.3lbs).

Operating temperature: 0 to +50C
Storage temperature: −40 to +70C

AC Supply: 85-265V 47-66Hz, continuous input voltage selection.

Power consumption:	30VA
LpA < 70 dB	LpA < 70 dB
operator position	am Arbeitsplatz
normal operation	Normaler Betrieb
per ISO 7779	nach DIN 45635 T. 19

Time-of-day Clock

Stability: ± 0.01 % (nominal)

Instrument settings storage

All settings and results are saved in protected memory when the instrument is switched off. In addition, the user can store up to five complete setups, with names, and recall them.

Connectors

Tx/Rx - bantam jacks, 310 jacks and DB15 connector, all in parallel
Slip reference - bantam jack and 310 jack in parallel
VF input - 310 jack
VF output - 310 jack
RS-232 printer output/remote control - DB25 connector
DS0 Tx/Rx - bantam jacks
DS0 bit and byte clocks - 9-pin D type
X.21 leased digital signal, drop and insert - 15-pin D type

Options

Option 001 Pulse Shape and Clock Slips and Wander Measurements

Pulse Shape Measurements. Pulse Width, Rise Time, Fall Time, Overshoot, Undershoot, Level(dBdsx), Mask pass/fail, pulse shape display

Range:	+6 to −26dBdsx (nominal)
Measurement time:	11 seconds (nominal)

The following four items are specified for DSX-1 pulses within ± 3dB of 0dBdsx, specifications are nominal for other signals.

Pulse width range:	200-500ns, accuracy:± 20ns (nominal)
Rise time resolution:	1ns (nominal)
Fall time resolution:	1ns (nominal)

Overshoot/undershoot resolution: 1% (nominal)

Pulse Masks: Pub 62411, ANSI T1.403, CB 119 (Old equipment), ANSI T1.102/CB 119 (New equipment), G.703/7790-B

The measured pulse is automatically fitted to the selected mask. For signal levels within ± 3dBdsx (nominal), pass/fail is indicated. Positive and negative pulses are displayed alternately. On a random data signal, pulses which are preceded and followed by at least 3 zeros are used to compute measurements. If this criterion cannot be met, pulses which are preceded and followed by at least 1 zero will be used. If neither of these criteria can be met, any pulse will be used and a message "insufficient zeros, pulse truncated" will be displayed to the user. Under these conditions, the pulse trace is reduced to 600ns.

Pulse measurement incorporates a trigger on which the display is frozen. The trigger conditions are: disabled, fails mask, meets mask, isolated pulse, truncated pulse or any pulse.

Pulse storage: There are 5 pulse stores with names, which store pulse pairs (positive and negative) for later display or print. Pulse stores are protected by a "lock".

Clock Slips Measurements. Estimated Bit Slips, Estimated Frame Slips, Positive Peak Wander, Negative Peak Wander, Peak to Peak Wander, Time Interval Error, 15 Minute Wander, 24 Hour Wander

Timing Reference DSX Input.

Rate:	1.544 Mb/s ± 130 ppm
Pulse Shape:	DSX-1 compatible as per ANSI Std T1.102-1987 There is an indication if no reference signal is present.
Input Impedance:	100 ohms (nominal)
Dynamic Range:	+6dB to −30dB relative to DSX-1 level (nominal)

Wander Measurement.

Bandwidth:	Low pass response −3dB at 10Hz (nominal)
Resolution:	0.125 UI
Accuracy:	± 0.125 UI ± 0.5% of reading, for wander frequency up to 1Hz
Range:	± 99999 UI

Also displayed in real time graphical form.

Option 002 Datacom accessory

The specifications for the datacomm accessory are given in a separate operating manual.

Option 004 DS0B testing

Testing of DS0B to TR-TSY-000439 - see DDS specification on pages 7-40 to 7-47 for more information.

Option H02 HP-IB Remote Control

See Chapter 10.

8

Installation

Introduction

This section provides installation instructions for the Hewlett-Packard Model 37702A Digital Data Tester and its accessories. This section also includes information about initial inspection, preparation for use, packaging, storage and shipment.

Initial Inspection

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 and so on).**

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 Chapter 5 of this manual. If the contents are incomplete, if there is mechanical damage or defect or if the T1 Tester 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 carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection. The HP office will arrange for repair or replacement at HP option without waiting for claim settlement.

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 (95 to 240 V ac) ±10%, 47 to 66 Hz single phase. The power consumption is less than 30 VA.

Line Fuses

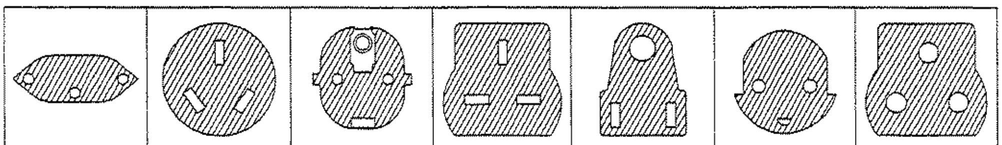
The line fuses are located in a compartment on the side panel above the line power input connector and line switch. The correct rating is 250V, 1 A Timed (HP 2110 - 0674).

Caution

Before connecting the instrument to a power outlet ensure that a fuse of the correct rating is fitted.

Power Cable

This instrument is equipped with a three-wire power cable. When connected to a properly grounded power outlet, this cable grounds the instrument case. The type of power cable supplied with each instrument depends on the country of destination. Refer to the following figure for the part numbers of the power cables and plug configurations available. The number shown below each plug is the Hewlett-Packard part number of a power cable equipped with that plug. If the appropriate power cable is not included with the instrument, notify the nearest Hewlett-Packard Sales and Service Office and a replacement will be provided.



8120-2104	8120-1369	8120-1689	8120-1351	8120-1378 US 8120-4753 JAP	8120-2956	8120-4211

The color code used in each power cable is given below:

Line	Brown
Neutral	Blue
Ground	Green/yellow

Mating Connectors

Connectors which mate with the Digital Data Tester connectors are listed in the following table.

Tester Port	Connector type	Mating Connector Part Number
T1 TRANSMIT	WECO 310	HP 1251-0695
T1 TRANSMIT	BANTAM	HP 1251-3060
T1 RECEIVE	WECO 310	HP 1251-0695
T1 RECEIVE	BANTAM	HP 1251-3060
TIMING REF DS1 INPUT	WECO 310	HP 1251-0695
TIMING REF DS1 INPUT	BANTAM	HP 1251-3060
T1 TRANSMIT/RECEIVE	15 WAY D	HP 1251-5503
VF OUTPUT	WECO 310	HP 1251-0695
VF INPUT	WECO 310	HP 1251-0695
DROP & INSERT	15 WAY D	HP 1251-5503
DS0 RECEIVE	BANTAM	HP 1251-3060
DS0 TRANSMIT	BANTAM	HP 1251-3060
DS0 CLOCKS	9 WAY D	HP 1251-0216
COMPOSITE CLOCK	WECO 310	HP 1251-0695
LOCAL LOOP	15 WAY D	HP 1251-5503
RS-232	25 W D SUBMIN	HP 1251-0063 (plug) HP 1251-1438 (hood)

T1 and DDS Tester Selection When Using the HP 15901A DATACOM accessory

If the Tester has the Datacom test accessory in the lid, set the Datacom module TEST SELECT to T1.

ACCESSORY Port - for Datacom Module Connection

Caution The Datacom-lid cable must only be connected or disconnected with the instrument powered down.

DROP & INSERT port - for Protocol Analyzer connection

To use the instrument as an interface for a protocol analyzer, use this port and select PATTERN EXTERNAL. Loop timing is normally required for drop and insert applications.

The pin assignments of the drop and insert connector are:

PIN A, B	FUNCTION
6, 13	Common clock
4, 11	Receive data (data dropped by instrument)
2, 9	Transmit data (data inserted by instrument)
5, 12	Indication (data drop control)
3, 10	Control (data insert control)
8	Ground
1	Shield
7, 14, 15	not connected

VF INPUT and VF OUTPUT ports - for TIMS connection

To use the instrument as an interface for a TIMS tester, use this port and select AUX VF ACCESS, AUDIO MONITOR ON.

DS0 ports

DS0 bit and byte clock connection is via the D shell connector in the DS0 section of the side panel. Composite clock connection uses the WECO 310 Composite clock connector on the side panel.

The pin assignments of the 9 pin CLOCKS connector are:

PIN	SIGNAL
1	D0-5V
2	DIGITAL GROUND
3	BIT CLOCK
4	BYTE CLOCK
5	GROUND
6	BYTE CLOCK POSITIVE
7	BYTE CLOCK NEGATIVE
8	BIT CLOCK POSITIVE
9	BIT CLOCK NEGATIVE

A cable for 5 pin DIN interface should have the following connections:

9 PIN D	5 PIN DIN
5	1
6	2
7	3
8	4
9	5

A cable for 9 pin D interface should have the following connections:

9 PIN D	9 PIN D
1	1
2	2
3	3
4	4
5	5

T1 TRANSMIT/RECEIVE Port (D-shell)

The 15 pin front panel D-shell port connections are:

1/9	Transmit output
3/11	Receive input
13	ground

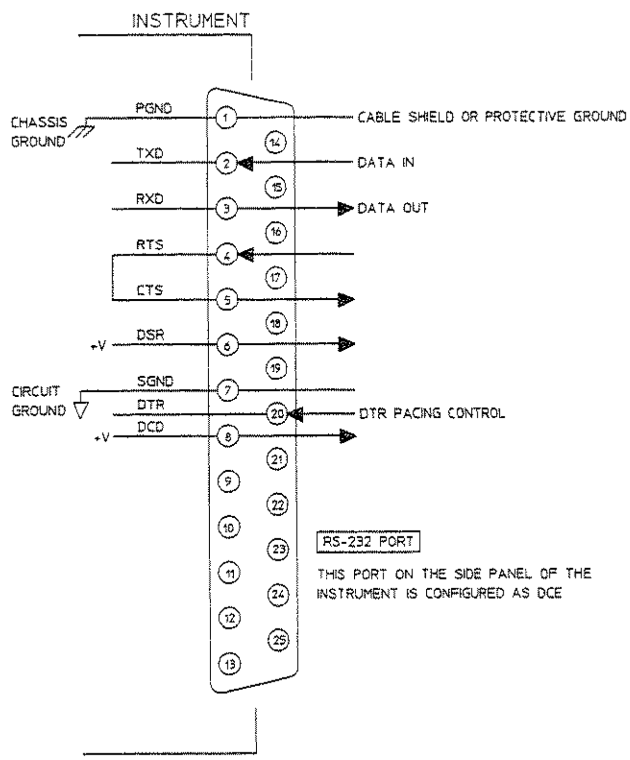
RS-232 Port - for Printer or Remote Control Connection

Caution This port is located on the side panel of the main instrument and is NOT to be confused with the RS-232/V.24 port on the Datacom accessory in the lid.

This port is a full duplex RS-232 serial interface configured as Data Communications Equipment (DCE). This port can be connected directly to printers, dumb terminals and controllers which are configured as Data Terminal Equipment (DTE).

Using an adaptor cable (see page xx), this port can also be connected to modems and other devices which are configured as DCE.

The *RS-232* connector pinout configuration and signal flow are shown in the following diagram:

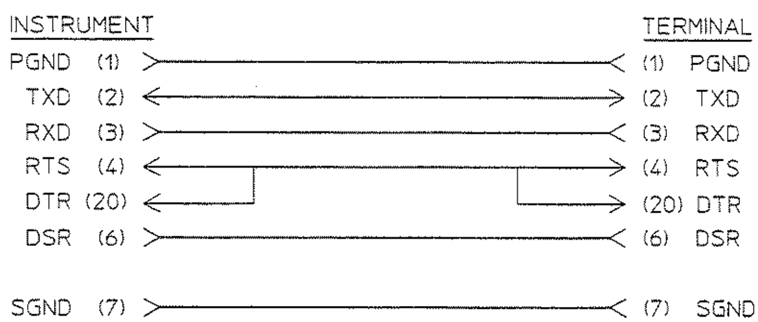


The *RS-232* port can only transmit or receive asynchronous data, any device connected to it must be set for asynchronous operation. The character formats for Printer and Remote Control are as follows:

	Printer Operation	Remote Control
Baud Rate	300, 600, 1200, 1800, 2400, 4800 or 9600	
Data Bits	8	7
Parity	None	Odd, Even, Zeros, Ones
Stop Bits	1 or 2	
Pacing	ENQ/ACK, Xon/Xoff or DTR	

To Connect for Direct Operation

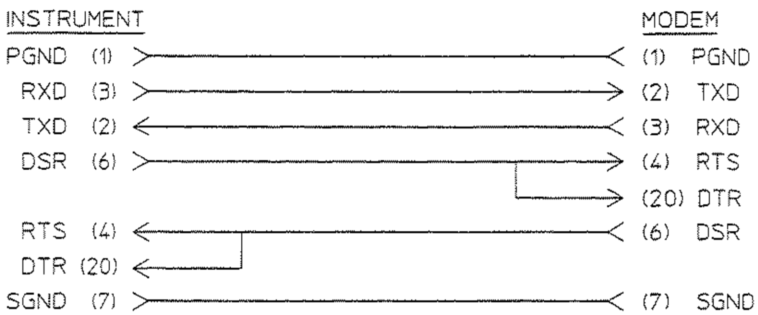
The connections of a cable suitable for direct connection to a printer or controller are shown in the following figure.



For more details on Printer operation and Remote Control, see chapters 5 Preparing to print, chapter 6 Printing Results and chapter 10 Remote Control.

Modem Connection

Only a full duplex modem may be used. The cable connecting the *RS-232* port to the modem should be configured as follows:



Rack Mounting

The general purpose rack mount kit, HP part number 37701-60050, comprises the following parts:

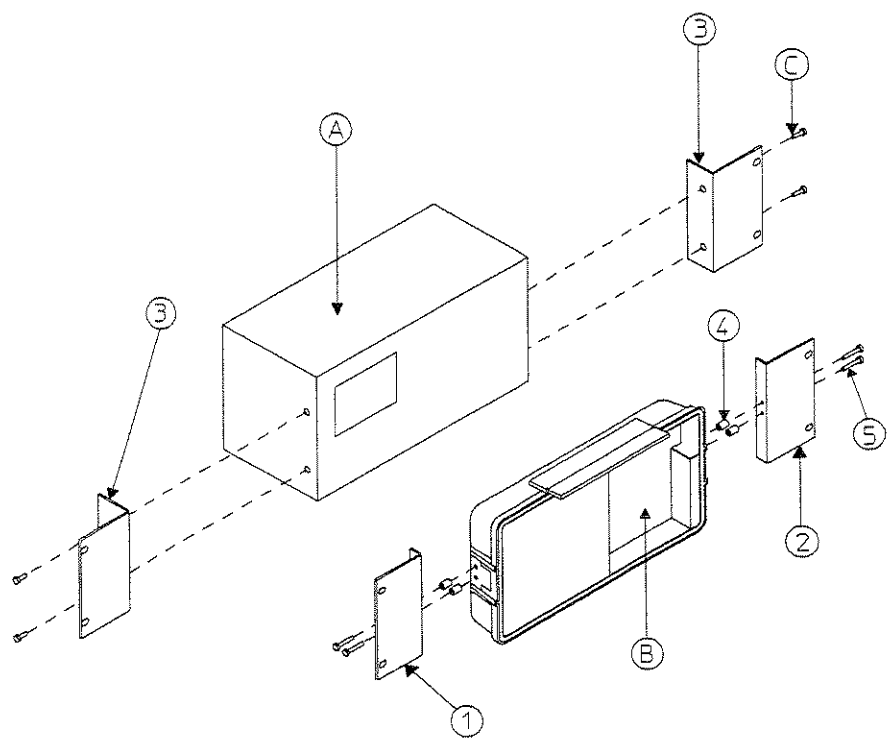
Main instrument
  Two brackets HP part number 37701-00048.
Accessory lid
  Two brackets HP part number 37701-00049.
  Four screws
  Four spacers

To fit the rack mount kit:

Main instrument
  Remove the front corner "feet", 12 screws (C).
  Fit the rack mount brackets over the fixed part of the protective front cover retaining catch.
  Fix the brackets to the instrument with 4 of the original screws (C)

  NOTE : the screws have fine threads. Care should be taken not to overtighten the screws during replacement as the threads in the casting could be damaged.
  If there is no accessory lid, discard the surplus kit parts.
Accessory lid
  Remove the 4 screws from beneath the latch catch and remove the assembly from the plastic cover,

Remove the latch catches by removing the nuts and washers on the inside of the plastic cover.
Refit the assembly inside the plastic cover.
Place the brackets, items (1) and (2) in position and fix using screws (5) and spacers (4) supplied.



Rack Mount Kit HP Part No.37701-60050

Operating Environment

Temperature	The instrument may be operated in temperatures from 0 degrees centigrade to +50 degrees centigrade. The temperature for battery operation is 0 degrees centigrade to +40 degrees centigrade.
Humidity	The instrument may be operated in environments with humidity up to 95% at 40 degrees centigrade. 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 4,600m (15,000 ft).
Air Flow	To provide adequate cooling, an air gap of approximately 3-inches should be maintained around the instrument.

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 without a battery and −20 degrees centigrade to +55 degrees centigrade with a battery.
Humidity	90%
Altitude	15,300m (50,000 ft)

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 (if you have one) or give details on a label then attach the tag or label 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 re-packing with commercially available materials:

a. Wrap 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 strong shipping container. A double-walled carton of 35-pound test material is adequate.

c. Use a layer of shock absorbing material 70 to 100 mm (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 the front cover provided or with cardboard.

d. Seal shipping container securely.

e. Mark the shipping container clearly.

f. In any correspondence, refer to instrument by model number and full serial number.

9

Digital Data Tester Performance Tests

Introduction

This chapter contains procedures which test the HP 37702A electrical performance to the specifications in Chapter 7.

There are two levels of performance testing contained in this chapter:

Operational Verification	Provides >90% confidence that the instrument is operating to its full warranted specification.
Full Performance Test	Ensures that the instrument is operating to its full warranted specification.

Results of the Performance Test may be recorded on the Test Record at the end of this chapter, or on the Abbreviated Test Record at the end of the Operational Verification procedures.

Calibration Cycle

Results recorded on the Test Record at incoming inspection can be used for comparison in yearly maintenance and calibration or after repairs or adjustments.

Recommended Test Equipment

The test equipment required is listed in the following table. Equipment which meets or exceeds the critical specifications may be substituted for the recommended model.

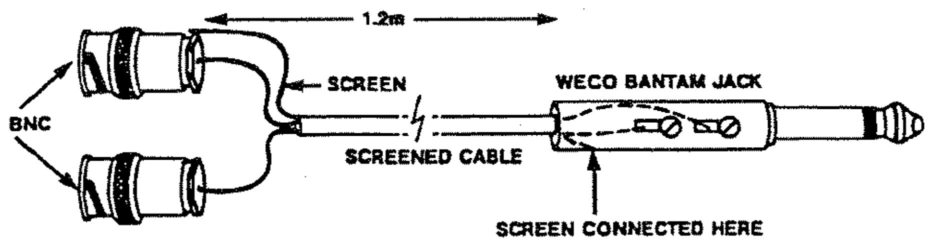
Recommended Test Equipment

Instrument	Critical Specification	Recommended Model
Frequency Counter	0.00015% accuracy up to 1.544 MHz; Trigger Level O/P available	HP 5316B OPT 001
DC Voltmeter	1% accuracy	HP 3456A
AC Voltmeter	2% accuracy at 772 kHz	HP 3458A
Synthesizer / Function Generator (2 off)	50 Ω unbalanced output. Sinewave frequency range 772 kHz ± 110Hz; Level range 23dBm to −20dBm	HP 3325B
Oscilloscope	100 MHz bandwidth; Dual I/P 50 Ω and 1 MΩ	HP 54201A/D
DC Power Supply	Variable DC supply voltage up to 20 V	HP 6205B
Impedance Converter	110 Ωbalanced (nominal) to 75 Ω unbalanced (nominal)	HP 15508B
WECO 310 to WECO 310 cable	Unique	HP 15513A
Bantam to bantam cable	Unique	HP 15670A
WECO 310 to BNC adapter (3 off)	Unique	HP 1251-3757
75 Ω Termination	75 Ω ±1%	HP 15522-80010

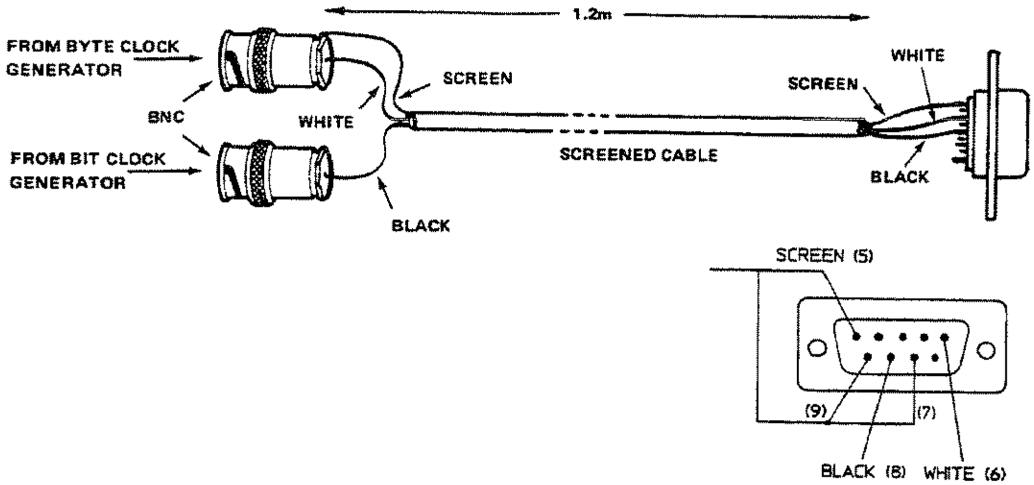
Recommended Test Equipment (continued)

Instrument	Critical Specification	Recommended Model
15 way connector	15 way D-shell connector male	HP 1251-5503
RS-232 Loopback connector	Unique	HP 5060-4462
Dual BNC to WECO 310 cable	see figure below	
Resistor	100 Ω ± 1%	HP 0757-0178
Resistor	33 Ω ± 1%; 5W	HP 0811-0563
Function Generator	Frequency - 8kHz, rectangular waveform, 5V pk-pk o/p into 50 Ω	HP 3314A
Dual BNC to 9 pin D-Shell (Bipolar)	see figure below	
Dual BNC to 9 pin D-Shell (Unipolar)	see figure below	

Dual BNC to Weco Bantam Cable

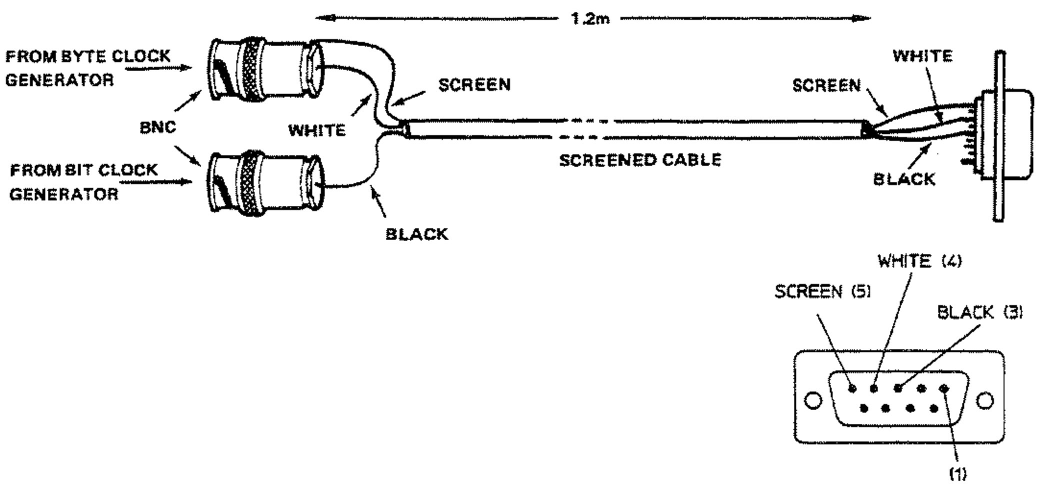


Description	QTY	HP Part Number
BNC Connector (male)	2	1250-1448
Weco Bantam Jack	1	1251-3060
Screened Cable (1.2m length)	-	8120-2272



Dual BNC to 9 pin D-Shell bipolar cable

Description	QTY	HP Part Number
BNC Connector (male)	2	1250-1448
9-pin D-Shell Plug	1	1251-0216
Hood for D-Shell	1	1251-1551
Screened Cable (1.2m length)	-	8120-2272



Dual BNC to 9 pin D-Shell unipolar cable

Description	QTY	HP Part Number
BNC Connector (male)	2	1250-1448
9-pin D-Shell Plug	1	1251-0216
Hood for D-Shell	1	1251-1551
Screened Cable (1.2m length)	-	8120-2272

Operational Verification

The Operational Verification tests quickly establish with >90% confidence that the instrument meets the specifications listed in Chapter 7. If any test fails to meet specification, refer to the Adjustments in the Service Manual. If after adjustment the specification still cannot be met, refer to the troubleshooting in the Service Manual.

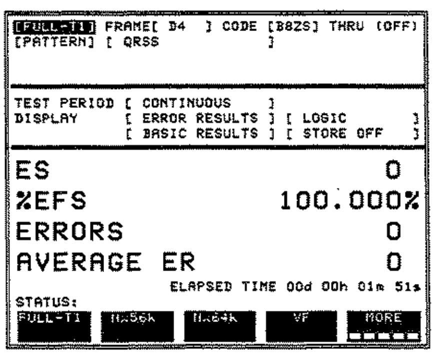
Default Settings

Description

The instrument default settings are factory preset and will be called to reconfigure the instrument when the following procedure is performed. The table below lists the default settings.

Procedure

1. Press (AUX).
2. Press the STORED SETTINGS softkey.
3. Select STORED SETTING NUMBER and press 0 0, is the default. Use (⇧) and (⇩) to highlight this field.
4. Select ACTION (again using the (⇧) and (⇩) keys) and press RECALL.
5. Press (CONFIG) to show the results display.



Digital Data Tester Self Test

Description

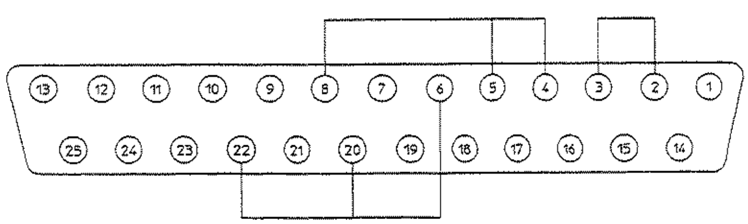
These tests give a high degree of confidence that the HP 37702A is operating to it's warranted specification. A description of each test is given on page 9-8. Loops are required for the RS-232 port check, the X.21, DROP & INSERT port check, the DS0 TRANSMIT and RECEIVE port, the T1 TRANSMIT WECO 310, T1 RECEIVE WECO 310, and the VF port checks. The remaining front panel T1 (bantam and D-Shell) ports are checked individually by looping each in turn.

Equipment

RS-232 Loopback Connector	:	HP 5060-4462
15 Way Connector	:	HP 1251-5503

Procedure

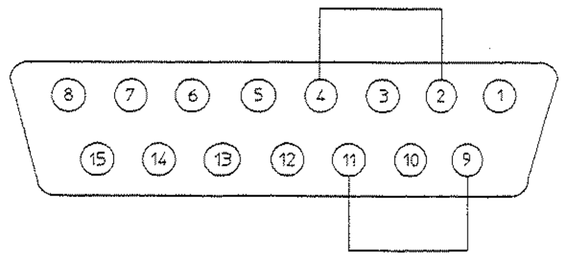
1. Connect the HP 37702A TRANSMIT WECO 310 output to the RECEIVE WECO 310 input (front panel).
2. Connect the RS-232 loopback connector to the RS-232 port (side of the instrument). Alternatively use wire links to either modify an RS-232 connector or connect across the RS-232 port as shown below.



RS-232 Connections

3. Take the 15 way Connector and use wire links to connect pins 2 to 4 and pins 9 to 11 (see figure below). Connect the modified 15 way connector to

the side panel DROP & INSERT PORT, D- Shell connector. The links give the loopback required for the X.21 self test.

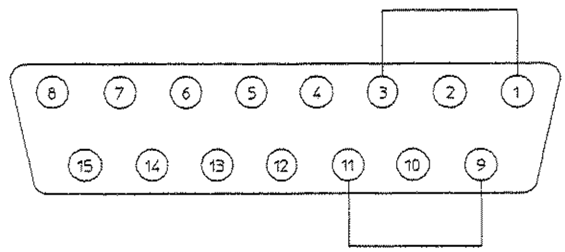


X.21 Drop and Insert Test Loops on the Pin-out Side of HP 1251-5503.

4. Connect the 37702A VF OUTPUT (front panel) to the VF INPUT (side panel).
5. Connect the DS0 TRANSMIT (side panel) to the DS0 RECEIVE (side panel).
6. Press HP 37702A (AUX), select SELF TEST (use MORE to bring up the SELF TEST field) and set the TEST TYPE for ALL TESTS.
7. Press HP 37702A (RESTART) and verify that "TEST STATUS PASSED" is displayed at the end of ALL TESTS, approximately 18 minutes.
8. Disconnect the HP 37702A TRANSMIT WECO 310 output from the RECEIVE WECO 310 input.
9. Connect the TRANSMIT Bantam output to the RECEIVE Bantam input (front panel).
10. Set the TEST TYPE for DS1 I/F TESTS (use the ⇧ and ⇩ keys to bring up the DS1 I/F TESTS field).
11. Press HP 37702A (RESTART) and verify that "TEST STATUS PASSED" is displayed at the end of the test.
12. Disconnect the HP 37702A TRANSMIT Bantam output from the RECEIVE Bantam input.

Digital Data Tester Self Test

13. Remove the loopback connector from the side panel DROP & INSERT port. Change the links to loop pins 1 to 3 and 9 to 11 as shown below. Connect the modified 15 way connector to the TRANSMIT/RECEIVE D-Shell connector (front panel). The loops give the loopback required for the front panel T1 TRANSMIT/RECEIVE port test.



T1 Transmit/Receive Test Loops on the Pin-out Side of HP 1251-5503.

14. Press (RESTART) and verify that "TEST STATUS PASSED" is displayed at the end of the test.

Note If a self test fails, each test can be run individually to discover the extent of the instrument malfunction. Refer to the service manual Troubleshooting to find out how to correct this failure.

Digital Data Tester Self Tests, Order and Fail Codes

When ALL TESTS is selected the individual tests (1 to 14)are performed in the order shown in the following table. Test 1 is a general test of the Control Processor Unit (CPU). Tests 2 to 14 use a comparison of measured results and expected results. The measurements are made on signals which are externally looped back from transmitter to receiver. If a test failure occurs, the failure code displayed indicates the part of the individual test which has failed. The test which failed is indicated by the group of failure codes shown in the following table. A more detailed list of fail codes is given with the remote control information in chapter 10.

Fail Code Group	Test	Test Number
1 to 99	CPU	1
100 to 299	DS1 I/F Test	2
300 to 399	DS1 Err Test	3
400 to 499	Level Measurement	4
500 to 599	Clock Recovery	5
600 to 699	Pulse Shape	6
700 to 799	Round Trip Delay	7
800 to 899	Slips	8
900 to 999	OOF and SEF	9
1000 to 1099	Sig Bits	10
1100 to 1199	T1 DDS Test	11
1200 to 1299	DS0 I/F Test	12
1300 to 1399	VF Test	13
1400 to 1499	X.21 Test	14

Auto Configure

Specifications

Framing, line code and pattern are automatically determined.

Description

The HP 37702A's ability to generate an Unframed, All Ones alarm is used to verify that the receiver will auto configure onto the incoming data.

Equipment

None

Procedure

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Connect the HP 37702A TRANSMIT output to the RECEIVE input.
3. Press HP 37702A AUX, select T1 ALARMS & LOOPING and set the T1 ALARM GENERATION for ALL ONES. The status line will flash the message "Generating ais alarm (see AUX)".
4. Press HP 37702A FRAME. Note that the display shows the FRAME set for D4, the CODE set for B8ZS and the PATTERN set for QRSS. Also, the T1 RECEIVE STATUS leds should show SIGNAL PRESENT, ALL ONES, FRAME LOSS, PATTERN LOSS and ERRORS all ON (the HISTORY led may also be on due to previous signal conditions).
5. Press AUTO/RESTART and, when auto set-up has been completed, verify that the display now shows the FRAME set for UNFRM, the CODE set for AMI and the PATTERN set for ALL ONES.

   The T1 RECEIVE STATUS leds should now show SIGNAL PRESENT, PATTERN SYNC and ALL ONES all ON (History may also be on).

Pulse Mask (Option 001)

Specifications

Pulse Masks ANSI T1.403. The measured pulse is automatically fitted to the selected mask. For signal levels within ± 3dBdsx (nominal), pass/fail is indicated. Positive and negative pulses are displayed alternately.

Description

This test verifies the Pulse Mask measurement by connecting the HP 37702A TRANSMIT to RECEIVE and verifying that an isolated pulse from the received data meets the mask called up.

Equipment

None

Procedure

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Connect the HP 37702A TRANSMIT output to the RECEIVE input.
3. Press HP 37702A (FRAME) and select UNFRAMED.
4. Press HP 37702A (PATTERN), use MORE to display the 1 in 8 field and select 1 IN 8.
5. Wait 15 seconds. Press HP 37702A (AUX) and select PULSE SHAPE.
6. Select ACTION (use (⇧) and (⇩)) and press MEASURE.
7. Ensure that both the positive and negative pulses displayed are within the mask shown and that T1.403 PASS is displayed adjacent to the mask (note: the display will alternate between positive and negative pulses continually).

Recovered Loop Timing

Specifications

Transmitter timing: The transmitter can be timed from the clock recovered at the receiver (loop timed)

Description

This test verifies that the transmitter output data rate can be timed by the received data rate.

Equipment

Synthesizer	: HP 3325B
Frequency Counter	: HP 5316B Option 001
WECO 310 to BNC Adapter	: HP 1251-3757
Balanced to Unbalanced Converter	: HP 15508B
75 Ohm Termination	: HP 15522-80010
T Connector	

Procedure

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Set the Synthesizer to generate a 772.110 KHz sinewave, 500mV pk-pk, a.c. coupled signal.
3. Connect the Synthesizer SIGNAL output to the HP 37702A RECEIVE input using the WECO 310 to BNC Adapter. Connect the HP 37702A TRANSMIT output to the Frequency Counter via the Balanced to Unbalanced Converter terminated in the 75 Ohm Termination (T Connector required).
4. Press HP 37702A [FRAME] and select UNFRAMED.
5. Press HP 37702A [CODE] and select AMI.
6. Press HP 37702A [PATTERN] and select ALL ONES.

7. Set the HP 37702A *T1 INTERFACE* TRANSMIT TIMING to RECOVD (LOOP).
8. Verify that the Frequency Counter tracks the received Synthesizer frequency - 772.11 KHz (Set the Frequency Counter to trigger on positive transitions and adjust the trigger level for a reading. If the Frequency Counter reads incorrectly, adjust the Frequency Counter trigger level for a reading of 1.1 volts at the trigger level output - use a DC Voltmeter to measure this).
9. Adjust the Synthesizer to generate a 771.890 KHz signal and verify that the Frequency Counter tracks the received Synthesizer frequency - 771.89 KHz.

Internal Transmitter Clock

Specifications

Internal Tx Clock

Frequency:	1.544 MHz
Stability:	±5 ppm 0 to 40°C (nominal)
	±10 ppm 0 to 50°C
Ageing:	±2 ppm per year typical

Description

This test verifies that the Internal Transmitter Clock frequency is within 12PPM with the provision that the instrument has been through it's yearly calibration cycle.

Equipment

Frequency Counter	: HP 5316B Option 001
Balanced to Unbalanced Converter	: HP 15508B
75 Ohm Termination	: HP 15522-80010
T Connector	

Procedure

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Connect the HP 37702A TRANSMIT port to the Frequency Counter via the Balanced to Unbalanced Converter. Terminate the Frequency Counter input in 75 Ohms (use the T Connector).
3. Press HP 37702A (FRAME) and select UNFRAMED.
4. Press HP 37702A (PATTERN) and select ALL ONES.
5. Ensure that the Frequency Counter reads between 772,009.3Hz and 771,990.7Hz.

Alarm Leds (red)

This is a functional test of the Alarm leds

Equipment

None

Procedure

1. Connect the HP 37702A T1 TRANSMIT output to the T1 RECEIVE input.
2. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
3. If either the POWER LOSS led or the HISTORY led in the RECEIVE STATUS area of the front panel is on, then press (RESET HISTORY).
4. The following *RECEIVE STATUS* leds should be on: SIGNAL PRESENT, FRAME SYNC, PATTERN SYNC and B8ZS.
5. Disconnect the Transmit port from the Receive port and ensure that the green leds are off and that the SIGNAL LOSS, FRAME LOSS, PATTERN LOSS, SLIP and HISTORY leds are on. The SLIP led depends on the timing of the signal path break and may not always come on.
6. Reconnect the Transmit port to the Receive port.
7. Press HP 37702A (AUX), select T1 ALARMS AND LOOPING and set the T1 ALARM GENERATION for All ONES.
8. Ensure that the ALL ONES, FRAME LOSS, PATTERN LOSS, ERRORS and HISTORY leds are on. SIGNAL PRESENT should be the only green led on.
9. Set the ALARM GENERATION to OFF.
10. Press HP 37702A (FRAME) and select UNFRAMED.
11. Press HP 37702A (CODE) and select AMI.
12. Press HP 37702A (PATTERN) and select USER PROGRAM. Set the USER PROGRAM for a 17 bit length (10000000000000000) and ensure that the

EXCESS ZEROS and ONES DENSITY leds are on. SIGNAL PRESENT and PATTERN SYNC are the only green leds on.

13. Decrease the USER WORD length to 16 bits and ensure that the EXCESS ZEROS led goes off while the ONES DENSITY led remains on. SIGNAL PRESENT and PATTERN SYNC are the only green leds on.
14. Decrease the USER WORD length to 9 bits, ensure that the ONES DENSITY led is on, then decrease the USER WORD length to 8 bits and ensure that the ONES DENSITY led goes off. SIGNAL PRESENT and PATTERN SYNC are the only green leds on.
15. Press HP 37702A (LOOP UP) and ensure that the LOOP UP led comes on for approximately 7 seconds (ignore other leds which momentarily flash on). SIGNAL PRESENT and PATTERN SYNC are the only green leds on.
16. Press HP 37702A (LOOP DOWN) and ensure that the LOOP DOWN led comes on for approximately 7 seconds (ignore other leds which momentarily flash on). SIGNAL PRESENT and PATTERN SYNC are the only green leds on.
17. Switch the instrument power off then on and ensure that the POWER LOSS led and the HISTORY leds are on. SIGNAL PRESENT and PATTERN SYNC are the only green leds on.
18. Press HP 37702A (RESTART) to clear the POWER LOSS led and the HISTORY led.
19. Disconnect the Transmit port from the Receive port then reconnect again. Ensure that the HISTORY led is on. Press (HISTORY/FREEZE) to view the results of disconnection (HISTORY LED flashes).
20. Press HP 37702A (RESET HISTORY). Ensure that the HISTORY led goes off and that when (HISTORY/FREEZE) is pressed, the only Red Led to come on is a flashing HISTORY led.
21. Press (RESET HISTORY) to disable the flashing HISTORY led.

Performance Tests

Digital Data Tester Self Test

Description

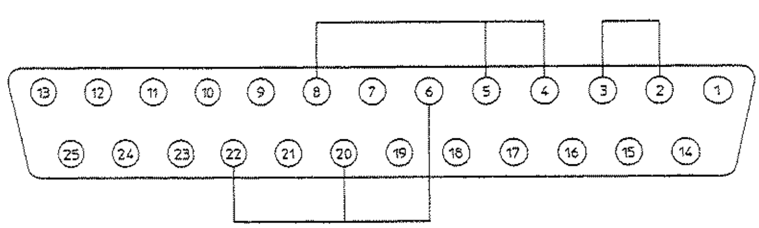
These tests give a high degree of confidence that the HP 37702A is operating to it's warranted specification. A description of each test is given on page 9-8. Loops are required for the RS-232 port check, the X.21, DROP & INSERT port check, the DS0 TRANSMIT and RECEIVE port, the T1 TRANSMIT WECO 310, T1 RECEIVE WECO 310, and the VF port checks. The remaining front panel T1 (bantam and D-Shell) ports are checked individually by looping each in turn.

Equipment

RS-232 Loopback Connector : HP 5060-4462
15 Way Connector : HP 1251-5503

Procedure

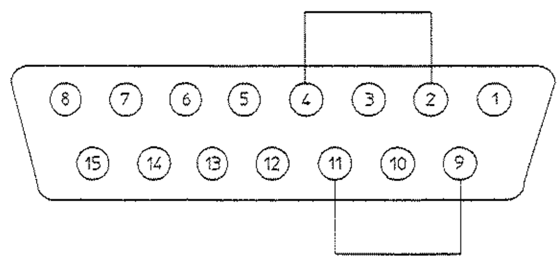
1. Connect the HP 37702A TRANSMIT WECO 310 output to the RECEIVE WECO 310 input (front panel).
2. Connect the RS-232 loopback connector to the RS-232 port (side of the instrument). Alternatively use wire links to either modify an RS-232 connector or connect across the RS-232 port as shown below.



RS-232 Connections

3. Take the 15 way Connector and use wire links to connect pins 2 to 4 and pins 9 to 11 (see figure below). Connect the modified 15 way connector to

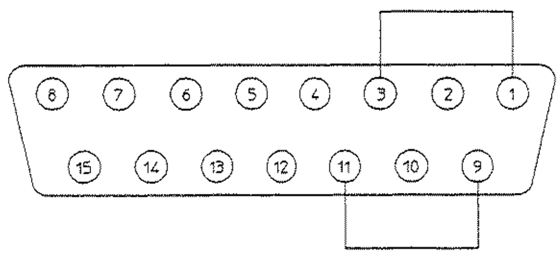
the side panel DROP & INSERT PORT, D- Shell connector. The links give the loopback required for the X.21 self test.



X.21 Drop and Insert Test Loops on the Pin-out Side of HP 1251-5503.

4. Connect the 37702A VF OUTPUT (front panel) to the VF INPUT (side panel).
5. Connect the DS0 TRANSMIT (side panel) to the DS0 RECEIVE (side panel).
6. Press HP 37702A (AUX), select SELF TEST (use MORE to bring up the SELF TEST field) and set the TEST TYPE for ALL TESTS.
7. Press HP 37702A (RESTART) and verify that "TEST STATUS PASSED" is displayed at the end of ALL TESTS, approximately 18 minutes.
8. Disconnect the HP 37702A TRANSMIT WECO 310 output from the RECEIVE WECO 310 input.
9. Connect the TRANSMIT Bantam output to the RECEIVE Bantam input (front panel).
10. Set the TEST TYPE for DS1 I/F TESTS (use the (⇧) and (⇩) keys to bring up the DS1 I/F TESTS field).
11. Press HP 37702A (RESTART) and verify that "TEST STATUS PASSED" is displayed at the end of the test.
12. Disconnect the HP 37702A TRANSMIT Bantam output from the RECEIVE Bantam input.

13. Remove the loopback connector from the side panel DROP & INSERT port. Change the links to loop pins 1 to 3 and 9 to 11 as shown below. Connect the modified 15 way connector to the TRANSMIT/RECEIVE D-Shell connector (front panel). The loops give the loopback required for the front panel T1 TRANSMIT/RECEIVE port test.



T1 Transmit/Receive Test Loops on the Pin-out Side of HP 1251-5503.

14. Press [RESTART] and verify that "TEST STATUS PASSED" is displayed at the end of the test.

Note

If a self test fails, each test can be run individually to discover the extent of the instrument malfunction. Refer to the service manual Troubleshooting to find out how to correct this failure.

Digital Data Tester Self Tests, Order and Fail Codes

When ALL TESTS is selected the individual tests (1 to 14)are performed in the order shown in the following table. Test 1 is a general test of the Control Processor Unit (CPU). Tests 2 to 14 use a comparison of measured results and expected results. The measurements are made on signals which are externally looped back from transmitter to receiver. If a test failure occurs, the failure code displayed indicates the part of the individual test which has failed. The test which failed is indicated by the group of failure codes shown in the following table. A more detailed list of fail codes is given with the remote control information in chapter 10.

Fail Code Group	Test	Test Number
1 to 99	CPU	1
100 to 299	DS1 I/F Test	2
300 to 399	DS1 Err Test	3
400 to 499	Level Measurement	4
500 to 599	Clock Recovery	5
600 to 699	Pulse Shape	6
700 to 799	Round Trip Delay	7
800 to 899	Slips	8
900 to 999	OOF and SEF	9
1000 to 1099	Sig Bits	10
1100 to 1199	T1 DDS Test	11
1200 to 1299	DS0 I/F Test	12
1300 to 1399	VF Test	13
1400 to 1499	X.21 Test	14

Internal Transmitter Clock

Specifications

Internal Tx Clock

Frequency:	1.544 MHz
Stability:	±5 ppm 0 to 40°C (nominal)
	±10 ppm 0 to 50°C
Ageing:	±2 ppm per year typical

Description

This test verifies that the Internal Transmitter Clock frequency is within 7PPM with the provision that the instrument has been through it's yearly calibration cycle.

Equipment

Frequency Counter	: HP 5316B Option 001
Balanced to Unbalanced Converter	: HP 15508B
75 Ohm Termination	: HP 15522-80010
T Connector	

Procedure

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Connect the HP 37702A TRANSMIT port to the Frequency Counter via the Balanced to Unbalanced Converter. Terminate the Frequency Counter input in 75 Ohms (use the T Connector).
3. Press HP 37702A [FRAME] and select UNFRAMED.
4. Press HP 37702A [PATTERN] and select ALL ONES.
5. Ensure that the Frequency Counter reads between 772,009.3Hz and 771,990.7Hz.

Transmitter Error Add

Specifications

Tx Error Add

Types:	Logic
Rates:	Selectable 10^-3, 10^-4, 10^-5, 10^-6 or 10^-7, or SINGLE

Description

The ability of the HP 37702A transmitter to generate various error rates is verified by inserting errors into a repeating AMI (0000) pattern and using a Frequency Counter to count the error rate. When errors are inserted, zeros become ones at a rate dependant on the error ratio. For example, if a 1544kb/s rate has errors inserted at 1E-3, then the positive and negative ones appear at a 1544 Hz (1544kb/s x 1E-3) rate.

Note In the following procedure the Frequency Counter triggers on the positive pulses therefore the reading on the counter will be at half the error rate (for the example above, 772Hz)

Equipment

Frequency Counter	: HP 5316B Option 001
Balanced to Unbalanced Converter	: HP 15508B
75 Ohm Termination	: HP 15522-80010
T Connector	

Procedure

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Connect the HP 37702A TRANSMIT output to the Frequency Counter input via the Balanced to Unbalanced Converter. Terminate the Frequency Counter in 75 Ohms (use the T Connector).
3. Press HP 37702A [FRAME] and select UNFRAMED.

4. Press HP 37702A (CODE) and select AMI.
5. Press HP 37702A (PATTERN) and select USER PROGRAM then set the USER PROGRAM LENGTH to 4 (0000).
6. Set the HP 37702A *TRANSMIT ERROR INSERT* (RATE) to 1E-3.
7. Verify that the Frequency Counter reads 772 Hz ± 0.0093 Hz (Set the Frequency Counter to trigger on positive transitions, and adjust for a reading. If the Frequency Counter reads incorrectly, adjust the Frequency Counter trigger level for a reading of 1.1 Volt at the trigger level output - use a DC Voltmeter to measure this).
8. Press HP 37702A (AUX) and select T1 ALARMS & LOOPING. Set the *TRANSMIT ERROR INSERT* (RATE) to USER PRGM. Use the (⇧) and (⇩) keys to select USER PROGRAM ERROR RATE.

   Select the rate using the softkeys and check the Frequency Counter reading is as shown in the table below (set the Frequency Counter attenuation to × 20). Note: Frequency Counter period mode could be used in this test.

Error Add Rate	Frequency Counter Reading
1E-3	772 Hz ± 0.0093 Hz
1E-4	77.2 Hz ± 0.00093 Hz
1E-5	7.72 Hz ± 0.000093 Hz
1E-6	772 x 10^3 Hz ± 0.0000093 Hz
1E-7	77.2 x 10^3 Hz ± 0.00000093 Hz

Error Add - Single

9. Set the HP 37702A *TRANSMIT ERROR INSERT* (RATE) to ERR FREE.
10. Set the Frequency Counter to TOT START (measures absolute count).
11. Press HP 37702A (SINGLE) 6 times to insert 6 errors.
12. Verify that the reading on the Frequency Counter is 3 counts (note: Single errors inserted are of opposite polarity therefore the Frequency Counter, being triggered on the positive pulses, reads only half the errors inserted).

Transmitter Output

Specifications

Output

Impedance:	100 ohm balanced (nominal)
Pulse Shape:	meets ANSI Standard T1.403-1989
Pulse Height:	±3V ±600mv (at the center)

Description

This test verifies the transmitter output level and pulse shape.

Equipment

Oscilloscope	: HP 54201A/D
Dual BNC to WECO 310 Cable	: see page 9-4

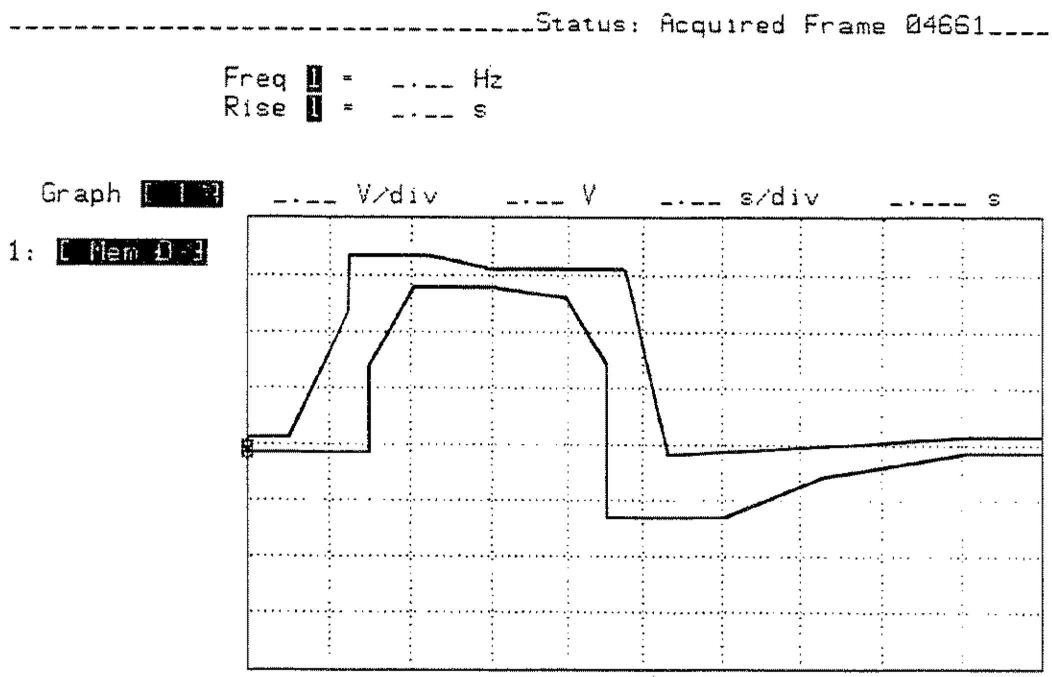
Procedure

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Connect the TRANSMIT output to the Oscilloscope channels 1 and 2 via the Dual BNC to WECO 310 Cable.
3. Press HP 37702A (FRAME) and select UNFRAMED.
4. Press HP 37702A (CODE) and select AMI.
5. Press HP 37702A (PATTERN) and select 1 IN 8.
6. Configure the Oscilloscope as follows, then display Channel 1-2

Transmitter Output

```
Status [Configuration] _________Status: Acquired Frame 00059____
                                Setup Label

Channel [ 1-2 ]-----------------------Timebase-------------------
        Inputs          Input 1-2   | Sampling @  200 MHz
 Range        4.0 V      8.0 V      | Mode        [ Trig'd   ]
 Offset       0.000 V    0.000 V    | Range        1.00 µs
 Probe       [ 1:1   ]  [ 1:1   ]   | Acquire     [Real Time ]
 Coupling    [dc ] [50 Ω] [dc ] [50 Ω] | Delay     -190.000 ns
 Store Mode  [Ave] [256 ] [Ave] [256 ] | Reference [   Left   ]
 Auto Scale  [ Disabled ] [ Disabled ] | Auto Scale [ Disabled ]
 Label

Trigger----------------------------------------------------------
                               * Refer to State Trigger Menus
 Mode [    Analog Only    ]      for Assignment and Sequence

 Analog Source [ Chan 1 ] [+ Slope ]   Auto Scale [ Disabled ]
        Level  [ Adjust ]  1.000 V     On Event   00001
        Probe  [  1:1   ]              Coupling   [dc ] [50 Ω]
```

7. Adjust the Oscilloscope Delay to position the positive peak pulse amplitude at mid-pulse-width point on the third division in from the left screen edge.
8. Measure the peak pulse amplitude at mid-pulse-width using the Oscilloscope and verify that this is between 2.4V and 3.6V.
9. Place the mask, shown in the following figure, over the Oscilloscope screen and adjust the Oscilloscope delay, gain and offset to ensure that the pulse can be brought within the mask (a transparent copy of the following figure should be used).



10. Adjust the Oscilloscope Delay to position the negative pulse at mid-pulse-width point on the third division in from the left screen edge then reset the Range (gain) to 1.00 V/div.
11. Repeat steps 8 and 9 for the negative pulse.

Recovered Clock Frequency Measurement

Specifications

Recovered Clock Frequency Measurement

Resolution:	1 Hz
Accuracy:	± 5ppm 0 to 40°C (nominal)
	± 10ppm 0 to 50°C
Ageing:	± 2ppm per year,typical

Description

This test verifies that the recovered clock frequency measurement capability is within 12 ppm with the provision that the instrument has been through its yearly calibration cycle.

Note

A Synthesizer is used to generate a signal at 772 Khz (half the data rate) which corresponds to a ternary all ones signal at the receiver input.

Equipment

Synthesizer	: HP 3325B
Frequency Counter	: HP 5316B Option 001
WECO 310 to BNC Adapter	: HP 1251-3757
T Connector	

Procedure

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Set the Synthesizer to generate a 772 KHz sinewave, 500mV pk-pk, a.c. coupled.
3. Equipment set-up: Place the T Connector on the Synthesizer SIGNAL output. Connect the Synthesizer to the HP 37702A RECEIVE input using

the WECO 310 to BNC Adapter. Also, connect the Synthesizer to the Frequency Counter.

4. Press HP 37702A (FRAME) and select UNFRAMED.
5. Press HP 37702A (PATTERN) and select ALL ONES.
6. Press HP 37702A (CODE) and select AMI.
7. Adjust the Synthesizer frequency to set it for 772000 Hz ± 0.75 Hz as read on the Frequency Counter.
8. Press HP 37702A (RESULTS) and select SIGNAL RESULTS.
9. Verify that the HP 37702A FREQUENCY displayed is between 1544019 MHz and 1543981 MHz.

Receiver Equalization, Gain and Level Measurement

Specifications

DSX-MON

For connection to protected monitor points. Automatic gain control (AGC) between 0 and +36dB compensates for the flat loss at these points.

Rate:	1.544 Mb/s ± 130 ppm
Input Impedance:	100 ohms nominal
Dynamic Range:	+6 to -30dB relative to DSX-1 level

BRIDGE

For use where the circuit is already terminated. Specification as TERMINATED, except input impedance is 1kohm (nominal).

TERMINATED

For terminating unprotected DSX-1 points or line terminations up to -36db. Frequency dependent gain is provided.

Input Impedance:	100 ohms nominal
Dynamic Range:	6V pk-pk to 95mV pk-pk or 0 to +36db equalization @ 772kHz

Description

This test verifies the receiver operation over the specified input level range and that the level measurement accuracy is met. A synthesizer is used to generate a signal at half the data rate which corresponds to a ternary all ones signal. Setting the level from 6.5dBdsx (23dBm) to -36.5dBdsx (-20dBm) relative to the nominal signal level allows us to verify Equalization in the receive TERM and BRIDGE mode and Automatic Gain in the receive DSX-MON mode. Level measurement accuracy is verified in the receive TERM mode. A mismatch between the synthesizer and HP 37702A impedance, allows us to generate the required levels into the HP 37702A.

Equipment

Synthesizer	: HP 3325B
AC Voltmeter	: HP 3458A
Resistor, 100 Ohms	: HP 0757-0178
WECO 310 to BNC Adapter	: HP 1251-3757
T Connector	

Procedure

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Equipment set up: Place the T connector on the Synthesizer SIGNAL output. Connect the Synthesizer to the HP 37702A RECEIVE input using the WECO to BNC adapter. Also, connect the Synthesizer to the AC Voltmeter.
3. Press HP 37702A (FRAME) and select UNFRAMED
4. Press HP 37702A (CODE) and select AMI
5. Press HP 37702A (PATTERN) and select ALL ONES.
6. Press HP 37702A (RESULTS) and select ERROR RESULTS.
7. Set the Synthesizer as follows:

Frequency	: 772 KHz
Function	: Sinewave

DSX-MON (Automatic Gain)

8. Set the Synthesizer to 9.7Vp-p and fine tune it until the AC Voltmeter reads 4.484Vrms (6.5dBdsx). note: set for AC Voltmeter readings shown and disregard the additional digits throughout these tests.
9. Press HP 37702A (RESTART) and verify that there are no errors displayed.
10. Set the Synthesizer to 139mVp-p and fine tune it until the AC Voltmeter reads 63.3mVrms (-30.5dBdsx) then repeat step 9.

TERM (Equalization)

11. Press HP 37702A *T1 INTERFACE* (INTERFACE) to select TERM.
12. Set the Synthesizer to 4.9Vp-p and fine tune it until the AC Voltmeter reads 2.247Vrms (0.5dBdsx).
13. Press HP 37702A (RESTART) and verify that there are no errors displayed.
14. Set the Synthesizer to 70.4mVp-p and fine tune it until the AC Voltmeter reads 31.7Vrms (-36.5dBdsx), then repeat step 13.

BRIDGE (Equalization)

15. Press the HP 37702A *T1 INTERFACE* (INTERFACE) to select BRIDGE.
16. Connect the 100 Ohm resistor across the AC Voltmeter terminals and repeat steps 12 to 14.
17. Remove the 100 Ohm resistor.

TERM (Level Measurement)

18. Press HP 37702A *T1 INTERFACE* (INTERFACE) to select TERM.
19. Press HP 37702A (RESULTS) and select SIGNAL RESULTS.
20. Set the Synthesizer to the synth v p-p level shown in the table below and fine tune it until the AC Voltmeter reads as shown in the Amplitude *AC Vrms* column then verify that the RECEIVER LEVEL limits for *dBdsx* and *Volts Pk-Pk* given are met.

Amplitude		RECEIVER LEVEL	
Synth Vp-p	*AC Vrms*	*dBdsx*	*Volts Pk-Pk*
9.23	4.233	+5 to +7	10.75 to 13.15
4.66	2.12	-1 to +1	5.4 to 6.6
1.45	0.67	-8 to -12	1.7 to 2.1
0.467	0.212	-17 to -23	0.42 to 0.78
0.075	0.0336	-33 to -39	0.07 to 0.13

Wander/Slips Measurement (Option 001)

Specifications

Measurements

Estimated Clock Slips, Estimated Frame Slips, Positive Peak Wander, Negative Peak Wander, Peak to Peak Wander, Time Interval Error

Timing Reference DSX Input

Rate: 1.544 Mb/s ± 130 ppm. There is an indication if no reference signal is present.

Wander Measurement

Bandwidth: Low pass response -3dB at 10Hz (nominal)
Resolution: 0.125 UI
Accuracy: ± 0.125 UI ± 0.5% of reading, for wander frequency up to 1Hz

Description

The Wander measurement is verified in two steps - First, the Receiver and Timing Reference inputs have the HP 37702A Transmitter coupled simultaneously to both. This exercises the wander measurement circuitry by using a division of the Reference input to latch the wander counters and so enable a count of the Receiver input bits. With both inputs being the same,the Wander measurement should be zero based on the expected count being correct. Secondly, two sources are used, one to provide an input to the Receiver port and the other as an input to the Timing Reference port. The sources frequencies are locked together but with one source offset by a known frequency. This allows us to measure for an expected number of bit Slips.

Equipment

Synthesizer/Function Generator (2 off) : HP 3325B*
WECO 310 to BNC Adapters (2 off) : HP 1251-3757
T Connector

*A HP 3335 may be substituted for one of the HP 3325B's.

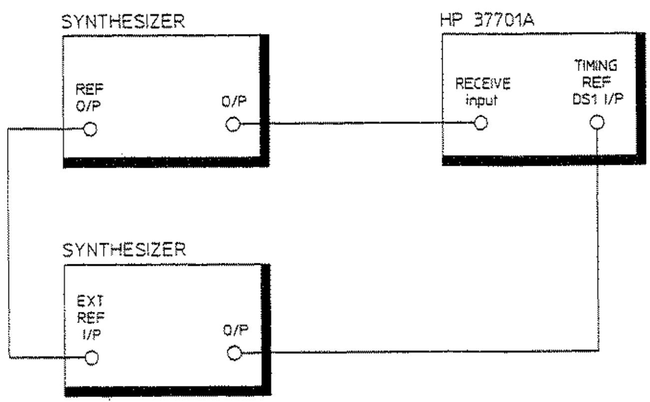
Procedure

Wander

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Connect the HP 37702A T1 TRANSMIT WECO 310 output to the T1 RECEIVE WECO 310 input and the T1 TRANSMIT BANTAM output to the TIMING REF DS1 INPUT BANTAM simultaneously.
3. Press HP 37702A (RESULTS), select SLIPS/WANDER and set the DISPLAY for WANDER (note: the WANDER, SLIPS or GRAPH soft keys are revealed by moving the (⇧) and (⇩) keys to the WANDER, SLIP or GRAPH field).
4. Press (RESTART) and verify that the display shows POSITIVE PEAK WANDER and NEGATIVE PEAK WANDER readings of 0.000 ± 0.125 BITS.
5. Remove the input from the TIMING REF DS1 INPUT and ensure that the display shows NO REF for POSITIVE PEAK WANDER, NEGATIVE PEAK WANDER, PEAK TO PEAK WANDER & TIME INTERVAL ERRORS.

Slips and Wander

6. Connect the equipment as shown below:



7. Press HP 37702A (RESULTS) and use (⇧) and (⇩) to highlight TEST PERIOD [ ].
8. Select USER PROGRAM and set the TEST PERIOD for 1 MINUTE.
9. Press HP 37702A (RESULTS) and set the DISPLAY for SLIPS
10. Press HP 37702A (FRAME) and select UNFRAMED.
11. Press HP 37702A (CODE) and select AMI.
12. Press HP 37702A (PATTERN) and select ALL ONES.
13. Set both Synthesizers amplitudes to 500mV pk to pk, ac coupled.
14. Set the Synthesizer connected to the RECEIVE input to generate a sinewave at 772092.36Hz and the Synthesizer connected to the TIMING REF DS1 INPUT to generate a sinewave at 772100.36Hz.
15. Press HP 37702A (RESTART) and verify that the display shows the following at the end of the test period:

UNCONTROLLED SLIPS	: N/A
CONTROLLED SLIPS	: N/A
ESTIMATED FRAME SLIPS	: -4 to -5
ESTIMATED BIT SLIPS	: -959 to -961 BITS

16. Press HP 37702A (RESULTS), set the DISPLAY for WANDER and verify that the display shows the following:

POSITIVE PEAK WANDER	: 0.000 BITS
NEGATIVE PEAK WANDER	: 955.125 to 964.875 BITS
PEAK TO PEAK WANDER	: 955.125 to 964.875 BITS
TIME INTERVAL ERROR	: -955.125 to -964.875 BITS
PEAK TO PEAK 15 MINUTES	:.... BITS
PEAK TO PEAK 2 HOURS	:.... BITS

17. Set the DISPLAY for SLIPS.
18. Set The Synthesizer connected to the RECEIVE input to generate 771891.64Hz and the Synthesizer connected to the TIMING REF DS1 INPUT to generate 771899.64 Hz and repeat steps 14 to 16.
19. Swop over the HP 37702A RECEIVE input with the TIMING REF DS1 INPUT, press HP 37702A (RESTART) and verify that the display shows the following at the end of the test period:

UNCONTROLLED SLIPS	: N/A
CONTROLLED SLIPS	: N/A
ESTIMATED FRAME SLIPS	: 4 to 5
ESTIMATED BIT SLIPS	: 959 to 961

20. Set the DISPLAY for WANDER and verify that the display shows the following:

POSITIVE PEAK WANDER	: 955.125 to 964.875 BITS
NEGATIVE PEAK WANDER	: 0.000 BITS
PEAK TO PEAK WANDER	: 955.125 to 964.875 BITS
TIME INTERVAL ERROR	: 955.125 to 964.875 BITS
PEAK TO PEAK 15 MINUTE	:.... BITS
PEAK TO PEAK 2 HOURS	:.... BITS

Simplex Current Measurement

Specifications

Range:	from $\pm$ 10 to $\pm$ 200 mA (Unsigned)
Accuracy:	5% $\pm$ 1mA
Resolution:	1 mA

Description

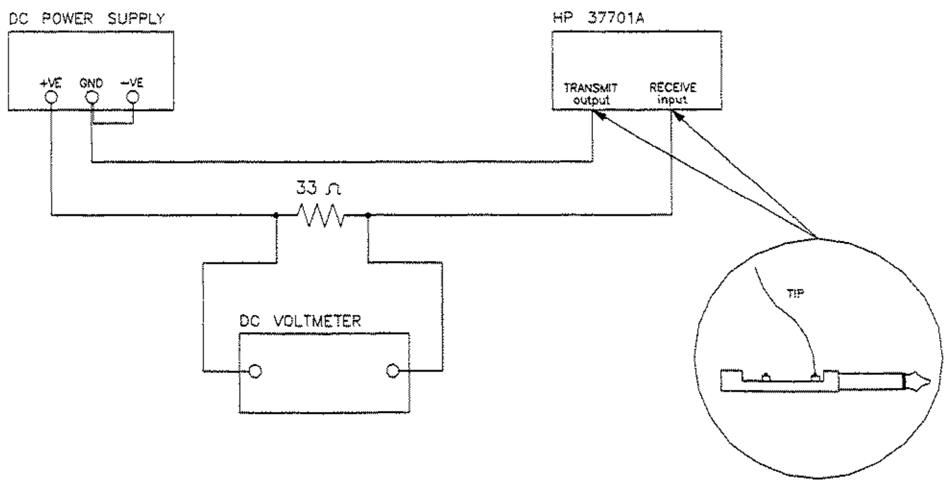
This test verifies that the HP 37702A will complete the current path and make a measure of Simplex Current.

Equipment

DC Power Supply	: HP 6205B
DC Voltmeter	: HP 3456A
33 Ohm, 1%, 5W Resistor	: 0811-0563

Procedure

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Connect the equipment as shown below:



Note: WECO 310 to BNC Adapters can be used in the HP 37702A TRANSMIT and RECEIVE ports to allow connections to be made.

3. Press HP 37702A (RESULTS) and select SIGNAL RESULTS.
4. Adjust the DC Power Supply until the DC Voltmeter reads as shown in the table below and verify that the HP 37702A displayed SIMPLEX CURRENT measurement meets the limits given in the table.

DC Voltmeter Reading	SIMPLEX CURRENT
6.60V	200 ±11 mA
1.98V	60 ±4 mA
0.33V	10 ±1.5 mA *

* Note: <10 mA may be displayed.

Alarm Leds (red)

This is a functional test of the Alarm leds

Equipment

None

Procedure

1. Connect the HP 37702A T1 TRANSMIT output to the T1 RECEIVE input.
2. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
3. If either the POWER LOSS led or the HISTORY led in the RECEIVE STATUS area of the front panel is on, then press (RESET HISTORY).
4. The following *RECEIVE STATUS* leds should be on: SIGNAL PRESENT, FRAME SYNC, PATTERN SYNC and B8ZS.
5. Disconnect the Transmit port from the Receive port and ensure that the green leds are off and that the SIGNAL LOSS, FRAME LOSS, PATTERN LOSS, SLIP and HISTORY leds are on. The SLIP led depends on the timing of the signal path break and may not always come on.
6. Reconnect the Transmit port to the Receive port.
7. Press HP 37702A (AUX), select T1 ALARMS AND LOOPING and set the T1 ALARM GENERATION for All ONES.
8. Ensure that the ALL ONES, FRAME LOSS, PATTERN LOSS, ERRORS and HISTORY leds are on. SIGNAL PRESENT should be the only green led on.
9. Set the ALARM GENERATION to OFF.
10. Press HP 37702A (FRAME) and select UNFRAMED.
11. Press HP 37702A (CODE) and select AMI.
12. Press HP 37702A (PATTERN) and select USER PROGRAM. Set the USER PROGRAM for a 17 bit length (10000000000000000) and ensure that the

EXCESS ZEROS and ONES DENSITY leds are on. SIGNAL PRESENT and PATTERN SYNC are the only green leds on.

13. Decrease the USER WORD length to 16 bits and ensure that the EXCESS ZEROS led goes off while the ONES DENSITY led remains on. SIGNAL PRESENT and PATTERN SYNC are the only green leds on.
14. Decrease the USER WORD length to 9 bits, ensure that the ONES DENSITY led is on, then decrease the USER WORD length to 8 bits and ensure that the ONES DENSITY led goes off. SIGNAL PRESENT and PATTERN SYNC are the only green leds on.
15. Press HP 37702A (LOOP UP) and ensure that the LOOP UP led comes on for approximately 7 seconds (ignore other leds which momentarily flash on). SIGNAL PRESENT and PATTERN SYNC are the only green leds on.
16. Press HP 37702A (LOOP DOWN) and ensure that the LOOP DOWN led comes on for approximately 7 seconds (ignore other leds which momentarily flash on). SIGNAL PRESENT and PATTERN SYNC are the only green leds on.
17. Switch the instrument power off then on and ensure that the POWER LOSS led and the HISTORY leds are on. SIGNAL PRESENT and PATTERN SYNC are the only green leds on.
18. Press HP 37702A (RESTART) to clear the POWER LOSS led and the HISTORY led.
19. Disconnect the Transmit port from the Receive port then reconnect again. Ensure that the HISTORY led is on. Press (HISTORY/FREEZE) to view the results of disconnection (HISTORY LED flashes).
20. Press HP 37702A (RESET HISTORY). Ensure that the HISTORY led goes off and that when (HISTORY/FREEZE) is pressed, the only Red Led to come on is a flashing HISTORY led.
21. Press (RESET HISTORY) to disable the flashing HISTORY led.

DS0-DDS Clocks

Description

For DSO-DDS operation, the HP 37702A requires that DDS Bit and Byte clocks be supplied from an external source. In the DDS network, three versions of the clocks exist - 1) Composite, 2) Bipolar and 3) Unipolar Bit and Byte clocks. The following test verifies that the HP 37702A's locks on to these clocks.

Equipment

Synthesizer	:	HP 3325B
Function Generator	:	HP 3314A
Oscilloscope	:	HP 54201A/D (a 1700 series scope can be used)
Dual BNC/9 pin D-Shell Cable - BIPOLAR	:	See page 9-5
Dual BNC/9 pin D-Shell Cable - UNIPOLAR	:	See page 9-6
WECO 310/BNC Adapter	:	HP 1251-3757
DC Power Supply	:	HP 6205B

Procedure

COMPOSITE CLOCK

A Synthesizer is used to supply a 32Khz sinewave which corresponds to the Bit clock. This tests the functionality of the composite clock by the circuitry correctly identifing the received bit clock while flagging the missing byte clock on the display.

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Press HP 37702A `DSO-DDS` softkey (use the `MORE` softkey to bring up the DSO-DDS field).

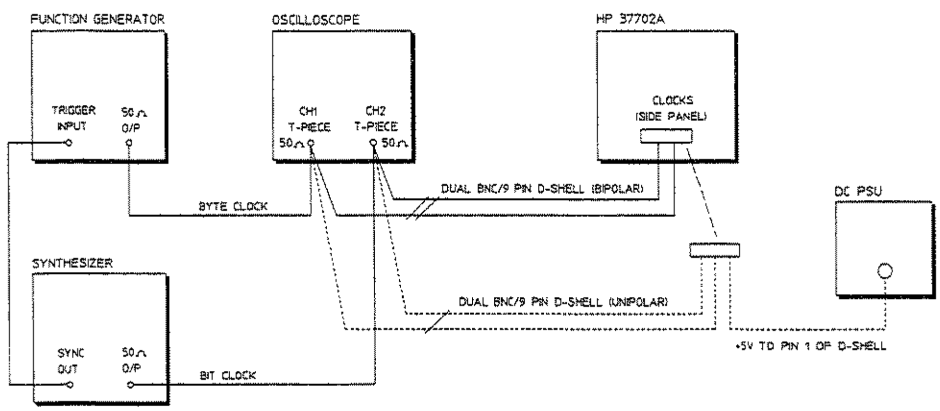
3. Use the HP 37702A cursor keys ⇩ and ⇧ to highlight the CLOCKS field and select COMPOSITE.

   Note that the displayed STATUS line shows "Waiting for DS0 bit clock".

4. Set the Synthesizer for Sinewave operation with a Frequency of 32 Khz and an Amplitude of 3V P-P.
5. Connect the DSO TRANSMIT output to the DSO RECEIVE input.
6. Connect the Synthesizer to the COMPOSITE CLOCK input (instrument side panel) using the WECO 310/BNC Adapter.
7. Ensure that the STATUS: display line now shows "Waiting for DS0 byte clock".

   Bit and Byte Clocks - Bipolar
   A Synthesizer is used to provide the required 64 kHz Bit Clock and also to synchronise a Function Generator which provides the required 8 kHz Byte Clock.

8. Connect the equipment as shown in the following figure:



9. Set the Function Generator and Synthesizer as follows:

DS0-DDS Clocks

Synthesizer

Frequency	:	64 kHz
Function	:	Rectangular Waveform
Amplitude	:	4.0 V pk-pk
Offset	:	0.0 V DC
Phase	:	0 degrees
Trigger	:	Internal

Function Generator

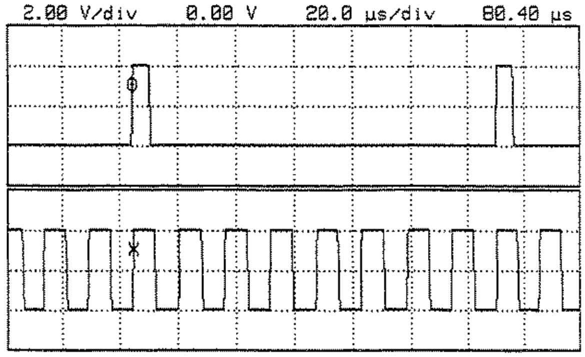
Frequency	:	8 kHz
Function	:	Rectangular Waveform
Amplitude	:	4.0 V pk-pk
Offset	:	0.0 V DC
Phase	:	0 degrees
Trigger	:	External
Mode	:	f in /N
Symmetry	:	5%
n	:	8

10. Configure the Oscilloscope as follows:

```
Status [Configuration] __________Status: No Trigger Found________
                                              REM MTA
                                 Setup Label

Channel [Dual ]                          Timebase
              Input 1       Input 2        Sampling @   5.00 MHz
 Range        8.0 V         8.0 V          Mode         [  Auto   ]
 Offset       0.000 V       0.000 V        Range         200 µs
 Probe        [  1:1   ]    [  1:1   ]     Acquire      [Real Time ]
 Coupling     [dc ] [50 Ω]  [dc ] [50 Ω]   Delay         80.4000 µs
 Store Mode   [ Normal  ]   [ Normal  ]    Reference    [  Left   ]
 Auto Scale   [ Disabled ]  [ Disabled ]   Auto Scale   [ Disabled ]
 Label

Trigger
                                 * Refer to State Trigger Menus
 Mode [   Analog Only   ]          for Assignment and Sequence

 Analog Source [ Chan 1 ] [+ Slope ]    Auto Scale [ Disabled ]
         Level [Centered]  0.0 V        On Event   00001
         Probe [  1:1   ]               Coupling   [dc ] [50 Ω]
```

11. The waveforms displayed on the Oscilloscope Channels 1 and 2 must be synchronous.
12. Adjust the Phase on the Function Generator until the rising edge of both waveforms occur at the same time as shown in the following figure.

```
Display _________________________Status: Acquired Frame 00453____
                                              REM MTA
 Graticule Type     [ Grid  ]      Reference Lines [  Off   ]
 Number of Graphs   [   2   ]      Accumulate Mode [Disabled ]
 Connect Dots       [  On   ]      Data Filter     [   On   ]

  Graph [ 1 ]   2.00 V/div    0.00 V    20.0 µs/div    80.40 µs
1: [Chan 1 ]

2: [Chan 2 ]
```



13. Use the HP 37702A cursor keys to highlight the CLOCKS field and select BIT & BYTE.

14. Ensure that the HP 37702A SIGNAL PRESENT and PATTERN SYNC (STATUS leds) are on.

Bit and Byte Clocks - Unipolar

15. Remove the Dual BNC\9 pin D-Shell BIPOLAR cable and replace it with the Dual BNC\9 pin D-Shell UNIPOLAR cable.
    NOTE: 5v dc, supplied by a dc power supply, is required on pin 1 of the D-Shell connector.

16. Set the Synthesizer and the Function Generator DC Offsets to 2Vdc.

17. Repeat step 14

DSO Clock Loss Indication

Description

This test is used to verify that, with external DDS Clocks applied, the DSO transmitter and receiver gains pattern sync and that the absence of either Bit or Byte clock is correctly flagged.

Equipment

Synthesizer	:	HP 3325B
Function Generator	:	HP 3314A
Oscilloscope	:	HP 54201A/D (a 1700 series scope can be used)
Dual BNC/9 pin D-Shell Cable (Unipolar)	:	See page 9-6
DC Power Supply	:	HP 6205B

Procedure

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Setup the equipment as described in the DSO-DDS Clocks test steps 8 through 12, using the Dual BNC/9 pin D-Shell UNIPOLAR cable in the setup.
3. Connect the DSO TRANSMIT output to the DSO RECEIVE input.
4. Press HP 37702A `DSO-DDS` softkey (use the `MORE` softkey to bring up the DSO-DDS field).
5. Use the HP 37702A cursor keys to highlight the CLOCKS field and select `BIT & BYTE`.
6. Ensure that all of the RECEIVE STATUS red alarm leds are off and that the green leds (SIGNAL PRESENT and PATTERN SYNC) are on.
7. Press HP 37702A [RESTART] and verify that no errors are counted and displayed.

DSO Clock Loss Indication

8. Disconnect the Bit Clock (Synthesizer) and ensure that the display shows DS0 bit clock loss on the displayed status line and that the RECEIVE STATUS red alarm leds (SIGNAL LOSS, FRAME LOSS and PATTERN LOSS) are on - green leds off.
9. Replace the Bit Clock. The displayed status line message should clear and the leds resume condition as in step 6.
10. Disconnect the Byte Clock (Function Generator) and ensure that the display shows DS0 byte clock loss on the displayed status line and that the RECEIVE STATUS red leds (SIGNAL LOSS, FRAME LOSS and PATTERN LOSS) are on - green leds off.
11. Replace the Byte Clock. The displayed status line message should clear and the leds resume condition as in step 6.

DDS - DSO Output Levels

Specification

DS0 Bipolar Output: level conforms to TA-NPL-000458

Description

The following tests ensure that the DSO Bipolar and Logic output levels are within the specified limits for shape and amplitude.

Equipment

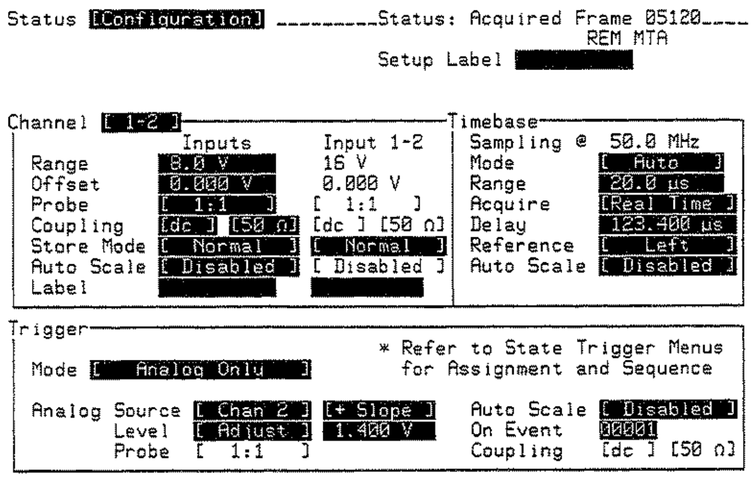
Synthesizer	:	HP 3325B
Function Generator	:	HP 3314A
Oscilloscope	:	HP 54201A/D (a 1700 series scope can be used)
Dual BNC/WECO Bantam Cable	:	See page 9-4
Dual BNC/9 pin D-Shell Cable UNIPOLAR	:	See page 9-6
DC Power Supply	:	HP 6205B

Procedure

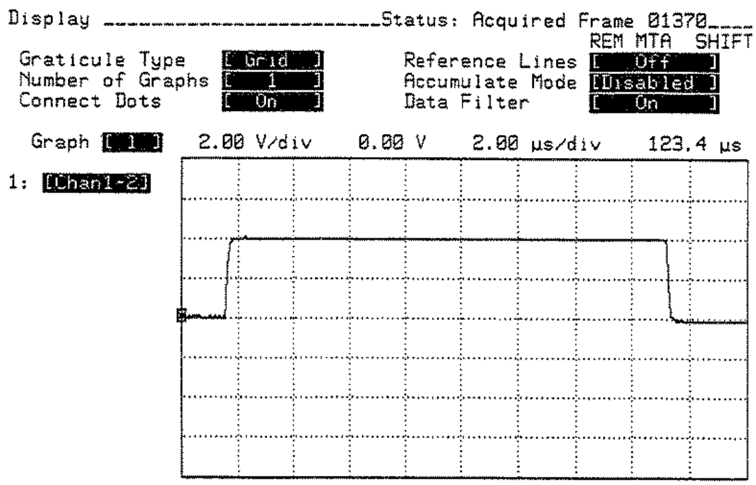
DSO Output Levels - Bipolar

1. Recall the HP 37702A DEFAULT SETTINGS as shown on page 9-7.
2. Setup the equipment as described in previous DSO-DDS Clocks test steps 8 through 12, using the Dual BNC/9 pin D-Shell UNIPOLAR cable in the setup.
3. Configure the Oscilloscope as shown below:

DDS - DSO Output Levels



4. Press HP 37702A DSO-DDS softkey (use the MORE softkey to bring up the DSO-DDS field).
5. Use the HP 37702A cursor keys (⇩) and (⇧) to highlight the PAYLOAD field and select 56.0kb/s.
6. Press HP 37702A (PATTERN) and select USER PROGRAM (Use MORE to bring up the USER PROGRAM field), then set the PATTERN for [F0000000].
7. Remove the T pieces from Oscilloscope channels 1 and 2, then connect the HP 37702A DSO Output (side panel) to Channels 1 and 2 of the Oscilloscope using the WECO Bantam to Dual BNC cable.
8. Adjust the Oscilloscope Sweep Speed, and Delay until the positive half cycle is centered on the display as shown in the figure below.



9. Measure the peak pulse amplitude at mid pulse width using the oscilloscope and verify that this is in the range 3 V to 5.5 V with respect to ground.

10. Adjust the oscilloscope delay to centre the negative pulse on the display and repeat step 9.

Operation Verification Test Record

Page No.	Test Description	Result		
		Min	*Actual*	*Max*
	Digital Data Tester Self Test			
9-9	Step 7: "TEST STATUS PASSED" displayed.			
9-9	Step 11: "TEST STATUS PASSED" displayed.			
9-10	Step 14: "TEST STATUS PASSED" displayed.			
	Auto Configure			
9-12	Step 5: FRAME set for UNFRAMED CODE set for AMI PATTERN set for ALL ONES			
	Pulse Mask (Option 001)			
9-13	Step 7: positive pulses within the mask. negative pulses within the mask. T1.403 PASS displayed.			

Operation Verification Test Record (continued)

Page No.	Test Description	Result		
		Min	*Actual*	*Max*
	Recovered Loop Timing			
9-15	Step 8: received Synthesizer frequency -772.11 kHz.			
	Step 9: received Synthesizer frequency -771.89 kHz.			
	Internal Transmitter Clock			
9-16	Step 5: Frequency Counter reading.	771.990.7Hz		772.009.3Hz
	Alarm Leds (red)			
9-17	Step 4: SIGNAL PRESENT, FRAME SYNC, PATTERN SYNC and B8ZS leds on.			
9-17	Step 5: green leds off. SIGNAL LOSS, FRAME LOSS, PATTERN LOSS, SLIP * and HISTORY leds on.			
9-17	Step 8: ALL ONES, FRAME LOSS, PATTERN LOSS, ERRORS and HISTORY leds on.			
9-17	Step 12: EXCESS ZEROS and ONES DENSITY leds on.			

* Occurrence of SLIP depends on signal path break time.

Operation Verification Test Record (continued)

Page No.	Test Description	Result		
		Min	*Actual*	*Max*
9-18	Step 13: EXCESS ZEROS led off and ONES DENSITY led on.			
9-18	Step 14: USER WORD length 9 bits, ONES DENSITY led on. USER WORD length 8 bits, ONES DENSITY led off.			
9-18	Step 15: LOOP UP led comes on approx. 7 seconds.			
9-18	Step 16: LOOP DOWN led comes on approx. 7 seconds.			
9-18	Step 17: POWER LOSS and HISTORY leds on.			
9-18	Step 19: HISTORY led on.			
9-18	Step 20: HISTORY led goes off. No Red Leds come on.			

Performance Test Record

Page No.	Test Description	Result		
		Min	*Actual*	*Max*
	Digital Data Tester Self Test			
9-21	Step 7: "TEST STATUS PASSED" displayed.			
9-21	Step 11: "TEST STATUS PASSED" displayed.			
9-22	Step 14: "TEST STATUS PASSED" displayed.			
	Internal Transmitter Clock			
9-24	Step 5: Frequency Counter reading.	771,990.7Hz		772,009.3Hz

Performance Test Record (continued)

Page No.	Test Description	Result		
		Min	*Actual*	*Max*
	Transmitter Error Add			
9-26	Step 7: Frequency Counter reading	771.9907Hz		772.0093Hz
9-26	Step 8: Frequency Counter readings			
	1E-3	771.9907Hz		772.0093Hz
	1E-4	77.19907Hz		77.20093Hz
	1E-5	7.719907Hz		7.720093Hz
	1E-6	.7719907Hz		.7720093Hz
	1E-7	.07719907Hz		.07720093Hz
	Step 12: Frequency Counter reading 3 counts.			
	Transmitter Output			
9-28	Step 8: peak pulse amplitude.	2.4V		3.6V

Performance Test Record (continued)

Page No.	Test Description	Result		
		Min	*Actual*	*Max*
9-28	Step 9: pulse falls within the mask.			
9-29	Step 11: Repeat of Steps (8) and (9).			
	(8) peak pulse amplitude	2.4V		3.6V
	(9) pulse falls within the mask.			
	Recovered Clock Frequency Measurement			
9-31	Step 9: FREQUENCY displayed.	1543981MHz		1544019MHz
	Receiver Equalization, Gain and Level Measurement			
	DSX-MON (Automatic Gain)			
9-33	Step 9: no errors displayed.			
	Step 10: no errors displayed.			
	TERM (Equalization)			
9-34	Step 13: no errors displayed.			
	Step 14: no errors displayed.			
	BRIDGE (Equalization)			
	Step 16: 2.247V rms - no errors displayed. 31.7V rms - no errors displayed.			

Performance Test Record (continued)

Page No.	Test Description	Result		
		Min	*Actual*	*Max*
	TERM (Level Measurement)			
9-34	Step 20: *Synth Vp-p* *AC Vrms*			
	9.23 4.233	+5dBdsx 10.75Vpk-pk		+7dBdsx 13.15Vpk-pk
	4.66 2.12	-1dBdsx 5.4Vpk-pk		+1dBdsx 6.6Vpk-pk
	1.45 0.67	-8dBdsx 1.7Vpk-pk		-12dBdsx 2.1Vpk-pk
	0.467 0.212	-17dBdsx 0.42Vpk-pk		-23dBdsx 0.78Vpk-pk
	0.075 0.0336	-33dBdsx 0.07Vpk-pk		-39dBdsx 0.12Vpk-pk
	Wander/Slips Measurement (Option 001)			
9-37	Step 4: POSITIVE PEAK WANDER NEGATIVE PEAK WANDER	-0.125 -0.125		+0.125 +0.125
	Step 5: POSITIVE PEAK WANDER, NEGATIVE PEAK WANDER, PEAK TO PEAK WANDER & TIME INTERVAL ERRORS all show NO REF.			
9-38	Step 15: UNCONTROLLED SLIPS - N/A CONTROLLED SLIPS - N/A ESTIMATED FRAME SLIPS ESTIMATED BIT SLIPS	 -5 -961		 -4 -959
9-39	Step 16: POSITIVE PEAK WANDER : NEGATIVE PEAK WANDER : PEAK TO PEAK WANDER : TIME INTERVAL ERRORS : PEAK TO PEAK 15 MINS..... .....BITS PEAK TO PEAK 2 HOURS..... .... BITS	0.000 BITS 955.125 BITS 955.125 BITS -955.125 BITS		0.000 BITS 964.875 BITS 964.875 BITS -964.875 BITS

Performance Test Record (continued)

Page No.	Test Description	Result		
		Min	*Actual*	*Max*
9-39	Step 18 Repeat of Steps (15) to (17).			
	(15) UNCONTROLLED SLIPS - N/A			
	CONTROLLED SLIPS - N/A			
	ESTIMATED FRAME SLIPS	-5		-4
	ESTIMATED BIT SLIPS	-961		-959
	(16) POSITIVE PEAK WANDER :	0.000 BITS		0.000 BITS
	NEGATIVE PEAK WANDER :	955.125 BITS		964.875 BITS
	PEAK TO PEAK WANDER :	955.125 BITS		964.875 BITS
	TIME INTERVAL ERRORS :	-955.125 BITS		-964.875 BITS
	PEAK TO PEAK 15 MINS..... .....BITS			
	PEAK TO PEAK 2 HOURS..... .... BITS			
	Step 19: UNCONTROLLED SLIPS - N/A			
	CONTROLLED SLIPS - N/A			
	ESTIMATED FRAME SLIPS	4		5
	ESTIMATED BIT SLIPS	959		961
	Step 20: POSITIVE PEAK WANDER :	955.125 BITS		964.875 BITS
	NEGATIVE PEAK WANDER :	0.000 BITS		0.000 BITS
	PEAK TO PEAK WANDER :	955.125 BITS		964.875 BITS
	TIME INTERVAL ERRORS :	955.125 BITS		964.875 BITS
	PEAK TO PEAK 15 MINS..... .....BITS			
	PEAK TO PEAK 2 HOURS..... .... BITS			
	Simplex Current Measurement			
9-41	Step 4: SIMPLEX CURRENT			
	DC Voltmeter Reading			
	6.60V	189ma		211ma
	1.98V	56ma		64ma
	0.33V	8.5ma		11.5ma

Performance Test Record (continued)

Page No.	Test Description	Result		
		Min	*Actual*	*Max*
	Alarm Leds (red)			
9-42	Step 4: SIGNAL PRESENT, FRAME SYNC, PATTERN SYNC and B8ZS leds on.			
9-42	Step 5: green leds off. SIGNAL LOSS, FRAME LOSS, PATTERN LOSS, SLIP * and HISTORY leds on.			
9-42	Step 8: ALL ONES, FRAME LOSS, PATTERN LOSS, ERRORS and HISTORY leds on.			
9-42	Step 12: EXCESS ZEROS and ONES DENSITY leds on.			

* Occurrence of SLIP depends on signal path break time.

Performance Test Record (continued)

Page No.	Test Description	Result		
		Min	*Actual*	*Max*
9-43	Step 13: EXCESS ZEROS led off and ONES DENSITY led on.			
9-43	Step 14: USER WORD length 9 bits, ONES DENSITY led on. USER WORD length 8 bits, ONES DENSITY led off.			
9-43	Step 15: LOOP UP led comes on approx. 7 seconds.			
9-43	Step 16: LOOP DOWN led comes on approx. 7 seconds.			
9-43	Step 17: POWER LOSS and HISTORY leds on.			
9-43	Step 19: HISTORY led on.			
9-43	Step 20: HISTORY led goes off. No Red Leds come on.			

Performance Test Record (continued)

Page No.	Test Description	Result		
		Min	*Actual*	*Max*
	DS0-DDS Clocks			
9-45	Step 7: Status display correct			
9-48	Step 14: SIGNAL PRESENT and PATTERN SYNC leds on.			
9-48	Step 17: SIGNAL PRESENT and PATTERN SYNC leds on.			
	DS0 Clock Loss Indication			
9-49	Step 6: All red alarms off. SIGNAL PRESENT and PATTERN SYNC leds on.			
9-49	Step 7: No errors counted or displayed.			
9-50	Step 8: Status display correct. SIGNAL LOSS, FRAME LOSS and PATTERN LOSS on. Green leds off.			
9-50	Step 9: Normal operation resumed.			
9-50	Step 10: Status display correct. SIGNAL LOSS, FRAME LOSS and PATTERN LOSS on. Green leds off.			
9-50	Step 11: Normal operation resumed.			
	DDS-DS0 Output Levels			
9-53	Step 9: peak pulse amplitude.	3V		5.5V
9-53	Step 10: peak pulse amplitude.	−5.5V		−3V

10

Remote Control

There are three forms of remote control available:

- Virtual remote, (option V01) using software HP 15800A. This provides operation via a front panel displayed on a workstation, the keys being operated with a mouse. Separate documentation is supplied for this type of remote operation.
- RS-232 commands from a terminal or computer.
- HP-IB commands from a computer (option H01)

Tests may be set up and run, results may be stored and retrieved, using the remote control facility. The operation of the Tester is the same as in manual operation from the front panel.

Additional facilities are available when using remote control:

Complete test configurations may be down loaded to the Tester either for immediate use or to be stored in the tester memory for future use.

Results may be returned to the controller for display, printing or further analysis.

Command History

The commands contained in this chapter apply directly to instruments with serial prefix(es) and/or firmware revision numbers given on the *Title Page* of this manual. In the command descriptions which follow you may be directed to the *Command History* table at the end of this chapter. This table contains a description of command changes for each firmware revision.

Preparation for Remote Control

The Tester may be controlled directly from a controller at the same location as the Tester, or over a telephone link via modems.

Where control is over a telephone link, the link may be a leased line or a dial-up line.

The controller may be a "dumb" terminal or a computer.

The Tester must be correctly connected and correctly set up for successful remote control.

The RS-232 port may be configured for either printer or remote control operation. When printer operation is selected, 8 bit data and no parity is transmitted. When remote control operation is selected, 7 bit data and parity is assumed. Xon/Xoff selections may be:

OFF, Rx ONLY, Tx ONLY or Rx AND Tx.

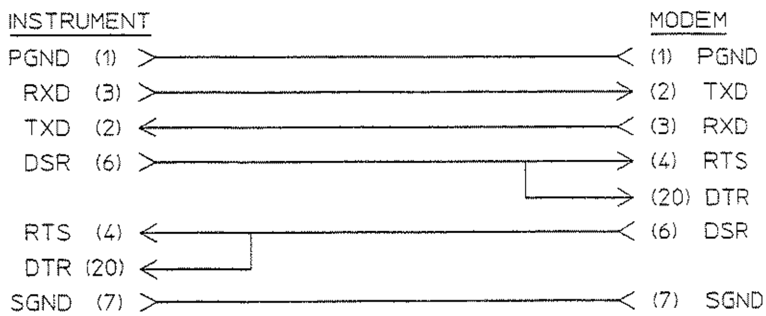
The tester receive buffer has a capacity of 128 bytes.

Remote Control / Printer Pin Assignments

Pin	Mnemonic	Description
1	PGND	Connected to chassis ground
2	TXD	37702A data input
3	RXD	37702A data output
4	RTS	Looped to pin 5
5	CTS	Looped to pin 4
7	SGND	Signal ground
20	DTR	Inhibits data output from the 37702A when held "OFF" by the receiving device.

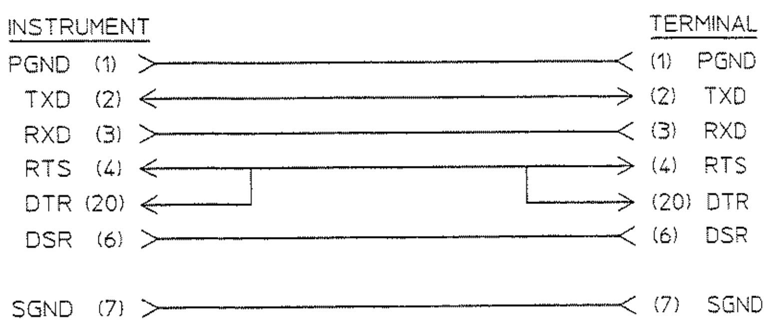
To Connect to Telephone Lines via Modems

The connections of a cable suitable for Tester / modem connection are shown in the following figure.



To Connect for Direct Operation

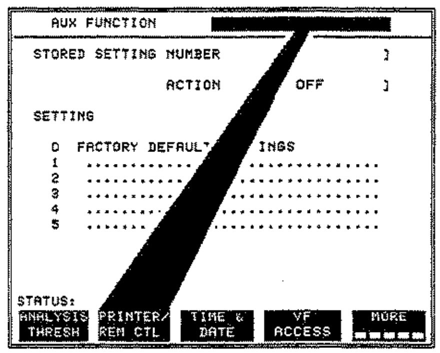
The connections of a cable suitable for direct connection to a controller are shown in the following figure.



To Set the Tester for Operation from a Terminal

Press (AUX)

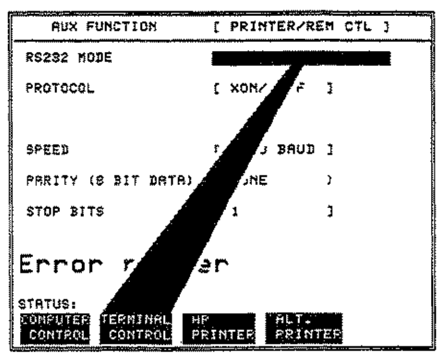
Select PRINTER REM CTL



Highlight

RS-232 MODE [ ]

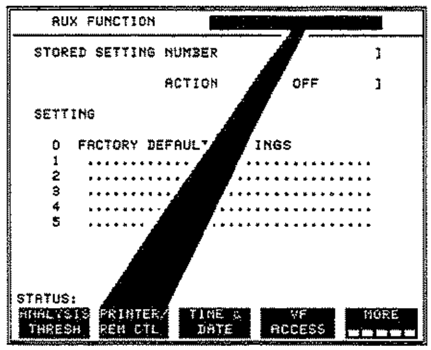
Select TERMINAL CONTROL



To Set the Tester for Operation from a Computer

Press (AUX)

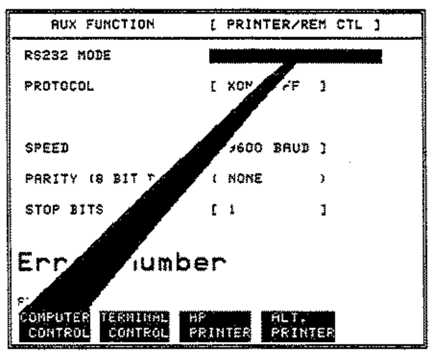
Select PRINTER REM CTL



Highlight

RS-232 MODE [ ]

Select COMPUTER CONTROL



Remote Operation

The following information assumes the user is familiar with the local operation of the tester.

Remote operation is performed by a computer or "dumb" terminal connected to the RS-232 port on the side of the tester. This port is also used as the printer output port. The printing of results may be performed by returning the results to the computer or printing terminal, or alternatively by storing them in the tester for printing at a later time.

The tester is operated by commands which are listed later in this chapter. Commands are shown in the actual form required and are presented in "computer type" for example the command for starting a test is shown as `STR`.

Many commands must be qualified with a variable for example the command `COD` which selects the line code has a qualifier <n> which specifies the type of line code AMI or B8ZS.

The qualifier <n> is presented in italic type.

The preferred form of the complete command has a space between the mnemonic and the variable. For example `COD 1` is preferred to `COD1`.

The possible alternative values for <n> are presented as a list. There is usually a choice in the form of the variable, a digit or an alpha-numeric code.

The command information for setting the line code to AMI or B8ZS is presented in the following form:

`COD` *n*	*n* =	`1` or **`AMI`**	AMI coding
		`2` or **`B8ZS`**	B8ZS coding

To set the code to AMI send: `COD 1` or `COD AMI`
To set the code to B8ZS send: `COD 2` or `COD B8ZS`
A space between the mnemonic part of the command (`COD`) and the variable (*n*) is desirable.

In local operation, all of the front panel controls are responsive and control the tester. In remote operation the controls which change parameters are inoperative, the tester being controlled by the remote controller. The front panel display reflects the remote programming commands received.

At power on the tester assumes the local state. To gain control of the tester the controller must put the tester into the remote state. This is accomplished by sending the "remote control enable" command (RMT). The tester can be returned to local control by sending the "return to local" command (LCL).

Commands are normally separated by "newlines" which can be either a single carriage return character or a carriage return-line feed pair. Tester responses will return with the separator which was present in the last command.

Terminal Control

In general this chapter describes how to control the tester under computer control. The differences when using a terminal are given here.

The operational differences with terminal use are :

- Characters typed are echoed to the terminal.
- The tester provides a prompt at the beginning of the command line.
- Rudimentary input editing (backspace, erase line) is provided.
- An asynchronous interrupt (quit) is provided.
- Errors are reported as text messages.
- A command history is provided.
- Status bit queries indicate active bits in mnemonic form.
- Selectable variable queries can return mnemonic values.

Note that line feeds are always ignored in input. (It is possible to put multiple commands on one line by separating them with semicolons.) Output lines are always separated by carriage return-line feed pairs, regardless of which separator was used on input. This is different to "computer mode", where the separator used for output is always the same as was used for input.

The length of an input line is limited to 280 characters. If the user tries to type more than 278 characters (the last two are used to store the CR LF), the terminal bell rings and the extra characters are discarded.

Prompting and Input Editing

The Prompt

With terminal operation, the tester provides a prompt which is displayed on the terminal screen. The preset prompt is :

```
HP37702A>
```

Input Editing

There are three special function characters used for input editing :

BACKSPACE	This character (DELETE) causes the last character typed to be erased (the tester outputs BACKSPACE-SPACE-BACKSPACE). If the user attempts to backspace over the prompt, the terminal bell rings.
KILL	This character (control-U) causes all of the line from the prompt to the end to be erased.
INTERRUPT	This character (control-C) interrupts the execution of the current command and the tester outputs a newline followed by a prompt. Pressing keyboard BREAK has the same effect.

Error Reporting

When using "computer" mode, errors in parsing or execution cause the processing of the current command to cease, and an error code describing the nature of the problem is placed in the error register, which the user can examine by issuing the ERR? command. In "dumb terminal" mode, the tester reports errors when they occur, without the user performing any special action. When an error occurs, the tester will echo the faulty command with a text message explaining what the problem was.

Examples :

Example 1 : `IDX?` sent instead of `ID?`.

```
HP37702A> idx?
idx? : Command header error
```

Example 2 : A command sent when the tester was not under remote control.

```
HP37702A> rst
rst : Command not executable in local mode
```

Example 3 : A mixture of valid and invalid commands sent.

```
HP37702A> id? ; idx?
HP37702A
idx? : Command header error
HP37702A>
```

In the third example above, a line contains one legal command (id?), and one illegal command (idx?). The legal command is executed, and the response written to the terminal, followed by an error message for the illegal command.

Note that in "dumb terminal" mode, the tester error register is NOT updated. This is because the tester effectively follows each error with an internal ERR? command, which has the effect of clearing the error register.

Mnemonic Responses

When in "computer mode", commands which query tester status registers (e.g. STA?,RQS? etc.) simply return integers. Where these registers are really collections of bits, each indicating a separate condition, "dumb terminal" mode will output a mnemonic string indicating which bits are active, in addition to the integer value of the register.

Example

```
HP37702A> sta?
28 <RDY LCL FPS>
```

In addition to mnemonic responses for status register queries, "dumb terminal" mode has the facility to return mnemonic responses to selectable variable queries.

Example

```
HP37702A> pat?
QRSS
```

"dumb terminal" mode also provides a command history feature. The tester maintains a buffer of up to 20 commands (or 200 characters, whichever runs out first) of commands entered. Commands are entered into the history buffer whether legal or not, and a command is not put into the history if it is exactly the same as the last command sent. If there is no space in the history store when a new command is received, commands are deleted from the store, oldest first, until there is enough space.

Commands are provided to list the contents of the store, re-execute the last command sent and to re-execute a particular command, specified by its number. These commands are not themselves placed into the history store.

`!l` : Lists the contents of the history store (if any).

NOTE : Character `l` in this command must be the lower case of character `L`.

Example : Response to a request to list the contents of the history store `!l`

```
HP37702A> !l
1 : sta?
2 : rst
3 : id?
4 : str
5 : STA?
HP37702A>
```

`!!` : Echoes and re-executes the last command in the history store.

Example : To re-execute the last command.

The last command in the previous example was `STA?`.
Typing `!!` after the prompt will cause the `STA?` command to be returned to the terminal and re-executed.

```
HP37702> !!
STA?  20 <RDY FPS>
```

`! n` : Echoes and re-executes command number `n` in the history store.

The command number is either the number given by the `!l` command, or a negative number indicating the "second from last (-2)" etc. If the selected command is not in the store an error message is written to the terminal.

The following errors can occur when using history commands :

`bad history command -- unrecognized history command.`

`no such history command -- the specified command is not in the store.`

HP-IB Operation (option H02)

The standard Telecom / Datacom Testers are provided with RS-232 printer output and remote control.

The special option H02 instruments are provided with Hewlett-Packard Interface Bus (HP-IB) printer output and remote control.

The printing and control information, including commands, in this manual, apply to both RS-232 and HP-IB. The variations in setting up the instrument for HP-IB operation are given in the following pages.

HP-IB Provides a parallel interface which allows the instrument to be incorporated into a system by the connection of other devices, for example : a Personal Computer or a Printer. Such a system allows great flexibility in communicating and controlling data.

The performance of the instrument may be extended by storing a greater number of test set-ups in the controller (or on disc) and loading them into the instrument as required. Similarly a greater number of results may be returned to the controller or printer for later analysis.

If long distance communication is required, suitable HP-IB Extenders are available. HP-IB Extenders are connected within the test system at both ends of the communication link.

Connecting to the HP-IB

The following points should be considered when connecting the instrument to the HP-IB :

- Operating distances
- Communication with the system controller

Operating Distances

To achieve interface design performance standards, restrictions are placed on the HP-IB system cable lengths. These restrictions allow the bus interface to maintain correct line voltage levels and timing relationships.

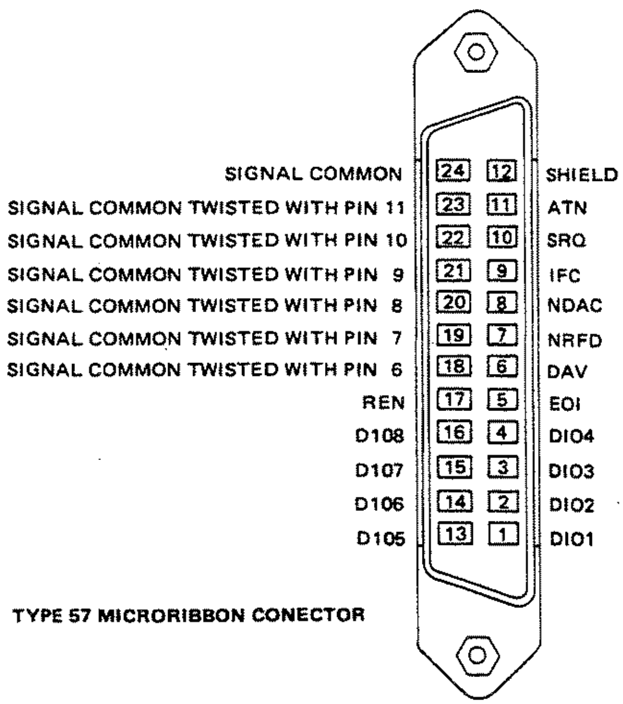
When connecting an HP-IB system the following rules should be observed :-

1. The total length of HP-IB cable must not exceed 2 meters (6 feet) × the number of devices in the system.

2. The total length of HP-IB cable, used to interconnect all devices in the system, must not exceed 20 meters (65 feet).

Hewlett-Packard Interface Bus Connector

A standard HP-IB connector is provided on the instrument rear panel. The connections and HP-IB logic levels are shown in the following figure. The Mating connector part number is HP 1251-0293 or Amphenol 57-30240.



HP-IB Connections and Logic Levels

Suitable Cables

The instrument may be connected to the HP-IB with one of the following HP-IB cables.

Table 10-1. HP-IB Interconnecting Cables

Length	Accessory Number
1 meter	10833A
2 meters	10833B
4 meters	10833C
0.5 meter	10833D

Connection Over Greater Distances

Operating distances can be increased by using HP-IB Extenders, HP 37204A or HP 37201A :

Up to 1250 meters use HP 37204A.

Over 1250 meters use two HP 37201A and two suitable Modems.

Setting Up for Printing or Controlling

A printout of alarms, results and instrument settings may be obtained by connecting a printer to the HP-IB connector and selecting the TALK ONLY mode of operation.

Instrument control may be obtained by connecting a controller to the HP-IB connector and selecting the ADDRESSABLE mode of operation.

To Print using Talk Only

Press (AUX)
Select `HP-IB PORT`
Highlight HP-IB `[        ]`
Select `TALK ONLY`

Use the information in chapter 6, Printing Results, to set the instrument for the type of print you want.

To Control the Instrument Remotely

Communication with the System Controller

Each device in the system must have a unique address to allow the controller to access it individually. The address is selectable from the instrument front panel.

HP-IB Address Selection

To select the HP-IB address:

Press (AUX)
Select HP-IB PORT
Highlight HP-IB [ ]
Select ADDRESSABLE
Highlight ADDRESS [ ]
Select a "system unique" address in the range 1 to 30

To Return to Local Operation

By selecting (AUX), HP-IB PORT, RETURN TO LOCAL

Status Reporting

The instruments contains 5 Registers which can be interrogated for status information. Two Status registers, A and B, Alarm register, Ready register and Error register.

To determine the current status of the instrument you must interrogate the Primary Status Byte register, Status register B. Three methods of interrogation are possible via HP-IB but only one method is available via RS-232. The three methods and the remote interface on which they are valid are listed below.

Method of Interrogation	HP-IB	RS-232
Poll using STB?	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 instrument to Request Service by using the "RQS n" command.
- Specify the action to be taken when an interrupt is issued by using the controller dependent ENABLE INTR and ON INTR (Basic) statements.
- Acquire the Primary Status Byte using the SPOLL (basic) statement.

The printer/ remote control display used for setting the HP-IB address, gives a service request indication.

Poll Using STB?

- Select the condition(s), under which you require the instrument to Request Service by using the "RQS n" command.
- Enter a waiting loop and acquire the Primary Status Byte by using the "STB?" command.

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

Device Clear and Selective Device Clear (SDC)

These commands are usually sent at the beginning of a program to reset the HP-IB interface of the instrument to a known state without changing the panel settings :

- All buffers flushed
- Stop asserting SRQ
- Service request mask set to ERR (32)
- Clear all errors
- Clear status, alarm mask and key registers
- Ready register RAC bit set

Device Clear using an HP 200 series controller is : CLEAR 7 (Where 7 is the Bus I/O select code).

Selective Device Clear using an HP 200 series controller is : CLEAR 705 (Where 7 is the Bus I/O code and 05 is the device address).

Interface Clear (IFC)

This command clears the HP-IB interface and returns the instrument to the listener idle state; it does not affect the parser or any of the internal buffers of the instrument.

Instrument Clear command using an HP series 200 controller is : ABORT 7 (Where 7 is the Bus I/O select code).

Remote Enable (REN)

The Remote Enable command instructs the instrument to accept instruction via the HP-IB. The instrument will accept commands while in local mode only if they do not change the configuration of the instrument. When the instrument receives the remote enable command, the front panel REMOTE indicator comes on.

It is highly recommended that the instrument be put into the remote with local lockout state (RWLS) when being controlled via the HP-IB. This will disable the front panel LOCAL selection and guarantee that the system controller has sole control of the instrument at all times. To do this the controller should send the REN command followed by the LLO command.

When in RWLS, selecting (AUX), HP-IB PORT, RETURN TO LOCAL will cause bit 2 (FPS) of the status byte to be set, generating an SRQ if the SRQ mask is enabled. It is then at the discretion of the controller whether to return the instrument to local control or ignore the request.

Programming Tips

The programming information given here covers the following :

The maximum rate of reading status registers.
How to determine the start/running/stop status of a test.
Delay in execution of some commands.

Reading of Status Registers

All status registers are updated on a 100ms basis, with the exception of the err register, which will be updated when a remote control error occurs. There is therefore no point in reading the registers at a faster rate than this, and the status register reads actually enforce a 100ms delay before the next read can be attempted. To minimize command queuing therefore, do not send status register query commands at a greater rate than every 100ms.

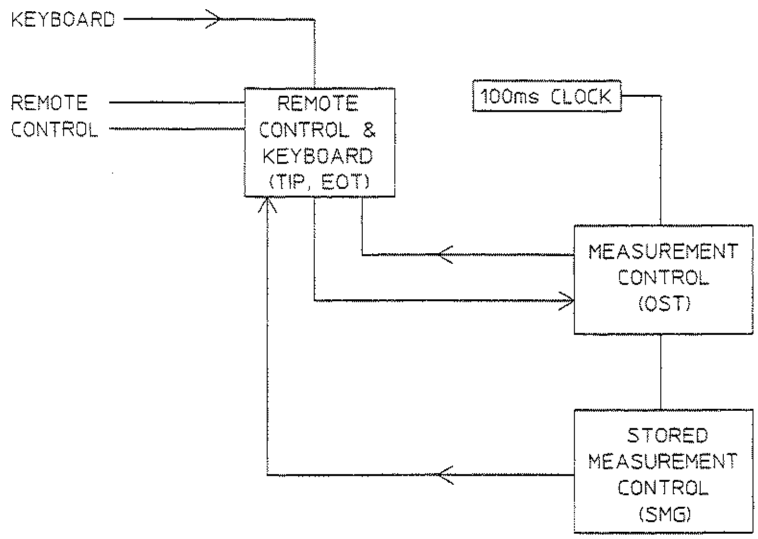
Determining Start and Stop

There are various bits associated with starting and stopping. These are as follows:

STA:
  EOT - Set at end of testing period
  TIP - Set whilst the tester is testing
  SMG - Set when Stored Measurement and Graphics (SMG) operations are in progress
STB:
  EOT - Set at end of testing period (same as STA)
RDY:
  OST - Set when the tester actually starts testing.

The significance of these bits is as follows: When the OST bit is set, any errors generated at the input to the tester will be counted; and when the SMG bit is set data may not be read from the results store.

The relationships between these bits is shown in the following diagram.



Start/Stop operation timing

Restarting with the STR command or with [RESTART]

Under these circumstances, the TIP bit will go TRUE and the EOT bit will go FALSE very soon after the command is received. As soon as a valid measurement can be carried out (i.e. a signal is presented) the OST bit will go TRUE. When testing has started this information is passed to the stored measurement graphics process, which will set the SMG bit some time later. The time it takes to set the bit depends on whatever other loading the tester is getting at the time, but typically may be up to 2 seconds.

Stopping with the STP command, with [RESTART] or after a timed measurement

Under these circumstances, the TIP bit will go FALSE, the OST bit will go FALSE and the EOT bit will go TRUE very soon after the command is received. Sometime later the SMG bit will be cleared. All the bits will have settled to their new values by typically 2 seconds after the command is received.

The Delay in the Execution of Some Commands

If the tester is controlled from a computer which sets a timeout for remote control read and write operations then it is important to realize what factors can contribute to delays.

The execution of commands can take a long time, for example `RST` will typically take 2 seconds for complete execution. The tester has an input buffer in excess of 100 characters, and can buffer up several commands before executing them. This is deliberate and desirable. It can lead to some long response times for example if the command `RST;RST;RST;ID?` is sent it will be more than 6 seconds before a response to the `ID?` command is received. The programmer should bear these considerations in mind when programming any timeouts.

THE COMMANDS

COMMON CAPABILITY MESSAGES

Reset

The reset action message presets the instrument to its default state. A full listing of this default state is given in the appendices. The predefined default state is as follows :-

- Configuration defined by stored setting 0
- Stop/restart testing
- All buffers flushed
- Stop asserting SRQ (HP-IB option only)
- Service request mask set to ERR (HP-IB option only)
- Clear all errors
- Clear alarm change and key registers
- Clear status registers except for DAT bit
- Ready register bits LQE,STC,ASC,RAC set.

Note Not RAC in TERMINAL CONTROL.

The remote control parser and executor are also reset by this command.

```
RST
```

Remote

This command causes the instrument to go remote with local lockout (RS-232 only). The command is as follows:-

```
RMT
```

Local

This command causes the instrument to disable local lockout and return to local (RS-232 only). The command is as follows:-

```
LCL
```

Clear

This command clears all instrument errors and flushes all buffers without affecting the programmed state of the instrument. The following things are performed by executing this command :-

- All buffers flushed except printer output
- Stop asserting SRQ (HP-IB option only)
- Service request mask set to ERR (HP-IB option only)
- Clear all errors
- Clear alarm mask and key registers
- Clear all bits in status registers, except for DAT and TIP and SMG which retain their original values
- Ready register RAC bit set (except in TERMINAL CONTROL)

```
CLR
```

Device Clear

This is implemented on the 37702A by sending a [BREAK]. These will return the instrument to the initialized condition regardless of the current state. A delay of at least 200ms should be allowed after sending this command. Its effect is identical to sending `CLR`.

Key

This command returns the value of the last key pressed on the front panel. The value is returned as an integer whose meaning is given below. If no key was pressed since the last time the command was used, 0 is returned. Note that this command does not wait until a key is pressed. Using this command clears the key register and clears FPS in status registers A & B.

KEY? returns n $\quad n =$ 1 to 31

KEY? returns	1 = Up Arrow
	2 = Down Arrow
	3 = Softkey 1
	4 = Softkey 2
	5 = Softkey 3
	6 = Softkey 4
	7 = Softkey 5
	8 = Aux
	9 = Interface Select
	10 = Line Build Out
	11 = Transmitter Timing
	12 = Transmit Error Type
	13 = Transmit Error Rate
	14 = Config
	15 = Frame
	16 = Code
	17 = Pattern
	18 = Results
	19 = Test Mode (15901A)
	20 = Manual Resync (15901A)
	21 = Auto/restart
	22 = Show History Depressed
	23 = Show History Released
	24 = Loopup
	25 = Loopdown
	26 = Decrease Volume
	27 = Increase Volume
	28 = Restart
	29 = Print Now
	30 = Reset History
	31 = Single Error

Request Service Mask

This command is used to enable or disable the reasons for setting the RQS bit in status register A and B. Associated with status register A is a mask which enables or disables the various sources (ie only the positive edge of a bit in status register A with it's corresponding mask bit enabled will cause the RQS bit to be set.)

`RQS` *n*	$n =$	`0` to `30719`	Status reg A mask range

The mask has a bit map identical to that of status register A,and can be set in three different ways.

1) The parameter can be a single 16 bit integer, corresponding to the addition of binary weighted bits wishing to be enabled. Eg. if we wished to enable STR and ERR then the command would be:-

`RQS 288`

2) The parameter can be a list of the binary weighted integers corresponding to all those sources wishing to be enabled separated by commas. Eg. if we wished to enable STR, ERR and FPS then the command would be:-

`RQS 256,4,32`

3) The parameter can be a list of three letter mnemonics defined in Status Registers, separated by commas. Eg. if we wished to enable ERR, RDY and LCL then the command would be:-

`RQS ERR,RDY,LCL`

As well as the three methods of passing the parameter outlined above, any combination may be used,remembering that the result is always evaluated to a 16 bit integer. Care should be taken to ensure the resultant integer is in range and the desired sources are enabled (Although range checking is done, no checking of constituent parameters is performed to ensure that they are binary values). There are two other special parameters to this command. They are `RQS ON` and `RQS OFF`. `RQS OFF` is not equivalent to `RQS 0` because it disables all reasons for SRQ but remembers the stored mask. Upon receipt of the `RQS ON` command service requests should be enabled again with the same mask as before (NOTE any positive edges of sources with their mask set should be caught, so that they will set the RQS bit when the `RQS ON` command is sent). If the RQS ON command is sent without a corresponding RQS OFF command sent before it, the instrument shall assume the RQS ERR state as a default.

The complement of this command is used to inspect the Service Request mask. The command responds with a 16 bit integer equivalent to the binary weighted values of those sources which are enabled (outlined in Status Registers).

RQS? returns 0 to 30719

Instrument Identification

This returns the instruments identification string.

ID? returns *HP 37702A*

Revision Date Query

This command is a request for the instruments firmware revision information. The instrument returns two four digit date codes separated by a comma, these date codes are in standard HP serial number format (a four digit code, where the first two digits indicate the year (from 1960), and the next two indicate the week (01 to 52)). The firmware revision date comes first, followed by the Codes and Formats date. The command is as follows:-

REV? returns *dddd,ffff* *dddd* = Firmware date code
ffff = Codes and Formats date

Serial Number Query

This command is a request for the instrument to return it's individually assigned serial number. The command is as follows:-

SER? returns "*ddddUnnnnn*"

A command in the same form, SER "*ddddUnnnnn*" may be used to set a new serial number.

Error Code Query

This command is a request to read the instrument's error register. The error register contains an integer in the range -32768 to 32767. The error codes have various meanings, some defined by "common capabilities" and some instrument dependent (see Error Codes for a full listing). If no error exists at the time of enquiry, then 0 is returned. The error register is cleared on reading the register or by sending the CLR or RST commands.

The error register will also contain the result of a remotely initiated selftest command. This is cleared as above. The command is as follows:-

ERR? returns -32768 to 32767

Ready Code Query

This command is a request to read the instrument's ready register. The result is a binary weighted decimal integer. The meanings of the bits is given in "Status Registers". The command is as follows:-

RDY? returns 0 to 127

Status/Events Query

This command is a request for the instrument to return the contents of status register A. It responds with an integer which represents the 16 bit binary weighted contents of the status register bits. A detailed description of status register A is given in "Status Registers". The command is as follows:-

STA? returns 0 to 32767

Status Query

This command is a request for the instrument to return the contents of status register B. It responds with an integer which represents the 8 bit binary weighted contents of the status register bits. The act of executing this command also clears the RQS bit in status registers A and B (similar to the serial poll). A detailed description of status register B is given in "Status Registers". The command is as follows:-

STB? returns 0 to 255

Options Query

This command is a request for the instrument to return its normally fitted options.

`OPT?` returns n $n =$ `0` to `1111` Coded as below

Number	Option Fitted
1	OPT-001 Pulse Mask/Wander Fitted
10	OPT-V01 Virtual Remote
100	OPT-004 DS0B Fitted
1000	OPT-H02 HP-IB Fitted

CONFIGURATION COMMANDS

Instrument Configuration

This command takes as its parameter a block of data which specifies the instrument's internal setup state. The block is a IEEE Std 728 '#H' format. This is intended only for restoring an instrument state saved using the CON? query and hence its internal format is not elaborated.

NOTE: This command does not record the settings of remote control sources, or current states of remote control registers. It is equivalent in scope to store/recall preset panels. One block should not be compared with another in a comparison attempt as redundant but variable information is also included in the block.

The command is as follows:- `CON #H` *data block*

The complement of this command is used to enquire about the configuration of the instrument; it returns the configuration of the instrument in exactly the same form, namely the IEEE Std 728 #H data block. The command is as follows:-

`CON?` returns `#H` *data block*

T1 Framing Type

Selects the T1 framing configuration.

`FRM` *n*	*n* =	1 or ESF
		2 or D4
		3 or SLC96
		4 or UNFRAMED

The corresponding query returns the framing configuration, in integer form as described above:-

`FRM?` returns *frame type* = 1 to 4

Pulse Shape Polarity Query

Provides the polarity of the pulse shape displayed (Option 001 only).

`PPO?` returns *pulse polarity*	*pulse polarity* = 0	No pulse has yet been sampled
	1	Positive pulse on display
	2	Negative pulse on display

Pulse Truncated Query

This queries whether the displayed pulse shape on the display is truncated or not, or not yet triggered (Option 001 only).

`PTC?` returns n	n = 0	no pulse has yet been sampled
	1	displayed pulse is not truncated
	2	displayed pulse is truncated

Pulse Mask Selection

This selects the pulse mask against which the measured pulse is compared in option-001 instruments. The choices refer to various published documents as detailed in the instrument specification.

`PMS` n	n = 1 or `ANSIT1403`	ANSI T1.403
	2 or `PUB62411`	TR62411
	3 or `OCB119`	CB119 (OLD)
	4 or `ANSIT1102`	ANSI T1.112 or CB119 (NEW)
	4 or `NCB119`	ANSI T1.112 or CB119 (NEW)
	5 or `CCITTG703`	CCITT G.703 / 7790-B

`PMS?` returns n n = 1 to 5

Application configuration

Selects the major application of the instrument.

`APP` n	n = 1 or `FULLT1`	Full-T1 measurements
	2 or `N56K`	Nx56k timeslot measurements
	3 or `N64K`	Nx64k timeslot measurements
	4 or `VF`	Nx56k timeslot measurements
	5 or `T1_DDS`	T1-DDS measurements
	6 or `DS0_DDS`	DS0-DDS measurements
	7 or `FDL`	4kb/s data link measurements

`APP?` returns n n = 1 to 7

Receiver Timeslot Selection

This selects whether the receive timeslots should map to the transmitter for fractional-T1 measurements. This is the same selection for DROP AS INSERT when the T1 pattern choice is EXTERNAL.

`RXT` *n*	*n* =	`1` or `ASTX`	Receive as transmit (drop as insert)
		`2` or `RECEIVE`	Select receive (drop) timeslots

`RXT?` returns *n*   *n* = `1` or `2`

Transmitter Multiple Timeslot Selection

This selects the transmit timeslots for fractional-T1 measurements, including which timeslots are being overwritten with pattern data in THRU mode and which timeslots are inserted with data from the X.21 leased port when in pattern EXTERNAL. It is also the receiver (or drop) timeslots when receive timeslots are ASTX. In this case, BER measurements will be performed on the timeslots if an internally generated pattern is selected. A timeslot is selected when the corresponding mask bit is set (1).

`TTM "`*mask*`"`   *mask* = 24 characters, `0` or `1`

`TTM?` returns `"`*mask*`"`   *mask* = 24 characters, `0` or `1`

Receiver Multiple Timeslot Selection

This selects the receive timeslots for fractional-T1 measurements, including which timeslots are being measured in THRU mode and which timeslots are dropped to the X.21 leased port when in pattern EXTERNAL. A timeslot is selected when the corresponding mask bit is set (1). This selection will only come into effect when the receiver timeslot selection (RXT) is RECEIVE.

`RTM "`*mask*`"`   *mask* = 24 characters, `0` or `1`

`RTM?` returns `"`*mask*`"`   *mask* = 24 characters, `0` or `1`

T1 Pattern

This selects the T1 pattern to be transmitted and received when in FULL-T1, Nx56k and Nx64k. For DDS patterns see DPA.

When in FULL-T1 all patterns except EXTERNAL are available. The USER pattern is a 24-bit user word for stress testing.

When in Nx56k or Nx64k, EXTERNAL is added to the set but patterns ALLONES, ALLZEROS, ONEIN8, ONEIN2 and STRESS are deleted. The USER word becomes 8-bits long in Nx64k and only 7-bits in Nx56k.

EXTERNAL permits an externally generated pattern to be inserted into the transmitted data stream via the X.21 leased port. Conversely, the received pattern is dropped out of the same port.

`PAT` *n*	*n* =	1 or `QRSS`	2^20-1 PRBS, (14 zero limit)
		2 or `THREEIN24`	3 zeros in 24 bits
		3 or `ALLONES`	111111 ...
		4 or `ALLZEROS`	000000 ...
		5 or `ONEIN8`	100000001 ...
		6 or `ONEIN2`	101010 ...
		7 or `STRESS`	Stress patterns
		8 or `USER`	User programmable 3 to 24 bit word
		9 or `LONGWRD`	User programmable long user word
		10 or `LIVE`	Invokes monitor mode
		11 or `PRBS15`	2^15-1 PRBS, (inverted)
		12 or `PRBS20`	2^20-1 PRBS
		13 or `PRBS23`	2^23-1 PRBS, (inverted)
		14 or `EXTERNAL`	Drop and insert function
`PAT?` returns *n*	*n* =	1 to 14	

Special Pattern Test

This selects which special measurement selection is to be performed in FULL-T1, Nx56k or Nx64k. There is no test period control and the instrument will not perform gated measurements. Instead, three non-gated monitoring modes are offered. These modes offer no results other than the one(s) selected.

In SIGBIT, the instrument monitors the AB or ABCD bits in channels 1-24. In TSCHECK, the instrument transmits a unique code in each of the 1-24 timeslots. If ALL is selected for the timeslot map display (TMD) and if the code is recognized at the receiver, the timeslot number will be displayed adjacent to the transmitted timeslot number, otherwise the hexadecimal representation of the timeslot contents are displayed. If the timeslot map display is SINGLE, then the selected timeslot contents are displayed in binary form. HIRESRTD performs a high resolution round trip delay measurement by transmitting a special pattern in one timeslot and receiving it in any timeslot with a resolution of 10us.

`SPT` *n*	*n* = `1` or `SIGBIT`	Monitor AB(CD) bits in channels 1-24
	`2` or `TSCHECK`	Timeslot swap check
	`3` or `HIRESRTD`	High resolution round trip delay

`SPT?` returns *n*	*n* = `1 to 3`

Long User Word

Specifies the identification number and pattern for one of the long user words. The word length is determined automatically by the length of pattern selected.

`LUW` *n*,*#H data*	*n* = `1 to 4`	User word number
	#H data = `#Haabbcc` ...	Long user word data (1 to 128 bytes)

The corresponding query returns the long user word pattern in #H block form:-

`LUW?`*n* returns *#H data*

Where *data* is 1 to 128 bytes, each byte comprising 2 hex characters.

Long User Word Length

Specifies the pattern length for one of the long user words.

This command may be used to restrict the pattern length of an existing long user word. It may also be used to restore the length to its original value after remotely changing the first n bytes.

`LUL` *n*,*length*	*n* = `1 to 4`	User word number
	length = `1 to 128`	Long user word length in bytes

The corresponding query returns the long user word pattern length:-

LUL?*n* returns *length*

Long User Word Select

Specifies which of 4 long user words to use.

LUS *n*	*n* =	1 to 4	Long user word number

The corresponding query returns the currently selected long user word, in integer form as described above:-

LUS? returns *long user word* = 1 to 4

Long User Word Sync Mode

Specifies whether the sync should be based on the length of the whole word or on a specified number of bytes.

LUY *n,sync mode*	*n* =	1 to 4	User word number
	sync mode =	1 or FULL	Full word length used
		2 or VARIABLE	Number of bytes can be controlled

The corresponding query returns the currently selected sync mode:-

LUY?*n* returns *sync mode* 1 or 2

Long User Word Sync Length

Specifies the long user word sync length which will be used when variable sync length is selected.

LSL *n,length*	*n* =	1 to 4	Long user word number
	length =	1 to 128	Number of bytes for sync

The corresponding query returns the currently selected sync length, in integer form as described above:-

LSL?*n* returns *sync length* = 1 to 128

Long User Word Left Hand Bit

Specifies whether the left hand bit of the user word bytes should be sent first or last. This command will set the bit transmission order for all 4 of the long user words.

`LHB` *direction*	*direction* =	1 or `FIRST`	Left hand bit sent first
		2 or `LAST`	Left hand bit sent last

The corresponding query returns the selected direction, in integer form as described above:-

`LHB?` returns *direction* = 1 or 2

Coding Type

Selects the coding type to be transmitted and configures the receiver accordingly.

`COD` *n*	*n* =	1 or `AMI`	AMI coding
		2 or `B8ZS`	B8ZS coding

The corresponding query returns the currently selected coding, in integer form as described above:-

`COD?` returns *coding type* = 1 to 2

User Word Pattern

This selects the user word pattern to be transmitted and received under both the T1 and DDS choices of PATTERN [USER PROGRAM]. For each application, where a user programmable word is permitted, the correct length of word must be sent. In FULL_T1, the length of the word will be determined by the length of the word sent in the range 3-24 bits. For all other applications the word length is fixed at 8 bits.

In the DDS applications, the leading bit is always used for framing ("F") except for 56kb/s. For non-56kb/s payload rates, the value of this bit will always be updated to the value of the passed parameter, even though "F" will appear on the display. In the query command, the actual display (including "F") will always be returned in the response string.

In the application N×56, the trailing bit of the 8 bit word is always used for signaling ("S"). Either "1", "0" or "S" will be permitted as a parameter. In the query command, the actual display (including "S") will always be returned in the response string.

PAU *n*, "*string*"	*n* =	1 or FULL_T1	Full-T1, word length 3 to 24 bits
		2 or N56K	Nx56k, word length 8 bits
		3 or N64K	Nx64k, word length 8 bits
		5 or T1_DDS	T1 DDS, word length 8 bits
		6 or DS0_DDS	DS0 DDS, word length 8 bits
	string =	*n* characters, 0 or 1,	F or S as required.

PAU? *n*	*n* =	1 or FULL_T1
		2 or N56K
		3 or N64K
		5 or T1_DDS
		6 or DS0_DDS

returns "*string*" *string* = 3 to 24 characters, 0, 1, F or S

T1 Stress Pattern

This sets the T1 stress pattern number for PAT STRESS.

PSS *n*	*n* =	1 or OCT_53	53-octet
		2 or OCT_54	54-octet (ball buster)
		3 or OCT_55	55-octet (DALY)
		4 or OCT_72	72-octet (ALBO)
		5 or OCT_96	96-octet (96-octet)
		6 or OCT_120	120-octet (trip test)
		7 or OCT_55_V2	55-octet (version 2)
		8 or OCT_55_V3	55 octet (version 3)

PSS? returns *n* *n* = 1 to 8

Send Signaling Bits

Selects the "foreground" signaling bit sequence for use in the signaling bit test. The user is able to separately select the AB bits for use in D4 etc. and the ABCD bits for use in ESF.

SSB *sig bit type*, "*sig bits*"

sig bit type =	1 or AB	D4 type
	2 or ABCD	ESF type
"*sig bits*" =	binary 00 to 11	D4 type signaling bits
	binary 0000 to 1111	ESF type signaling bits

The corresponding query command.

SSB? *sig bits type* returns "*binary form*"

Send Background Signaling Bits

Selects the "background" signaling bit sequence for use in the signaling bit test. The signaling bits in all channels except the one selected for the "foreground" will have their signaling bits set to this value.

SSO *sig bit type*,"*sig bits*"

sig bit type =	1 or AB	D4 type
	2 or ABCD	ESF type
"*sig bits*" =	binary 00 to 11	D4 type signaling bits
	binary 0000 to 1111	ESF type signaling bits

The corresponding query command.

SSO? *sig bits type* returns "*binary form*"

Send Signaling Bits in Channel

Selects the channel that the foreground signaling bits should be inserted into.

SSI *channel*	*channel* =	1 to 24	Foreground channel.

The corresponding query returns the selected timeslot, in integer form as described above:-

SSI? returns *channel* = 1 to 24

High Resolution Round Trip Delay Transmit Timeslot Selection

Selects the timeslot that the high resolution round trip delay should be transmitted on.

RTT *timeslot*	*timeslot* = 1 to 24	rtd timeslot.

The corresponding query returns the selected channel, in integer form as described above:-

RTT? returns *timeslot* = 1 to 24

High Res Round Trip Delay Rx Timeslot Select

Selects the timeslot that the high resolution round trip delay measurement should be received from if the rx timeslot is not "AS TRANSMITTER".

RTR *timeslot*	*timeslot* = 1 to 24	rtd timeslot.

The corresponding query returns the selected rtd rx timeslot in integer form as described above:-

RTR? returns *rtd rx timeslot* = 1 to 24

High Res Round Trip Delay Rx From Select

Selects whether the high resolution round trip delay rx timeslot should be the same as the transmitter timeslot or should be selectable.

RTF *n*	*n* =	1 or ASTX	Receiver timeslot is the same as transmitter
		2 or SELECT	Receiver timeslot is selectable

The corresponding query returns the currently selected timeslot mode in integer form as described above:-

RTF? returns *timeslot from mode* = 1 or 2

VF Channel Select

This command selects the TX/RX single channel within the VF application. This channel is used to send and receive internally generated tones or external signals via the VF ports and an internal codec.

This field also appears on the VF ACCESS (AUX) page where it is used to access the selected timeslot and drop it to the VF OUTPUT on the front panel. Note that VF ACCESS is not inhibited for unusual selection choices, eg dropping a channel containing DDS data.

`VFC` *n*	*n* = `1` to `24`	Channel number
`VFC?` returns *n*	*n* = `1` to `24`	

VF Audio Monitor

This field appears on both the VF application page and the VF ACCESS (AUX) page. It enables both the VF OUTPUT port and the instrument's internal speaker such that monitoring the audio content of the selected channel (on either VF application of VF ACCESS (AUX) page) is possible. Note that the speaker volume control has no effect on the VF OUTPUT port.

`VFA` *n*	*n* = `0` or `OFF`	Disable audio/VF output
	`1` or `ON`	Enable audio/VF output
`VFA?` returns *n*	*n* = `0` or `1`	

VF Channel Mapping

This command selects the type of channel mapping to be used.

`CHM` *n*	*n* = `1` or `D1D`	D1D mapping
	`2` or `D2`	D2 mapping
	`3` or `D3/D4`	D3/D4 mapping

The corresponding query returns the channel mapping selection, in integer form as described above:-

`CHM?` returns *mapping selection* = `1`, `2` or `3`

VF Timeslot Query

This command returns the current VF timeslot after it has been translated from the VF rx channel number, in integer form:-

VFT? returns *vf timeslot* = 1 to 24

Test Period

This command selects the mode of test period control.

TPD *n*	*n* =	1 or CON	Continuous (Controlled by RESTART)
		2 or T15M	15 minute timed test
		3 or T2H	2 hour timed test
		4 or T24M	24 hour timed test
		5 or USER	User defined test duration (see TDU)

The corresponding query returns the test time mode, in integer form as described above:-

TPD? returns *test time type* = 1 to 5

Test Period (User-Defined)

Selects the user-defined test duration, applicable when the "USER" test time mode is in force. "LOOPS" is only applicable when "MULTI" is the active choice for the PAS command.

TDU *duration,units*	*duration* =	1 to 100	Duration of test
	units =	0 or SECONDS	Test duration is seconds
		1 or MINUTES	Test duration is minutes
		2 or HOURS	Test duration is hours
		3 or DAYS	Test duration is days
		4 or LOOPS	Test duration is loops

TDU? returns *duration,units*

T1 In-Band (CSU) Loopcodes Auto Response

This selects whether in-band T1 loop up/down should be performed automatically on detection of in-band (CSU) loop up/down codes. Auto response is not available for the FULL-T1, Nx56k or Nx64k choice of SPECIAL monitoring modes. It is also unavailable for DS0-DDS.

`CSA` *n*	*n* = `0` or `OFF`	Auto response off
	`1` or `ON`	Auto response on

`CSA?` returns *n*	*n* = `0` or `1`

T1 Out-Band (CSU) Loopcodes Auto Response

This selects whether out-band T1 loop up/down should be performed automatically on detection of out-band (CSU) loop up/down codes. Auto response is not available for the FULL-T1, Nx56k or Nx64k choice of SPECIAL monitoring modes. It is also unavailable for DS0-DDS.

`COA` *n*	*n* = `0` or `OFF`	Auto response off
	`1` or `ON`	Auto response on

`COA?` returns *n*	*n* = `0` or `1`

T1 Loopback Band

This selects whether the instrument should be monitoring (or sending) T1 in-band or out-band loopback patterns when receiving (or transmitting) a T1 signal. OUTBAND is only permitted when ESF framing is present or in FDL with SLC96 framing.

`LPB` *n*	*n* = `1` or `INBAND`	TX/RX in-band loopcodes
	`2` or `OUTBAND`	TX/RX out-band loopcodes

`LPB?` returns *n*	*n* = `1` to `2`

T1 In-Band (CSU) Loopcodes - Tester Looped Manual Control

This selection is for T1 in-band manual control of the loop up/down state of the instrument. It is only permitted for in-band use with the appropriate T1 application and will be rejected otherwise. Note that the field will follow the instrument state if auto response is enabled such that the query command (CSM?) will reflect the current looped status.

CSM *n*	*n* = 0 or DOWN	In-band manual loop down
	1 or UP	In-band manual loop up

CSM? returns *n* — *n* = 0 or 1

T1 Out-Band (CSU) Loopcodes - Tester Line Looped Manual Control

This selection is for T1 out-band manual control of the line loop up/down state of the instrument. It is only permitted for out-band use with the appropriate T1 application and will be rejected otherwise. Note that the field will follow the instrument state if auto response is enabled and the instrument receives a line loop up/down pattern. The query command (COL?) will thus reflect the current line looped status.

COL *n*	*n* = 0 or DOWN	Out-band manual line loop down
	1 or UP	Out-band manual line loop up

COL? returns *n* — *n* = 0 or 1

T1 Out-Band (CSU) Loopcodes - Tester Payload Looped Manual Control

This selection is for T1 out-band manual control of the payload loop up/down state of the instrument. It is only permitted for out-band use with the appropriate T1 application and will be rejected otherwise. Note that the field will follow the instrument state if auto response is enabled and the instrument receives a payload loop up/down pattern. The query command (COP?) will thus reflect the current payload looped status.

COP *n*	*n* = 0 or DOWN	Out-band manual payload loop down
	1 or UP	Out-band manual payload loop up

COP? returns *n* — *n* = 0 or 1

T1 Alarm Generation

This selects either AIS or Yellow alarm for T1 transmission. These selections only take effect when transmitting any T1 signal. Yellow alarm is not permitted for T1 unframed use and the alarm is set to OFF after a power cycle. No alarm generation is permitted for DS0-DDS.

ALG *n*	*n* = 0 or OFF	No alarm generation
	1 or AIS	Generate AIS
	2 or YELLOW	Generate Yellow alarm

ALG? returns *n* *n* = 0 to 2

T1 In-Band Loopcodes

This selects the value of the T1 in-band loop up/down codes. This selection is only relevant when receiving a T1 signal.

LPC *n*	*n* = 1 or LINE	Line (CSU) loopcodes
	2 or SMART4 or FAC4B	4-bit smartjack loopcodes
	3 or SMART5 or FAC5B	5-bit smartjack loopcodes
	4 or USER	User Programmable loopcodes
	5 or ADRS	Addressable loopback device

LPC? returns *n* *n* = 1 to 5

T1 Out-Band Loopcodes

This selects the value of the T1 out-band loop up/down codes. This selection is only valid when receiving a T1 signal with ESF framing. The exception to this is FDL with SLC96 framing.

LOC *n*	*n* = 1 or LINE	Line (CSU) loopcodes
	2 or PAYLOAD	Payload (CSU) loopcodes
	3 or SMARTJACK	Smartjack loopcodes
	4 or USER	8-bit user programmable loopcodes
	5 or ADRS	Addressable loopback device

LOC? returns *n* *n* = 1 to 5

T1 User Program Out-Band Loop-Up Loopcodes

This selects the user programmable values of the T1 out-band loop up codes as selected under 'LOC USER'. Only six bits are actually programmable as the outer bits are defined by standards.

LOU "*string*" *string* = 6 characters, 0 or 1

LOU? returns "*string*" *string* = 6 characters, 0 or 1

T1 User Program Out-Band Loop-Down Loopcodes

This selects the user programmable values of the T1 out-band loop down codes as selected under 'LOC USER'. Only six bits are actually programmable as the outer bits are defined by standards.

LOD "*string*" *string* = 6 characters, 0 or 1

LOD? returns "*string*" *string* = 6 characters, 0 or 1

T1 User Defined In-Band Loop-Down Code

This selects the T1 user program in-band loop-down code for transmitting or receiving. The correct length of word must be sent in the range 3 to 8 bits. The query command may return trailing spaces but will always be 8-characters long.

LPD "*string*" *string* = 3 to 8 characters, 0 or 1

LPD? returns "*string*" *string* = 8 characters, 0 or 1 or " "

T1 User Defined In-Band Loop-Up Code

This selects the T1 user program in-band loop-up code for transmitting or receiving. The correct length of word must be sent in the range 3 to 8 bits. The query command may return trailing spaces but will always be 8 characters long.

LPU "*string*" *string* = 3 to 8 characters, 0 or 1

LPU? returns "*string*" *string* = 8 characters, 0 or 1 or " "

Choose T1 addressable loopback protocol by RBOC

This command controls the type of protocol used when commanding addressable repeaters. The protocol used by each RBOC is subtly different. For independents it is possible to choose a protocol by manufacturer.

`RBOC` *n*	*n* = 1 to 11	1 or `AMERITECH`
		2 or `BELL_S` (Bell South)
		3 or `NYNEX`
		4 or `PACBELL`
		5 or `ATLANTIC` (Bell Atlantic)
		6 or `SW_BELL` (South Western Bell)
		7 or `US_WEST`
		8 reserved
		9 reserved
		10 or `WESTELL`
		11 or `TELTREND` (generic)

The default is `RBOC AMERITECH`

`RBOC?` returns *n* *n* = 1 to 11

Set T1 addressable repeater address

The ADRN command sets the address of the addressable loopback to be talked to. The range is protocol specific, and when appropriate address 0 means IOR; other numbers are ILRs.

`ADRN` *n*	*n* = 0 to 1999	for Teltrend protocols
	0 to 20	for Westell protocols
	1 to 1999	

The default is `ADRN 20`

Bell_South use a Westell protocol; others use Teltrend.

`ADRN?` returns *n* *n* = 0 to 1999

Effect T1 addressable repeater action.

Addressable repeaters may be commanded to do a number of activities. The syntax is:-

ADRA *n*	*n* = 0 to 11	
	0 or OFF	
	1 or ARM	
	2 or DSX_NI	(Arm from DSX toward NI direction).
	3 or DISARM	
	4 or LOOP	
	5 or UNLOOP	(but keep armed)
	6 or QUERY	(query for address)
	7 or TIMEOUT	(defeat timeout)
	8 or POWER_Q	(query for repeater in power loop)
	9 or SPAN	(query for repeater in span cut thru)
	10 or NI_DSX	(Arm from NI to DSX direction)
	11 or POWER_DN	(Set power down)

The default is ADRA OFF

ADRA? returns *n*   *n* = 0 to 11

Loop Up

This command causes the instrument to transmit the selected T1 or DDS loop up loopcodes or action MJU functions. It is equivalent to pressing the LOOP UP key on the front panel. If this is attempted while the instrument itself is looped or during autosetup or selftest an error is generated. VF mode loopback is V.54 loopback.

LUA

Loop Down

This command causes the instrument to transmit the selected T1 or DDS loop down loopcodes. It is equivalent to pressing the LOOP DOWN key on the front panel. If this is attempted while the instrument itself is looped or during autosetup or selftest an error is generated. An error will also be generated while in a DDS application and MJU functions are selected. VF mode loopback is V.54 loopback.

LDA

T1/DDS In-Band Loop Up Status Query

This query command returns the outcome of the last T1 or DDS in-band loop up/down command. Note that a successful loop up cannot be determined with T1 out of band loopcodes.

LST? returns *n*	*n* =	0	No attempt to loop up has been made yet.
		1	The last loop up was successful.
		2	The last loop up failed.
		3	A pre-existing loop up was detected.
		4	Attempting loop up.

T1 In-Band Loopcodes - Framing Insertion

This selects insertion or overwriting of T1 framing into the loopcodes. In INSERT, the T1 framing is placed in gaps in the loopcode pattern, while in OVERWRITE the T1 framing is simply placed over the top of the loopcode pattern.

LPF *n*	*n* =	1 or INSERT	Insert T1 framing
		2 or OVERWRITE	Overwrite with T1 framing

LPF? returns *n* *n* = 1 or 2

Printer Squelch

This command enables or disables the squelch feature.

PRS *n*	*n* =	1 or OFF	Squelch disabled
		2 or ON	Squelch enabled

The corresponding query returns the state of the squelch feature, in integer form as described above:-

PRS? returns *squelch type* = 1 or 2

PRINT NOW Key Control

This command selects what to print when the "PRINT NOW" key is pressed on the front panel of the instrument. CURRENT SETTINGS will result in a broadbase printout of all of the instrument's main settings while RESULTS SNAPSHOT will cause the output of all of the current main results of the instrument. Changing this field will not result in the instrument restarting its tests.

PRD *n*	*n* =	1 or SETTINGS	Print current settings on "PRINT NOW"
		2 or RESULTS	Print current results on "PRINT NOW"

PRD? returns *print on demand type* = 1 or 2

Printer Auto Trigger

Selects the mode of auto triggering of printer output.

Note that in practice this command cannot be acted upon immediately. The instrument will only allow logging to occur when the remote control is deselected. This is not a facility available on remote control.

PRA *n*	*n* =	1 or OFF	No auto triggered output
		2 or EVENT	Event log summaries
		3 or FIFTEENMIN	Results at 15 minute intervals
		4 or TWOHOUR	Results at 2 hour intervals
		5 or ENDOFTEST	End of test results
		6 or MESSAGEONLY	Only major messages

PRA? returns *auto trigger type* = 1 to 6

Interface Type

Selects T1 interface type.

IFC *n*	*n* =	1 or DSX	DSX monitor interface
		2 or TERM	100 ohm terminated interface
		3 or BRIDGE	> 1kohm bridged interface

The corresponding query returns the interface type, in integer form as described above:-

IFC? returns *interface type* = 1 to 3

Line Build Out

Selects T1 line build out.

`LBO` *n*	*n* =	1 or `ZERO`	0dB
		2 or `SEVENPOINTFIVE`	7.5dB
		3 or `FIFTEEN`	15dB

The corresponding query returns the line build out value, in integer form as described above:-

`LBO?` returns *line build out type* = 1 to 3

Transmit Timing

Selects transmit timing source.

`TRT` *n*	*n* =	1 or `INTERNAL`
		2 or `RECOVERED`

The corresponding query returns the transmit timing source, in integer form as described above:-

`TRT?` returns *timing source type* = 1 or 2

Signaling Bit Display Type Select

This command allows either single or all signaling bits to be displayed when in T1 special mode. This is necessary because certain results may only be read when this is correctly configured. (Cf. SIG?, SCG?)

`SBD` *n*	*n* =	1 or `SINGLE`	A single t/s sig. bit is displayed
		2 or `ALL`	All t/s sig. bits are displayed

`SBD?` returns *displayed sig bit type* = 1 or 2

Signaling Bit Display Channel Select

Selects the channel number that should be displayed when the single channel monitor test is selected in T1 special mode.

SBS *channel no*	*channel* =	1 to 24	Channel to display.

The corresponding query returns the selected channel in integer form as described above:-

SBS? returns *channel no* = 1 or 24

Timeslot Map Display Type Select

This command allows either single or all timeslots to be displayed in the timeslot check measurement. This is necessary because certain results may only be read when this is correctly configured. (Cf. TSS?, BIT?)

TMD *n*	*n* =	1 or SINGLE	A single t/s sig. bit is displayed
		2 or ALL	All t/s sig. bits are displayed

TMD? returns *displayed t/s check type* = 1 or 2

Timeslot Map Display Timeslot Select Command

Selects the timeslot number that should be displayed when a single timeslot is selected in the timeslot map test.

TMS *timeslot no*	*timeslot* =	1 to 24	Timeslot to display.

The corresponding query returns the selected timeslot in integer form as described above:-

TMS? returns *timeslot no* = 1 to 24

DS0 Clock Source

This selects the form of the DS0 clock source presented to the instrument at the DS0 CLOCKS port. The clock is used to transmit and receive DS0 data. BIT & BYTE are a pair of TTL clocks at 8kb/s and 64kb/s. The

COMPOSITE clock signal is a single ternary signal at 64kb/s with bipolar violations at 8kb/s for byte timing.

DCS *n*	*n* =	1 or BIT_BYTE	Bit & Byte clocks
		2 or COMPOSITE	Composite clock

DCS? returns *n*   *n* = 1 to 2

DDS Error Correction

This selects the DS0A dataport error correction mode for the DDS applications. Error correction is only available for DS0A payloads of less than 38.4kb/s.

DEC *n*	*n* =	0 or OFF
		1 or ON
DEC? returns *n*	*n* =	0 or 1

DS0 Interface Termination

This command selects the DS0 interface format for the DS0-DDS application. The signal at the DS0 Bantam jack connectors can be either BIPOLAR (NRZ, TTL, AMI), LOGIC NEAR (tip) or LOGIC FAR (ring).

DIT *n*	*n* =	1 or BIPOLAR	Non-return to zero, TTL, AMI
		2 or LOGIC_NEAR	TTL unipolar (tip)
		3 or LOGIC_FAR	TTL unipolar (ring)

DIT? returns *n*   *n* = 1 to 3

DDS/VF Switched-56 Pattern

This selects the DDS pattern used in the DDS applications. Pattern EXTERNAL permits an externally generated user pattern to be inserted/dropped via the X.21 leased port. The user programmable word is f-bits, (leading bit is used for framing, F).

A sub-selection is provided for use in VF switched-56 testing. This selection is PRBS2047, PRBS511, STRESS, ALLONES and ALLZEROS. (Not available for 37701B).

DPA *n*	*n* = 1 or PRBS2047	PRBS 2047
	2 or PRBS511	PRBS 511
	3 or STRESS	DDS stress patterns
	4 or PRBS2047_2C	Secondary channel PRBS 2047
	5 or PRBS511_2C	Secondary channel PRBS 511
	6 or ALLONES	All 1's
	7 or ALLZEROS	All 0's
	8 or EXTERNAL	External via X.21 leased port
	9 or USER	User programmable word (8-bit)

DPA? returns *n* *n* = 1 to 9

DDS Payload Rate

This selects the payload rate for the DDS applications. Each payload rate can have DDS frame sync/loss and/or DDS frame error count associated with it, as indicated by * in the following table.

Payload Rate	Frame Sync	Frame Errors
56.0kb/s		
38.4kb/s	*	*
19.2kb/s	*	*
9.6kb/s	*†	*
4.8kb/s	*†	*
2.4kb/s	*†	*

Note

† Applies to DS0B and applies to DS0A when Error Correction enabled. Not available for cross-mux testing.

DPR *n*	*n* = 1 or T56000	56.0kb/s
	2 or T38400	38.4kb/s
	3 or T19200	19.2kb/s
	4 or T9600	9.6kb/s
	5 or T4800	4.8kb/s
	6 or T2400	2.4kb/s

DPR? returns *n* *n* = 1 to 6

DDS DS0B Customer Number

This selects the DS0B customer number. The range of the parameter depends on the payload rate as shown in the following table.

Payload Rate	Customer Number
56.0kb/s	1
38.4kb/s	1
19.2kb/s	1 to 2
9.6kb/s	1 to 5
4.8kb/s	1 to 10
2.4kb/s	1 to 20

DCU *n* *n* = 1 to 20 customer number

DCU? returns *n* *n* = 1 to 20

DDS Single/multi Customer Mode

Selects the DDS single (DS0A) or multi (DS0B) customer mode. These are available for T1-DDS. A further two cross-mux selections are available for DS0-DDS.

DDC *n*	*n* = 1 or DS0A	single customer
	2 or DS0B	multi customer
	3 or DS0AB	cross-mux DS0A to DS0B
	4 or DS0BA	cross-mux DS0B to DS0A

DDC? returns *n* *n* = 1 to 4

DDS Stress Pattern

This selects which of the four DDS stress patterns to use when a DDS stress pattern is selected.

DSP *n*	*n* = 1 to 4	
DSP? returns *n*	*n* = 1 to 4	

T1-DDS Timeslot Select

This command selects the TX/RX single T1 timeslot within the T1-DDS application. DS0A DDS data is contained in this timeslot.

DTS *n*	*n* = 1 to 24	Timeslot number
DTS? returns *n*	*n* = 1 to 24	

FDL Host Address

Selects the host address to be contained in the FDL data.

FAD *n*	*n* = 1 or CUSTOMER	Customer (CI)
	2 or CARRIER	Carrier (NI)
FAD? returns *n*	*n* = 1 or 2	

FDL Protocol

Selects the FDL protocol choice. EXTERNAL permits FDL data to be dropped and inserted via the X.21 leased port.

FPR *n*	*n* = 1 or T1403	T1.403 protocol
	2 or TRTSY8	TR-TSY-000008 protocol
	5 or EXTERNAL	External FDL data
FPR? returns *n*	*n* = 1, 2, 5	

DDS MJU Operation Branch Select Code Number Result

This result is only valid for DDS MJU operations. This is the result of the instrument reading the branch select code from equipment that has been selected while being routed to set up the test path. The result becomes invalid when any loopback selection/operation is actioned upon. This command has no effect on instrument status flags.

BSC? returns *flag,oor,n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Always in range
	n = 1 to 4	Branch number

DDS Alternating OCU-DP Loopback HL-96NY Card Presence

This informs the instrument of the presence of an HL-96NY card in the path to an OCU-DP when DDS alternating loopbacks are selected. This can only be set when DDS ALTERNATING loopbacks are selected (LBT).

HLP *n*	*n* = 0 or NO	There is no HL-96NY card present
	1 or YES	There is an HL-96NY card present

HLP? returns *n* *n* = 0 or 1

DDS MJU Operation Hub-ID Result

This result is only valid for DDS latching loopback type MJU or DDS MJU operations. The instrument remembers both the HUB-ID of the last MJU looped, and the HUB-ID of the last mju routed, blocked etc. Depending on the looping operation selected (see LBT command) the relevant HUB-ID is returned. For all but a latching choice the MJU operation HUB-ID is returned. This command has no effect on instrument status flags.

HUB? returns *flag,oor,n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Always in range
	n = 0 to 77	Octal number (HUB-ID)

DDS Alternating Loopback Type

This selects the type of DDS alternating loopback to be set up when in either T1-DDS or DS0-DDS. This can only be set when DDS ALTERNATING loopbacks are selected (LBT).

LBA *n*	*n* =	1 or DSU	Data Services Unit
		2 or CHANNEL	Channel Service Unit
		3 or OCUDP	Office Channel Unit dataport
		4 or HL96NY	HL-96NY
		5 or REPEATER	Repeater (56kb/s)
		6 or DSODP	DS0 dataport

LBA? returns *n*   *n* = 1 to 6

DDS Latching Loopback Type

This selects the type of DDS latching loopback to be set up when in either T1-DDS or DS0-DDS. This can only be set when DDS LATCHING loopbacks are selected (LBT).

LBL *n*	*n* =	1 or CHANNEL	Channel Service Unit
		2 or OCUDP	Office Channel Unit dataport
		3 or DSODP	DS0 dataport
		4 or HL222	HL-222
		5 or MJU	MJU
		6 or V54	V.54

LBL? returns *n*   *n* = 1 to 6

DDS Loopback Operation Type

This selects the type of loopcode to be transmitted when in either T1-DDS or DS0-DDS and loop up/down is requested. When dealing with MJU functions, only the loop up command (LUA) is permitted to action the function. Also note that dataport cards may be restricted to which type of loopback they respond to.

LBT *n*	*n* =	0 or NONE	No DDS loopback operation select
		1 or ALT	Select DDS alternating loopbacks
		2 or LATCH	Select DDS latching loopbacks
		3 or MJU	Select DDS MJU function

LBT? returns *n*   *n* = 0 to 3

DDS Latching Loopback Map Code Result

This result is only valid for DDS latching loopback type CHANNEL, OCU-DP, DS0- DP and HL-222. This is the result of the instrument reading the mapcode of equipment that has been looped back using a DDS latching loopback. The result becomes invalid when any loopback selection/operation is actioned upon. This command has no effect on instrument status flags.

MAP? returns *flag*,*oor*,"*string*"	*flag* =	0 or 1	Validity Flag
	oor =	1	Always in range
	string =	8 ASCII characters	Mapcode

DDS Multi-Point Junction Unit (MJU) Operation

This selects the type of DDS MJU operation to be performed as part of a test path selection procedure. This will typically involve selecting a MJU branch and performing an operation on it. The operation can only be set when DDS MJU OPERATIONS are selected ("LBT").

MJU *n*	*n* =	1 or SELECT	Select a branch
		2 or BLOCK	Block the selected branch
		3 or UNBLOCK	Unblock the selected branch
		4 or RELEASE	Unblock all branches

MJU? returns *n*   *n* = 1 to 4

DDS MJU Operation Branch Number

This selects the DDS MJU operation branch number as part of a test path selection procedure. This can only be set when DDS MJU OPERATIONS are selected ("LBT").

SBR *n*	*n* = 1 to 4	
SBR? returns *n*	*n* = 1 to 4	

T1 Pattern or Special Measurements

This selects which measurement selection should be performed in FULL- T1, Nx56k or Nx64k. (In all other configurations, this choice will be forced to PATTERN). In the case of PATTERN, all of the basic T1 pattern choices are available along with the measurement TEST PERIOD control. In the case of SPECIAL, there is no TEST PERIOD control and the instrument will not perform gated measurements. Instead, three non-gated monitoring modes are offered and are as detailed in the SPT command.

PAS *n*	*n* = 1 or PATTERN	T1 pattern measurements
	2 or SPECIAL	T1 special monitoring
	3 or MULTI	T1 multi-pattern measurements

PAS? returns *n* *n* = 1 to 3

Multi pattern commands

Multi-pattern choice

This command selects between 3 different multi-pattern tests:

Bridge Tap test	This sequence of 21 separate patterns with different frequency spectral characteristics is used to search for bridge taps.
Quick test	This pattern suite of 5 separate (all-1s, 2-in-8, 3- in-24, QRSS) tests is a quick check on the overall performance of a T1 line.
User test	This selection allows user customization of a test suite.

`PML` *n*   *n* = 1 or `BRIDGE`
2 or `QUICK`
3 or `USER`

The default is `PML BRIDGE`

`PML?` returns *n*   *n* = 1 to 3

Bridge tap sub-test time

This command sets the length of time each sub-test runs. The default is 20 seconds.

`TMB` *n*   *n* = 10 to 60 step 1

`TMB?` returns *n*   *n* = 10 to 60

Quick pattern sub-test time

This command sets the length of time each sub-test runs. The default is 3 minutes.

`TMQ` *n*   *n* = 1 to 60 step 1

`TMQ?` returns *n*   *n* = 1 to 60

User Multi pattern setup command

This command sets up the patterns used, and test duration for each of the 7 user selections that comprise the user defined pattern command. Note:

- the choice of no pattern ("NONE") is not available for slots 1 and 2.

- the pattern time must be 10 seconds or greater.

- the stress pattern selected by "STRESS" is the "DALY" 55-octet pattern.

- the user pattern selected is that which is current under T1; ie no separate control of length and bit pattern can be made.

- the long user pattern selected is forced to selection #1.

`MLU` *n,p,t,u*	*n* =	1 or 7	pattern number
	p =	0 or `NONE`	no selection made
		1 or `QRSS`	2^20-1 PRBS, (14 zero limit)
		2 or `THREEIN24`	3 zeros in 24 bits
		3 or `ALLONES`	111111 ...
		4 or `ALLZEROS`	000000 ...
		5 or `ONEIN8`	100000001 ...
		6 or `ONEIN2`	101010 ...
		7 or `STRESS`	stress patterns
		8 or `USER`	User programmable 3 to 24 bit word
		9 or `LONGWRD`	User programmable long user word
		10 or `LIVE`	(not valid)
		11 or `PRBS15`	2^15-1 PRBS, (inverted)
		12 or `PRBS20`	2^20-1 PRBS
		13 or `PRBS23`	2^23-1 PRBS, (inverted)
	t =	1 to 60	pattern time value
	u =	1 or `SECONDS`	pattern time is seconds
		2 or `MINUTES`	pattern time is minutes

The defaults are:

```
MLU 1,QRSS,3,MINUTES
MLU 2,THREEIN24,3,MINUTES
MLU 3,ALLONES,3,MINUTES
MLU 4,ALLZEROS,3,MINUTES
MLU 5,ONEIN8,3,MINUTES
```

```
MLU 6,ONEIN2,3,MINUTES
MLU 7,STRESS,3,MINUTES
```

MLU? *n*	*n* = 1 to 7	pattern number

returns *p*,*t*,*u*	*p* = 1 to 13
	t = 1 to 60
	u = 1 or 2

Multi pattern sync byte

This command sets the value of the inter sub test synchronisation pattern. Note the algorithm will not work if this pattern is present in user patterns selected; ie if it mimics 1-in-8 and 1-in-8 is selected then the algorithm will fail. Similarly for an 8-bit pattern repeated in 55-octet, user word (short or long) but not for PRBS.

MLS "*string*"	*string* = 8 characters, 0 or 1

There is no default, but a suitable value is 11111010.

MLS? returns "*string*"	*string* = 8 characters, 0 or 1

VF Tone Frequency

This command selects one of the fixed value tone frequencies available from the VF application for insertion into the selected channel number.

TFF *n*	*n* = 1or T404	404Hz
	2 or T1008	1008Hz
	3 or T2100	2100Hz
	4 or T2804	2804Hz
	5 or USER	User program frequency

TFF? returns *n*	*n* = 1 to 5

VF Tone Level

This selects the tone level for the VF application when the VF payload is a selectable TONE. The parameter must be a multiple of 5dBm0.

TFL *lvl*	*lvl* = 0 to -55	dBm0 in 5dBm0 steps
TFL? returns *lvl*	*lvl* = 0 to -55	

VF User Defined Tone Frequency

This command selects the user defined tone frequency as applicable under TFF USER for the VF application.

TFU *freq*	*freq* = 100 to 3900	Frequency in Hz
TFU? returns *freq*	*freq* = 100 to 3900	

Thru mode

Thru mode is only permitted for the configurations of Nx56k and Nx64k with any PATTERN selection. It is also unconditionally permitted for VF and T1-DDS. Thru mode, when enabled, passes any non-selected timeslots straight thru from receiver to transmitter. The instrument drops out the selected timeslot(s) for measurement and the transmitter inserts data into the selected timeslot(s). If an EXTERNAL pattern is selected, then the selected timeslots are dropped to the X.21 leased port and data is inserted into the transmitter from there also. The framing bits are passed straight thru (including FDL) also, but CRC bits are recalculated.

THU *n*	*n* = 0 or OFF	Through mode off
	1 or ON	Through mode on
THU? returns *n*	*n* = 0 or 1	

Alternating Channel Loopback Intermediate Repeater Number

This selects the intermediate repeater number for DDS alternating loopbacks of type CHANNEL. The intermediate repeater number is only relevant for a payload rate of 56kb/s. This can only be set when DDS ALTERNATING loopbacks are selected (LBT).

`TIR` *n*	$n =$ 0 to 2	
`TIR?` returns *n*	$n =$ 0 to 2	

Loopback Tandem Unit Number

This selects the tandem unit number for DDS alternating or latching loopbacks of type DS0-DP. This can only be set when either DDS ALTERNATING or LATCHING loopbacks are selected (LBT).

`TNU` *n*	$n =$ 1 to 8	
`TNU?` returns *n*	$n =$ 1 to 8	

DDS Alternating Repeater Loopback Repeater Number

This selects the repeater number for DDS alternating loopbacks of type REPEATER. The repeater number is only relevant for a payload rate of 56kb/s. This can only be set when DDS ALTERNATING loopbacks are selected (LBT).

`TRN` *n*	$n =$ 1 to 2	
`TRN?` returns *n*	$n =$ 1 to 2	

VF Dialing Signaling Bits

This selects whether the VF application on-hook/off-hook signaling bits, as used in pulse dialing, are FIXED or USER programmable.

`VDS` *n*	$n =$ 1 or `FIXED`	VF signaling bits are fixed
	2 or `USER`	VF signaling bits are user program
`VDS?` returns *n*	$n =$ 1 or 2	

VF Channel Payload

This selects the content of the VF application channel. It can either be an internally generated TONE, an EXTERNAL signal via the VF ports and an internal codec or one of a range of switched 56kb/s patterns.

VFP *n*	*n* = 1 or TONE	Selectable tone
	2 or QUIET	Zero level DC signal
	3 or EXTERNAL	External signal to/from VF ports
	4 or SWITCHED_56	Switched 56kb/s pattern

VFP? returns *n* *n* = 1 to 4

VF Signal/Dialing Control

This selects the VF dialing control to dial out the correct signaling information in order to seize a line (go "OFF-HOOK"). This field is effectively a state machine and is instrument controlled as well as user controlled.

The states of ON/OFF_HOOK are displayed, while signaling/dialing activity is controlled by making the relevant dialing selection of DIAL_PULSE/DTMF. Dialing activates a state machine which drops the current circuit (ON_HOOK), seizes a line (OFF_HOOK), dials (DTMF or PULSE) and remains in the (OFF_HOOK) state to run the test. To accommodate multiple dialing requests from one seizure, CHAIN dialing is offered; CHAIN dialing does not go thru the ON_HOOK state. The instrument will return to OFF_HOOK from any DIAL or CHAIN state.

Note

While dialing, the following fields are locked on the VF application page to prevent change:

CHANNEL

MAPPING

PHONE

VFS *n*	*n* =	1 or ON_HOOK	Line is idle
		2 or DIAL_DTMF	Transient state of DTMF dialing
		3 or DIAL_PULSE	Transient state of PULSE dialing
		4 or OFF_HOOK	Line is seized
		5 or CHAIN_DTMF	Transient state of DTMF dialing
		6 or CHAIN_PULSE	Transient state of PULSE dialing
		7 or DIAL_MF	Transient state of MF dialing
		8 or CHAIN_MF	Transient state of MF dialing

VFS? returns *n*   *n* = 1 to 8

VF Phone Number

This selects the telephone number selection used when in the VF application. The 0 to 15 digits are dialed out in order from left to right and any spaces in the number are ignored to assist number readability. Special PABX characters are permitted and all characters are converted to upper case. The empty string is acceptable though no characters can be dialled out. The query command returns the full 15 character field width, empty or not.

VPH "*tel*"	*tel* =	0 to 9	numeric characters 0 to 9
		A to D	alpha characters A to D
		#, ,*	special characters hash, space, asterisk
		',"	special characters prime, double-prime
		$	special characters treble-prime
			all to a total of 0 to 15 digits

VPH? returns "*tel*"   *tel* = 0 to 9,A to D, ,#, ,*,',",$

VF User Programmable Signaling Bits

This sets up both the AB or ABCD user programmable on-hook and off- hook signaling bits as used in the VF application for pulse dialing. There are three parameters to this command, the first one determines whether AB or ABCD bits are being referred to, the second and third are string parameters and set up the ON HOOK and OFF HOOK values respectively.

VUS *n*, "*on_hook*", "*off_hook*"	*n* = 1 or AB	Set up AB on/off-hook signaling bits
	2 or ABCD	Set up ABCD on/off-hook signaling bits
	on_hook = 2 or (AB) or 4 (ABCD) char 0 or 1	
	off_hook = 2 or (AB) or 4 (ABCD) char 0 or 1	

VUS? *n*	*n* = 1 or AB	Query AB on/off-hook signaling bits
	2 or ABCD	Query ABCD on/off-hook signaling bits

returns

"*on_hook*",	*on_hook* = 2 (AB) or 4 (ABCD) characters 0 or 1
"*off_hook*"	*off_hook* = 2 (AB) or 4 (ABCD) characters 0 or 1

Control of SLC-96

Send control

This command controls what message type is sent when the loop-up or loop-down commands are sent; it chooses between doing a "far-end-loop" or a "protection" switch.

```
SLCS n      n =  1 or FARENDLOOP
                 2 or PROTECTSW
```

The default is SLCS FARENDLOOP

SLCS? returns *n* $n = 1$ or 2

Protection Switch Selection.

This command controls which line (or lines) are switched the protection circuit. To effect this command the test set must control the A line.

```
SLCP n      n =  1 or A_RX
                 2 or B_TX
                 3 or C_TX
                 4 or D_TX
                 5 or B_TX&RX
                 6 or C_TX&RX
                 7 or D_TX&RX
```

The default is SLCP A_RX

SLCP? returns *n* $n = 1$ to 7

Far end loop selection.

If in context, this command chooses which line is acted upon at the RTU when the loop-up/down command is issued.

```
SLCF n      n =  1 or A
                 2 or B
                 3 or C
                 4 or D
                 5 or P
```

The default is SLCF A

SLCF? returns n $n = 1$ to 5

SLC96 Read alarms and FELP conditions.

This command returns the status of various TR-TSY-000008 related flags, and 2 multi-pattern flags. The multi-pattern flags give indication as to whether the instrument is counting errors or is sending inter-pattern sync code.

SLCA? returns n $n = 0$ to 65535

The 16 bits within n are decoded as follows

bit	mnemonic	decimal	value	notes
15				always 0
14	NLP	16384	1/(0)	Multi-pattern completed 1 cycle
13	GAT	8192	1/(0)	Multi-pattern counting logic errors
12	FEA	4096	1/(0)	A line is/(is not) Far End Looped
11	FEB	2048	1/(0)	B line is/(is not) Far End Looped
10	FEC	1024	1/(0)	C line is/(is not) Far End Looped
9	FED	512	1/(0)	D line is/(is not) Far End Looped
8	FEP	256	1/(0)	P line is/(is not) Far End Looped
7	AMJ	128	1/(0)	Major Alarm
6	AMN	64	1/(0)	Minor Alarm
5	ASA	32	1/(0)	A shelf Alarm
4	ASB	16	1/(0)	B shelf Alarm
3	ASC	8	1/(0)	C shelf Alarm
2	ASD	4	1/(0)	D shelf Alarm
1	AMS	2	1/(0)	Misc Alarm
0	NOT	1	1/(0)	The RTU is/(is not) a NOTE;

When the RTU is a "NOTE" the A field frame length is 16, otherwise 13.

The NLP bit is cleared upon reading, and is set each time the measurement of the last pattern is completed.

MISCELLANEOUS COMMANDS

Auto/Restart

This command is equivalent to pressing the AUTO/RESTART key which will stop the instrument testing, auto-setup onto the current signal and then restart testing. The instrument configuration (CONFIG) must be set first. The progress of the auto-setup can be determined by the ASC flag in the ready register, (RDY?). If auto-setup or selftest is in progress when the command is sent an error will be generated.

AUT

Stored Settings Lock

This command allows the stored settings to be store locked. That is to say, if the stored settings lock is set then the save operation is prohibited. After any save or recall operation this field is always set back to ON.

SLK *n*	*n* =	0 or OFF	Stored settings lock disabled
		1 or ON	Stored settings lock enabled

SLK? returns *store lock status* = 0 or 1

Beep Command

This command causes an audio "beep" to be made by the instrument. It has no local equivalent operation and is as follows:-

BEEP

Volume Command

This command sets the beeper volume. It is equivalent to pressing either the increase or decrease volume keys on the front panel. Note that the volume setting is not remembered after a power cycle. In this case the volume will be set to a value equivalent to setting the midrange value. There is no corresponding query command.

VOL *parameter*	*parameter* =	OFF or 0	Switches sound to its quietest level
		ON or 1	Switches sound to its loudest level
		DECREASE or 2	Decreases the level
		INCREASE or 3	Increases the level
		MIDRANGE or 4	Sets the level to a midrange value

Save Stored Settings

This command instructs the instrument to save it's current configuration in one of the non-volatile memory locations numbered 1 thru 5. This function will be prevented if the settings lock is enabled.

SAV *n* $\quad$ *n* = 1 to 5

Name Stored Setting

This command permits stored settings 1-5 to be named by a string of up to 32-characters. Not all of the character positions need be filled and any ASCII character is permitted, including control characters, (although this may cause problems with RS-232 operation). Note: either single or double quotes around the string parameter are acceptable, as long as the opening quote is the same as the closing quote. Using this command to title a setting will force all of the "." padding characters (initial condition) to white space.

NAM *n*, "*string*"	*n* = 1 to 5	Stored setting 1-5
	string = 1-32 ASCII characters	

NAM? *n* $\quad$ *n* = 1 to 5

returns "*string*" $\quad$ *string* = 1-32 ASCII characters

Recall Stored Settings

This command instructs the instrument to configure itself as defined in one of the non-volatile memory locations, dependent upon the associated parameter. Recalling settings 0 will reset the instrument to its default settings (similar to RST command).

RCL *n*

Restart Measurement

This will cause the instrument to initiate a start/restart of a measurement. It is identical in function to pressing the RESTART key and will do the following, in order:

- If stopping a test, set the stored measurement & graphics resolution field to OFF.
- If stopping a test, set the auto triggered print field to OFF.
- Zero all test period based measurements and start testing. The complete restart operation can take up to 500ms as the instrument has to synchronize to its internal 100ms clock for both stopping and starting. Starting can be monitored by using either the EOT, TIP or OST bits in the relevant status registers.

STR

Stop Measurement

This command has no local equivalent. It stops the instrument testing regardless of the type of test period currently set. The results are frozen at that point and can be read back freely at any time. The instrument will only restart on receipt of a STR command or any other command which has a side effect of restarting. On stopping, the instrument will do the following:

- Stop the instrument running the current test (if any).
- If stopping a test, set the stored measurement & graphics resolution field to OFF.
- If stopping a test, set the auto triggered print field to OFF.
- The complete stop operation can take up to 300ms as the instrument has to synchronize to its internal 100ms clock. Stopping can be monitored by using either the EOT, TIP or OST bits in the relevant status registers.

STP

T1/Datacom Mode

Selects the mode of the instrument to be either telecom or datacom.

Note: This command causes the instrument to be completely reconfigured. During this reconfiguration any remote control commands sent to the instrument will be ignored, and afterwards the instrument will be LOCAL.

`MODE` *n*	*n* =	1 or `DATACOM`
		2 or `TELECOM`

An error is generated if this command is sent to an HP 37702A, without the HP 15901A accessory fitted.

Returns the currently selected mode in integer format as described below:-

`MODE?` returns 1 or 2

RS-232 Printer Interface

This command configures the printer serial interface configuration. Notice that it sets up parameters for both HP and ALT type printers.

`PTR` *baud_rate,stop_bits,protocol,style*	*baud_rate* =	1 (300baud)
		2 (600 baud)
		3 (1200 baud)
		4 (1800 baud)
		5 (2400 baud)
		6 (4800 baud)
		7 (9600 baud)
	stop_bits =	1 or 2
	protocol =	0 or `OFF`
		1 or `ENQUACK`
		2 or `XONXOFF`
		3 or `DTR`
	style =	1 or `COMPRESSED`
		2 or `NORMAL`

Notice that the data width is always set to 8 bits wide. This is equivalent to 7 bit wide data with zeroes parity. Notice that this command does not set the RS-232 port up to be a printer interface, it only sets up the parameters.

PTR? returns *baud_rate,stop_bits,protocol,style*

baud_rate =	1 to 7
stop_bits =	1 or 2
protocol =	0 to 3
style =	1 or 2

Date Set-Up

This command sets the date in the instrument, in terms of the year, month, and day. If a non-existent date is passed (31st November), then an error is generated. This command is equivalent to selecting "TIME AND DATE SETUP" mode on the front panel, updating the setup date, then selecting "TIME AND DATE RUN" mode.

DAT *years,months,days*

years =	1980 to 2050	
months =	1	JAN
	2	FEB
	3	MAR
	4	APR
	5	MAY
	6	JUN
	7	JLY
	8	AUG
	9	SEP
	10	OCT
	11	NOV
	12	DEC
days =	1 to 31	

The complementary command returns current the real time clock date in integer form as shown above.

DAT? returns *years,months,days*

Time Set-Up

This command sets the time in the instrument in terms of hours, minutes, and seconds. This command is equivalent to selecting "TIME AND DATE SETUP" mode on the front panel, updating the setup time, then selecting "TIME AND DATE RUN" mode.

`TIM` *hours,mins,secs*	*hours* =	0 to 23
	mins =	0 to 59
	secs =	0 to 59

The complementary command returns the time in integer form as shown above.

`TIM?` returns *hours,mins,secs*

Display

Switches the Instrument electroluminescent display ON or OFF. Notice that for instruments without battery power, this will not have any effect (ie. the display will remain on, even if off is sent). The command is still valid however, as is the corresponding query command.

`DIS` *n*	*n* =	0 or `OFF`	Display disabled
		1 or `ON`	Display enabled

The complementary command returns the current threshold in integer form as described above:-

`DIS?` returns *display status* = 0 or 1

Alarm Status Query

This command is a request for the instantaneous status of the alarms in the instrument. They are returned as an integer representing the binary weighted alarm bits of the Alarm Register.

When executed, the `ALM?` command clears the ALC bit in both status register A and B. A change in state of any of these alarms causes the ALC bit to be set in status registers A and B only if their corresponding mask is enabled in the alarm mask register.

The `ALM` command has no local equivalent, and is as follows:-

`ALM?`

The complementary command returns the current threshold in integer form as described above:-

`ALM?` returns *n* = 0 to 32767

Alarm Change Query

This command is a request to determine which alarms have changed their state. The bits which have changed are returned as an integer representing the binary weighted alarm bits of the Alarm Register.

When executed, the `ALC?` command clears all alarm change bits.

The `ALC?` command has no local equivalent, and is as follows:-

`ALC?` returns n = 0 to 32767

Where the bits have the same significance as the alarm register.

Alarm Mask Register Set-Up

Sets up Alarm Mask Register (AMR). This register is used to determine under what conditions the Alarm Change (ALC) bit in Status Register A should be set. If a bit in the Alarm Status register changes (either from 1 to 0 or vice-versa), and the corresponding bit in the Alarm Mask Register is set, the ALC bit in Status Registers A and B are set. The ALC bit is cleared by the ALM?, RST, CLR commands.

The argument to AMR can be specified in a number of ways:-

- As a binary-weighted integer
- As a list of integer values (which are OR'ed)
- As a list of alarm mnemonics (defined later)

`AMR` n n = 0 to 32767

To disable all alarms, specify AMR 0 or AMR NONE.

The corresponding query returns the current value of Alarm Mask Register in integer form as described above.

`AMR?` returns n = 0 to 32767

Alarm History Query

This command queries the history of the alarm status register to determine which alarms in that register have occurred during the last test period or during the current test period if a new period has been started. The returned result is a binary weighted integer with alarm register weightings. This is equivalent to viewing the alarm history (red leds) via the HISTORY/FREEZE key. It should be noted that the display freeze feature is not available under remote control and if the display was frozen locally, it would not interfere with obtaining the correct results from the instrument.

HIS?

Reset History

This command resets the alarm status register history, the alarm status leds and the HISTORY/FREEZE feature if it is running. It is functionally equivalent to pressing the RESET HISTORY key on the front panel. It should be noted that the display freeze feature is not available under remote control and if the display was frozen locally, it would not interfere with obtaining the correct results from the instrument.

HSR

Stored Pulse Lock

This command allows the stored pulses to be locked. If the stored pulse lock is set then the save pulse operation is prohibited.

PLK *n*	*n* = 0 or OFF	Pulse storage not permitted
	1 or ON	Pulse storage permitted

PLK? returns *n*	*n* = 0 or 1

Name Stored Pulse

This command permits stored pulses 1-5 to be named by a string of up to 32-characters. Not all of the character positions need be filled and any ASCII character is permitted, including control characters, (although this may cause problems with RS-232 operation). Note: either single or double quotes around the string parameter are acceptable, as long as the opening quote is the same as the closing quote. Using this command to title a setting will force all of the "."padding characters (initial condition) to white space.

PNM *n*, "*string*"	*n* = 1 to 5	Stored pulse 1-5
	"*string*" = 1-32 ASCII characters	

`PNM? n` $n =$ `1 to 5`

returns "*string*" *string* = `32 ASCII characters`

Save Trapped Pulse

This command instructs the instrument to save the currently displayed pulse in one of the five available pulse stores. This function will be prevented if the pulse store lock is enabled. Note that there is no corresponding recall command. Instead, use the PPR? command to retrieve stored pulse data.

`PSV n` $n =$ `1 to 5`

RX Timeslot Bandwidth Query

This queries the RX fractional-T1 bandwidth in kHz. It corresponds to the rx bandwidth field displayed beside the rx timeslot selection field when that field is as RECEIVE.

`RBW?` returns *n* $n =$ `0 to 1536` kHz

Print Now

This command remotely simulates the "PRINT NOW" key on the front panel. The instrument will respond by returning the contents of its internal buffer followed by the characters EOI. This command will only function if the instrument is remote and the Auto Triggered Print is off.

`REMLOG?` returns

print output line 1
print output line 2
|
|
print output line n
EOI

Result Display

This controls the main result DISPLAY field. To gain access to the GRAPH page, the PAGE command should be used. Note that there is no complementary query command.

```
RESDIS n    n =  1 or BER
                 2 or SCAN
                 3 or GRAPH
                 4 or MULTI
                 5 or SIGNAL
                 6 or SLIPS
                 7 or SLPWAN
                 8 or ALARMS
                 9 or BITMON
                 10 or TONES
                 11 or FDL
```

ERROR INSERT COMMANDS

Transmit Error Insert Rate

This selects the rate of error insert into the transmit data stream. For the case when no error insert is available (see EIT) the choice will forced to ERR FREE.

EIR *n*	*n* =	1 or ERRFREE	Insert no errors
		2 or ONEINMIN3 or EMIN3	Insert 1E-3 errors
		3 or USER	Insert user program rate error
EIR? returns *n*	*n* =	1 to 3	

Transmit Error Insert Type

This selects the type of errors to be inserted. For the applications FULL-T1, Nx56k and Nx64k LOGIC error insert is not available for T1 patterns LIVE or EXTERNAL or for any T1 SPECIAL function. FRAME error insert is only available for framed T1 signals and CRC error insert is only available for a T1 signal with ESF framing. BPV error insert is always available except for pattern EXTERNAL.

There is no error insert at all for the VF or FDL applications and only LOGIC error insert is available for the DDS applications, except for pattern EXTERNAL when there is no error insert available. For the case when no error insert is available, the query command will return 0.

EIT *n*	*n* =	1 or LOGIC	Insert logic errors
		2 or FRAME	Insert frame errors
		3 or CRC	Insert CRC errors
		4 or BPV	Insert BPV errors
EIT? returns *n*	*n* =	0	No error insert
		1 to 4	available

Transmit Error Insert User Program Ratio

This selects the user programmable error insert ratio and comes into effect when the transmit error insert rate is USER PROGRAM. This field can be found on the sub-menus AUX-T1 ALARMS & LOOPING and AUX-DDS ERRORS & LOOPING. The selectable range for non-DDS applications is 3 to 7 and for DDS applications it is 2 to 6.

`EIU` *n*	*n* = 2 or `EMIN2`	10^-2 (DDS only error ratio)
	3 or `EMIN3`	10^-3
	4 or `EMIN4`	10^-4
	5 or `EMIN5`	10^-5
	6 or `EMIN6`	10^-6
	7 or `EMIN7`	10^-7 (non-DDS only error ratio)

`EIU?` returns *n*　　*n* = 2 to 7

Transmit Single Error Insert

This command injects a single error into the generator output stream provided that the generator is in ERROR FREE mode and a transmit error insert source type is selected. If not, an error is produced. This command is equivalent to pressing the front panel single error button.

`SEI`

RESULT QUERY COMMANDS

This section contains all measurement result query commands. If these commands are executed outside testing, the last testing period results are returned; during testing the results returned are the "current" results.

Some results are not always available, therefore they return not only the result but a validity flag. In addition a second flag indicates whether the result is inrange, under or overrange. For most results this will always be inrange, but it is used in the case of simplex current and wander results. It is included in all results however, to maintain a consistent format.

Wander Lock Query

This query command returns the instantaneous lock status of the wander measurement.

`WLK?` returns *flag* =	0	No reference present
	1	Reference is present

Logic Error Result Query

This command requests one of the logic error results. The format of the result returned will depend upon the selected result. These results will be invalid for LIVE or EXTERNAL patterns. This request will reset the EOT bits in STA and STB.

`RLE?` *n*	*n* =	1 or ES	Asynchronous error seconds count
		3 or EFS	Error free seconds
		4 or PCEFS	% error free seconds
		5 or EC	Error count
		6 or ER	Average error ratio
		7 or CUER	Current error ratio

returns *flag*,*oor*,*n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Out of range (always inrange)
	n =	0 to 999999	ES, EFS, EC <1000000
	n =	XX.XXE+X	EC ≥1000000
	n =	0.0 to 1.0E–XX	ER, CUER
	n =	XX.XXX or 100.000	PCEFS

These results will be invalid if the pattern is LIVE.

Logic Analysis Result Query

This command requests one of the logic analysis results. The format of the result returned will depend upon the selected result. These results will be invalid for LIVE or EXTERNAL patterns. This request will reset the EOT bits in STA and STB.

RLA? *n*	*n* =	1 or PCAVAIL	% availability
		2 or DM	Degraded minutes count
		3 or PCDM	% degraded minutes
		4 or SES	G821 severely errored seconds count
		5 or PCSES	% G821 severely errored seconds
		6 or ES	G821 error seconds count
		7 or PCES	% G821 error seconds
		8 or CSES	Consecutive severely errored seconds
		9 or UAS	Unavailable seconds count

returns *flag*,*oor*,*n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Out of range (always inrange)
	n =	0 to 999999999	DM, SES, ES, CSES, VAS
	n =	0.000 to 100.000	PCAVAIL, PCDM, PCSES, PCES

These results will be invalid if the pattern is LIVE.

BPV Error Result Query

This command requests one of the BPV error results. The format of the result returned will depend upon the selected result. This will reset the EOT bits in STA and STB.

RBP? *n*	*n* =	1 or ES	Asynchronous error seconds count
		2 or EFS	Error free seconds
		3 or PCEFS	% error free seconds
		4 or EC	Error count
		5 or ER	Average error ratio
		6 or CUER	Current error ratio

returns *flag,oor,n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Out of range (always inrange)
	n = 0 to 999999	ES, EFS, EC <1000000
	n = XX.XXE+X	EC ≥1000000
	n = 0.0 to 1.0E-XX	ER, CUER
	n = XX.XXX or 100.000	PCEFS

T1 Frame Error Result Query

This command requests one of the T1 frame error results. The format of the result returned will depend upon the selected result. This will reset the EOT bits in STA and STB.

RFE? *n*	*n* = 1 or ES	Asynchronous error seconds count
	2 or EC	Error count
	3 or OOFC	Out of frame events count
	4 or COFA	COFA events count
	5 or LOSS	Frame loss seconds count
	6 or LOFC	Loss of frame events count
	7 or SEFC	Severely errored framing events count
	8 or ER	Average error ratio

returns *flag,oor,n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Out of range (always inrange)
	n = 0 to 999999999	ES, EC, OOFC, COFA, LOSS, LOFC, SEFC
	n = 0.0 to 9.9E-99	ER

These results will be invalid if the T1 framing type is UNFRAMED.

T1 Frame Analysis Result Query

This command requests one of the frame analysis results. The format of the result returned will depend upon the selected result. This will reset the EOT bits in STA and STB.

RFA? *n*	*n* = 1 or PCAVAIL	% availability
	2 or UAS	Unavailable seconds count
	3 or SES	G821 severely errored seconds count
	4 or CSES	Consecutive SES count

returns *flag*,*oor*,*n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Out of range (always inrange)
	n = 0 to 999999999	SES, CSES, UAS
	n = 0.000 to 100.000	PCAVAIL

These results will be invalid if the T1 framing type is UNFRAMED.

CRC Error Result Query

This command requests one of the CRC error results. The format of the result returned will depend upon the selected result. This will reset the EOT bits in STA and STB.

RCR? *n*	*n* = 1 or ES	Asynchronous error seconds count
	2 or EFS	Error free seconds
	3 or PCEFS	% error free seconds
	4 or EC	Error count
	5 or ER	Average error ratio
	6 or CUER	Current error ratio

returns *flag*,*oor*,*n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Out of range (always inrange)
	n = 0 to 999999999	ES, EFS, EC
	n = 0.0 to 9.9E-99	ER, CUER
	n = 0.000 or 100.000	PCEFS

These results will only be valid if the T1 framing type is ESF.

CRC Analysis Result Query

This command requests one of the CRC analysis results. The format of the result returned will depend upon the selected result. This will reset the EOT bits in STA and STB.

`RCA?` *n*	*n* = `1` or `PCAVAIL`	% availability
	`2` or `DM`	Degraded minutes count
	`3` or `PCDM`	% degraded minutes
	`4` or `SES`	G821 severely errored seconds count
	`5` or `PCSES`	% G821 severely errored seconds
	`6` or `ES`	G821 error seconds count
	`7` or `PCES`	% G821 error seconds
	`8` or `CSES`	Consecutive severely errored seconds
	`9` or `UAS`	Unavailable seconds count

returns *flag*,*oor*,*n*	*flag* = `0` or `1`	Validity Flag
	oor = `1`	Out of range (always inrange)
	n = `0` to `999999999`	DM, SES, ES, CSES, VAS
	n = `0.000` or `100.000`	PCAVAIL, PCDM, PCSES, PCES

These results will only be valid if the framing type is ESF.

Receiver Level Result Query

This command requests the receiver level result. This will reset the EOT bits in STA and STB. Only valid for FULL and FRACTIONAL-T1.

`RRL?` *n*	*n* = `1` or `LEVDSX`	Signal level in dBx
	`2` or `LEVDBM`	Signal level in dBm
	`3` or `LEVVOLTS`	Signal level in volts
	`4` or `LEVBAL`	Imbalance in volts

returns *flag*,*oor*,*n*	*flag* = `0` or `1`	Validity Flag
	oor = `0` or `1`	Underrange or inrange
	n = `-40` to `+6`	dBx
	n = `-23` to `+23`	dBm
	n = `-9.99` to `9.99`	Volts

The measurement will be underrange if no signal is present.

Wander Results Query

This command requests the wander results. Opt.001 is required to perform this measurement and an error number will be generated if it is not fitted. This will reset the EOT bits in STA and STB.

`RWN?` *n*	*n* =	1 or `WANINST`	instantaneous wander
		2 or `WANPOS`	positive pk wander
		3 or `WANNEG`	negative peak wander
		4 or `WANPKPK`	pk-pk wander
		5 or `WAN15MIN`	15 min wander
		6 or `WAN24HR`	24 hour wander

returns *flag*,*oor*,*n*	*flag* =	0 or 1	Validity Flag
	oor =	0 to 2	Under, in or over range
	n =	0.000 to 999.999	Wander

The result will be underrange if the wander reference circuit has lost lock.

The result will be invalid in no wander measurement hardware is present.

VF Signaling Bits Result Query

This command requests the signaling bits result that appear on the VF page. The result can be either two or four bits long dependent on whether AB or ABCD bit signaling is current. ABCD signaling is valid for ESF framing only. This command has no effect on instrument status flags.

`RSG?` returns *flag*, *oor*, "*n*"	*flag* =	0 to 1	Validity flag
	oor =	1	Inrange
	n =	2 bits 0 or1	AB signaling bits
	n =	4 bits 0 or1	ABCD signaling bits

Sig Bits Test - All Signaling Bits Query

This command requests the bit result for the currently selected signaling bit display. The returned result will be a binary number string. Results will be invalid if the pattern is anything other than SPECIAL - SIG BIT TEST with the displayed result type field set to ALL.

The timeslot that the channel corresponds to will depend on the mapping selected (Cf. CHM command).

`SIG?` *n* where *n* is a channel number

returns *flag,oor,"n"*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	"*n*" =	"00" to "11"	Signaling bits for non ESF framing in channel *n*
		"0000" to "1111"	Signaling bits for ESF framing in channel *n*

Sig Bits Test - Single Signaling Bits Query

This command requests the signaling bit result from the currently selected channel. The result will only be valid if the Special Signaling Bit Test has been selected, and the display type is set to SINGLE. The returned result will be a binary number string.

The timeslot that the channel corresponds to will depend on the mapping selected (Cf. CHM command).

SCG? returns *flag,oor,"n"*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	"*n*" =	"00" to "11";	Signaling bits for non ESF framing
		"0000" to "1111"	Signaling bits for ESF framing

Simplex Current Result Query

Only valid for FULL and FRACTIONAL-T1, this command requests the simplex current result. This will reset the EOT bits in STA and STB.

RSI? returns *flag,oor,n*	*flag* =	0 or 1	Validity Flag
	oor =	0 or 1	underrange
	n =	10 to 999	milliamps

The result will be underrange if the current drops below 10mA.

Signal Frequency Result Query

Only valid for FULL and FRACTIONAL-T1, this command requests the signal frequency result. This will reset the EOT bits in STA and STB.

RSF? returns *flag,oor,n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	n =	0 to 9999999	Hz

Notice that this result remains valid even if no signal is present. Under these circumstances the count will be zero.

Signal Frequency Offset Result Query

Only valid for FULL and FRACTIONAL-T1, this command requests the signal frequency offset result. This will reset the EOT bits in STA and STB.

RFO? returns	*flag,oor,n*	*flag* =	0 or 1	Validity Flag
		oor =	1	Inrange
		n =	0 to 9999	parts per million

Notice that this result remains valid even if no signal is present. Under these circumstances the count will be zero.

Signal Round Trip Delay Query

This command requests the signal round trip delay. This will reset the EOT bits in STA and STB.

RRT? returns	*flag,oor,n*	*flag* =	0 or 1	Validity Flag
		oor =	0 or 1	underrange or inrange
		n =	0 to 500	milliseconds

The result will go underrange if no signal is present.

Uncontrolled Slips Result Query

This command requests the uncontrolled slips result. This will reset the EOT bits in STA and STB.

RUS? returns	*flag,oor,n*	*flag* =	0 or 1	Validity Flag
		oor =	1	Inrange
		n =	0 to 999999	Slip count

This result will be valid if we have a T1 PRBS or QRSS pattern or we have any framing other than unframed.

Controlled Slips Result Query

This command requests the controlled slips result. This will reset the EOT bits in STA and STB.

`RCS?` returns *flag*,*oor*,*n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	n =	0 to 999999	Slip count

This result is only valid if the pattern is a T1 PRBS or QRSS and the framing is anything other than unframed.

Estimated Bit Slips Result Query

This command requests the bit slips result. This will reset the EOT bits in STA and STB.

`RBS?` returns *flag*,*oor*,*n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	n =	0 to 9999999	Slip count

This result will only be valid if the wander option is fitted.

Estimated Frame Slips Result Query

This command requests the estimated frame slips result. This will reset the EOT bits in STA and STB.

`RFS?` returns *flag*,*oor*,*n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	n =	0 to 9999999	Slip count

This result will only be valid if the option is fitted.

Pulse Shape Result Query

This command requests the currently displayed pulse shape results. This is only valid when the pulse mask option is fitted.

RPM? *n*	$n =$ 1 or RTIME	pulse rise time(ns)
	2 or FTIME	pulse fall time(ns)
	3 or WIDTH	pulse width(ns)
	4 or OVERSHOOT	pulse overshoot(%)
	5 or UNDERSHOOT	pulse undershoot(%)
	6 or OVERALL	fits mask - pass/fail
	6 or LEVEL	pulse signal level (dBdsx)
	7 or FREQ	pulse frequency (Hz)
	8 or IMBALANCE	pulse signal imbalance (V)

returns *flag*, *oor*, *n*	*flag* = 0 to 1	Validity Flag
	oor = 1	Inrange
	$n =$ 0 to 100	percentage results
	$n =$ 0 to 999	time results (ns)
	$n =$ 0 or 1	overall result; 1 = pass, 0 = fail
	$n =$ -40 to +10	level result (dBdsx)
	$n =$ 0 to 9999999	frequency result (Hz)
	$n =$ 0.0 to 9.99	imbalance result (V)

Pulse Shape Plot Query

This command requests the pulse shape and mask plot information for the currently displayed pulse. The validity *flag* indicates that the pulse points are valid. Some will not be valid if the pulse has been truncated. A value of 0 for *n* means that the result is not yet available. The pixel data y-coordinates consist of, in order, the lower mask point, the pulse point (result) and the upper mask point. These points are in terms of the pixel y-coordinates which would be sent to a graphics printer, the x-coordinate being time and the output position of the points. This command is only valid when the pulse shape option is fitted and has no effect on status register flags.

RPP? returns

n, *crlf*

[*flag:1*, *lwr_msk_pnt:1*, *pulse_pnt:1*, *upp_msk_pnt:1 crlf*
flag:2, *lwr_msk_pnt:2*, *pulse_pnt:2*, *upp_msk_pnt:2 crlf*

....

flag:*n*, *lwr_msk_pnt:n*, *pulse_pnt:n*, *upp_msk_pnt:n crlf*]

n =	0 to 88	number of following lines of results
crlf =		line separator pair - carriage return, line feed
flag =	0 or 1	validity flag for each trio of points
lwr_msk_pnt, *pulse_pnt*,= *upp_msk_pnt* =	0 to 6000	y-coordinate of mask boundaries and pulse shape coordinate

Pulse Shape Plot and Result Query

This command requests the pulse shape plot information of the currently displayed pulse (RPP?), along with the various measurements which were carried out on the pulse (RPM?). This will provide an exhaustive list of all the pulse shape results information in one compact command. A value of 0 for *n* means that the measurement has not yet triggered.

The validity *flag* indicates that the pulse points are valid. Some will not be valid if the pulse has been truncated. The pixel data y-coordinates consist of, in order, the lower mask point, the pulse point (result) and the upper mask point. These points are in terms of the pixel y-coordinates which would be sent to a graphics printer, the x-coordinate being time and the output position of the points. This command is only valid when the pulse shape option is fitted and has no effect on status register flags.

RPD? returns

n crlf

[*years*, *months*, *days*, *crlf*, *hours*, *mins*, *secs*, *crlf*, *mask*, *pol*, *rise*, *fall*, *width*, *osh*, *ush*, *lvl*, *freq*, *imbal*, *pass*, [*flag:1*, *lwr_msk_pnt:1*, *pulse_pnt:1*, *upp_msk_pnt:1*, *crlf*, *flag:2*, *lwr_msk_pnt:2*, *pulse_pnt:2*, *upp_msk_pnt:2*, *crlf*

....

flag:n-3, *lwr_msk_pnt:n-3*, *pulse_pnt:n-3*, *upp_msk_pnt:n-3*, *crlf*]]

n =	0 to 91	number of following lines of results
crlf =	0 or 1	line separator pair - carriage return, line feed
flag =	0 or 1	validity flag
years =	1970 to 2069	trigger timestamp
months =	1 to 12	trigger timestamp
days =	1 to 31	trigger timestamp
hours =	0 to 23	trigger timestamp
mins =	0 to 59	trigger timestamp
secs =	0 to 59	trigger timestamp
mask =	1 to 5	mask used (see PMS command)
pol =	0 or 1	pulse polarity, 0:Negative, 1:Positive
rise =	0 to 999	rise time (ns)
fall =	0 to 999	fall time (ns)
width =	0 to 999	width (ns)
osh =	0 to 100	percentage overshoot (%)
ush =	0 to 100	percentage undershoot (%)
lvl =	-40 to +10	level (dBdsx)
freq =	0 to 9999999	frequency result (Hz)
imbal =	0.0 to 9.99	imbalance result (V)
pass =	0 or 1	0:fail, 1:pass
flag =	0 or 1	validity flag for each trio of points
lwr_msk_pnt, *pulse_pnt*, *upp_msk_pnt* =	0 to 200	y-coordinate of mask boundaries and pulse shape

Pulse Sample Trigger Event and Pulse Type

This selects the trigger event and pulse type which the PULSE SHAPE measurement captures (traps) and displays in option-001 instruments. When the trigger is DISABLED the measurement simply repetitively displays any pulse which comes along. In one of the three triggered modes the instrument behaves as before, displaying the current pulse, until the trigger condition is satisfied when it will hold the captured pulse until a retrigger command (PSR) is received.

The type of pulse captured and held (trapped) is given by the second parameter. An ISOLATED pulse is one which has three zeros either side of it, a TRUNCATED pulse does not, with the result that the pulse display is truncated to avoid the distortion caused by intersymbol interference.

PST n, "m"	$n =$ 0 or DISABLED	Triggering off (no trapping)
	1 or FAILS	Trap pulse failing mask
	2 or MEETS	Trap pulse meeting mask
	3 or ANY	Trap first pulse
	$m =$ 1 or ISOLATED	Trap an isolated pulse

PST? returns n, m	$n =$ 0 to 4
	$m =$ 1

Pulse Sample Trigger Reset

This resets (or rearms) the pulse shape trigger. After this command has been sent, the first pulse to meet the trigger conditions specified by the PMS command will be trapped.

PSR

Elapsed Time Result Query

This command requests the elapsed time since the start of the current test. This will reset the EOT bits in STA and STB.

ELP? returns *flag,dd,hh,mm,ss*	*flag* =	0 or 1	Validity Flag
	dd =	0 to 99	Days
	hh =	0 to 23	hours
	mm =	0 to 59	Minutes
	ss =	0 to 59	Seconds

Timeslot Monitor Query

Only valid for T1-SPECIAL TIMESLOT CHECK of a SINGLE timeslot, this command requests the bit result from the currently selected timeslot. The returned result will be a binary number string.

BIT? returns *flag,oor*,"*n*"	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	"*n*" =	"00000000" to "11111111"	Monitor result

TX Timeslot Bandwidth Query

Only valid for T1-SPECIAL TIMESLOT CHECK of a SINGLE timeslot, this queries the TX fractional-T1 bandwidth in kHz. It corresponds to the tx bandwidth field displayed beside the tx timeslot selection field.

TBW? returns *n* $n =$ 0 to 1536 kHz

Timeslot Swap Result Query Command

Only valid for T1-SPECIAL TIMESLOT CHECK of a SINGLE timeslot, this result gives details about any swapped timeslots. Querying a particular timeslot will return information specifying that either a valid timeslot data stream has been detected or that no valid signature has been detected. In the case of the latter the current timeslot data is returned instead.

TSS? *n* $n =$ 1 to 24

returns *flag,valid ts,n*	*flag* = 0 or 1	Validity Flag
	valid ts = 0	The monitor result is timeslot data
	valid ts = 1	The monitor result is a mapped timeslot
	n = 0 to 255	Monitor result (timeslot data)
	n = 1 to 24	Monitor result (mapped timeslot)

High Resolution Round Trip Delay in Timeslot Query

This result gives details of round trip delay in a timeslot. The result will be underrange if no signal is present and invalid if the test has not been selected.

RDT? returns *flag,oor,n*	*flag* = 0 or 1	Validity Flag
	oor = 0 or 1	Underrange or Inrange
	n = 0 to 999.999	Round trip delay (ms)

Alarm Seconds Results Query

This requests any one of the alarm seconds results as indicated by the parameter. This will reset the EOT flags in status registers A & B.

`ALR?` *n*	*n* = 1 or `SIGNAL`	Signal loss seconds
	2 or `AIS`	All Ones (AIS) seconds
	3 or `FRAME`	T1 frame loss seconds
	4 or `DDSFRAME`	DDS frame loss seconds
	5 or `PATTERN`	Pattern loss seconds
	6 or `XS_ZEROS`	Excess zeros seconds
	7 or `YELLOW`	Yellow alarm seconds
	8 or `DDS_CODE`	DDS control code seconds
	9 or `POWER`	Power loss seconds

returns *flag*,*oor*,*n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Inrange
	n = 0 to 999999999	seconds result

DDS Bit Monitor Control Code and Timestamp Result Query

This requests the results which make up the DDS bit monitor control code and timestamp results. A control code is recognized when the least significant bit of the payload is 0. At that instant, the control code is latched and displayed along with the time and date when it first occurred. If the control code is found to be a member of the mnemonic set found in TR-TSY-00476 table 6-5 then that mnemonic will also be displayed. These results are cleared at the start of a new test period and reading them clears the EOT flags in status registers A & B.

`DCC?` *n*	*n* = 1 or `CODEWORD`	DDS control codeword (8-bits)
	2 or `MNEMONIC`	DDS control codeword mnemonic
	3 or `TIMESTAMP`	DDS control codeword timestamp

returns *flag*,*oor*, "*string*"	*flag* = 0 or 1	Validity Flag
	oor = 1	Inrange
	string = 8-bit byte	CODEWORD, 8 characters "0" or "1"
	string = 4 character mnemonic	MNEMONIC, 4 ASCII characters

or :-

flag,*oor*,*hours*, *mins*,*secs*,*years*, *months*,*days*	*flag* = 0 or 1	Validity Flag
	oor = 1	Inrange
	hours = 0 to 23	TIMESTAMP
	mins = 0 to 59	TIMESTAMP
	secs = 0 to 59	TIMESTAMP
	years = 1970 to 2069	TIMESTAMP
	months = 1 to 12	TIMESTAMP
	days = 1 to 31	TIMESTAMP

Network Byte Monitor Query

This corresponds to the DDS BIT MONITOR network byte result and the VF TONES timeslot sample result. The result is only available for applications VF, T1-DDS and DS0-DDS, it is continuously updating and will reset the EOT flags in status registers A & B when queried.

PAY? returns *flag*, *oor*, "*string*"	*flag* = 0 or 1	Validity Flag
	oor = 1	Inrange
	string = 8-bit byte	8 characters, 0 or 1

Pulse Shape Plot and Results For Stored Trapped Pulse Query

This command requests the complete pulse shape plot and results information of either the currently trapped pulse (RPD?) or for one of the stored pulses. The response is exactly as for the RPD? command and is discussed therein. The parameters of this command can access either the positive or the negative pulse and its constituent results. Store 0 is the currently trapped pulse.

PPR? *m*, *p*	*m* = 0 to 5	0 = displayed pulse
		1-5 stored pulse
	p = 1 or POS	positive pulse
	2 or NEG	negative pulse

returns the same response as RPD?

DDS Frame Error Result Query

This requests one of the DDS frame error result types. The validity of the results are as indicated under the DPR command. This will reset the EOT flags in status registers A & B.

`RDE?` *n*	*n* = 1 or `ES`	DDS frame error seconds count
	2 or `EFS`	DDS frame error free seconds count
	3 or `PCEFS`	DDS frame percentage error free seconds
	4 or `EC`	DDS frame error count
	5 or `ER`	DDS frame error ratio

returns *flag*, *oor*, *n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Inrange
	n = 0 to 999999999	ES, EFS, EC
	n = 0.0 to 9.9E-99	ER
	n = 0.000 to 100.000	PCEFS

Tone Coder Results Query

This command queries the various results found from the analysis of the received tone codewords in the selected VF channel under the VF application. The OFFSET measurement is continuously updating while the MAXPOS/MAXNEG results are controlled from the instrument test period. Querying this result clears the EOT flags in status registers A & B.

`TSC?` *n*	*n* = 1 or `OFFSET`	Coder offset
	2 or `MAXPOS`	Coder positive maximum
	3 or `MAXNEG`	Coder negative maximum

returns *flag*, *oor*, *n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Inrange
	n = -99 to +99	OFFSET result
	n = -127 to +127	Maximum peak results

Tone Frequency Query

This queries the frequency of the received tone in the selected VF channel under the VF application. This result is continuously updating and querying this result clears the EOT flags in status registers A & B.

`TSF?` returns *flag*, *oor*, *n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Inrange
	n = 0 to 9999999	tone frequency in Hertz

Tone Level Query

This queries the level of the received tone in the selected VF channel under the VF application. This result is continuously updating and querying this result clears the EOT flags in status registers A & B.

TSL? returns *flag*, *oor*, *n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Inrange
	n = 0.0 to -80.0	tone level in dBm0

FDL Monitor Result Query

This returns the FDL bit monitor results as a list of binary weighted integers corresponding to the FDL message octets listed under FDL results monitor.

FCM? returns

flag, *oor*, *oct2*,	*flag* = 0 or 1	Validity Flag
oct3, *oct5*, *oct6*,	*oor* = 1	Inrange
oct7, *oct8*, *oct9*,	*oct* = 0 to 255	00000000 to 11111111
oct10, *oct11*, *oct12*		

FDL CRC Result Query

This returns the requested FDL CRC or OTHER result formulated from the FDL data link data. This command resets the EOT flags in status registers A and B.

FCR? *n*	*n* = 1 or CRC_G1	N = 1
	2 or CRC_G2	N = 1 to 5
	3 or CRC_G3	N = 6 to 10
	4 or CRC_G4	N = 11 to 100
	5 or CRC_G5	N = 101 to 319
	6 or CRC_G6	N $\geq$ 320
	7 or OTH_SE	sef events
	8 or OTH_FE	frame error events
	9 or OTH_LV	bpv events
	10 or OTH_SL	slip events
	11 or OTH_LB	loopback
	12 or OTH_U1	undefined
	13 or OTH_U2	undefined

returns *flag*, *oor*, *n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Inrange
	n = 0 to 999999999	counts result

(RADR?) T1 addressable repeater result query.

This command returns the number of errors counted in the acknowledgement phase of an addressable repeater action; including loop-up/ loop-down sequences activated by the loop-up/-down keys.

`RADR?` returns *f*,*r*,*n*	*f* = 0 or 1	validity
	r = 1	range
	n = 0 to 999	

Multi pattern results Query

This command requests the bit error count results of a multi-pattern test. The first line is the loop count, the subsequent 21 lines are the results of the test. For bridge taps all 21 lines may contain valid data; For the fixed pattern suite up to 5 lines are used; For the user defined suite up to 7 lines will be used.

`RML?` returns

flag0,oor0,loop,<crlf>,*ntests*<crlf>
[*flag1:1,oor1:1,err1:1,*
flag2:1,oor2:1,err_sec2:1,
flag3:1,oor3:1,par_sync_sec3:1<crlf>
flag1:2,oor1:2,err1:2,
flag2:2,oor2:2,err_sec2:2,
flag3:2,oor3:2,par_sync_sec3:2<crlf>
|
|
|
flag1:n,oor1:n,err1:n,
flag2:n,oor2:n,err_sec2:n,
flag3:n,oor3:n,par_sync_sec3:n<crlf>]

flag0 =	0 or 1	validity
orr0 =	1	
loop =	0 to 999999999	
n =	2 to 21	Number of active tests
<crlf> =	<crlf>	Line separator pair - carriage return, line feed
*flag** =	0 or 1	validity of each result
*oor** =	1	Always in range
*err** =	0 to 999999999	err < 1000000
	1.000E+6 to 9.999E+99	err >= 1000000
*err_sec** =	0 to 999999999	
*pat_sync_sec** =	0 to 999999999	

DDS / VF Receive PRBS Inversion Indication Query

An indication is provided, adjacent to the pattern choice field, for the polarity of the received PRBS pattern when in a DDS or VF configuration. This only applies to choices PRBS2047, PRBS511, PRBS2047_2C and PRBS511_2C. It has no meaning outside of these selections.

`DPI?` returns n	$n =$ 0	normal
	1	inverted

SLC-96 results query

This command allows access to different SLC96 results; response time and bit monitor results.

`RSLC?` n	$n =$ 1	Response time (decimal ms)
	2	C field value (binary)
	3	M field value (binary)
	4	A field value (binary)
	5	S field value (binary)

returns $flag, oor, n$	$flag =$ 0 or 1	Validity flag
	$oor =$ 0 or 1	Range flag
	$n =$	value as selected above

Note the bit monitor results are coded with one binary digit per character position; ie 0x5 (hex) returns as 101.

STORED RESULTS COMMANDS

SMG commands described in this and the following sections access and control the stored measurement and graphics results of the instrument. All commands can access data from a store which contains stored measurement information from previously run tests. Stored measurement result query commands are similar to those listed in the various RESULT QUERY sections with the addition of a first parameter pointing to the store in question. (This parameter should have value 0 to access the LAST measurement store).

These commands do not affect any status registers unlike their RESULT QUERY command counterparts.

Store Size and Usage

`SMS?` accesses the fixed size and the current usage of the stored measurement store. The returned results are in samples and the ratio of the two will give the relative store size used. (A sample may represent either 1, 15 or 60 minutes duration).

`SMS?` returns *size*, *usage*

storesize = 4096	Max size in samples
storeuse = 0 to 4096	Usage in samples

Detailed Store Use Query

The `SMC?` command returns store use information as lines. Each line will contain statistical information related to each used store entry. Unused stores will produce no lines. This information corresponds to that found on the STORE STATUS sub-page.

`SMC?` returns *storenum*,*demobit*,*year*,*month*,*day*,*hour*,*min*, *samples*,*res*

storenum =	-9 to 0	store number
demobit =	0 to 1	1 for DEMO or 0 for TEST PERIOD
year =	1970 to 2069	year test was started
month =	1 to 12	month test was started
day =	1 to 31	day test was started
hour =	0 to 23	hour test was started
min =	0 to 60	minute test was started
length =	1 to 6000	the number of samples in the test
res =	1, 15, 60	the resolution of the samples in minutes

followed by one line: `EOI`

Entries will only be printed for store entries that are in use. For example:

```
0, 0, 1990, 1, 24, 10, 14, 2345, 1
-1, 0, 1990, 1, 10, 23, 54, 980, 1
-2, 1, 1989, 12, 24, 7, 45, 458, 15
-3, 0, 1989, 12, 5, 7, 23, 561, 15
-4, 0, 1989, 11, 7, 8, 12, 2197, 60
EOI
```

Stored Graphical Data Query

SMD? returns store sample data as a series of records, one for each sample, for store *n*. This could return as much as 6000 lines of information.

`SMD?` *n*	*n* = -9 to 0	Store number

returns

```
<g1.1>,<g2.1>,<g3.1>,<g4.1>,<g5.1>,"<alm1.1>","<alm2.1>","<fdl1.1>","<fdl1.1>"
<g1.2>,<g2.2>,<g3.2>,<g4.2>,<g5.2>,"<alm1.2>","<alm2.2>","<fdl1.2>","<fdl1.2>"
<g1.3>,<g2.3>,<g3.3>,<g4.3>,<g5.3>,"<alm1.3>","<alm2.3>","<fdl1.3>","<fdl1.3>"
|
|
|
EOI
```

```
<g1> = XE+Y    : logic error count in 1 sample
<g2> = XE+Y    : bpv error count in 1 sample
<g3> = XE+Y    : T1 frame error count in 1 sample
<g4> = XE+Y    : crc error count in 1 sample
<g5> = XE+Y    : dds frame error count in 1 sample
```

```
<alm1> = 8 characters 1 or 0 : alarms (block-1) in 1 sample
<alm2> = 8 characters 1 or 0 : alarms (block-2) in 1 sample
<fdl1> = 8 characters 1 or 0 : FDL flags (CRC) in 1 sample
<fdl2> = 8 characters 1 or 0 : FDL flags (OTHER) in 1 sample
```

The alarms, (alm1 and alm2), definition, using alarm register mnemonics, are:

```
alm1 : D7  D6  D5  D4  D3  D2  D1  DO
       PWL SGL AIS FML SFM PTL SLP EXO

alm2 : D7  D6  D5  D4  D3  D2  D1 DO
       OSD YEL EXW LPU LPD DCC 0  O
```

N.B. In block-2, DCC does not appear in the alarm register. It is a record of the duration of a DDS control code when in a DDS configuration. Both SFM and DCC are HP 37702A only.

The FDL (T1.403) flag definitions are:

```
fdl1 : D7 D6 D5 D4 D3 D2 D1 DO
       G1 G2 G3 G4 G5 G6 G7 G8

fdl2 : D7 D6 D5 D4 D3 D2 D1 DO
       SE FE LV SL LB U1 U2 0
```

An example of returned data for a 3-sample period is:

```
OE+O, OE+O, OE+O, OE+O, OE+O, "00000000", "01000000", "00000000", "00000000"
1E+O, OE+O, OE+O, OE+O, OE+O, "00000000", "00100000", "00100000", "00000000"
4E+1, 5E+2, OE+O, OE+O, OE+O, "00010000", "00110000", "00001000", "01100000"
EOI
```

Stored Graphical Data in Compressed Form Query

SMZ? returns store sample data for the specified store in a more compressed form than that of the SMD? command. Each output line is prepended by an integer repeat counter. Since for live data a lot of the samples will be zero, the data size will be very much compressed. It is up to the controller to interpret the data back to its uncompressed form.

SMZ? *n*	*n* = -9 to 0	Store number

returns

```
<n1>, <g1.1>,<g2.1>,<g3.1>,<g4.1>,<g5.1>,"<alm1.1>","<alm2.1>","<fdl1.1>","<fdl1.1>"
<n1>, <g1.2>,<g2.2>,<g3.2>,<g4.2>,<g5.2>,"<alm1.2>","<alm2.2>","<fdl1.2>","<fdl1.2>"
<n1>, <g1.3>,<g2.3>,<g3.3>,<g4.3>,<g5.3>,"<alm1.3>","<alm2.3>","<fdl1.3>","<fdl1.3>"
|
|
|
EOI

<n1>,<n2>=1 to 6000   : Number of repeated results
<g1>  = XE+Y    : logic error count in 1 sample
<g2>  = XE+Y    : bpv error count in 1 sample
<g3>  = XE+Y    : T1 frame error count in 1 sample
<g4>  = XE+Y    : crc error count in 1 sample
<g5>  = XE+Y    : dds frame error count in 1 sample
<alm1> = 8 characters 1 or 0 : alarms (block-1) in 1 sample
<alm2> = 8 characters 1 or 0 : alarms (block-2) in 1 sample
<fdl1> = 8 characters 1 or 0 : FDL flags (CRC) in 1 sample
<fdl2> = 8 characters 1 or 0 : FDL flags (OTHER) in 1 sample
```

The alarms, (alm1 and alm2), definition, using alarm register mnemonics, are:

```
alm1 : D7  D6  D5  D4  D3  D2  D1  D0
       PWL SGL AIS FML SFM PTL SLP EXO

alm2 : D7  D6  D5  D4  D3  D2  D1 D0
       OSD YEL EXW LPU LPD DCC 0  0
```

N.B. In block-2, DCC does not appear in the alarm register. It is a record of the duration of a DDS control code when in a DDS configuration.
The FDL (T1.403) flag definitions are:

```
fdl1 : D7 D6 D5 D4 D3 D2 D1 D0
       G1 G2 G3 G4 G5 G6 G7 G8

fdl2 : D7 D6 D5 D4 D3 D2 D1 D0
       SE FE LV SL LB U1 U2 0
```

An example of returned data for a 3-sample period is:

```
1, 1E+0, 0E+0, 0E+0, 0E+0, 0E+0, "00000000", "00100000", "00100000", "00000000"
1, 4E+1, 5E+2, 0E+0, 0E+0, 0E+0, "00010000", "00110000", "00000000", "00000000"
2, 0E+0, 0E+0, 0E+0, 0E+0, 0E+0, "00000000", "00000000", "01000000", "00100000"
1, 8E+8, 5E+5, 0E+0, 0E+0, 0E+0, "01100000", "00000000", "00100000", "00100000"
2, 0E+0, 0E+0, 0E+0, 0E+0, 0E+0, "00000000", "01000000", "00000000", "00000000"
EOI
```

Stored Measurement Results Enable

This enables or disables results and graphs storage. The enable choice also includes how often results are stored during a test, ie the resolution of the graphics histogram bars. Changing this field results in the instrument stopping the current test to allow a local user time to confirm the selection as store number -9 will be deleted to make room for new data. The instrument can then be restarted using STR or by changing another restart field. Subsequent restarts will result in the instrument switching OFF stored measurements and graphics and requiring another restart.

SRG *n*	*n* =	0 or OFF	Results/graphs storage off
		1 or MIN1	Storage on, resolution 1 minute
		2 or MIN15	Storage on, resolution 15 minutes
		3 or MIN60	Storage on, resolution 60 minutes

The corresponding query returns the currently selected coding, in integer form as described above:-

SRG? returns *storage selection* = 0 to 3

Stored Logic Error Result Query

This command requests a logic error result from a specified store. The format of the result returned will depend upon the selected result.

SRLE? *store,result*	*store* =	-9 to 0	Store number
	result =	1 or ES	Asynchronous error seconds count
		3 or EFS	Error free seconds
		4 or PCEFS	% error free seconds
		5 or EC	Error count
		6 or ER	Average error ratio

flag,oor,n	*flag* =	0 or 1	Validity Flag
	oor =	1	Always inrange
	n =	0 to 999999999	ES, EFS, EC
	n =	1.000E+06 to 9.999E+99	EC
	n =	0.000 to 100.000	PCEFS
	n =	9.9E-99 to 1.0E+00	ER

These results will be invalid if the stored pattern was LIVE.

Stored Logic Analysis Result Query

This command requests a stored logic analysis result from a specified store. The format of the result returned will depend upon the selected result.

SRLA? *store,result*	*store* =	-9 to 0	Store number
	result =	1 or PCAVAIL	% availability
		2 or DM	Degraded minute count
		3 or PCDM	% degraded minutes
		4 or SES	G821 severely errored seconds count
		5 or PCSES	% G821 severely errored seconds
		6 or ES	G821 error seconds count
		7 or PCES	% G821 error seconds
		8 or CSES	Consecutive severely errored seconds
		9 or UAS	Unavailable seconds count
flag,oor,n	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	n =	0 to 999999999	Count Results
	n =	0.000 to 100.000	Percentage Results

These results will be invalid if the stored pattern was LIVE.

Stored BPV Error Result Query

This command requests a stored BPV error result from a specified store. The format of the result returned will depend upon the selected result.

SRBP? *store,result*	*store* =	-9 to 0	Store number
	result =	1 or ES	Asynchronous error seconds count
		2 or EFS	Error free seconds count
		3 or PCEFS	% error free seconds
		4 or EC	Error count
		5 or ER	Average error ratio
flag,oor,n	*flag* =	0 or 1	Validity Flag
	oor =	1	Always inrange
	n =	0 to 999999999	ES, EFS, EC
	n =	1.000E+06 to 9.999E+99	EC
	n =	0.000 to 100.000	PCEFS
	n =	9.9E-99 to 1.0E+00	ER

Stored T1 Frame Error Result Query

Queries one of the T1 frame error result types for the instrument for the particular store requested. The response corresponds with the RFE? command.

SRFE? *store,result*	*store* =	-9 to 0	Store number
	result =	1 or ES	Asynchronous error seconds count
		2 or EC	Error count
		3 or OOFC	Out of frame events count
		4 or COFA	COFA events count
		5 or LOSS	Frame loss seconds count
		6 or LOFC	Loss of frame events count
		7 or SEFC	Severely errored framing events count
		8 or ER	Average error ratio

returns *flag,oor,n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Always inrange
	n =	0 to 999999999	Count Results
	n =	1.000E+06 to 9.999E+99	EC
	n =	9.9E-99 to 1.0E+00	ER

Stored Frame Analysis Result Query

This command requests a stored frame analysis result from a specified store. The format of the result returned will depend upon the selected result.

SRFA? *store,result*	*store* =	-9 to 0	Store number
	result =	1 or PCAVAIL	% availability
		2 or UAS	Unavailable seconds count
		3 or SES	G821 severely errored seconds count
		4 or CSES	Consecutive severely errored seconds

returns *flag,oor,n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Out of range (always inrange)
	n =	0 to 999999999	Count, Seconds Result if <1000000000
	n =	XX.XXE+X	Count, Seconds Result if ≥1000000000
	n =	XX.XXX or 100.000	Percentage Results

Stored CRC Error Result Query

This command requests a stored CRC error result from a specified store. The format of the result returned will depend upon the selected result.

`SRCR?` *store,result*	*store* =	-9 to 0	Store number
	result =	1 or ES	Asynchronous error seconds count
		2 or EFS	Error free seconds count
		3 or PCEFS	% error free seconds
		4 or EC	Error count
		5 or ER	Average error ratio

returns *flag,oor,n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Always inrange
	n =	0 to 999999999	ES, EFS, EC
	n =	1.000E+06 to 9.999E+99	EC
	n =	0.000 to 100.000	PCEFS
	n =	9.9E-99 to 1.0E+00	ER

Stored CRC Analysis Result Query

This command requests a stored CRC analysis result from a specified store. The format of the result returned will depend upon the selected result.

`SRCA?` *store,result*	*store* =	-9 to 0	Store number
	result =	1 or PCAVAIL	% availability
		2 or DM	Degraded minute count
		3 or PCDM	% degraded minutes
		4 or SES	G821 severely errored seconds count
		5 or PCSES	% G821 severely errored seconds
		6 or ES	G821 error seconds count
		7 or PCES	% G821 error seconds
		8 or CSES	Consecutive severely errored seconds
		9 or UAS	Unavailable seconds count

returns *flag,oor,n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	n =	0 to 999999999	Count Results
	n =	0.000 to 100.000	Percentage Results

Stored Wander Results Query

This command requests a stored wander result from a specified store. Opt.001 is required to perform this measurement and an error number will be generated if it is not fitted.

SRWN? *store,result*	*store* =	-9 to 0	Store number
	result =	1 or WANINST	instantaneous wander
		2 or WANPOS	positive pk wander
		3 or WANNEG	negative peak wander
		4 or WANPKPK	pk-pk wander
		5 or WAN15MIN	15 min wander
		6 or WAN24HR	24 hour wander

returns *flag,oor,n*	*flag* =	0 or 1	Validity Flag
	oor =	0 or 1	underrange or inrange
	n =	0 to 99999999.999	Wander

Stored DDS Frame Error Result Query

Queries one of the DDS frame error result types for the instrument for the particular store requested.

SRDE? *store,result*	*store* =	-9 to 0	Store number
	result =	1 or ES	Error seconds count
		2 or EFS	Error free seconds count
		3 or PCEFS	Percentage error free seconds count
		4 or EC	Error count
		5 or ER	Average error ratio

returns *flag,oor,result*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	result =	0 to 999999999	ES, EFS, EC
	result =	1.000E+06 to 9.999E+99	EC
	result =	0.000 to 100.000	PCEFS
	result =	9.9E-99 to 1.0E+00	ER

Refer to the RDE? command for details of this reply.

Stored DDS Control Code and Timestamp Query

Queries the latched DDS control code, its mnemonic or its timestamp for the particular store requested.

SDCC? *store*, *n*	*store* =	-9 to 0	Store Number
	n =	1 or CODEWORD	DDS control codeword (8-bits)
		2 or MNEMONIC	DDS control codeword mnemonic
		3 or TIMESTAMP	DDS control codeword timestamp

returns *flag*,*oor*, "*string*"	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	string =	8-bit byte	CODEWORD, 8 characters "0" or "1"
	string =	4 character mnemonic	MNEMONIC, 4 ASCII characters

Refer to the DCC? command for details of this reply.

Stored Alarm Seconds Result Query

Queries one of the alarm seconds results for the instrument for the particular store requested.

Note that DDS_CODE is purely a stored result and has no current result counterpart for ALR?.

SALR? *store*,*result*	*store* =	-9 to 0	Store number
	result =	1 or SIGNAL	Signal loss seconds
		2 or AIS	All Ones (AIS) seconds
		3 or FRAME	T1 frame loss seconds
		4 or DDSFRAME	DDS frame loss seconds
		5 or PATTERN	Pattern loss seconds
		6 or XS_ZEROS	Excess zeros seconds
		7 or YELLOW	Yellow alarm seconds
		8 or DDS_CODE	DDS control code seconds
		9 or POWER	Power loss seconds

returns *flag*,*oor*,*n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	n =	0 to 999999999	seconds result

Refer to the ALR? command for details of this reply.

Stored Tone Frequency Result Query

Queries the tone frequency result for the instrument for the particular store requested.

STSF? *store*	*store* = -9 to 0	Store Number
returns *flag*, *oor*, *n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Inrange
	n = 0 to 9999999	tone frequency in Hertz

Refer to the TSF? command for details of this reply.

Stored Tone Level Result Query

Queries the tone level result for the instrument for the particular store requested.

STSL? *store*	*store* = -9 to 0	Store Number
returns *flag*, *oor*, *n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Inrange
	n = 0.0 to -80.0	tone level in dBm0

Refer to the TSL? command for details of this reply.

Stored Tone Coder Results Query

Queries the tone coder result for the instrument for the particular store requested. The response corresponds with the TSC? command.

STSC? *store*,*result*	*store* = -9 to 0	Store number
	result = 1 or OFFSET	Coder offset
	2 or MAXPOS	Coder positive maximum
	3 or MAXNEG	Coder negative maximum
returns *flag*, *oor*, *n*	*flag* = 0 or 1	Validity Flag
	oor = 1	Inrange
	n = -99 to +99	OFFSET result
	n = -127 to +127	Maximum peak results

Refer to the TSC? command for details of this reply.

Stored FDL CRC Result Query

Queries the FDL CRC results for the instrument for the particular store requested. The response corresponds with the FCR? command.

SFCR? *store,result*	*store* =	-9 to 0	Store Number
	result =	1 or CRC_G1	N = 1
		2 or CRC_G2	N = 1 to 5
		3 or CRC_G3	N = 5 to 10
		4 or CRC_G4	N = 10 to 100
		5 or CRC_G5	N = 100 to 319
		6 or CRC_G6	N $\geq$ 320
		7 or OTH_SE	sef events
		8 or OTH_FE	frame error events
		9 or OTH_LV	bpv events
		10 or OTH_SL	slip events
		11 or OTH_LB	loopback
		12 or OTH_U1	undefined
		13 or OTH_U2	undefined

returns *flag*, *oor*, *n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	result =	0 to 999999999	counts result

Stored Uncontrolled Slips Result Query

This command requests the stored uncontrolled slips result from a specified store. The response corresponds with the RUS? command.

SRUS? *store* = -9 to 0 Store number

returns *flag*,*oor*,*n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	n =	0 to 999999999	Slip count

Stored Controlled Slips Result Query

This command requests the stored controlled slips result from a specified store. The response corresponds with the RCS? command.

SRCS? *store* =	-9 to 0	Store number	

returns *flag,oor,n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	n =	0 to 999999999	Slip count

Stored Estimated Bit Slips Result Query

This command requests the estimated bit slips result. Opt.001 is required to perform this measurement and an error number will be generated if it is not fitted. The response corresponds with the RBS? command.

SRBS? *store* =	-9 to 0	Store number

returns *flag,oor,n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	n =	0 to 999999999	Slip count

Stored Estimated Frame Slips Result Query

This command requests the stored estimated frame slips result from a specified store. Opt.001 is required to perform this measurement and an error number will be generated if it is not fitted. The response corresponds with the RFS? command.

SRFS? *store* =	-9 to 0	Store number

returns *flag,oor,n*	*flag* =	0 or 1	Validity Flag
	oor =	1	Inrange
	n =	0 to 999999999	Slip count

Stored Framing Type Query

Queries the T1 framing type for the instrument for the particular store requested. The response corresponds with the FRM? command.

SFRM? *store* = -9 to 0 Store number

returns *frame type* = 1 to 4

Refer to the FRM? command for a detailed breakdown of the reply.

Stored Coding Type Query

This command requests the stored T1 linecode type for a specified store.

`SCOD?` *store* = `-9 to 0` Store number

returns *code type* = `1 or 2`

Refer to the `COD?` command for a detailed breakdown of the reply.

Stored T1 Pattern Query

This command requests the stored T1 pattern type for a specified store.

`SPAT?` *store* = `-9 to 0` Store number

returns *pattern type* = `0 to 14`

Refer to the `PAT?` command for a detailed breakdown of the reply.

Stored T1 Interface Type Query

This command requests the stored T1 interface type for a specified store.

`SIFC?` *store* = `-9 to 0` Store number

returns *interface type* = `1 to 3`

Refer to the `IFC?` command for a detailed breakdown of the reply.

Stored Test Period Query

Queries the test period for the instrument for the particular store requested.

`STPD?` *store* = `-9 to 0` Store number

returns *test time type* = `1 to 5`

Refer to the `TPD?` command for a detailed breakdown of the reply.

Stored Elapsed Time Result Query

This command requests the elapsed time since the start of the current test from a specific store. The response corresponds with the `ELP?` command.

SELP? *store* = -9 to 0 Store number

returns *flag*,*dd*,*hh*,*mm*,*ss*

flag =	0 or 1	Validity
dd =	0 to 99	Flag Days
hh =	0 to 23	Hours
mm =	0 to 59	Minutes
ss =	0 to 59	Seconds

Stored Test Period (User Program) Query

Queries the user program test period for the instrument for the particular store requested. The response corresponds with the TDU? command.

STDU? *n* *n* = -9 to 0 Store number

returns *l*,*m* *l* = 1 to 100 0
m = to 4

Stored User Word Pattern Query

This command requests the T1 and DDS user word pattern from a specified store.

SPAU? *store* = -9 to 0 Store number

returns *string* 3 to 24 characters 0, 1, F or S.

Refer to the PAU? command for details of this reply.

Stored T1 Stress Pattern Query

This command requests the stored T1 stress pattern of the instrument for the particular store requested.

SPSS? *store* = -9 to 0 Store number

returns *stress pattern type* 0 to 8

Refer to the PSS? command for details of this reply.

Stored Application Query

This command requests the stored application/configuration of the instrument for the particular store requested.

`SAPP?` *store* = `-9` to `0` Store number

returns *application type* `1` to `7`

Refer to the `APP?` command for details of this reply.

Stored Receive Timeslot Query

Queries the receive timeslot selection for the instrument for the particular store requested.

`SRXT?` *store* = `-9` to `0` Store number

returns *timeslot mode* `1` or `2`

Refer to the `RTX?` command for details of this reply.

Stored Long User Word Number Query

This command requests the stored long user word number from a specified store.

`SLUS?` *store* = `-9` to `0` Store number

returns *long user word number* `1` to `4`

Refer to the `LUS?` command for details of this reply.

Stored Transmitter Multiple Timeslot Selection Query

Queries the transmit multiple timeslot selection for the instrument for the particular store requested.

`STTM?` *store* = `-9` to `0` Store number

returns "*timeslots*" 24 characters,0 or 1

Refer to the `TTM?` command for details of this reply.

Stored Receiver Multiple Timeslot Selection Query

Queries the receive multiple timeslot selection for the instrument for the particular store requested.

SRTM? *store* = -9 to 0 Store number

returns "*timeslots*" 24 characters, 0 or 1

Refer to the RTM? command for details of this reply.

Delete one SMG store

SDMS *n* deletes the selected stored measurement and graphics (SMG) store *n* in order to free up memory for subsequent storage. Normally, if all ten stores contain data and storage is enabled, store -9 will be deleted automatically when a test is run. The SDMS command allows selective store deletion to avoid this.

SDMS *n* *n* = -9 to 0 Store number

Delete All SMG Stores

The SMDA command deletes all stored measurement and graphics (SMG) stores in order to free up memory for subsequent storage.

SMDA

Stored Thru Mode Query

This command requests the thru mode setting for a specified store.

STHU? *store* = -9 to 0 Store number

returns *thru mode state* = 0 or 1

Refer to the THU? command for a detailed breakdown of the reply.

Stored Line Build Out Query

This command requests the stored T1 line build out selection for a specified store.

SLBO? *store* = -9 to 0 Store number

returns *line build out* = 1 to 3

Refer to the LBO? command for a detailed breakdown of the reply.

Stored Transmit Timing Query

Queries the transmit timing selection for the instrument for the particular store requested.

STRT? *store* = -9 to 0 Store number

returns *transmit timing* = 1 or 2

Refer to the TRT? command for a detailed breakdown of the reply.

Stored VF Channel Select Query

Queries the VF channel selection for the instrument for the particular store requested.

SVFC? *store* = -9 to 0 Store number

returns *channel*, 1 to 24

Refer to the VFC? command for details of this reply.

Stored Channel Mapping Query

Queries the channel mapping for the instrument for the particular store requested.

SCHM? *store* = -9 to 0 Store number

returns *channel*, 1 to 24

Refer to the CHM? command for details of this reply.

Stored VF Channel Payload Query

Queries the VF channel payload for the instrument for the particular store requested.

SVFP? *store* = -9 to 0 Store number

returns *payload*, 1 to 4

Refer to the VFP? command for details of this reply.

Stored VF Tone Frequency Query

Queries the VF tone frequency for the instrument for the particular store requested.

`STFF?` *store* = -9 to 0 Store number

returns *frequency code*, 1 to 5

Refer to the `TFF?` command for details of this reply.

Stored User Defined Tone Frequency Query

Queries the user defined tone frequency for the instrument for the particular store requested.

`STFU?` *store* = -9 to 0 Store number

returns *frequency*, 100 to 3900

Refer to the `TFU?` command for details of this reply.

Stored VF Tone Level Query

Queries the VF tone level for the instrument for the particular store requested.

`STFL?` *store* = -9 to 0 Store number

returns *level*, 0 to −55

Refer to the `TFL?` command for details of this reply.

Stored FDL Host Address Query

Queries the FDL host address for the instrument for the particular store requested.

`SFAD?` *store* = -9 to 0 Store number

returns *host*, 1 or 2

Refer to the `FAD?` command for details of this reply.

Stored FDL Protocol Query

Queries the FDL protocol choice for the instrument for the particular store requested.

SFPR? *store* = −9 to 0 Store number

returns *protocol choice*, 1 to 5

Refer to the FPR? command for details of this reply.

Stored DDS T1 Timeslot Select Query

Queries the DDS T1 timeslot selection for the instrument for the particular store requested.

SDTS? *store* = −9 to 0 Store number

returns *channel*, 1 to 24

Refer to the DTS? command for details of this reply.

Stored DDS Payload Rate Query

Queries the DDS payload rate for the instrument for the particular store requested.

SDPR? *store* = −9 to 0 Store number

returns *payload rate*, 1 to 6

Refer to the DPR? command for details of this reply.

Stored DDS DS0B Customer Number Query

Queries the DDS DS0B customer number for the instrument for the particular store requested.

SDCU? *store* = −9 to 0 Store number

returns *customer number*, 1 to 20

Refer to the DCU? command for details of this reply.

Stored DDS Single / Multi Customer Mode Query

Queries the DDS single / multi customer mode for the instrument for the particular store requested.

SDDC? *store* = -9 to 0 Store number

returns *customer mode*, 1 to 4

Refer to the DDC? command for details of this reply.

Stored DDS Error Correction Query

Queries the DDS DS0A error correction for the instrument for the particular store requested.

SDEC? *store* = -9 to 0 Store number

returns *error correction*, 0 or 1

Refer to the DEC? command for details of this reply.

Stored DDS/VF Switched-56 Pattern Type Query

Queries the DDS pattern type for the instrument for the particular store requested.

SDPA? *store* = -9 to 0 Store number

returns *pattern type*, 1 to 9

Refer to the DPA? command for details of this reply.

Stored DDS Stress Pattern Number Query

Queries the DDS stress pattern number for the instrument for the particular store requested.

SDSP? *store* = -9 to 0 Store number

returns *pattern number*, 1 to 5

Refer to the DSP? command for details of this reply.

Stored DS0 Interface Termination Query

Queries the DS0 interface termination for the instrument for the particular store requested.

SDIT? *store* = -9 to 0 Store number

returns *interface termination*, 1 to 3

Refer to the DIT? command for details of this reply.

Stored DS0 Clock Source Query

Queries the DS0 clock source for the instrument for the particular store requested.

SDCS? *store* = -9 to 0 Store number

returns *clock source*, 1 or 2

Refer to the DCS? command for details of this reply.

Stored T1 Pattern or Special query

Queries the T1 special selection for the instrument for the particular store requested. The response corresponds with the PAS? command.

SPAT? *n* *n* = -9 to 0 Store number

returns *m* *m* = 1 to 3

Stored Multi pattern query

Queries the T1 special selection for the instrument for the particular store requested. The response corresponds with the PML? command.

SPML? returns *n* *n* = 1 to 3

SELF TEST COMMANDS

Number Of Tests

This command yields the total number of self tests implemented in this instrument as used by the TST command. ie If the reply is 3 then the commands TST 0 ... TST 3 are legal.

NTST? returns n $n = 15$ for this instrument

Number of Sub-tests in a Test

This command yields the total number of selftest subtests within a test, i.e. TST 3 is a selftest. Within this test are a number of hidden subtests which can be accessed by the command:

NSUB? t returns	$n =$	Total number of tests within subtest t
	$m =$	Number of runnable tests in current option structure

Self-test

The self test command performs a selected self-test on the instrument. A subsequent response of 0 to the ERR? query command indicates that the test has passed, any other number indicates a failure (error codes are listed at the end of this chapter).

TST n	$n =$	0 or ALL	Do all the tests
		1 or TEST1	CPU
		2 or TEST2	DS1 interface
		3 or TEST3	DS1 error
		4 or TEST4	Level measurement
		5 or TEST5	Clock recovery
		6 or TEST6	Pulse shape measurement
		7 or TEST7	Round trip delay
		8 or TEST8	Slips
		9 or TEST9	OOF and SEF
		10 or TEST10	Sig bits
		11 or TEST11	T1 DDS
		12 or TEST12	DS0 interface
		13 or TEST13	VF mode
		14 or TEST14	X.21 / PLL

Default Conditions

The following settings are used for the instrument following RAM backup failure. The RST command and RCL 0 command reset the instrument to these conditions. (except remote control defaults).

System:		
(Unaffected by "RCL 0")	SRQ mask register	ERR
	Status register A (STA)	LCL*, RDY
	Ready register	LQE, STC, ASC, DRO
	Error register	0
	Alarm mask register	0
	Key register	0
Transceiver Settings:		
	Config	FULL T1
	Frame	D4
	Code	B8ZS
	Thru	OFF
	Pattern	QRSS
	T1 Interface	DSX-MON @ 0 dB
	Clk Source	INT
	Tx Multiple TS	TS-1 only
	Rx Multiple TS	(ASTX) TS-1 only
	VF Tx/Rx Channel	1
	Mapping	D3/D4
	Send	TONE 1008 Hz @ 0 dBm0
	Audio Monitor	OFF
	FDL protocol	T1.403
	FDL host addr	CUSTOMER
	HP 37702A ONLY:	
	Phone	0123456789ABCD#
	Signal	ON HOOK
	T1-DDS TS	TS-1
	DDS Mode	DS0A
	DDS Payload	19.2 kb/s
	Error Correction	OFF
	DDS Pattern	PRBS 2047
	DS0-DDS Interface	BIPOLAR
	DS0-DDS Clocks	BIT & BYTE

Transmitter Error Insert:	Error Type	LOGIC
	Error Rate	ERR FREE
	User Prog. Error Rate	1E-3
	Alarm Generation	OFF
Results Control:		
	Test Period Type	CONTINUOUS
	Test Duration (User)	10 MINUTES
	Storage	OFF
Signaling Bit Test:		
	Send sig bits (non-ESF)	01
	Send sig bits (ESF)	0101
	Send sig bits in others (non-ESF)	01
	Send sig bits in others (ESF)	0101
	Send channel	1
	Display Sig. Bits	ALL
	(Single Channel	1)
Timeslot Check:		
	Timeslot Map	ALL
	(Single Timeslot Map	1)
High Res. Round Trip Delay:	Timeslot	01
Stored Settings:		
	Stored Setting Number	0
	Stored Panel Lock	ON
	Real Time clock mode	RUN
Pulse Shape:		
	Pulse Mask Type	ANSI T1.403
	Pulse Shape Trigger Event	DISABLED
	Stored Pulse Number	1
	Stored Pulse Lock	ON

T1 Loopcodes (In-band):	Type	LINE (CSU)
	Framing	INSERTED
	User Prog. Loopup Length	8
	User Prog. Loopup Pattern	10101010
	User Prog. Loopdown Length	8
	User Prog. Loopdown Pattern	10101010
	Auto Response	OFF
	Tester Looped	DOWN
T1 Loopcodes (Out-of-band):	Out-of-band code	LINE
	Out-of-band auto response	OFF
	Out-of-band line looped	DOWN
	Out-of-band payload looped	DOWN
DDS Loopcodes:		
	HP 37702A ONLY	
	DDS Operation	NONE
	Alternating L/B	DSU
	Latching L/B	CHANNEL
	MJU Operation	SELECT BRANCH
Long User Word:		
	Word Number	1
	Byte Length	128
	Sync	FULL LENGTH
	Send LHB	FIRST
VF Access:		
	Signaling Bits	FIXED
	Signaling Bits User	AB-11/00 ABCD-1111/0011
	Rx Channel	1
Printer:		
	Squelch	OFF
	"PRINT NOW" Key	CURRENT SETTINGS
	Auto Triggered Print	OFF
Selftest:		
	Function	ALL

Status Registers

STATUS REGISTER A

This register is accessed by the STA? command and contains a 16 bit word describing the instrument's status. Each bit is a latched record of an event (not an instantaneous reading). The cause of setting and method of clearing are described below:-

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
MSG	RQS	ERR	RDY	LCL	FPS	PWR	RQC

DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8
0	SMG	DAT	TIP	PUL	SCA	ALC	EOT

Bit 0 RQC : For compatibility with "common capabilities". Not used in this instrument.

Bit 1 PWR : For compatibility with "common capabilities". The instrument is about to power down or the battery is in a low state of charge.

Bit 2 FPS : Front panel service request. A front panel switch has been pressed. Cleared by KEY? , RST or CLR.

Bit 3 LCL : Local operation. This is set when the power has just been cycled. Cleared by STA?, STB?, CLR or RST.

Bit 4 RDY : This bit is a direct reflection of the DRO bit (bit 3) of the ready register. It is set when a command causes the instrument to output data, cleared when the instrument has finished outputting the data.

Bit 5 ERR : Error. An error of some description has occurred (see ERR? command and Error Codes for further information). Cleared by ERR?, CLR or RST.

Bit 6 RQS : Service requested. This is required for common capability reasons. It has no function in this instrument, unless HP-IB option is fitted.

Bit 7 MSG :	For compatibility with "common capabilities". There is an ASCII string in the display area or the instrument has something to say. Not used in this instrument.
Bit 8 *EOT :	This bit is set when the instrument reaches the end of its testing period. It is set as the results become valid at EOT. Cleared by STR, RST or CLR, or by reading any result.
Bit 9 *ALC :	Alarm change. This is set when any of the alarms in the alarm status register change and their corresponding mask in the alarm mask register is enabled. Cleared by ALM?, RST or CLR.
Bit 10 *SCA :	Scan Trouble detected. Set when the scan has found an error in one of its tests. Cleared by STR, RST or CLR.
Bit 11 *PUL :	This bit is set when the pulse shape circuitry triggers on a pulse capture event. The pulse shape results for that event will be valid at that point. Cleared by any pulse result query, a pulse shape retrigger command, RST or CLR.
Bit 12 *TIP :	This bit is set during any testing period and cleared when the instrument is not testing. It is set at the start of any period by STR and cleared by RST or CLR.
Bit 13 *DAT :	When set the instrument is in datacom mode, else it is in telecom mode.
Bit 14 *SMG :	When set the instrument is logging data to an smg store. Stored results or setting information can only be read when this is cleared.
Bit 15 0 :	Zero. This is included to be compatible with "common capabilities" and is used to ensure a positive number for STA? response in 16 bit computers.

* = Status bit not HP standard.

Each of the bits in this register (excluding bit 6) can give rise to a change of state of bit 6 (RQS) and hence in the case of instruments with HP-IB capability, can generate an SRQ dependent upon the state of the SRQ mask setting. The RQS command is used to set the SRQ mask which has bits identical to that in Status Register A. An SRQ, and hence a change of state of the RQS bit, is generated on the positive edge of any bit in Status Register A if the corresponding bit in the SRQ mask is set. If this function is disabled by the RQS OFF command, any positive transition of a source with its mask bit enabled will be caught and SRQ'd when the RQS ON command is sent.

STATUS REGISTER B

This register is accessed by the STB? command and contains an 8 bit word describing the important instrument status information. Each bit is a latched record of an event (not an instantaneous reading). The causes of setting and method of clearing are described below:-

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	RQS	ERR	RDY	LCL	FPS	ALC	EOT

Bit 0 *EOT : This bit is set when the instrument reaches the end of its testing period. It is set as the results become valid at EOT. Cleared by STR, RST or CLR, or by reading any result.

Bit 1 ALC : Alarm change. This is set when any of the alarms in the alarm status register change and their corresponding mask in the alarm mask register is enabled. Cleared by ALM?, RST or CLR.

Bit 2 FPS : Front panel service request. A front panel switch has been pressed. Cleared by KEY?, RST or CLR.

Bit 3 LCL : Local operation. This is set when the power has just been cycled. Cleared by STA?, STB? or CLR.

Bit 4 RDY : Ready. A direct reflection of the DRO bit (bit 3) of the ready register. It is set when a command causes the instrument to output data, cleared when the instrument has finished outputting the data. NOTE: There is a (small but) finite time between reading the last byte of a message and the RDY bit going low.

Bit 5 ERR : Error. An error of some description has occurred (see ERR? command for further information). Cleared by ERR?, CLR or RST.

Bit 6 RQS : Service requested. This bit is set if an SRQ is generated for any reason. Cleared by STB?, RST or CLR.

* = Status bit not HP standard.

READY REGISTER

This register is accessed using the RDY? command. The ready register is a byte with binary weighted bits assigned as follows:-

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	LQE	STC	ASC	DRO	AOC	OST	RAC

Bit 0 RAC : Ready to accept new command. This bit is included for "common capabilities" and is not used in this instrument. This bit will always appear set except in dumb terminal mode where it will always appear clear.

Bit 1 OST : Operation started, this bit is set when the instrument starts testing and reset when it has stopped. This is used to show when the testing has actually started. (cf. TIP in Stat reg A).

Bit 2 AOC : All operations complete. This bit is included for "common capabilities" and is not used in this instrument. This bit will always appear clear.

Bit 3 DRO : Data ready for output. This bit is set while a command is outputting data on reply to a query command and is included for common capabilities but has no real use in this instrument. However, the RDY bit in status registers A and B directly follow this bit and a positive transition of the former will generate an SRQ if its mask is enabled. On reads of these registers this bit will always appear set.

Bit 4 ASC : Auto-setup complete. This bit is cleared following a request for auto-setup, and set on completion of that setup.

Bit 5 STC : Self-Test complete. This bit is cleared following a request for self test, and set on test complete.

Bit 6 LQE : Logging queue empty. This bit indicates that the logging queue is empty. Included for common capabilities, but will always be set on this instrument.

ALARM REGISTER

This register is accessed by the ALM? command. A 1 in a bit position indicates that the specified condition is prevailing. If a given alarm condition changes and the corresponding bit in the Alarm Mask Register (see AMR/AMR?) is a 1, then the Alarm Change (ALC) bit will be set in Status Registers A & B.

DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
ERR	OSD	EX0	SLP	PTL	FML	AIS	SGL

DB15	DB14	DB13	DB12	DB11	DB10	DB9	DB8
0	SFM	UAV	EXW	LPD	LPU	PWL	YEL

Bit 0 SGL :	Signal loss. Set when no signal is present.
Bit 1 AIS :	All 1s signal. Set when an all ones data pattern is received.
Bit 2 FML :	T1 Frame loss. Set when T1 frame sync is lost.
Bit 3 PTL :	Pattern loss. Set when pattern sync is lost.
Bit 4 SLP :	Slip detected. Set if a slip has occurred in the last 100ms.
Bit 5 EX0 :	Excess Zeros. Set if excess zeros have occurred in the last 100ms.
Bit 6 OSD :	Ones Density. Set if density < 12.5 % in the last 100ms.
Bit 7 ERR :	Errors. Set if an error has occurred in the last 100ms.
Bit 8 YEL :	Yellow Alarm. Set if a yellow alarm has occurred in the last 100ms.
Bit 9 PWL :	Power Loss. Set if a power loss has occurred during the last test period, or the currently running period.
Bit 10 LPU :	Loopup detected. Set if a loopup pattern is being detected.
Bit 11 LPD :	Loopdown detected. Set if a loopdown pattern is being detected.
Bit 12 EXW :	Excess Wander. Set if excess wander has occurred.

Bit 13 UAV :	Unavailability. This flag is set when the system under test appears to be unavailable during a testing period (Notice that this will be set if any of the three types of error (ie. logic, frame or crc) go unavailable.
Bit 14 SFM :	DDS rate frame loss. Set when DDS frame sync is lost while in a DDS configuration. Otherwise clear.

Error Codes

The following tables list the error codes which are returned following an ERR? command.

Parse Time Errors (Error codes -100 to -199)

The errors listed here occur during the parsing of remote control commands.

-100	Command error (Unknown command)
-101	Invalid character received
-110	Command header error
-111	Header delimiter error
-120	Numeric argument error
-121	Wrong data type (Numeric expected)
-122	Precision error; rounding occurred
-123	Numeric overflow
-129	Missing numeric argument
-130	Non numeric argument error
-131	Wrong data type (char 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	Comma is not a legal command separator
-143	Argument delimiter error
-144	Comma is not a legal command separator
-150*	Invalid message unit delimiter
-151*	CR found without following LF
-160	RS-232 Parity Error
-161	RS-232 Framing Error
-162	RS-232 UART Overrun Error
-163	RS-232 Internal Input Buffer Overrun Error

* = Instrument dependent error code.

Execution Time Errors (Error codes -200 to -299)

These errors are caused at execution time of remote control commands.

-200	No can do (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 doing something else
-222	Insufficient capability or configuration
-231	Input buffer full or overflow
-232	Output buffer full or overflow
-240*	Command provided through HP-IB meta-message only
-241*	Command not implemented
-250*	Command illegal during testing
-251*	Command illegal when not testing
-252*	Cannot start with testing period of zero
-253*	Cannot start while selftesting, autosetup
-254*	Cannot change while transmitting alarms
-255*	Cannot change while sweeping (datacom)
-256*	Cannot change while not sweeping (datacom)
-257*	Sweep is already running (datacom)
-258*	The cct is already sweeping
-259*	Cannot change while in-band loopback
-260*	Cannot change while out-band loopback
-261*	Only allowed when ESF framing
-263*	Cannot change while tester looped
-264*	Cannot change while accessory faulty
-265*	Cannot change while dialing
-266*	Only allowed when correct DDS loopcode selected

* = Instrument dependent error code.

Error Codes for Stored Measurement Results and Graphics

-410	Not allowed while SMG running
-411	Requested SMG store out of range
-412	Requested SMG store unused - no data
-413	Requested SMG text result out of range

Option or Capability Errors (Error codes -350 to -370)

The error codes in this section are issued if a legal command is received, but it cannot be executed due to insufficient capability or unsuitable option configuration. They are all diagnosed by the remote control parser or executor.

600	Instrument has no pulse mask or wander measurement capability
601	Instrument has no datacom lid accessory fitted
605	Only permitted when in telecom mode
606	Only permitted when in datacom mode

Restart Causing Commands

The following commands cause the instrument to discard current results and start a new test.

Mnemonic	Mnemonic	Mnemonic
APP	LBO	SPT
AUT	LDA	SRG
CHM	LHB	STO
COD	LSL	STR
CON	LUA	TDU
DAT	LUL	TFF
DCS	LUS	TFL
DCU	LUW	TFU
DDC	LUY	THU
DEC	PAF	TIM
DIT	PAS	TPD
DPA	PAT	TRT
DPR	PAU	TTM
DSP	RCL	VFC
DTS	RST	VFP
FPR	RTM	VFS
FRM	RXT	
IFC	SAV	

Index

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U