Critical Release Notice

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The content of this customer NTP supports the SN06 (DMS) and ISN06 (TDM) software releases.

Bookmarks used in this NTP highlight the changes between the baseline NTP and the current release. The bookmarks provided are color-coded to identify release-specific content changes. NTP volumes that do not contain bookmarks indicate that the baseline NTP remains unchanged and is valid for the current release.

Bookmark Color Legend

Black: Applies to new or modified content for the baseline NTP that is valid through the current release.

Red: Applies to new or modified content for NA017/ISN04 (TDM) that is valid through the current release.

Blue: Applies to new or modified content for NA018 (SN05 DMS)/ISN05 (TDM) that is valid through the current release.

Green: Applies to new or modified content for SN06 (DMS)/ISN06 (TDM) that is valid through the current release.

Attention!
Adobe® Acrobat® Reader™ 5.0 is required to view bookmarks in color.

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Standard release 02.04 for software release SN06 (DMS) and ISN06 (TDM).

Change of phone number from 1-800-684-2273 to 1-877-662-5669, Option 4 + 1.

662-7001-100

Network Test Systems

Digital Test Head

General Description

Standard 02.03 January 2000

How the world shares ideas.

Network Test Systems

Digital Test Head

General Description

Document number: 662-7001-100
Product release: Application
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Publication history

January 2000

Made editorial changes. In response to CSR UT80788, there is a new DTH feature that permits the DTH to accept up to 15 digit long signal string.

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June 1992

First Preliminary issue of Release 33 documentation.

February 1992

First preliminary issue of Release 32 documentation.

November 1991

First draft issue of Release 32 documentation.

Contents

About this document

This document describes the Digital Test Head (DTH) and its features. It also describes the principles of input and output for DTH. It is for a DTH user who wishes to become familiar with the general nature of DTH.

Using this NTP

This NTP describes the features and services of DTH. It has the following sections:

- Introduction - introduces DTH and provides a functional overview
- DTH system description - describes the high level model for network
- DTH configuration - discusses DTH hardware and software
- The local terminal user interface - mentions the user interface
- System administration - describes DTH administration
- Digital tests - discusses the digital features
- Analog tests and monitoring - mentions the analog features
- ROTL functions - describes the ROTL features
- Digital call origination - for digital trunk testing, the Digital Call Origination function provides a means of placing call to Type 108 test lines at a far end office.
- 108 test line provisioning - explains 108 test line provisioning
- DTH/DTT interface to digital switch - gives a description of the test access digroup (TAD) interface between the Digital Test Head (DTH) and the DMS-100 switch.

Associated NTPs

This NTP gives a detailed discussion of the DTH and the tests it can perform. For step-by-step instructions on each procedure that a DTH administrator or user can perform, refer to 662-7001-300.

General

The DTH uses digital signal processor technology to perform tests of both digital and analog telecommunications circuits. Table 1-1 shows the DTHs testing arrangements and capabilities. In central office applications, use the DTH for trunk testing. It provides Remote Office Test Line (ROTL), type 105 test line, and responder functionalities for CAROT (centralized automatic reporting on trunks) center trunk testing.

In addition to trunk testing, the DTH can test other circuits in the central office, including switched and non-switched special services circuits. Access such circuits through a DS1TAD (test access digroup) from the DTH to a digital switch, channel bank, digital cross connect (DCC), or other digital system.

Table 1-1
DTH testing arrangements and capabilities

Function	Control system	Test access
analog and digital trunk testing	CAROT, through ROTL access telephone lines	4-wire E&M ROTL trunks and type 105 test lines
digital and analog circuit testing	Local terminal, through RS-232 port	digital DS0 channels to switch, digital cross connect, channel bank, and so forth

The DTH local terminal is typically at the DTH site, but you can extend its RS-232 interface (for example, through a packet network) to a central location. It provides access to:

- digital transmission testing
- analog transmission testing
- digital monitoring
- voice monitoring
- ROTL configuration and status monitoring
- management and operational information
- administrative tasks

- maintenance tasks

DTH users

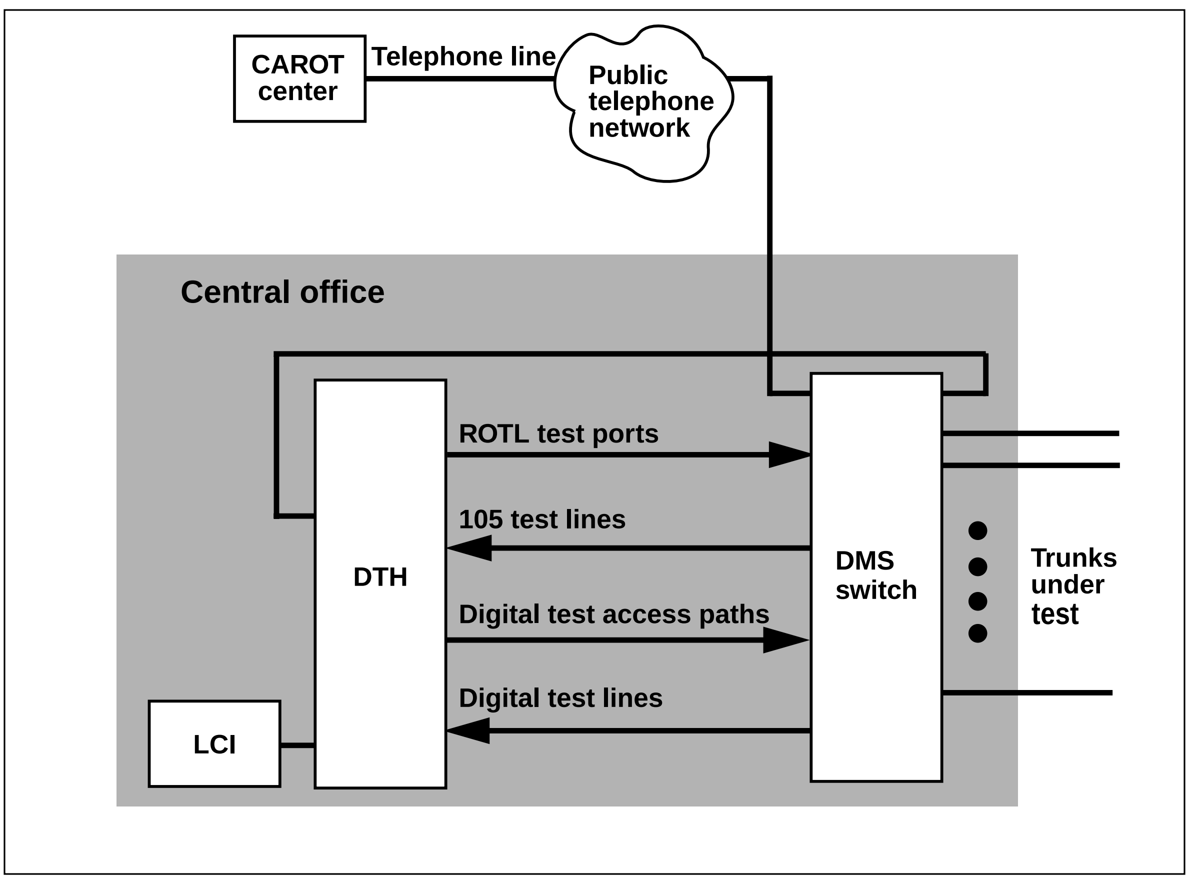
There are two classes of DTH users, tester and administrator. The administrator has greater privileges than the tester. Only the administrator can perform administrative functions. (For detailed information on administrative functions, see *662-7001-300*.

DTH system description

DTH central office configuration

Figure 2-1 shows DTH's configuration for trunk testing in a central office environment. (For other circuit testing arrangements, see "General circuit testing with the DTH". The local terminal, and CAROT center provide user access to the DTH. A 4-wire analog trunk (for ROTL test ports and test lines), and DS0 channels on a DS1 digital link (for digital test access paths and test lines) provide access to the DMS switch for control and measurement.

Figure 2-1
Trunk testing in a central office environment

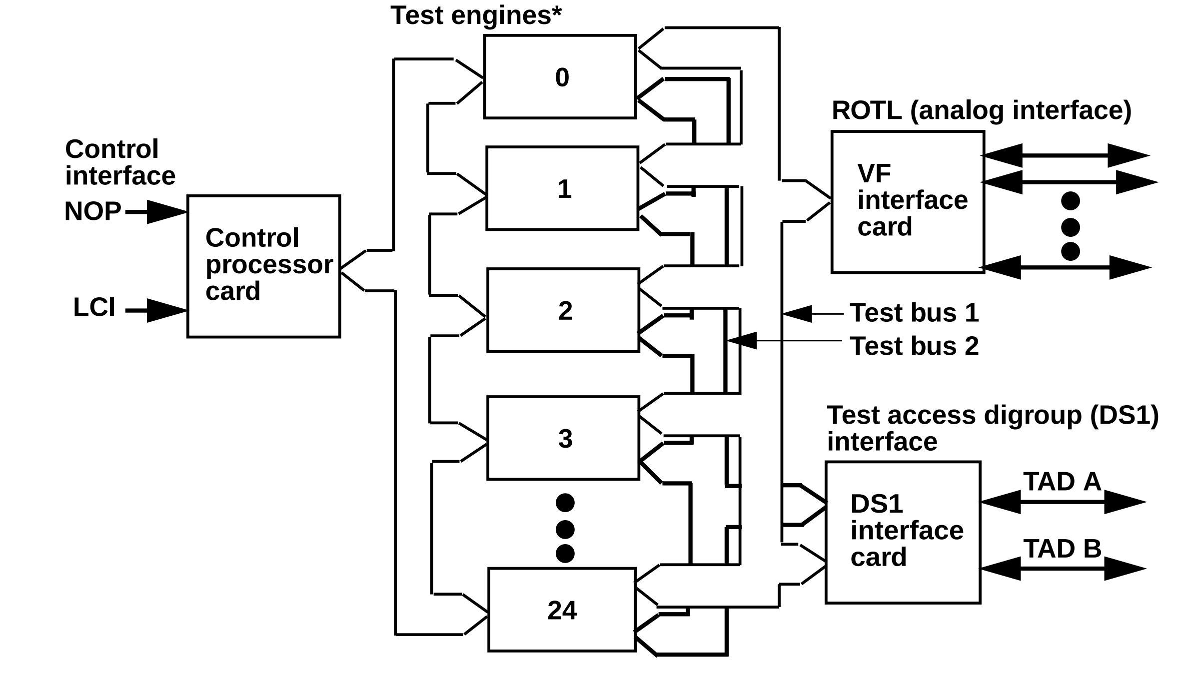


DTH system architecture

The DTH has four major architectural elements (refer to Figure 2-2):

1. the control processor (CP), with NOP and local terminal user interface ports
2. a number of test engines, which are digital signal processors. There are four test engines on each DS0 handler card
3. an analog interface (the VF interface card) for ROTL functions
4. a TAD interface (the DS1 interface card) for access and control of digital network elements such as a digital switch

Figure 2-2
DTH architecture



Note: There are four test engines per DS0 handler card

The CP handles user interfaces, performs system diagnostics, and directs the activity of test engines. In turn, the test engines originate and answer calls, perform tests, make measurements, and perform other operations. The DTH performs test engine operations on individual or multiple DS0 level channels of a test bus. There are two test busses. Each provides a path between the test engines and the analog or digital interfaces to the network elements whose circuits are to receive testing.

Note that there are some restrictions on test engine quantity and use:

- One DTH can have as many as 24 test engines (six DS0 handler cards, with four test engines per card).
- If there is a DS1 interface card, but no VF interface card, each test engine can access any channel on either test bus. This means a test engine can access any of 48 DS0 channels, 24 channels of TAD A and 24 channels of TAD B.
- Both a DS1 and a VF interface card may be present. If so, the DTH allocates the first four test engines and all of test bus 1 to ROTL and type 105 test line functions. Additional test engines can access only the 24 DS0 channels of TAD B. This configuration is typical for DTH installations which perform both ROTL and DTT operations on a digital switch.
- If a VF interface card is present, and there is no DS1 interface card, the DTH has a ROTL configuration, and performs only type 105 test line functions. Additional test engines, after the first four, have no function. (You can not test DS0 channels on a TAD.) This configuration is typical for DTH installations which perform only ROTL operations.

Network views of ROTL (and type 105 test line) operations and of DTT (and type 108 test line) operations are given later in the chapter.

Test engine functions

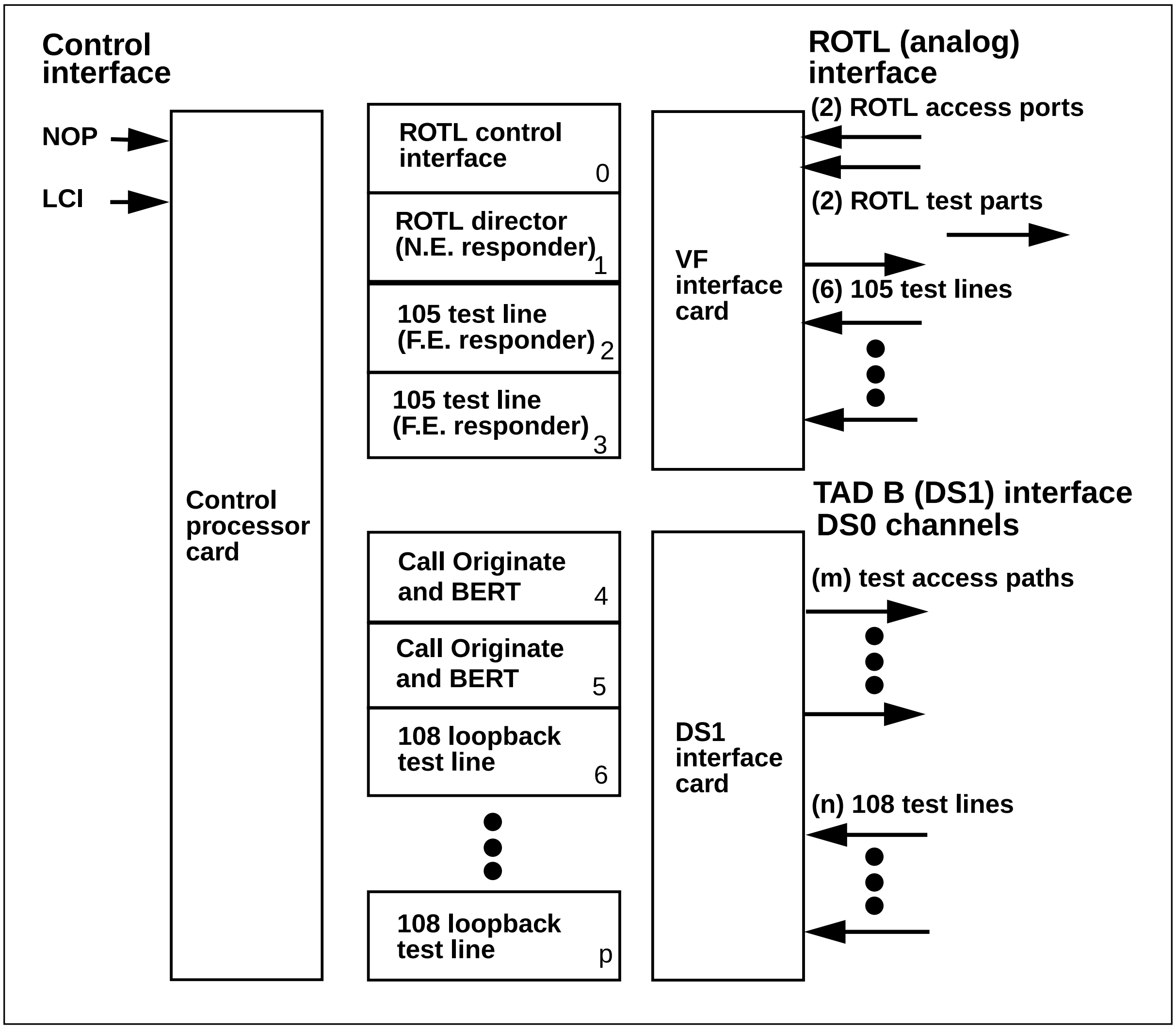
DTH test engines are digital signal processors with digital memory and input/output circuitry. The DTH determines the activity of each test engine by what it downloads from memory on the CP board.

In some cases, a test engine is provisioned for a particular function such as a type 108 loopback test line. The DTH downloads the software at provisioning, and it remains until the test engine is re-provisioned. In other cases, a test engine receives software for the duration of a particular activity, such as a BER test. At the conclusion of the test, it is idled and is ready for a new activity. The following sections describe the test engine functions that pertain to two common applications, DTH/ROTL and DTH/DTT. Figure 2-3 illustrates the functions.

ROTL and type 105 test line functions

When there is a VF interface card, the first four test engines automatically have functions which support the ROTL and type105 test line testing. One test engine becomes the ROTL control interface which responds to commands from the CAROT center. Another test engine becomes a near-end (NE) responder, which accesses the NE switch, generates signals toward the far-end (FE), and measures signals from the FE.

Figure 2-3
DTH test engines functions



Two other test engines become FE responders which answer calls from the switch and carry out tests with a NE responder at another location.

The ROTL control interface test engine operates on DS0 channels associated with two analog telephone lines. Analog/digital conversion and signaling occur on the VF interface card. The two telephone lines function as ROTL access ports. One or more CAROT centers can use the telephone network using commands and responses in the form of tones, including MF digits.

The ROTL director test engine communicates on one side with the ROM control interface test engine. On the other, it communicates with DS0 channels associated with two trunks to the NE switch. These are four trunks with E&M signaling. Sense points and control points augment the information content of the E&M signaling protocol, four of each per trunk. The trunks function as ROTL test ports.

The two type 105 test line test engines function independently from the ROTL control interface and ROTL director. Instead, they operate on DS0 channels associated with up to six 4-wire E&M trunks that the switch uses as type 105 test lines. After establishing a call from the switch, the test engine performs the test functions of a FE responder.

Note that in the CAROT center the telephone lines for ROTL access ports effect control of the ROTL control interface and director test engines. The NOP and local terminal support certain ROTL status query, configuration, and diagnostics functions, but can not support trunk testing using ROTL. Similarly, the type 105 test line test engines are controlled by the test lines with which they associate.

Digital trunk testing functions

A digital trunk test typically consists of a call, using a NE test engine, to a type 108 loopback test line at a FE DTH. After establishment, the NE test engine performs a BERT and disconnects the call. It sends the NE test engine its functional software as the call and the test progress. The FE test engine receives type 108 test line software during test line provisioning.

The NE test engine operates on a TAD B DS0 channel used as a test access path (TAP). The TAP is a digital trunk, with AB bit signaling and MF pulsing, outgoing to the switch. A local terminal user can select a channel and initiate a test.

The FE test engine operates on a TAD B DS0 channel used as a type 108 test line. The test line is a on digital trunk, with AB bit signaling and no digit pulsing, outgoing from the switch.

1. The switch selects the specific test line, seizing it with an off-hook signal.
2. The test engine responds with an off-hook answer signal and provides a non-inverting loopback of the received PCM information.
3. The test lines type 108 test line control their associated test engines.
4. You can use the local terminal to provision the type 108 test lines and to perform certain status query and diagnostics operations.

The number of TAPs and TLs is engineered based on the testing requirements for the associated switch. Hence, the necessary number TAPs and test lines determines the number of test engines.

DTH user access

There are two categories of DTH user access:

1. DTH tester access using the local terminal. A tester working at the local terminal can access all DTH functionality except for ROTL and hardware diagnostics.
2. DTH administrator access, using the local terminal. An administrator can execute all tests and all monitoring functions.

Control from a local terminal

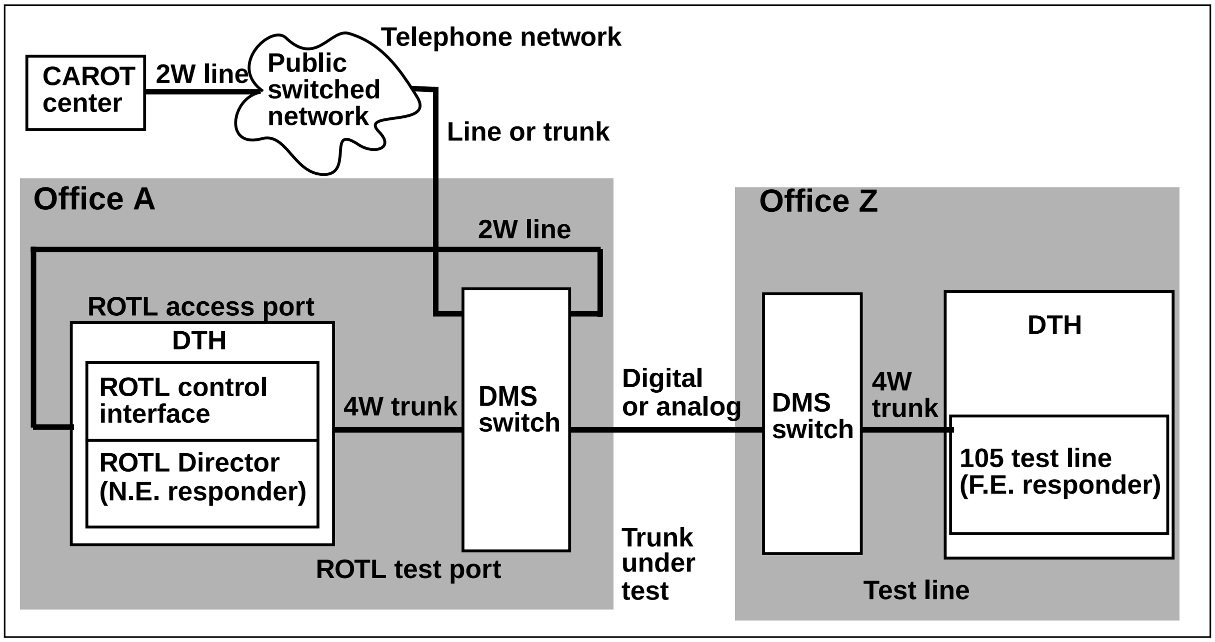
A user at the local terminal can control the DTH. It is a VT220 or VT220-compatible terminal configured in asynchronous ASCII mode. Configure it according to specific setup parameters used for DTH. For communication parameters and information on configuring ASCII terminals, refer to *DTH Installation and Maintenance*, 662-7001-200. For specific instructions on setting the parameters for a given terminal, refer to the manufacturer's documentation.

Network view of ROTL testing

Figure 2-4 depicts trunk testing using type 105 test lines from a network perspective. The analog or digital trunk under test (TUT) is between NE office A and FE office Z.

1. Using the public switched telephone net work, the CAROT center calls the ROTL access port at the NE DTH.
2. In turn, the ROTL director (NE responder) begins a call to the type 105 test line at the FE DTH.
3. After call connection, the NE and FE responders conduct tests.
4. The ROTL control interface reports results to CAROT and, when directed by CAROT, disconnects the call. The NE DTH uses two test engines, and the FE DTH one.

Figure 2-4
Network view of ROTL testing



The key steps in the call are:

1. ROTL answers a call from CAROT.
2. It connects the test port to the switch.
3. It sends priming information to ROTL.
4. It relays priming information to the switch.
5. There is trunk seizure and a connection to the FE equipment.
6. The DTH performs tests over the trunk.
7. CAROT receives the results.
8. ROTL and the FE equipment release the trunk under test (TUT).
9. CAROT releases the connection to ROTL.

Network view of digital trunk testing

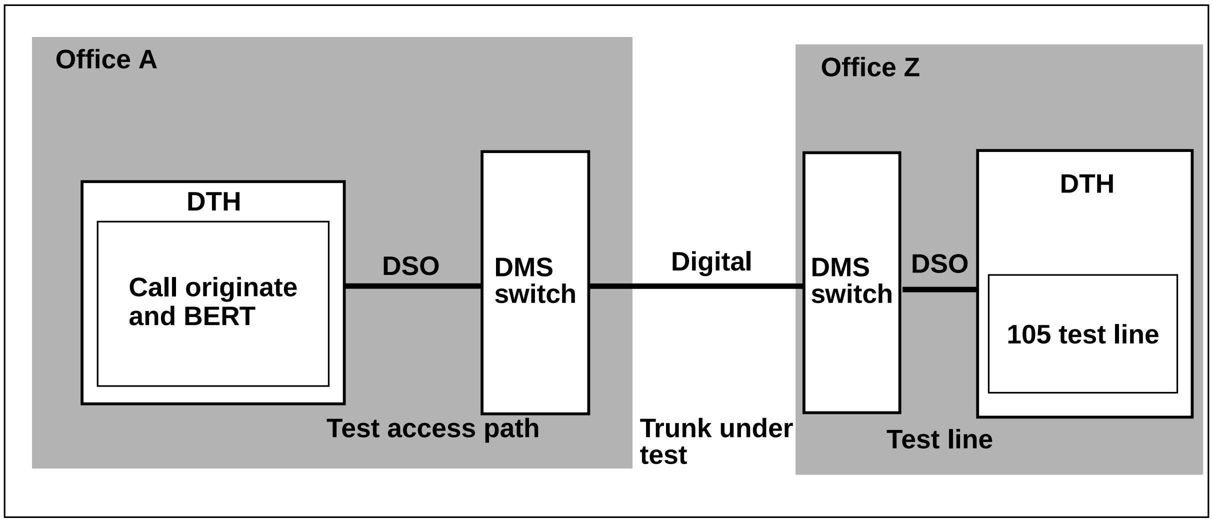
Figure 2-5 shows DTT, using type 108 test lines, from a network perspective. The digital TUT is between the NE and FE offices.

1. Specify a NE TAP and invoke a digital call origination through a packet switched data network.
2. The call goes through the TUT to a type 108 test line at the FE DTH.
3. After call connection, invoke BER testing.

4. The FE test line simply echoes the BERT pattern.
5. When the test is complete, the NE DTH reports results and disconnects the call.

Both the FE, and FE DTH use one test engine.

Figure 2-5
Network view of digital trunk testing



General circuit testing with the DTH

In addition to trunk testing, the DTH can perform tests on other circuits in the central office, including switched and non-switched special services circuits. Access such circuits using a DS1 TAD from the DTH to a digital switch, channel bank, digital cross connect (DCC), or other digital system. Perform this type of testing from the local terminal.

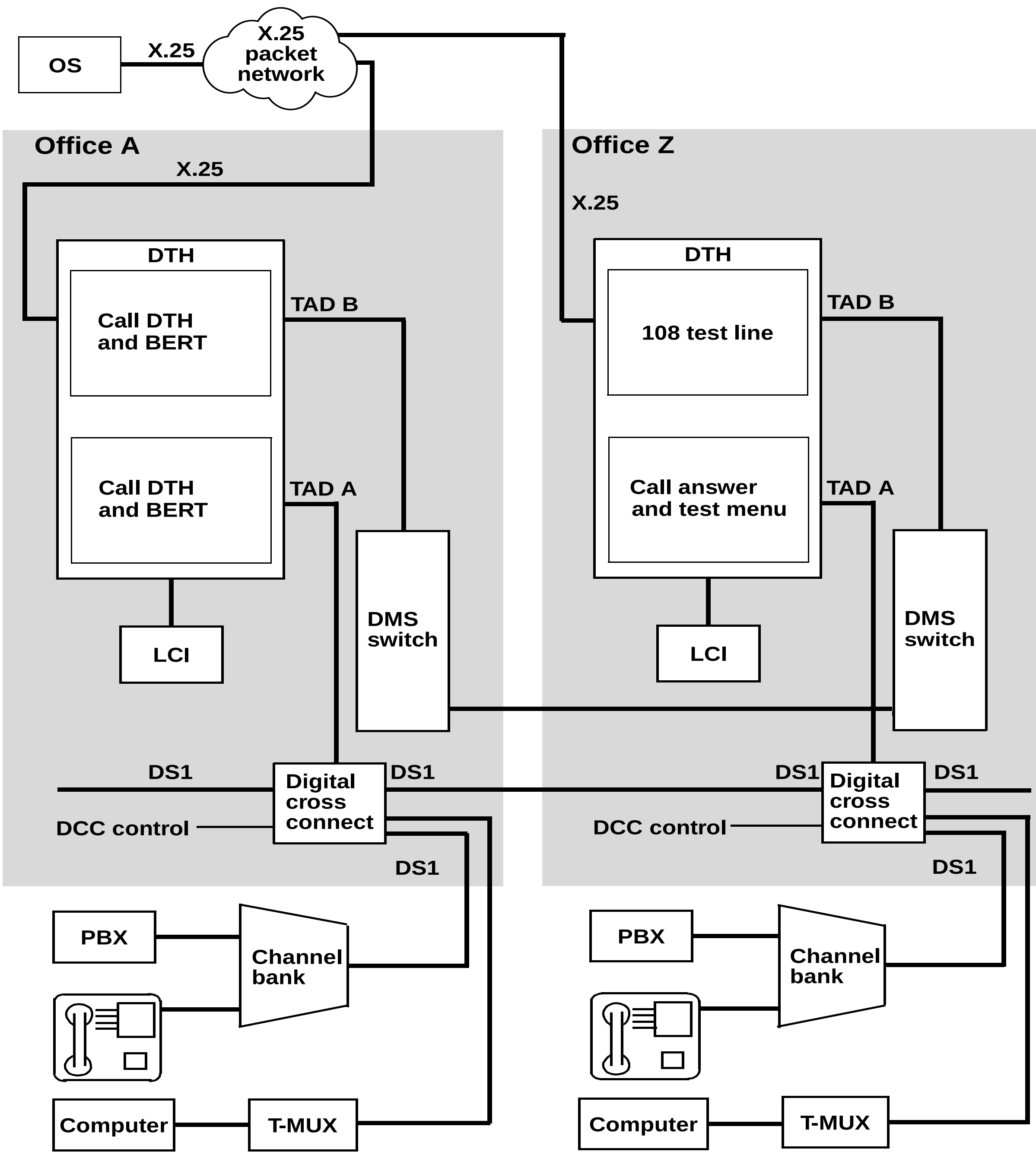
Network view of general circuit testing

The network view in Figure 2-6 illustrates the application of the DTH to general circuit testing as well as trunk testing. Both TADs are in use. TAD B is for testing trunks in the switched network, while TAD A is for testing switched and non-switched circuits. The illustration shows access through a DCC system; you can connect the TAD to any system (for example, digital PBX, T1 multiplex, channel bank) that has a DS1 interface. The DCC system allows flexibility such that you can access almost any circuit. Test configurations include circuits having a DTH:

- at each end
- at one end (or in the middle), monitoring the circuit or providing a stimulus to the circuit

- at one end and a loopback, termination, or other test device at the other end. For example, you can perform tests of circuits terminating on customer premises with a loopback device at the customer's equipment.

Figure 2-6
Network view of general circuit testing



You can perform both analog and digital testing. The analog tests include:

- frequency and level
- gain slope
- peak-to-average ratio (PAR)
- non-linear distortion (NLD)
- C-Notched noise
- message noise
- 3 kHz flat noise
- return loss
- phase jitter

Digital BER testing is possible with a wide range of patterns and bit rates, including:

- pseudorandom patterns (2^{N}-1, with N = 9, 11, 15, and 23)
- low, medium, and all ones density stress patterns
- alternating density stress patterns
- user definable patterns (6, 7, or 8 bits)
- ASCII Fox pattern (ASCII, EBCDIC, BCDIC, and Baudot)
- DS0/DS0A format subrates (2400, 4800, 9600, and 56 000 baud, for DDS)
- DS0/DS0B format subrates (2400, 4800, and 9600 baud)
- DS0 multiple rates, from DS0 (64 kb/s) to DS1

Refer to *DTH Operations*, 662-7001-300, for a detailed description of the available test parameters and modes.

PBX trunk circuit testing example

In Figure 2-7, TAD B connects to a switch, while TAD A connects to a channel bank (or to a DCC serving a channel bank). The channel bank provides a path to one of the PBX lines.

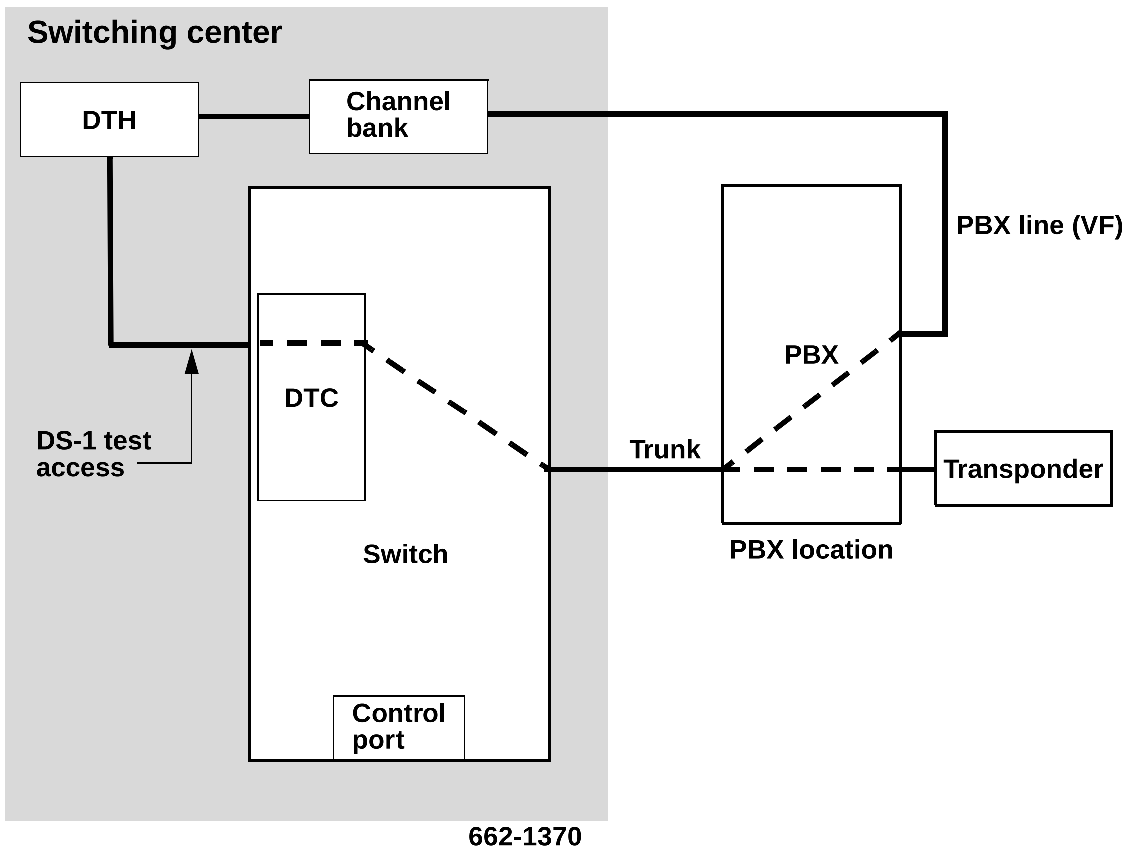
The DTH has several call originate and call answer modes for example:

- loop start
- wink start
- MF pulsing
- dial pulsing

which facilitate the type of call shown. After establishing a connection, you can begin end-to-end analog tests.

An alternative test involves the use of a loopback, termination, or other transponder at the PBX. You can perform BER testing of a digital PBX trunk in this fashion.

Figure 2-7
PBX trunk testing between switch and PBX



Perform the following steps to test incoming and mixed PBX trunks:

- Verify that there is a TAP to the trunk from the switch side.
- Use DTH to dial the test line on the PBX.
- After establishing the connection, perform the tests.

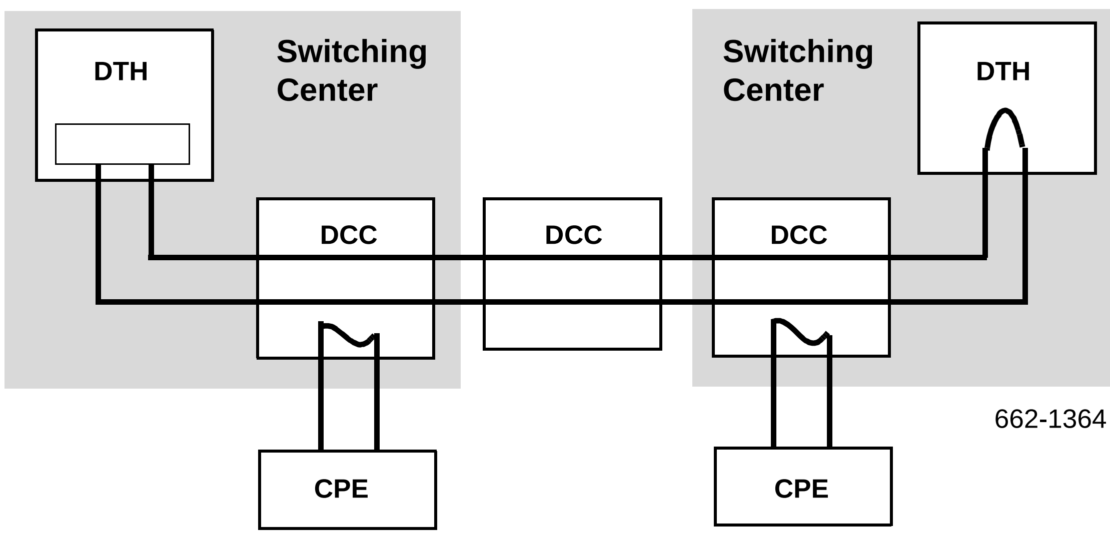
When the DTH connects to the PBX test line, you can perform tests from DTH to itself. Outgoing PBX trunks do not accept dialing from the switch, you must access from the PBX. You can test these trunks on a CPE-to-CPE basis from the PBX to the switch connecting to the trunk.

Some PBXs allow you to define line appearances as maintenance lines from which you can select a specific trunk. Using the maintenance lines, you can select specific PBX trunks for testing. For PBXs that do not provide maintenance line capabilities, you can test outgoing trunks only on a random basis, CPE-to-CPE type testing.

Non-switched circuit testing example

Testing non-switched circuits (refer to Figure 2-8) carried over a DCC network involves testing the transport circuit as well as the customer access circuits. To test the transport circuit, perform a connectivity and quality check on the circuit portion connecting the end DCCs.

Figure 2-8
Transport network connectivity and quality test



Perform the following steps:

- Verify that there is a TAP between the DTH units at the end DCCs.
- Perform a BERT. The DTH works in tandem with a loopback device (which could be a DTH unit) at the FE.
- Display results from the DTHs.

To test customer access circuits, test the part of the circuit between the end DCCs and CPEs. Loopback capabilities must exist at the customer end.

Figure 2-9, and Figure 2-10, show the configurations for this type of test. For digital circuits, verify the performance using a BERT. Note that you must activate the loopback configuration at the customer end.

For analog circuits, use regular analog measurements.

Figure 2-9
Local access circuit testing

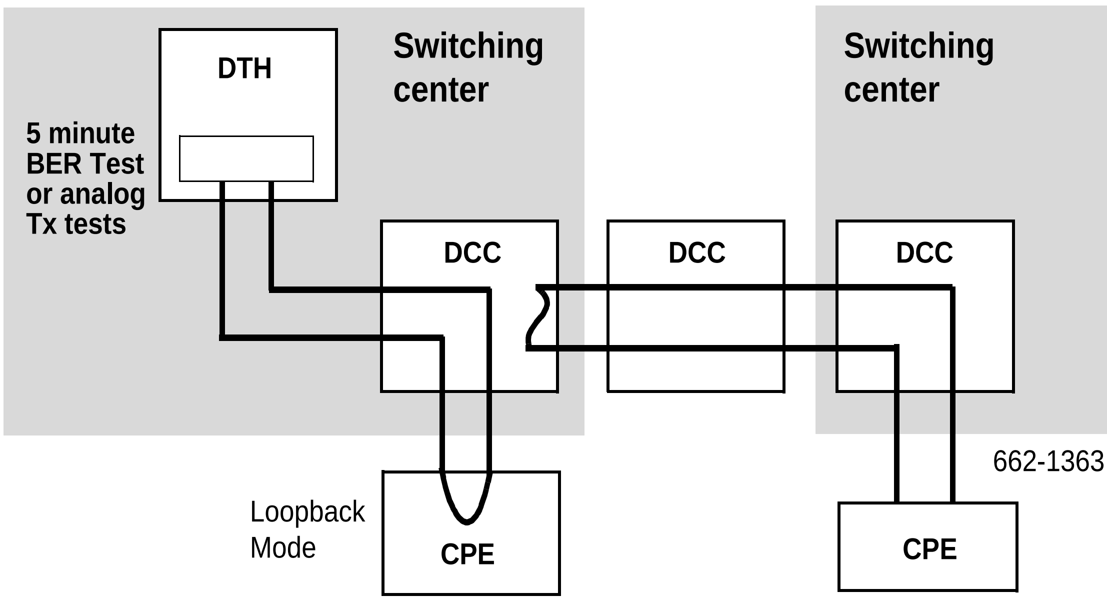
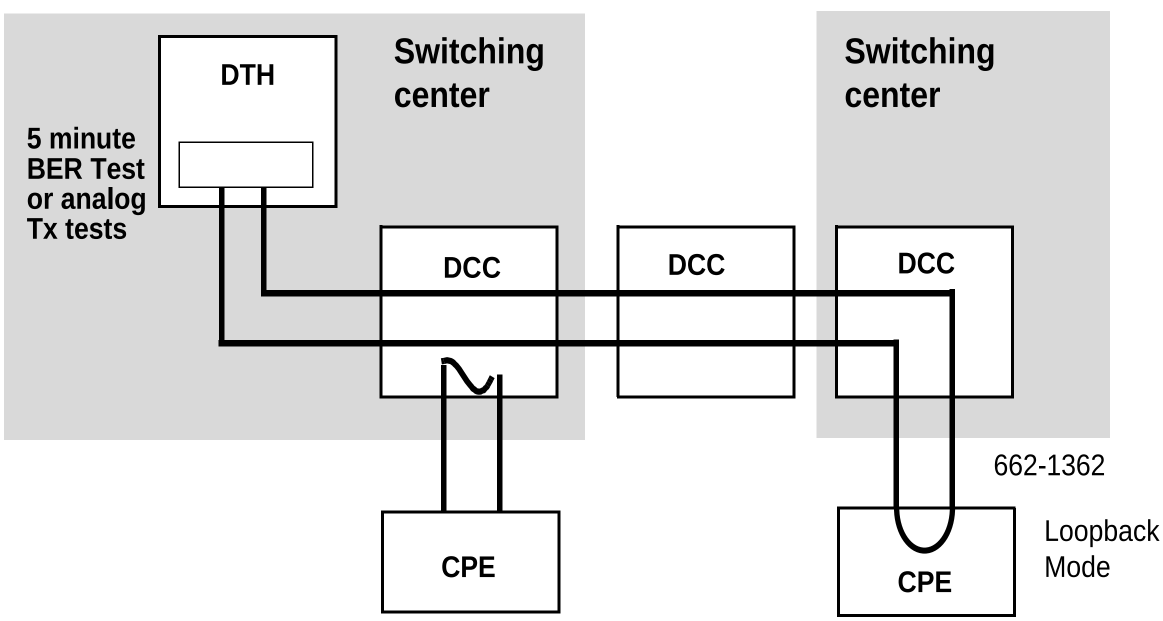


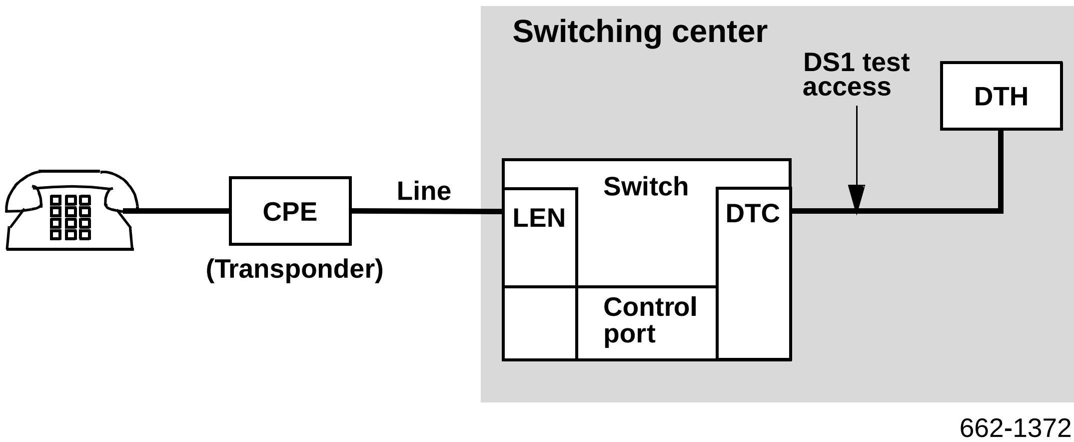
Figure 2-10
Remote access circuit testing



Switched line testing example

Figure 2-11 shows the configuration for switched line testing.

Figure 2-11
On demand testing for switched lines



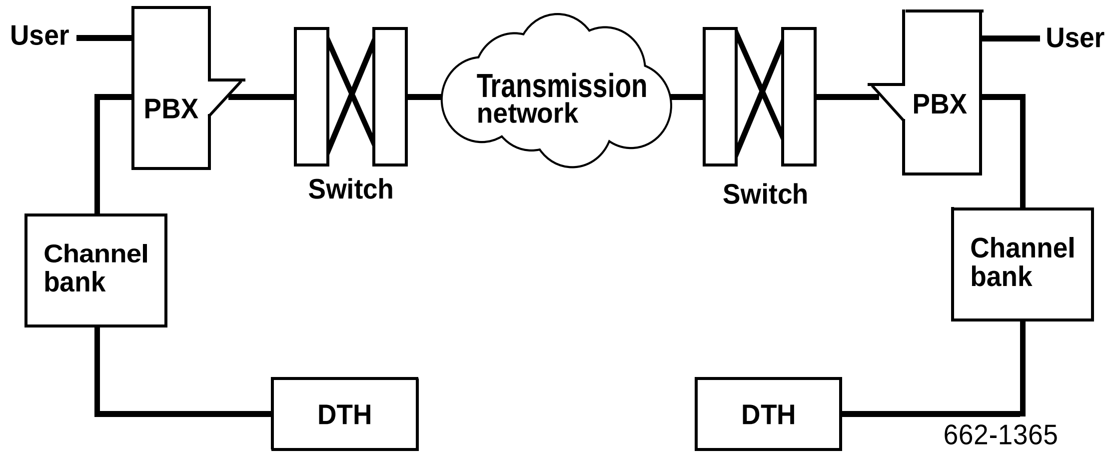
To test a switched line, perform the following:

1. Verify that there is a TAP from the DTH to the line. (Typically, you do this at the control port of the switch.)
2. To test a data line, activate the loopback configuration of the terminating equipment at the customer line end. If it is a data service unit (DSU) or a CPE channel, loopback testing is automatic. Otherwise, you must perform it manually. Perform a BERT to evaluate the line's continuity and performance quality.

CPE-to-CPE connections testing example

CPE-to-CPE testing (refer to Figure 2-12) allows you to perform transmission quality measurements between any two switches or PBXs. Establish a connection using normal call processing, which results in a random trunk path selection. The line appearance on each class 5 switch and PBX connects to its corresponding DTH for testing.

Figure 2-12
CPE-to-CPE testing example



Using two DTH units, perform the following steps:

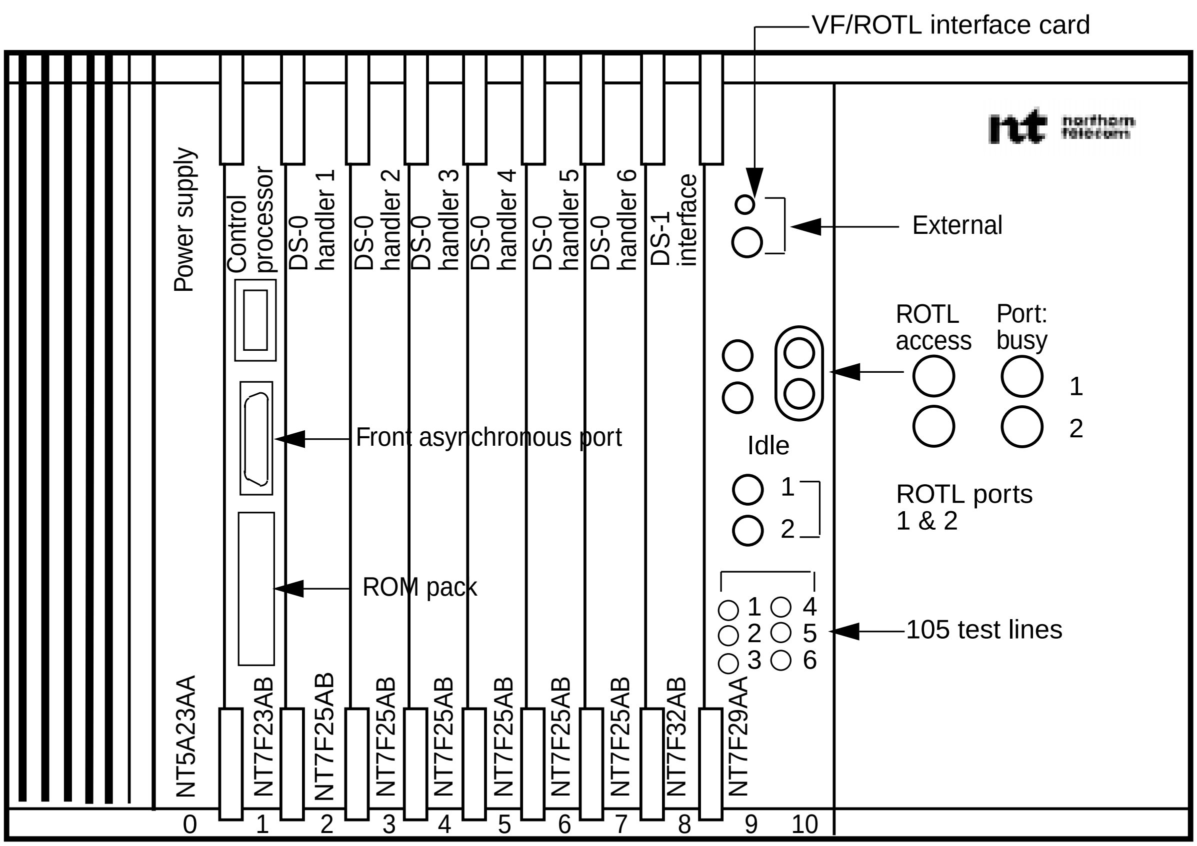
1. Put the FE DTH in answer mode.
2. At the NE, use the Call command to dial the FE CPE.
3. The FE DTH answers the call. (If you can not establish a connection, the NE DTH displays a ‘Call not connected’ message.)
4. After establishing a connection, invoke tests from both DTH units to verify the transmission quality of the circuit. For example, the FE operator can use a stimulus command to provide a 1004 Hz holding tone. Then, the NE operator invokes a test to verify circuit’s the transmission quality.
5. Once testing is complete, release the DTH units from the connection.

DTH configuration

Hardware

The DTH resides in a shelf measuring 58.42 cm (23 in.) wide by 35.56 cm (14 in.) high by 33.02 cm (13 in.) deep. (These dimensions do not include the mounting hardware.) You can mount the shelf in a standard 23-inch rack or in a standard 26-inch rack (using rack adapters). It is available in brown only. Figure 3-1 and Figure 3-2 illustrate the front view and a view of the backplane of the DTH.

Figure 3-1
Front view of the DTH unit



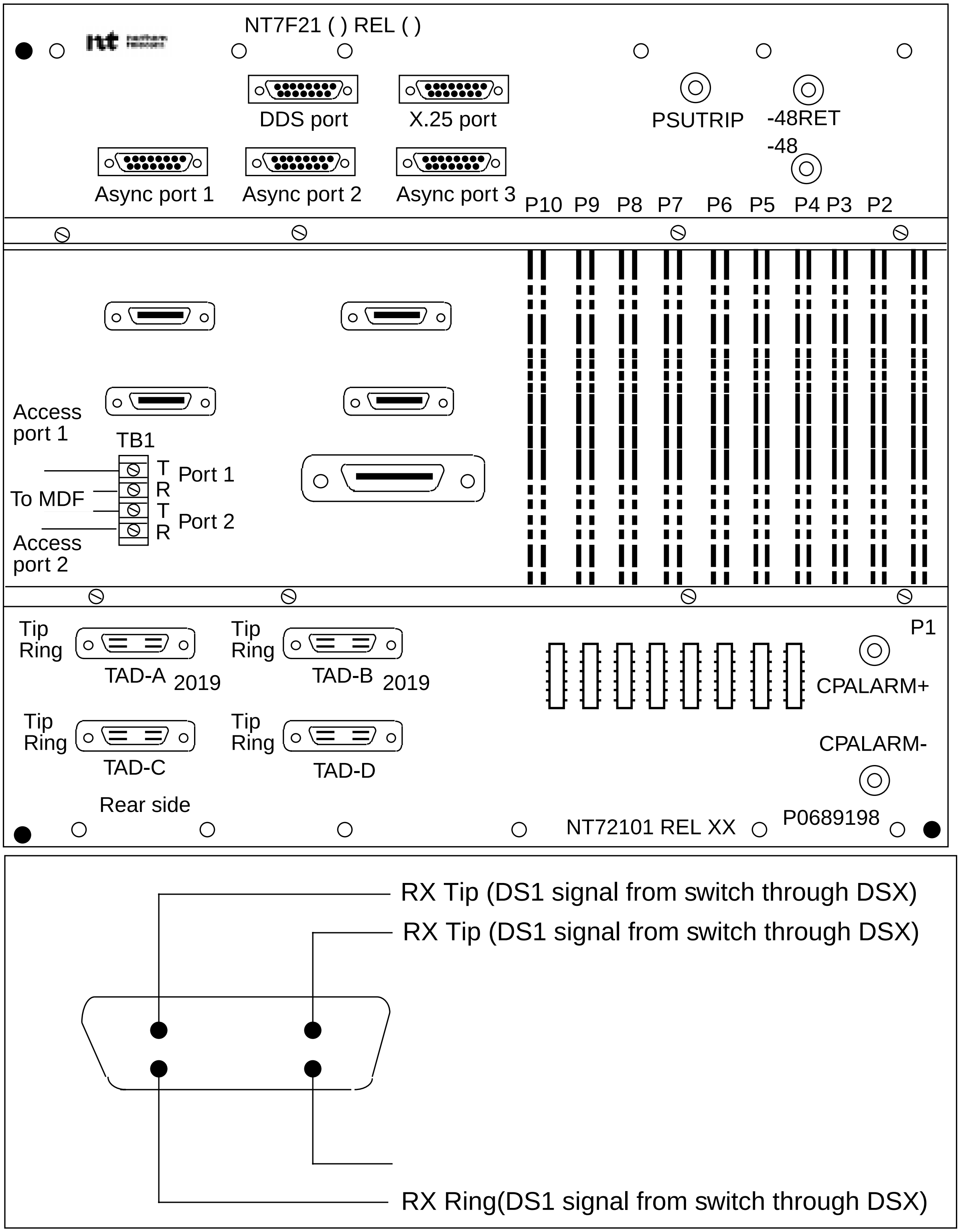
662-7001-200 explains DTH connections.

The DTH cabinet holds a maximum of ten cards. They are:

- power supply unit
- CP card with ROMPACK
- DS1 interface card
- VF interface card (for ROTL)
- DS0 handler card

The DTH is a minimum configuration unit. It includes one power supply, one CP card (including ROMPACK), one DS1 interface card, and one DS0 handler card. For a detailed discussion of the cards, refer to 662-7001-200.

Figure 3-2
Backplane of the DTH unit



Maintenance

You can replace cards. The CP card has visual indicators to help diagnose problems. You can replace cards without removing the unit from its permanent mount, but you should must the unit down.

Software

When you receive a new DTH software upgrade, it comes in a new insertable ROMPACK. You must insert the ROMPACK while the DTH is powered down, or you will lose calibration values. For major software revisions, you may also need to replace the CP boot ROM socketed chips.

The local terminal user interface

When accessing DTH from the local terminal, you use the menu-driven local terminal user interface. The user interface provides data entry, does input verification, and sends status messages to the user. Figure 4-1 shows the hierarchy of DTH menus and screens for the user interface.

Use the local terminal user interface to perform certain operations, such as:

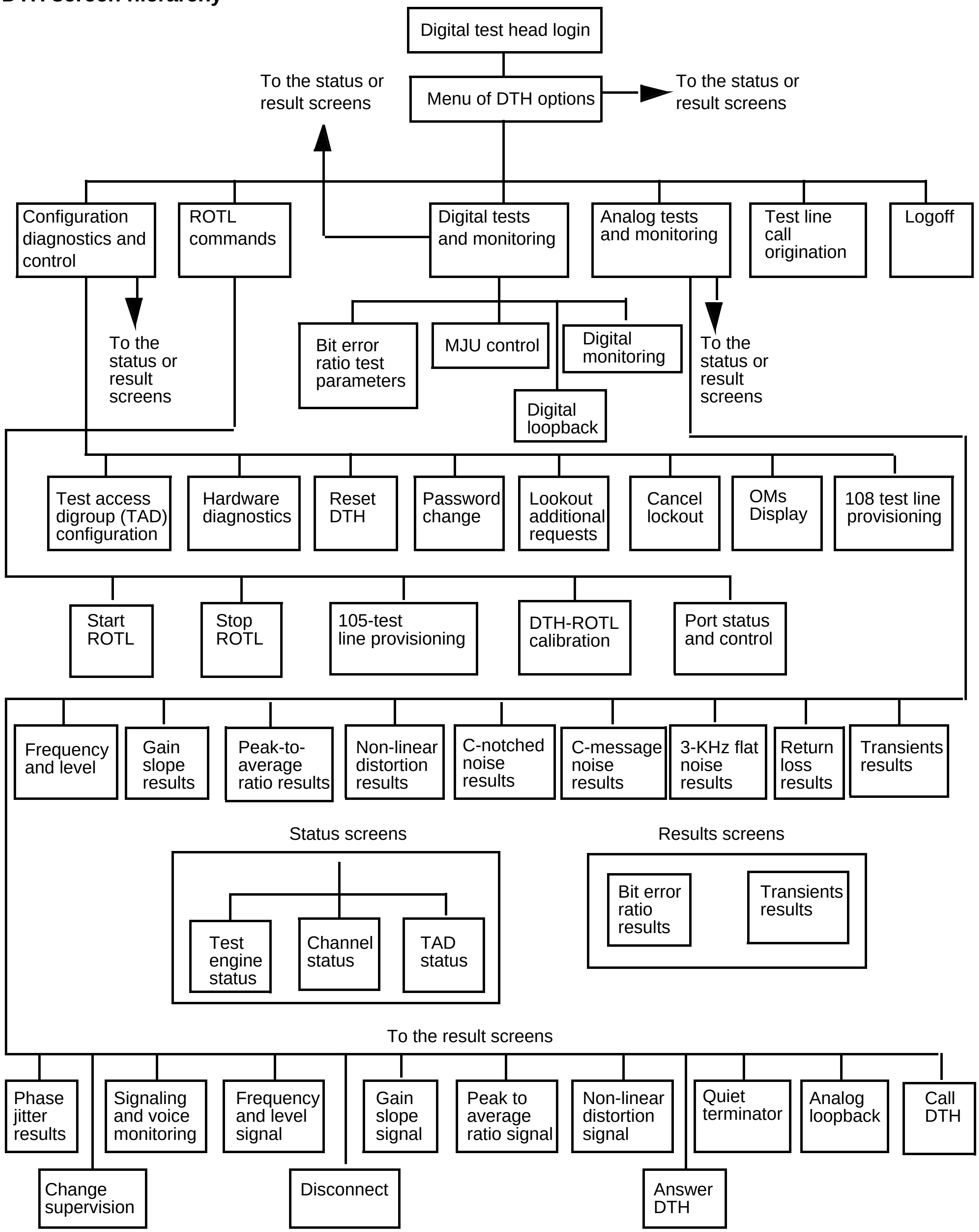
- VF interface calibration (ROTL only)
- 105 test line provisioning (ROTL only)
- freeing and blocking ROTL ports (ROTL only)
- freeing and blocking 105 test lines (ROTL only)
- performing hardware diagnostics

The top level screen in the local terminal user interface is the Menu of DTH Options. This menu provides access to the following lower-level screens:

- Configuration, Diagnostics, and Control
- ROTL Commands (ROTL only)
- Digital Tests
- Analog Tests and Monitoring

Note: Only the DTH administrator can access the Configuration, Diagnostics, and Control and ROTL commands screen.

Figure 4-1
DTH screen hierarchy



Local terminal screen layout

The local terminal is a VT220 or VT220-compatible terminal. The screen as shown in Figure 4-2, is 24 lines by 80 columns. It allows full-screen data manipulation using the arrow keys.

Here is the line designation:

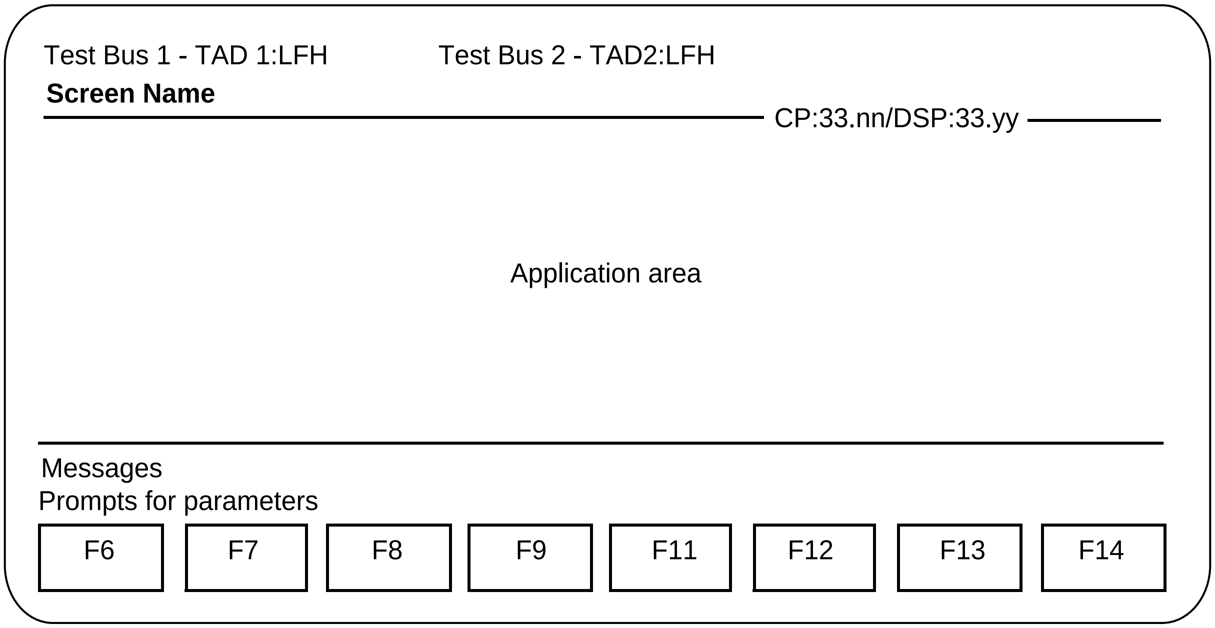
- Line 1 displays the test bus status.
- Line 2 displays the screen name.
- Line 3 shows the DTH's release number.
- Lines 4 through 19 display DTH menus, lists, and forms.
- Line 20 displays DTH messages. (Additional DTH messages may appear on lines 21 and 22.).
- Lines 21 and 22 display prompts that request parameters for tests. (Some tests have separate parameter entry screens.)
- Lines 23 and 24 display softkey icons.

If a test bus is assigned to a TAD, the status display on line 1uses the letters LFH to show whether the following faults have been detected on a TAD:

- loss of signal (L)
- framing failure (F)
- high bipolar violation count (H)

The DTH shows failures by highlighting the appropriate letter.

Figure 4-2
VT220 screen layout



Softkeys

Softkeys are pre-programming function keys. You press softkeys to select a command. Softkey functions appear as icons at the bottom of each screen. The softkey set shown depends on the screen you are in and the activity you are performing.

Using the screens

The local terminal user interface uses menus, lists, and forms, along with a number of associated softkey commands.

Each item in a list opens to a data form defining the characteristics of that selection. To perform a function on a screen, press one of the available softkeys.

The following rules apply to the local terminal user interface:

- On each screen, the name of the feature to which the screen belongs is displayed in the upper left-hand corner.
- Messages appear in response to errors, and to give information about system conditions.
- To select an item in a list, use the arrow keys to move the cursor to the item. Highlighting shows the current cursor position.

- To select a menu option, use the arrow keys to position the cursor on the desired option, and press `Select`.
- Forms have two types of fields, input fields and display-only fields. Press the arrow keys to move from field-to-field.
  - Input fields require you to type information. (Some input fields allow the user to scroll through options instead of typing.)
  - Display-only fields display output, but do not accept the entry of or changes to data. Usually, these fields are not highlighted.

System administration

User administration and security

The DTH administrator has full command access and configuration capabilities. Only the administrator has access to the DTH Configuration, Diagnostics, & Control option on the Menu of DTH Options. DTH provides access security by requesting user identification and a password. Only the administrator can change passwords.

Administration and maintenance functions

An administrator, at the local terminal, can use all DTH functionality in the user interface. The following functionality is available:

- performing ROTL commands
- resetting DTH
- changing local passwords
- locking and unlocking DTH
- displaying operational measurements
- performing on demand hardware diagnostics

For details on administrator functionality, see 662-7001-300.

Softkey commands

When you use the local terminal to access DTH, use softkeys to allocate and deallocate channels, and display status information.

Allocate

This command allocates one or more channels for a user. After allocation, the DTH dedicates it to that user, who can then use it to perform tests. Upon test completion, the same user, or the administrator, must issue the Deallocate command to release the channel.

Deallocate

This command releases allocated channels.

Selected channel state

Use selected channel state to display the current operating state of the active channel. The possible states are:

- idle
- activity name
- results pending
- unavailable

Engine status

Engine status displays the current state of each test engine. (There are four test engines on each DS0 handler card.) The possible states are:

- Not present
- Nonfunctional Hardware check
- VF Hardware check
- Activity Name
- ROTL function

Channel status

Channel status shows the current operating state for all channels. The following information appears about each channel:

- the channel’s status
  - — Unavailable - Either the TAD is not provisioned, or the channels are not available for general use because the entire TAD id dedicated to ROTL functions.
  - — TAD failure
  - — Idle
  - — Locked (during calibration)
  - — Long Test results pending
  - — Activity Name
  - — ROTL
- the channel's current user

TAD status

TAD status displays the status of the TADs.

Test bus status

Test bus status automatically appears on the top left of each screen.

Other functions

Use the following softkeys to display activity results and to abort activities:

- Activity results - Certain test results do not display automatically. use this key to display the results of BERT and transients tests.
- Abort activity - allows you to view activity results or abort an activity on the selected channels. For example, if you had the DTH transmit a stimulus signal, abort the activity to terminate the transmission. You can abort an activity if you initiated it or if you are the system administrator.

Digital tests

This chapter describes the digital testing capabilities of the DTH, which are:

- bit error ratio (BER) testing
- digital loopback
- multi-junction unit (MJU) control

Bit error ratio test

BER testing shows the performance of a digital circuit. You can perform it for the following rates:

- DS0A data subrates
  - 2.4 kb/s
  - 4.8 kb/s
  - 9.6 kb/s
  - 56 kb/s
- DS0B data subrates
  - 2.4 kb/s
  - 4.8 kb/s
  - 9.6 kb/s
- DS0 rate (64 kb/s)
- multiple DS0 rates up to full DS1 rate (24 DS0 channels)

The following test data sequences measure the channel’s error performance:

- 511
- 2047
- PRBS 15
- PRBS 23
- stress patterns
  - low ones density
  - medium ones density

  - all ones
  - alternating medium and low ones densities
  - alternating high and low ones densities
  - alternating ones and zeroes
- user defined pattern byte (6, 7, or 8 bits)
- Fox patterns

A BERT performs comprehensive bit pattern tests on digital trunks. The test is typically run for several minutes. It reports on the various classes of failures, based on the characteristics of the bit errors detected during the test.

BERT automatic disconnect

When initiating a BERT, the DTH calculates the expected duration of the test and requests the results shortly after that time-span. When the test duration expires, the DTH automatically disconnects the NE. This feature applies to all BERT rates.

The DTH also monitors for FE trunk release, which if detected, causes an immediate and automatic disconnect. However, the DTH holds partial but meaningful test results. Far-end disconnect monitoring applies only to DS0A BERT rates at 2.4, 4.8, 9.6, and 56 kb/s.

Pseudorandom patterns

The DTH generates the first four patterns using shift register logic. Patterns 511 and 2047 follow CCITT specification 0.152. Patterns PRBS 15 and PRBS 23 follow CCITT specification 0. 15 1, except that the output value is not inverted. This provides compatibility with existing BERT devices such as the Tekelec TE820A and the Firebird 6000. These four patterns are ones and zeroes limited. A DTH can generate a maximum of N consecutive ones or N 1 consecutive zeroes (where N = 9, 11, 15, and 23).

Use pattern lengths 511 and 2047 for subrate tests, and pattern lengths 215 and 223 for testing at DS0 rate or multiple DS0 rates. All test sequences are available for every rate and subrate.

Stress patterns

The following stress patterns are binary sequences made of 8-bit octets.The DTH inserts them in the 6 bits (DS0A, DS0B), 7 bits (56 kb/s DS0A), 8 bits (DS0) data field of the DDS format chosen.

- low ones density - a continuous series of octets of 01000000
- medium ones density - a continuous series of octets of 00110010
- all ones - a continuous series of octets of 11111111

- alternating medium and low ones density - a repeated sequence of 100 octets of 0 1111110 followed by 100 octets of 00000000
- alternating high and low ones density - a repeated sequence of 100 octets of 11111111 followed by 100 octets of 00000000
- alternating ones and zeroes - a continuous series of octets of 10101010

User-defined pattern

The user-defined pattern consists of one byte that you specify. The DTH transmits it every frame. The number of bits included in this byte depends on the DDS format. The 2.4, 4.8, and 9.6 kb/s DS0A and DS0B rates require 6-bit bytes, 56 kb/s DS0A requires 7-bit bytes, and DS0 or multiple DS0s require 8-bit bytes.

Fox patterns

The fox pattern is a phrase that includes every letter and digit:

THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 1234567890 (cr)

The DTH can transmit this phrase for these character encoding tables:

- ASCII
- EBCDIC
- BCDIC
- Baudot

It inserts the resulting bits from the table encoding in the 6-bit (DS0A, DS0B), 7-bit (56 kb/s DS0A), and 8-bit (DS0) data fields of the DDS format chosen.

Subrates

DS0A

When conducting a test on DS0A subrates 2.4, 4.8, and 9.6 kb/s, specify whether or not to apply error correction to the received data before calculating the bit performance. If you require error correction, the DTH performs bit-wise majority voting (3 out of 5) before calculating the bits in error. It performs the voting on the first five bytes for all the subrates.

DS0B

When performing a test on a DS0B subrate channel, specify the subrate channel of interest (customer number). The DTH calculates the error performance by identifying the proper subrate channel inside the DS0B and adding the bits in error. In optimal efficiency situations, there is no repeat of data bytes. The test engine recognizes if the rate of the subrate channel under test is lower than the maximum rate channel found in the DS0B. For example, a 9.6 kb/s multiplexer can multiplex a 4.8 kb/s channel into a DS0B with four other 9.6 kb/s DS0As. You can then calculate the error performance on the repeated bytes for the subrate channel in the same fashion as for the DS0A. The DTH accepts the repeated data bytes, and computes the bit performance only once for each bit position. It terminates the other subrate channels (customers) included in the DS0B signal, and sends DDS test codes to their far-ends.

The test engine detects situations where a request for a test for an non-existing customer inside a DS0B. The test aborts immediately. The control processor returns an error message. The test engine does not detect a situation where an a DS0B attempt on a non-DS0B signal.

Multiple DS0s

In a multiple DS0 rate test, the DTH treats DS0 channels used as one channel (that is, the bit pattern sequences are split between the channels under test instead of being repeated for each one). Therefore, the assumption is that these channels travel along through the same path, so that their relative timing is preserved, and there is a correct measurement bit performance.

Far-end devices

When performing a test using a FE device in loopback mode, the DTH remotely initializes the loopback using special control sequences. The duration of this sequence varies from 1 to 5 seconds, depending on the specific devices. Because it does not know the exact configuration of the path between the test engine and the device, the test engine control uses ‘maximal sequences’. They always suppose that there is an HL96NY device before the OCU, and that, for 56 kb/s rate, there are always two repeaters in the transmission path between the OCU and the CSU.

The DTH supports both non-latching (flywheel loopback) and latching loopback devices.

When using a non-latching loopback device at the FE in loopback mode, the DTH interleaves a control byte with each test byte. The effective transmission rate during the test is half of the specified transfer rate. The device is in loopback mode at the beginning of the test, and returns to normal mode upon test termination. The DTH stops sending loopback control bytes to the FE.

There is support for following non-latching devices:

- HL96NY
- OCU
- Up to two 56 k repeaters
- CSU
- DSU

- DS0 Dataport (DS0DP)

The DTH can also perform tests with a latching loopback device at the FE. Latching loopback are preferable because there is no need to interleave a control byte within data bytes. Therefore, the effective transmission rate is the nominal rate.

There is support for following latching devices:

- HL96NY
- DSU
- OCU
- CSU
- MJU
- DS0DP

When looping back DS0DP, you must specify the number of intervening DS0DP between the test access point and the device to loopback.

If you do not select a loopback device, the DSP engines assume that there is an external digital loopback or another bit error device at the FE.

Test process

BERTs require another device at the FE of the channel. The device may be another bit error device or any device capable of operating in loopback mode. When using a loopback device, the test engine sends the proper control sequence to initiate loopback mode. It then reports the result of this operation (success/failure) to the CP. If the loopback did not succeed, the DTH aborts the test immediately.

The test engine then starts sending a data test sequence and monitoring the incoming data for an identifiable test sequence. When the DTH correctly receives a sequence length of at least 24 bytes, the bit error performance calculation begins. The control processor decides whether to interrupt the test if the engine can not trigger on the incoming bit sequence.

If during the test, the bit error ratio increases above 10^{-2} (one in a hundred), the DTH assumes that it has lost synchronization due to a frame slip. It erases the results for the last second and restarts the triggering process on the input sequence.

While performing a test, you may want to inject errors in the output sequence. The DSP engines read the number of errors to inject every second. When testing on a, 2.4, 4.8, or 9.6 kb/s DS0A, the DTH injects the errors in every copy.

Upon test completion, if there was a loopback device at the FE, the test engine transmits the control sequence necessary to return the device to normal operation. The CP receives the result of this operation's (success/failure).

Test requirements

Note the following requirements for a BERT:

- a subrate test requires one test engine
- a multi-rate test requires a pair of companion test engines (engines 1 and 2, or 3 and 4)

Test results

The results the test engine computes in real-time during a BERT consist of:

- bits in error for the last second
- blocks in error for the last second
- framing errors for the last second (for DS0B only)

Results are sent every second to the CP. It computes additional statistics, based on the number of bits transmitted and the elapsed time. The DTH computes the blocks-in-error measure by dividing the input bit stream into blocks of 1000.

Restrictions

The following restrictions apply to a BERT:

- For multi DS0 channels rates, this test supposes that the composing channels travel along, for preserving their relative timing.
- You can not run a BERT on an ADPCM channel.
- You can only perform DS0 rate or multiple DS0 rates tests on B8ZS (bipolar 8 zero substitution) TAD types.

Digital loopback

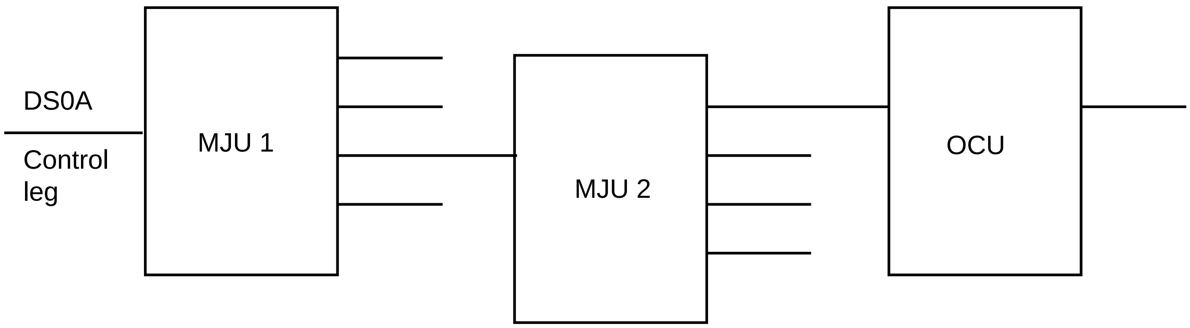
This command instructs the test engine to place from 1 to 24 channel(s) into the loopback mode (clear channel). In this mode, the DTH echoes data from on a channel back along the same channel with a one frame delay. The test engine receives the parameters from the CP.

The engine provides this stimulus until there is an abort command.

Multi-junction unit control

Multi-junction units (MJUs) allow multi-point connections in the DDS network. By connecting the DTH to the control leg, you can test up to four branches.You can cascade MJUs by tying the control leg of a second MJU to a branch of the previous MJU, see Figure 6-1. The MJU input and output signals are in the DS0A signal format. The DS0A may be carrying a 2.4, 4.8, 9.6, or 56 kb/s data stream.

Figure 6-1
Cascaded MJUs in the DDS network



To provide testing capabilities, you can:

- select (tie them temporarily to the control leg)
- release (return to normal operation)
- block (remove from service in case of trouble)
- unblock (restore to service)

branches of an MJU.

The DTH supports these MJU operations:

- selecting a branch
- releasing all selected branches
- blocking a branch
- unblocking a branch
- unblocking all branches

After selecting a branch, the MJU returns its hub and branch identification. The DSP engine continues sending the MJU control codes. This maintains the branch selection state until test completion (multiple MJUs only), at which time it sends BERT data. After BERT termination, the DSP engine maintains the MJU branch in the same state.

One second of idle code releases all selected branches in a multiple MJU path. This is a Release all. You can not release a branch of a single MJU when access is through multiple MJUs.

For maintenance purposes, it is desirable to block branches. A blocked branch can not transmit data to the control leg. The DTH can block any leg of the MJU and unblock it later. Do this using Block and Unblock. Unblock All unblocks all blocked branches on all MJUs downstream from the point of test access. Block and Unblock operate on the last branch selected.

Results

The engine returns the following results upon completion of an operation:

- completion code (success/failure)
- MJU Hub ID and branch (select only)

Analog tests and monitoring

This chapter describes the analog measurements and stimuli that the DTH test engines can perform. They are:

- channel unit support
- analog measurements
  - frequency & level
  - gain slope
  - C-notched noise
  - C-message noise
  - 3 kHz flat noise
  - echo and singing return loss
  - transients
  - peak-to-average ratio (PAR)
  - phase jitter
  - nonlinear distortion
- stimuli
  - frequency & level
  - gain slope signal
  - quiet termination
  - PAR signal
  - Non-linear distortion signal
  - analog loopback

Channel unit support

In channel units, signaling bits A and B change the outgoing supervision state, or reflect the incoming supervision state on the DS0 channel. The meaning of the bits depends on the kind of channel unit that terminates the DS0 channel. It ignores signaling bits C and D, part of the extended super frame (ESF) DS1 signal.

Table 8-1 lists all the functions in this chapter support the channel units.

Table 7-1
Channel units and signaling bit mapping

	Name		**Transmit AB**				**Receive AB**	
	00	**01**	**10**	**11**	**00**	**01**	**10**	**11**
SAO	—	idle*	ring	busy	idle		busy	—
SAS	idle	seize*	busy	—	—	idle*	ring	busy
FXO	ring	busy	—	idle*	seize*	idle	—	busy
FXS	seize*	idle	—	busy	ring	busy	—	idle*
E&M	idle	—	—	busy	idle	idle	busy	busy
TO	—	—	—	always	—	—	—	—
ETO	—	—	—	always	—	—	—	—
DPO	idle	—	—	busy	idle	idle	busy	busy
SDPO	idle	—	—	busy	idle	idle	busy	busy
DPMO	idle	—	—	busy	idle	idle	busy	busy
DPT	idle	—	—	busy	idle	idle	busy	busy
RSCO	always	—	—	busy	idle	idle	busy	busy
PLR	idle	—	—	busy	idle	idle	busy	busy
LSXO	idle	—	—	busy	idle	idle	busy	busy
DX	idle	—	—	busy	idle	idle	busy	busy
TANDEM	One of the above**				One of the above**			

Note: The signaling direction is with respect to the channel unit. '*' means that these states are for ground start lines only. '--' means no assignment to this code. '**' means signaling is that of the channel unit at the other end of the digital link.

Analog measurements

This section explains the analog measurements that the DTH can perform.

Frequency and level

This is a measurement of the power and the frequency of the received signal. The DTH performs the frequency measurement using a digital phase locked loop. Table 7-2 explains the measurements.

Then, the test engine performs a level measurement on the unfiltered input.

Table 7-2
Frequency and level measurement test specification

Level measurement	
Input signal range	-40 to + 3 dBm
Accuracy	+/-0.2 dB
Frequency measurement	
Input signal range	304 to 3504 Hz
Accuracy	+/- 1 Hz

Gain slope

This measurement ensures VF transmission quality. It yields roughly the frequency response of the circuit. Low frequency slope affects voice quality. Excessive high frequency slope degrades speech intelligibility.

The differential losses between the result at 1004 and, those at 404 and 2804, are the slope at 404 or 2804 Hz respectively. The gain slope measurement is essentially three level measurements, one at 404 Hz, one at 1004 Hz, and one at 2804 Hz. Table 7-2 shows the specifications for level measurement.

A time-out keeps the test engine from waiting indefinitely to detect the tones. The detection threshold is set -40 dBm per frequency.

C-notched, C-message, and 3 kHz flat noise

Noise is the amount of power which has no association with the signal of interest, that a channel conveys. A C-message weighting filter measures the subjective annoyance to somebody listening to noise with a receiver. During a C-message noise measurement, the DTH measures the background noise once, filtered though a C-message filter.

The 3kHz flat noise measurement is similar to the C-message noise measurement, except that it uses a 3 kHz low-pass filter.

During a C-notched noise measurement, a 1004 Hz holding tone is received and removed (notched out). The DTH then measures the power of the remaining signal, after passing through a C-message filter. This yields a figure of the noise active network devices generate. Table 7-3 shows the noise test specifications.

Table 7-3
Noise tests specification

Table	15 to 90 dBmc or dBm
Accuracy	+/- 1.0 dB
Holding tone level	-40 to +3 dB
Notch filter	
Rejection for 995 to 1025 Hz	>50 dB
Bandpass ripple	+/-0.5 dB
3 kHz low pass filter	
0dB band	2.2 kHz
3 dB point	3 kHz
Pass-band ripple	+/- 0.1 dB
Roll-off between 3 and 4k Hz	18 dB/octave
C-Message filter	See Section 4.3.2.2 of IEEE Std. 743-1984

Echo and singing return loss

Return loss consists of three measurements, echo return loss, singing return loss low, and singing return loss high (refer to Table 7-4). Each measurement calculates the ratio of the power of the transmitted signal to the power of the received signal. The received signal is known here as the echo or singing signal. The other end of the circuit must apply a quiet termination during the measurement.

The DTH injects a band-limited Gaussian distributed noise, whose spectral shape depends on the measurement, into the circuit. The test engine then measures the energy of the signal it receives.

Table 7-4
Return loss test specification

Transmitted noise level	**-2 to -10 dBm in 1 dB steps**
Echo returns signal response (Hz)	
<200	>30 dB

Table 7-4
Return loss test specification

Transmitted noise level	**-2 to -10 dBm in 1 dB steps**
300	21.8 +/-2.3 dB
560	3.0 +/-0.4 dB
750	0.2 +/-0.2 dB
1000	0.0 +/- 0.1 dB
1500	0.1 +/- 0.2 dB
1965	3.0 +/- 0.4 dB
2400	10.9 +/- 1.2 dB
3000	22.9 +/- 3.0 dB
4000	42.6 +/- 5.0 dB
Singing return low signal response (Hz)	
<100	>20.0 dB
120	20.0 dB
200	9.5 +/- 1.1 dB
260	3.0 +/- 0.5 dB
360	0.0 +/- 0.2 dB
500	3.0 +/- 0.5 dB
650	10.0 +/- 1.2 dB
1000	20.0 dB
>1200	>20.0 dB
<1000	>30.0 dB
1300	30.0 dB
2000	11.5 +/- 1.3 dB
2200	3.0 +/- 0.5 dB
2700	0.0 +/- 0.2 dB
3400	3.0 +/- 0.5 dB

Table 7-4
Return loss test specification

Transmitted noise level	**-2 to -10 dBm in 1 dB steps**
3700	10.9 +/- 1.3 dB
Input signal range	+3 to -60 dBm
Measurement span (depends upon level of transmitted signal)	loss = Xmt level-Rcv level (-2,-10) (+3, -60) thus, Maximum loss = 58 dB Minimum Loss = -13 dB
Minimum loss = -13 dB	+/- 0.5 dB
Flatness detector	
Range	300, 3000 (Hz)
Deviation	-0.5, +1.0 dB
Low frequency noise protection	
60Hz loss: (dB)	>20
200Hz loss: (dB)	<0.5

Transients

Transients consist of:

- impulse noise
- phase hits
- gain hits
- dropouts

Transients are measured in the presence of a 1004 Hz holding tone. There is a front end bandpass filter which passes energy near 1 kHz. This ensures the protection of hit and dropout counters from low-frequency noise and noise at the upper end of the voice band.

You can set the counting rate to between 4 - 100 counts/second. This determines the blanking interval. It is the minimum delay between counts of two events of the same type (for example, two phase hits).

Detection of a dropout blocks the counting of hits or impulse noise for a period of time. The time begins when the dropout is first qualified, and ends one second after the dropout ends. The DTH counts simultaneous gain and phase hits in the absence of dropout.

There must be a qualification interval to avoid counting individual cycles of a damped oscillation impulse. The DTH counts only those phase hits, gain hits, and dropouts that exceed their threshold for longer than the qualification interval. Table 7-5 shows the requirements.

Table 7-5
Transient measurements common requirements

Test duration	1 second to 9 days, 23 hrs, 59 min, 59 seconds
Count display	0-999 with overflow indication
Blanking interval	(0.125 msec) 80-1000
Qualification interval	4 msec (about 4 periods of the holding tone)
Holding tone	
Level (dBm)	-40 to +3
Pass band	995 to 1025 (0.1 dB attenuation max.)
Stop-band (Hz)	0 to 862, 1182 to 4000 (50 dB attenuation min)

Dropouts

A dropout occurs when the loss of the received signal increases by 12 dB or more from the level at the start of the measuring interval.

The DTH counts dropouts when the level of the holding tone decreases for a longer than the qualification interval. After a dropout, the DTH waits for the signal to return to its initial level for a second before counting again. Therefore, the count rate can not be greater than one per second.

Impulse noise

Impulse noise is any excursion of the noise waveform that exceeds a specific threshold. The received holding tone passes through a C-notched filter. The DTH measures the output waveform against three variable thresholds. If the count exceeds a threshold, an impulse noise is counted at that threshold, and the DTH starts the blanking interval. No count can occur during that interval.

Table 7-6 shows the default thresholds.

There are three different counters, one for each threshold. The counters are independent, and each threshold has its own blanking interval timer. The blanking interval length is the same for all thresholds.

The impulse count is cumulative. The number of impulses the DTH records at the lowest threshold includes those recorded at the higher thresholds.

The DTH also counts dropouts during this test. If there is a dropout, it stops impulse noise measurements until one second after the dropout ends.

Table 7-6
Impulse noise test specification

Threshold setting range (dBmC)	30 to 93
Default Threshold levels (dBrnC)	50, 52, and 54
Threshold adjustment step (dB)	1
Number of counters	1 per threshold

Gain hits

A gain hit is a rapid change in the received signal amplitude. The DTH counts a gain hit when a holding tone amplitude change exceeds a preset threshold for a time longer than the qualification interval. A gain hit may be the result of an increase or a decrease in amplitude.

There are three thresholds to count gain hits. You can select the level of these thresholds in 1 dB steps. As for the impulse noise, each threshold is associated with a counter and a blanking interval timer. The blanking interval is identical for each threshold. The number of hits the DTH records at the lower levels includes those recorded at the higher levels. Refer to Table 7-7.

The DTH also counts dropouts during this test. If there is a dropout, gain hits measurements stop until one second after the dropout ends. Table 7-7 shows the specifications.

Table 7-7
Gain hits test specification

Threshold setting range (dBrmC)	2-10
Default Threshold levels (dBrmC)	2, 4, and 6
Threshold adjustment step (dB)	1
Number of counters	1 per threshold

Phase hits

A phase hit is a rapid change in the phase of the received signal. A holding tone phase change that exceeds a preset threshold (a time longer than the qualification interval) registers a hit. The change may be positive or negative.

The threshold setting range is from 5 to 45 degrees, in 5 degree steps. The threshold accuracy is +/- 10%, plus an additional 0.5 degrees (see Table 7-8). The qualification interval is such that a hit registers only when the signal:

- exceeds the threshold value
- is present for at least 4.5 periods of the holding tone

The DTH also counts dropouts during this test. If there is a dropout, phase hits measurements stop until one second after the dropout ends.

Table 7-8
Phase hits test specification

Phase threshold setting range: (degrees)	5 to 45
Default phase threshold (degrees)	5
Threshold adjustment step (degrees)	5

Peak-to-average ratio

Peak-to-average ratio (PAR) measures channel dispersion (spreading in time of signal amplitude) due to transmission imperfections.

The DTH weighs the input signal with the appropriate filter. It also calculates the peak value and the full-wave rectified average value.

The U-255 companding law, and the PCM encoding restrict the total power of the received PAR waveform to 12 dBm. Over that limit, the DTH clips the peak value. Table 7-9 shows the specifications.

Table 7-9
Peak-to-average ratio test specification

Input range (dBm)	-12 to -30
Results	
Accuracy	30 to 110 +/-2 outside (PAR units) +/-4
Range	0 to 120
Indication of received signal below permissible range	yes; standard formula to derive PAR result: P/AR = 100 * (2 * Ep/Efwa - 1) where: EP = normalized peak & Efwa normalized full wave rectified average

Phase jitter

The phase jitter test measures the amount of incidental phase modulation present in the system. This disturbing effect causes the zero crossing of a signal to jitter.

The DTH can measure the peak-to-peak phase jitter of a 1004 Hz holding tone. It is not a continuous measurement. The DTH measures one shot for about four seconds. Table 7-10 shows the appropriate information.

Table 7-10
Phase jitter test specification

Level range (dBm)	3,-40
Out of range indicator	yes
Frequency range (Hz)	995,1025
Jitter bandwidth (Hz)	20,300
Display range (degree)	0, 25
Accuracy	+/- 5% +/-0.2 degree peak-to-peak

Non-linear distortion

Non-linear distortion is the generation of signal components from the transmitted signal that add to it within individual voice channels. refer to Table 7-11 for the specifications.

The DTH uses the four-tone method to derive the non-linear distortion of a voice channel. Two of the tones are 6 Hz apart, centered at 860 Hz. The other two tones are centered at 1380 Hz, and are 16 Hz apart. The receiver end compares the power averages of the second and third order products to the received composite fundamentals.

To compensate for noise that might influence the four-tone results, the DTH also performs a two-tone measurement. The two-tone and the four-tone signals should be at the same level. Non-linear distortion is not a continuous measurement. The DTH measures one shot for about 2.5 seconds.

Table 7-11
Non-linear distortion test specification

Input level range (dBm)	+3, -33
Accuracy of the reading (dB)	+/-1
Measurement span (dB)	10, 60, where the minimum distortion_power can be - 80 dBm
Filter specifications	

Table 7-11
Non-linear distortion test specification

Pass-band tracking: (dB)	+/-1
Third-order product range: (Hz)	1877,1923
Second-order products range	
Lower	503, 537
Higher	2223, 2257
Correction for Signal/Noise ratio	automatically included if two-tone signal is detected

A time-out keeps the test engine from waiting indefinitely to detect the tones. The detection threshold is set at 40 dBm per frequency.

Stimuli

The DTH supports the stimuli described here. The assigned engine tests these stimuli until given an abort. You can request these stimuli only if the channel is not busy.

Frequency and level signal

This command lets you request the generation of a single frequency signal, such as a 1004 Hz holding tone, at a desired level. Table 7-12 contains the specifications.

Table 7-12
Frequency and level specifications

Level range (dBm)	+3, -40) in 1 dBm steps
level accuracy (dB)	+/-0.2
Frequency range (Hz)	(304 to 3504) in 1 Hz steps
Frequency accuracy (Hz)	+/-0.25

Gain slope signal

The gain slope signal is a continuous pattern having three alternating power frequencies: 404, 1004, and 2804 Hz.

Table 7-13
Gain slope signal specifications

Level of each frequency: (dBm)	3 to -40 in 1 dBm steps

Quiet termination

Perform a quiet termination, when for example, the other end of the circuit performs an echo return loss or a C-message noise measurement.

To provide a quiet termination, the test engine writes FF on the PCM bus. (the equivalent to a grounded termination).

Peak-to-average ratio signal

Use this signal in conjunction with the peak-to-average (PAR) test routine. Table 7-14 provides the specifications.

Table 7-14
Peak-to-average ratio test signal specification

Frequency (Hz)	Relative magnitude (dB)	Phase (deg)
140.625	-33.7	-173.73
390.625	-15.8	-161.24
640.625	-14.5	-143.95
890.625	-15.1	-114.31
1140.625	-16.3	-055.37
1390.625	-11.9	30.19
1640.625	-03.9	86.41
1890.625	0.0	113.78
2140.625	-0.4	128.62
2390.625	-3.1	137.78
2640.625	-6.5	144.00
2890.625	-10.0	148.52
3140.625	-13.6	151.95
3390.625	-17.2	154.67
3640.625	-20.8	156.87
3890.625	-24.7	158.70

Non-linear distortion signal

The DTH uses this signal in conjunction with the non-linear distortion test routine. The test engine provides a continuous pattern consisting of a two-tone signal alternating with a four-tone signal.

Table 7-15
Intermodulation distortion signal specification

Two-frequency signal (Hz)	857,863
Four-frequency signal (Hz)	857,863,1372,1388
Frequency accuracy (Hz)	+/- 1
Total level (dBm)	-3 to -33 in 1 dB steps
Duration (seconds)	parameter received from CP

Analog loopback

This test copies the signal from the receive side of the PCM bus to the transmit side.

DTH line signaling and monitoring

The signaling and monitoring functionality of DTH allows a user to establish or break a connection with a network element.

If you access DTH through the local terminal, use the DTH Analog Tests and Monitoring screen to enter signaling and monitoring commands. For more information on the screen, see *DTH Operations*, 662-7001-300.

The DTH supports the following signaling and monitoring commands:

- call DTH
- answer DTH
- change supervision
- voice monitoring

Call DTH

The DTH accepts this command if the channel is idle or allocated. It invokes a routine to establish a connection with another DTH by placing a call through the switched network.

DTH gets the signaling information from the channel unit configuration table of the CP. It then:

1. signals an off-hook condition

2. waits for the start dialing signal [dial tone after loop start (LS), dial tone after ground start (GS), wink start (WS), delay dial (DD) or none immediate dial (ID)]
3. dials the number of the remote DTH using one of the four dialing classes MF, DTMF, DP, and SF
4. waits for the connection
5. the FE DTH sends a 2225 Hz, winks for 2 seconds

If the engine detects busy or reorder, or if a time-out occurs, the DTH reports the status to the CP and aborts the call. The threshold frequency for tone detection is set to -40 dBm.

> ***Note:*** You must issue this command before testing non-dedicated lines, or you will get false results.

The following restrictions apply to the Call DTH command:

- If the DTH can not establish a connection before the time-out, it aborts the call. The time-out varies, depending on the number of digits and the type of dialing (DTMF is faster than dial pulse). It is equal to 45 seconds plus the time necessary to dial the number.
- There is a connection only when the FE answers with the wink tone.
- Inter-digit intervals are not user programmable.

Dialing classes

There are four dialing classes supported by the DTH:

1. multi-frequency (MF) signaling
2. dual tone multi-frequency (DTMF) signaling
3. dial pulse (DP) signaling
4. single frequency (SF) signaling

Multi-frequency

The MF signaling is for inter-switch signaling. The DTH dials MF when it connects to trunk appearances on a switch.Table 7-16 defines the frequency combinations that represent digits or control signals.

Table 7-16
Multi-frequency codes

Hertz	900	1100	1300	1500	1700
700	1	2	4	7	Ring Back
900		3	5	8	Code 12

Table 7-16
Multi-frequency codes

1100			6	9	KP1
1300				0	KP2
1500					ST

> ***Note:*** For all codes, the tone-on and inter-digit interval time is 70 ms. The signal level is -6 dBm per frequency.

Dual tone multi-frequency signaling

DTMF signaling is for signaling between CPE and the network. The DTH dials DTMF when it connects to line appearances. Table 7-17 defines the frequency pairs and corresponding digits.

Table 7-17
DTMF signaling frequency pairs assignment

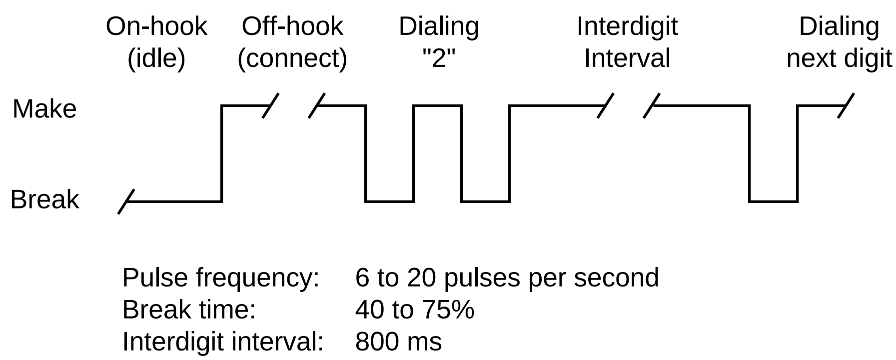
High-group frequencies (HZ)					
		1209	1336	1477	1633
Low-group frequencies (Hz)	697	1	2	3	A
	770	4	5	6	B
	852	7	8	9	C
	941	*	0	#	D

> ***Note:*** For all codes, the tone-on time and inter-digit interval is 55 ms. The signal level is -6 dBm per frequency.

Dial pulse signaling

Dial pulse signaling is for signaling between CPE and the network. Figure 7-1 defines the timing of pulse dialing.

Figure 7-1
Dial pulse signaling timing specification



Signal frequency signaling

SF signaling uses an AC in-band signal to handle both supervision and dialing, if dial pulsing is the dialing code. On a DS0 channel, the AB signaling bits carries SF supervision and dialing (like dial pulse).

Table 7-18 contains the specifications of SF signaling.

Table 7-18
SF signaling specifications

Pulse frequency	10/second
Pulse duration	
Tone-on (break)	60 ms
Tone-off (make)	40 ms
Digit pattern	1 - 10 pulses mapped on digits 1, 2,..., 9, 0
Inter-digit interval	800 ms

Answer DTH

This command instructs DTH to listen for ringing (according to the channel configuration) and to go off-hook upon detection. After connection establishment, the DTH sends a wink tone to the originating end, and then sends quiet termination. The DTH remains in answer mode until there is either a connection or it receives an abort.

The specifications for the wink tone are shown in Table 7-19.

Table 7-19
Wink tone specifications

Connection-established tone	2225 Hz
Level	-10 dBm
Time	2 seconds

Disconnect

This command works with the Call DTH and Answer DTH commands. It instructs DTH to place the channel in the on-hook state. This command drops an established connection, typically after a series of tests.

Change supervision

This function instructs the DS1 card to change the outgoing supervision on the selected channel to idle, busy, ringing, or seize.

Voice monitoring

These modes depend upon the DCC for access to the DS0 channels to be tested. In monitor mode, one TAD channel monitors both directions of the channel under test. In split mode, the DTH uses two TAD channels over both directions of the channel under test, to run through the DTH.

During voice monitoring, you can perform five functions:

- monitoring supervision
- changing supervision
- outpulsing dial digits
- capturing dial digits
- sending winks

Monitor supervision

During voice monitoring, the DTH continuously monitors the supervision on the DS0 channel(s). It displays the results on the local terminal. The supervision status is one of the states listed below (the states depend on the channel unit terminating the DS0 channel). The CP receives a message whenever the signaling bits show a new state for at least 350 msec. It also receives a message when the DTH detects a wink.

The DTH can report the following Supervision:

- on-hook (Idle)
- off-hook (Busy)
- wink

- seizure
- ringing
- ? (The received supervision state does not exist for the selected channel unit; there is something wrong with the actual setup.) During voice monitoring, the test engine can receive any one of the following commands from CP:
  - — change supervision
  - — outpulse digits
  - — capture digits
  - — monitor supervision
  - — send wink

Changing supervision

During supervision on a DS0 channel, the DTH can change only if it terminates the DS0 channel, that is, if the DS0 channel is split. Depending on the channel unit terminating the other end of the DS0 channel, you can change supervision to one of these states:

- on-hook (idle)
- off-hook (busy)
- seizure
- ringing

Outpulsing digits

You can only perform outpulsing digits on a terminated (split) DS0 channel. It is very similar to the call function except that the DTH does not check the supervision conditions. It simply outpulses a sequence of digits.

Either connect the DS0 channel or take it off-hook before outpulsing.

Capturing digits

The DTH can capture and display dialing digits of all kinds (MF, DTMF, DP, and SF).

For tone digit capture, the threshold is set to 40 dBm per frequency. When capturing supervision digits, the monitor reports the supervision the DTH receives after each digit.

Monitor supervision

In this mode, the DTH only monitors the received supervision states on one channel (if in split mode) or on two channels (if in monitor mode).

Send wink

In split mode, this command sends a wink on the transmit side of the DS0 channel.

Monitor supervision

In this mode, the DTH only monitors the received supervision states on one channel (if in split mode) or on two channels (if in monitor mode).

ROTL functions

The Digital Test Head-Remote Office Test Line (DTH/ROTL) card can perform a variety of tests or functions, as this chapter shows. Near-end (NE) tests use the DTH/ROTL director to initiate the test. DTH\ROTL also has two test engines that can emulate up to six 105 type test lines, which act as far-end (FE) equipment.

Near-end functions

The control interface (I/F) and the director operate in tandem to perform the DTH/ROTL NE functions.

Access to DTH/ROTL and priming information

CAROT can reach DTH/ROTL through two access lines that share a common telephone number. Table 8-1 shows the possible states of an access line. You can not serve or park the two access lines at the same time.

Table 8-1
Possible states of an access line

State	Meaning
Idle	line is on hook; wafting for a ringing condition
Busy	line is connected to CAROT and is being served by the control I/F
Parked	line is parked; TPT is sent to CAROT

The control I/F alternately serves the two access lines. The service alternates following a recycle or disconnect command on the access line being served. The signals for these commands are shown in Table 8-2. DTH/ROTL only responds to a recycle command during service of the access line.

The DTH can not service an access line for more than five minutes. It must receive a recycle command within five minutes, or the control I/F acts as if CAROT sent a disconnect command.

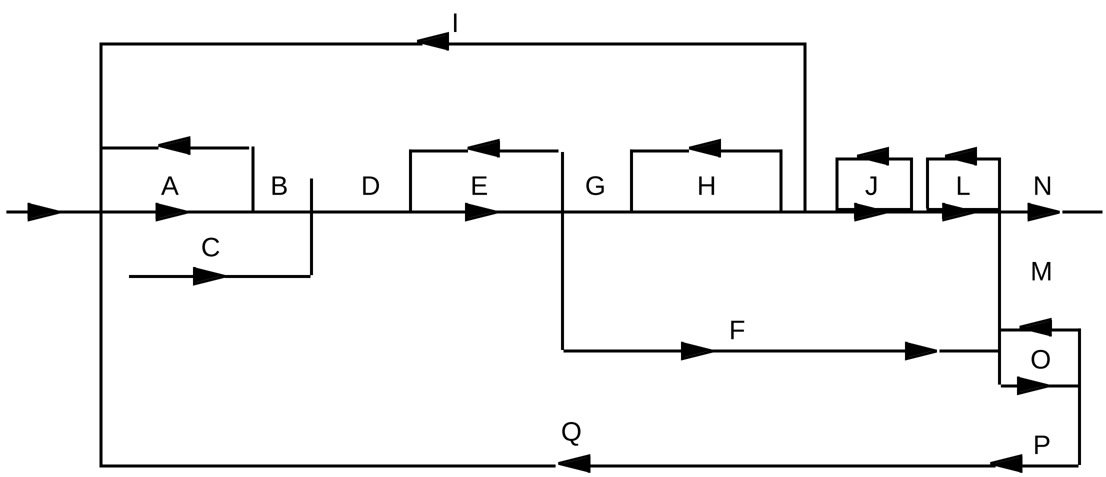
The release MF command is similar to the recycle command. It ‘s use is while the control I/F emulates a 52A responder during transmission tests. See for more details.

Table 8-2
Recycle and disconnect command signals from CAROT

Command	Signal send by CAROT
Recycle	one second of 1300 Hz tone or release MF command during 52A responder emulation
Disconnect	two seconds or more of 1300 Hz tone

Figure 8-1 shows the initial sequence when the control I/F serves one of the access lines.

Figure 8-1
Control I/F serving an access line



The DTH:

- A - detects a ringing condition on the access line. If it detects one, start over on the other.
- B - sends 300 ms of quiet termination
- C - skips A and B, if line was parked
- D - sends TPT to CAROT. If the other line is receiving service, park this one and continue to serve the other.
- E - allows a six second time-out waiting for connection to switch established from the director
- F - waits for double recycle, if it receives no signal before time-out

- G - waits for the end of the one second time-out and removes TPT from CAROT
- H - waits for MF priming digits from CAROT
- I - if it receives no MF priming digits before overall time-out, disconnects from the access port. It starts over on the other access line.
- J - tells the director to relay priming digits to the switch. It also waits for a disposition code from the switch over the control points.
- L - after receiving the disposition code, waits a maximum of 10 seconds, or until the handshake on the control and sense points completes
- M - after ten seconds, either tells the director to reset the sense points and wait for double recycle. If the priming was in error, it returns 120 ipm low tone for four seconds, and waits for recycle whether or not the 10 seconds has elapsed.
- N - executes the routine corresponding to the type of request
- 0 - waits for a recycle, disconnect, or double recycle command
- P - if it receives no command within the overall time-out period, disconnects from access port. If it receives a command, execute it.
- Q - start over on the other line.

There is connection to the switch when the director receives a wink start signal. Wink start is a transition to the off-key state that lasts from 100 to 350 ms. The director detects wink start as either an on-hook/off-hook/on-hook sequence, or an off-hook/on-hook sequence, where the off-hook state lasts at least 100 ms.

During a double recycle, the control I/F must remain silent and. When it receives a recycle command, it must return 4 seconds of 120 ipm low tone. The control I/F then waits for a second recycle command and responds to it normally.

Table 8-3 shows the various requests CAROT might send, along with the priming digits format associated with each request.

The priming sequence always begins with a key pulse (KP) digit. The DTH rejects any digits before KP with no error indication. Two digits that specify the type of test requested follow the KP. This meaning of the other digits depends on the test. The priming sequence always ends with a stop pulse (ST) digit.

If the DTH sends more than 24 digits, or if the test type is not valid, the priming is in error.

Table 8-3
Priming digits format

Test type	**Test line**	**Digits** **01234567890123456789012**
Transmission tests	100	KOOGGGTTTTXXXFFFFFFFFS
	102	02
	105	05
Override	100	10
OSS	102	12
	105	15
Operational tests	non-sync	20
	sync	21
	103	23
Override	non-sync	30
OSS	sync	31
	103	33
Terminal balance test		40
Override OSS		42
Make busy (OSS) remotely		50GGGGTTTTS
Restore idle remotely		51
Individual trunk status		52
Trunk group status by trunk		53
Trunk group status by group		54GGGGS
Call back request		55/S
Connection appraisal test	100	60FFFFFFFFFFFFS
	102	62
	105	65

Table 8-3
Priming digits format

Test type	Test line	Digits 01234567890123456789012
Home office test lines	100	70CCCCCCCCD
	102	72
	103	73
	non-sync	74
	105	75

Table 8-4
Legend for priming digits format

K	KP digit
S	ST digit
I	ID code
XXX	do not send to the switch
GGGG	trunk group number
TTTT	trunk group member number
FFFFFFFF	far-end test line number
CCCCCCCC	trunk group and member
Blank digits	mean same as above

Table 8-5 shows the messages the DTH can send the switch over the sense points. After the switch receives the disposition code, the action is takes depends on the nature of the request.

Table 8-5
Sense points messages sent to the switch

S0	S1	S2	S3	Meaning
1	0	0	1	start dialing
1	0	1	0	access line disconnected
1	0	1	1	place TUT out of service

Table 8-5
Sense points messages sent to the switch

S0	S1	S2	S3	Meaning
1	1	0	0	unlock security condition
1	1	1	0	acknowledge signal

Trunk status request

Trunk status requests (priming digits 52, 53, 54) do not require the seizure of a trunk and a connection to FE equipment. Instead, the requests ask the switch for information about the status of a particular trunk or a group of trunks. The disposition code the switch returns is the trunk status result. The possible status results are shown in Table 8-6. If the control I /F receives any other code, it waits for a double recycle command.

A trunk can either be in-service or out-of-service (OOS). The number of OOS trunks within a group of trunks can either be below, at, or above the limit. The control I/F sends a signal to CAROT corresponding to the code received.

Table 8-6
Trunk status request result codes

C0	C1	C2	C3	Meaning	Signal sent to CAROT
1	0	0	1	trunks not OOS	.05 second TPT
1	0	1	0	some trunks are OSS	.5 second TPT .5 second quiet .5 second TPT
(53 & 54 only)					
1	0	1	1	trunk OOS (52) trunks OOS at or above limit (53 & 54)	four seconds 60 ipm low tone
1	1	0	0	priming errors time-out error	four seconds 120 ipm low tone

Trunk restoral and make busy request

Trunk restoral and make busy requests (priming digits 50 and 51) do not require the seizure of a trunk and a connection to FE equipment. The disposition code shows the action taken when the request was made. Table 8-7 shows the possible actions.

If the control I/F receives any other code, it waits for a double recycle command. The switch can either deny or honor a request. It denies a request if the number of OOS trunks exceeds the limit, or if there is a lock on security.

You must perform a security unlock (call back) before issuing any trunk restoral or make busy requests. Otherwise the switch sends a request denied code to all requests. CAROT receives a signal corresponding to the code at the DTH.

Table 8-7
Trunk restoral and make busy request result codes

C0	C1	C2	C3	Meaning	Signal sent to CAROT
1	0	0	1	request honored	.05 second TPT
1	0	1	0	trunks put OOS exceeded	.5 second TPT .5 second quiet .5 second TPT
(50 only)					
1	0	1	1	request denied limit exceeded	four second 60 ipm low tone
1	1	0	0	request denied security locked priming errors time-out errors	four second 120 ipm low tone

Release and make busy request

A release and make busy request is similar to a make busy request, except for a different invocation process.

Upon completion of a transmission or operational test, CAROT sends two release MF commands to the switch within 200 ms.

- The control I/F then tells the director to send a Place TUT (trunk under test) out of service command to the switch over the sense points, see Table 8-5.

Table 8-8
Acknowledge code from the switch

C0	C1	C2	C3	Meaning
1	1	1	0	acknowledge

- When the director receives the acknowledge code, refer to Table 8-8, execution is identical to the make busy.
- If the DTH detects one or more supervisory hits are, it does not respond to the automatic make busy request and does not classify the trunk maintenance busy.
- When the director receives a recycle command, it returns 60 ipm low tone, and the DTH/ROTL waits for a second recycle command.
- When it receives the second recycle command, it recycles normally.

A supervisory hit is a transition to on-hook that lasts less than 200 ms. The director counts any off-hook to on-hook transition as a hit and does not check the duration of the on-hook state.

Security unlock request

For security unlock (call back) requests, the control I/F continues execution only if the disposition code shows that it should process the request. If it receives any other code, it waits for a recycle command from CAROT.

Table 8-9 shows the signals that the DTH must send to CAROT when the director receives certain disposition codes. If the control I/F receives any other code, it waits for a double recycle command.

Table 8-9
Security unlock request disposition codes

C0	C1	C2	C3	Meaning	Signal sent to CAROT
1	0	0	1	processing	.05 seconds TPT
1	0	1	0	ID disabled	four second 60 ipm low tone
1	1	0	0	priming or time-out error	four second 120 ipm low tone

- If the switch is processing the request, the director sends a ‘start dialing’ command to the switch over the sense points to reach the FE.
- If the director receives the acknowledge signal, it listens for the FE.
- The director accepts the unlock request if it detects a 1004 Hz tone over the test port.
- If it does not detect that tone within the overall time-out period, DTH/ ROTL disconnects from the test port and access line.
- Upon tone detection, the director tells the control I/F to send 0.5 seconds of TPT to CAROT. It sends an unlock security condition command to the switch over the sense points.
- When DTH/ROTL receives the acknowledge signal from the switch, it waits for a recycle command.

- Security remains unlocked until the access connection is released.
- CAROT receives FE detection, as described in Table 8-10..

Table 8-10
Far-end detection for security unlock request

Condition received	Signal sent to CAROT
1004 Hz tone	0.5 seconds of TPT
far end busy	four second 60 ipm low tone
far end off ice busy	four second 120 ipm low tone
audible ring, voice	low tone follow

- While listening for the FE, tones received over the trunk are sent to CAROT as low tone.
- If the NE detects four tone bursts (not 1004 Hz or TPT) in four seconds, it assumes that there is a connection to a voice announcement and waits for recycle.
- Otherwise, the DTH/ROTL passes up to 15 tone bursts are passed before giving up. It then waits for a recycle command.

Access to trunk and far-end test line detection

For transmission and operational requests, the control I/F continues to service the request only if the disposition code shows that the TUT was seized. otherwise it waits for a recycle command from CAROT.

Table 8-11 shows the signals that the control I/F must send to CAROT when it receives certain disposition codes.

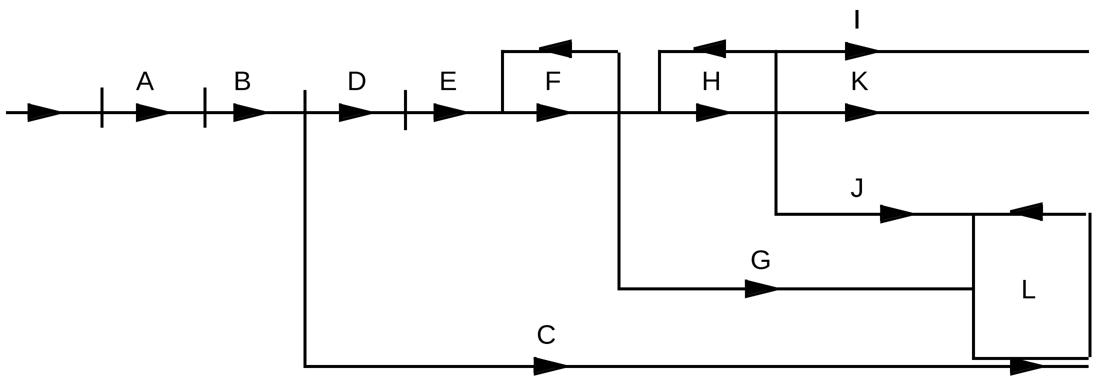
If the control I/F receives any other code, it waits for a double recycle command.

Table 8-11
Trunk seizure disposition codes

C0	C1	C2	C3	Meaning	Signal sent to CAROT
1	0	0	1	trunk seized	.05 seconds TPT
1	0	1	0	trunk busy	four second 60 ipm low tone
				printing error - time-out error	four second 120 ipm low tone
1	1	0	0	equipment failure	double recycle

Figure 8-2 shows the NE timing sequence when DTH/ROTL attempts to access a trunk and a FE test line.

Figure 8-2
Access to trunk under test and far-end sequence



- A - For an operational test, the control I/F sends 0.5 seconds of TPT to CAROT (NE ready).
- B - The director receives the disposition code over the control points and completes the handshake with the switch.
- C - If the disposition code is not ‘trunk seized’, the control I/F sends the appropriate signal to CAROT. The control I/F waits for a recycle command.
- D - If the disposition code is ‘trunk seized’, the control I/F sends 0.5 seconds of TPT.
- E - The director sends a start dialing command over the sense points.
- F - A 10 second time-out waits for the completion of the handshake with the control points.
- G - No command received before time-out Control I/F waits for a double recycle command.
- H - The director listens to detect the FE until the end of the overall time-out.
- I - If there is no FE signal, the control I/F disconnects from the access port.
- J - If it receives busy or voice signal, the control I/F relays the appropriate signal to CAROT and waits for a recycle command.
- K - If detects the FE, execute the routine corresponding to the type of test line.

- L - Control I/F waits for a recycle, disconnect, or double recycle command. If if it receives none within the overall time-out period, the control I/F disconnects from the access line.

For transmission tests, FE detection depends on the FE equipment. For operational tests, detection corresponds to off-hook supervision from the FE. When is detects off-hook, the control I/F TPT to CAROT.

Some FE detection signals are common to any type of trunk tests. The DTH relays these signals to CAROT (refer to Table 8-12). The DTH/ROTL waits for a recycle command when it receives any of these signals.

Table 8-12
Common far-end detection signals for trunk tests

Condition received	Signal sent to CAROT
Test line ready	four second 60 ipm low tone
Far end office busy	four second 120 ipm low tone
Audible ring, voice	low tone follow

During transmission tests, the DTH detects and notes supervisory hits, but the testing continues until CAROT sends a recycle command. The DTH/ROTL returns 60 ipm low tone and waits for a second recycle command. Then it recycles normally.

105 type transmission test

The 105 type routine interacts with a 105 type test line that has a 52A responder, and can receive and forward the following test requests:

- insertion loss measurement
- near and far-end C-message noise measurement
- C-notched noise (or noise with tone) measurement
- echo return loss measurement
- singing return loss (high and low) measurements
- self-check counterpart of all the above tests

Here is the sequence of events:

- The control I/F receives commands from CAROT, and tells the director what test to perform.
- The director relays MF commands to the FE or slave.
- It performs the required measurements and receives the measurements made by the slave over the trunk.

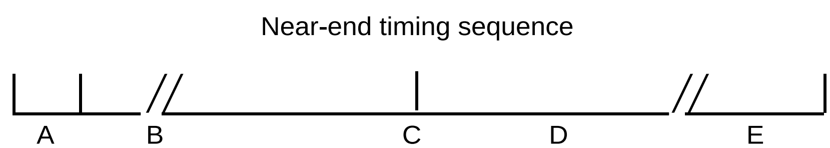
- The director sends results to the control I/F, which relays them CAROT.
- The 105 type transmission test starts when the director detects a TPT sent by the slave.
- The director then tells the control I/F to send TPT for a minimum of 0.5 seconds, or as long as it receives TPT from the slave.
- Then, 0.5 seconds of quiet interval must follow.
- The DTH then sends another 0.5 seconds of TPT to CAROT, followed by 0.5 seconds of quiet interval.
- The first TPT quiet sequence means FE responder ready and the second sequence means NE responder ready.
- Because the NE responder is always ready, the duration of the corresponding TPT goes to its minimum value.
- The director tells the control I/F to start its 52A responder emulation, and the NE is ready to accept a request.
- The 52A responder emulation is a combination of director and control I/F functionality.

“52A responder emulation”, describes the 52A responder emulation as implemented in the DTH/ROTL system.

Insertion loss measurement

Timing diagrams (Figure 8-3 and Figure 8-4) show the near-end and slave states during loss measurements.

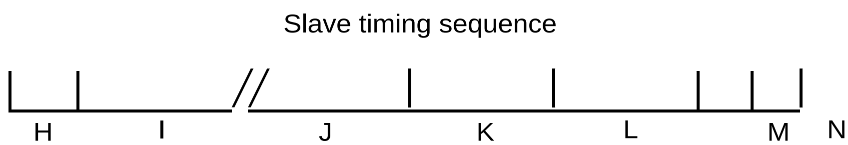
Figure 8-3
105 type loss measurement timing (near-end)



- A - The control I/F sends the request to the director.
- B - The director sends MF command signals to the slave for 75 ms each. It tells the control I/F to send a guard tone to CAROT.
- C - The director detects test tone sent from the slave and performs the far-to-near loss measurement for 375 ms.
- D - The director sends the test tone to the slave for 640 ms. It sends the result of the far-to-near loss to the control I/F. The control I/F relays the result to CAROT with a data tone. The control I/F sends 50 ms of guard tone to CAROT.

- E - The director detects the guard tone sent from the slave. It sets the automatic gain, opens a second window, and relays the received signal to the control I/F. The control I/F sends the guard tone to CAROT until the signal ceases or the window closes.
- // - There is a 2.56 second time-out interval before this event occurs.

Figure 8-4
105 type loss measurement timing (far-end)



- H - The slave receives and decodes the MF command signals.
- I - It sends test tone for 430 ms.
- J - It detects test tone from director and performs near-to-far loss measurement for 430 ms.
- K - It sends guard tone for 430 ms.
- L - It sends data tone according to near-to-far loss measurement.
- M - It sends guard tone for 50 ms.
- N - There is a dead period before awaiting further instructions.
- // - There is a 2.56 second time-out interval before this event occurs.

C-message noise measurements

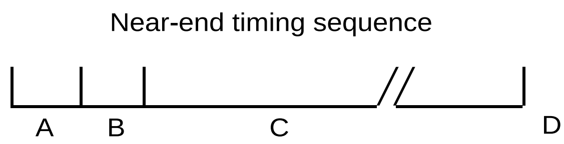
CAROT may send two different, NE and FE noise measurements, requests to the director to perform noise measurements.

The timing diagrams shown in:

- Figure 8-5
- Figure 8-6
- Figure 8-7
- Figure 8-8

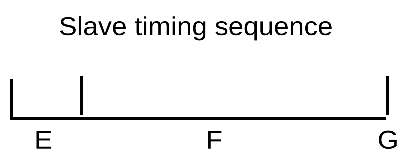
describe the NE and FE states during noise measurements.

Figure 8-5
105 type near-end noise measurement timing



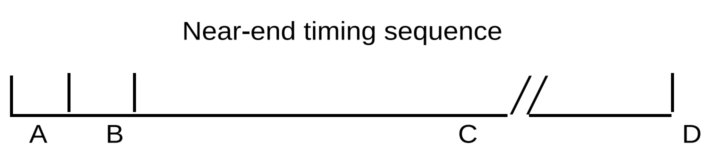
- A- The control I/F sends the request to the director.
- B - The director sends MF command signals for 75 ms each to the slave. The director tells the control I/F to send guard tone to CAROT.
- C - The director performs the NE noise measurement for 375 ms.
- D - It sends the result to the control I/F, and relays the result to CAROT with a data tone. The control I/F sends 50 ms of guard tone to CAROT.

Figure 8-6
Slave timing sequence



- E - The slave receives and decodes the MF command signals.
- F - It sends quiet termination for 430 ms.
- G - There is a dead period before awaiting further instructions.

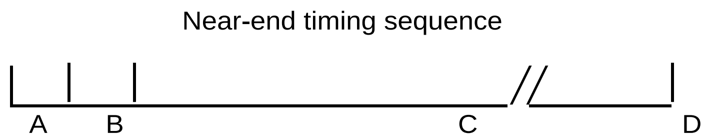
Figure 8-7
105 type far-end noise measurement timing



- A - The control I/F sends the request to the director.
- B - The director sends MF command signals for 75 ms each.
- C - It puts quiet termination for 430 ms.

- D - It detects the guard tone sent from the slave. The director then sets the automatic gain, opens a 2.1 second window, and relays the received signal to the control I/F. The control I/F sends the guard tone to CAROT until the signal ceases or the window closes.

Figure 8-8
Far-end slave timing sequence



- G - The slave receives and decodes MF command signals.
- H - It performs the FE noise measurement for 430 ms.
- I - It sends the guard tone for 430 ms.
- J - It sends the data tone according to the made measurement.
- K - It sends guard tone for 50 ms.
- L - There is a dead period before awaiting further instructions.
- // - 2.56 second time-out interval before this event occurs.

Noise-with-tone measurement

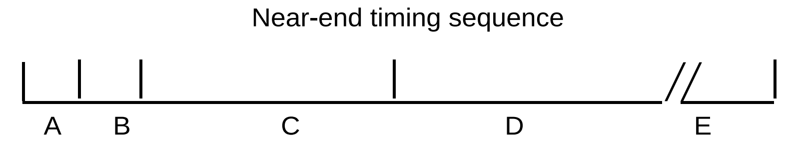
The noise-with-tone measurement is like the loss measurement, except that the received signal is weighted with the C-message filter and a filter that has a deep 1004 Hz notch. The transmitted tone is always 1004 Hz at 16 dBm.

Return loss measurements

Return loss measurements are made up of echo, singing high, and singing low return loss. The timing is the same for all three. The nature of the transmitted signal is different, however. The DTH generates a gaussian noise signal and, passes it through a bandpass filter before it is sending it over the trunk. A different filter is used for each type of measurement.

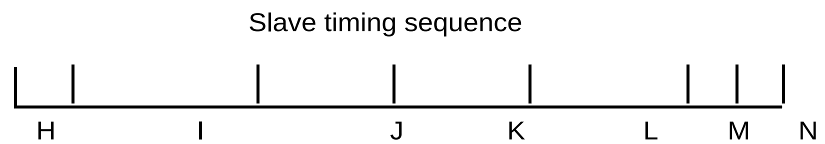
Timing diagrams (Figure 8-9 and Figure 8-10) describe the NE and slave states during return loss measurements.

Figure 8-9
105 type return loss measurement timing (near-end)



- A - The control I/F sends the request to the director.
- B - The director sends the MF command signals to the slave for 75 msec each. It tells control I/F to send guard tone to CAROT.
- C - It sends test tone over trunk and performs return loss measurement for 2.56 seconds.
- D - It puts quiet termination on trunk for 2.56 seconds. It sends the result of the NE return loss to the control I/F. The control I/F relays the result to CAROT with a data tone. It also sends CAROT 50 ms of guard tone.
- E - It detects the guard tone sent from the slave. It sets the automatic gain, opens a 2.1 second window, and relays the received signal to the control I/F. The control I/F sends the guard tone to CAROT until the signal ceases or the window closes.
- // - There is a 2.56 second time-out interval before this event occurs.

Figure 8-10
105 type return loss measurement timing (far-end)



- H - The slave receives and decodes MF command signals.
- I- It puts a quiet termination on trunk for 2.56 seconds.
- J - It sends test tone over trunk and performs echo return loss measurement for 2.56 seconds.
- K - It sends guard tone for 430 ms.
- L - It sends data tone according to FE echo return loss measurement.
- M - It sends guard tone for 50 ms.
- N - There is a dead period before awaiting further instructions.

Self-check measurements

The timing for self-check measurements is the same as for regular measurements, except that there is no signal transmission over a trunk. At the NE, the signal loops through the VF card during measurement.

Table 8-13
Calculation of the duration of the data tone

Test	Data formula (milliseconds)	Typical cases Measured level	Duration of data tone
Loss, 0 dBm	2(160 - 1 OL)-1	L = 0 dB	319
Loss, -16 dBm	2(210 - 1 OL)-1	L = 0 dB	419
C-message noise	2(N - 13)-l	N = 23 dBrnC	19
C-notched noise	2(N - 32)-1	N = 74 dBrnC	83
Return loss	2(42 - RL)-1	RL=OdB	83
Legend	L: loss with respect to the transmitted signal level N: noise measured in dBmC RL: return loss with respect to the transmitted signal level		

100 type transmission test

The 100 type routine interacts with a 100 type test line. It can receive the following test requests:

- far-to-near insertion loss measurement
- NE C-message noise measurement
- NE return loss measurement
- self-check counterpart for all of the above tests

Here is the sequence of events:

- The control I/F receives commands from CAROT, and tells the director what test to perform.
- The director performs the measurements and sends results to the control I/F, which relays them to CAROT.
- The 100-type transmission test starts after the director detects a 1004 Hz tone from the slave.
- After transmitting a 1004 Hz tone to the NE for 5.5 seconds, the slave places a quiet termination on the trunk.
- The director tells the control I/F to send 0.5 seconds of TPT, and 0.5 seconds of quiet interval, then 0.5 seconds of TPT, to CAROT.
- The director tells the control I/F to start its 52A responder emulation.

- The NE is now ready to accept a request.

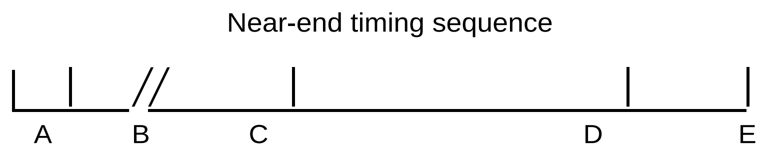
“52A responder emulation”, later in this chapter, describes the 52A responder emulation as implemented in the DTH/ROTL system.

Far-to-near insertion loss measurement

When CAROT requests a far-to-near insertion loss measurement, the director has to receive the request early enough to catch the 1004 Hz signal from the slave.

A timing diagram, Figure 8-11, describes the NE states during the loss measurement.

Figure 8-11
100 type loss measurement timing



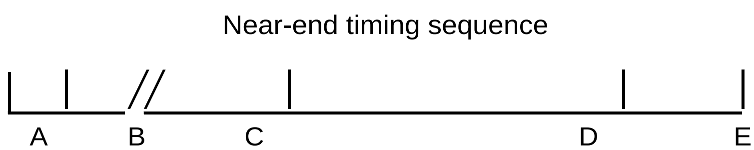
- A - The control I/F sends the request to the director.
- B - The director tells the control I/F to send the guard tone to CAROT.
- C - It detects test tone sent from slave and performs the far-to-near loss measurement for 375 ms.
- D - It sends the result of the far-to-near loss to the control I/F. The control I/F relays the result to CAROT with a data tone. The control I/F sends 50 ms of guard tone to CAROT.
- E - It tells control I/F to send 1004 Hz tone to CAROT as long as it receives the 1004 Hz from the slave.
- // - There is a 2.56 second time-out interval before this event occurs.

After the FE removes its test tone and puts a quiet termination on the trunk, the responder emulation can perform either a NE noise or a NE return loss measurement.

Near-end C-message noise measurement

A timing diagram, Figure 8-12, describes the NE during a noise measurement.

Figure 8-12
100 type near-end noise measurement timing

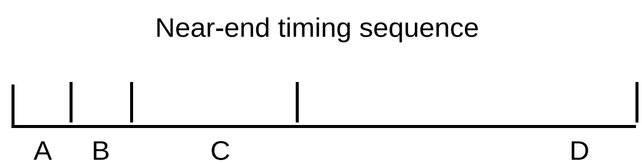


- A - The control I/F sends the request to the director.
- B - The director tells the control I/F to send the guard tone to CAROT.
- C - It performs the NE noise measurement for 375 ms.
- D - It sends the result to the control I/F. The control I/F relays the result to CAROT. The control I/F sends 50 ms of guard tone to CAROT.

Near-end return loss measurement

A timing diagram, Figure 8-13, describes the NE during a return loss measurement.

Figure 8-13
100 type near-end return loss measurement timing



- A - The control I/F sends the request to the director.
- B - The director tells the control I/F to send guard tone to CAROT.
- C - It sends test tone over trunk and performs return loss measurement for 2.56 seconds.
- D - The director sends result of the NE return loss to the control I/F. The control I/F relays the result to CAROT with a data tone. The control I/F sends 50 ms of guard tone to CAROT.

Near-end self-check measurements

When testing to a 100 type test line, the NE can also do self-check measurements. The timing is the same as for 105 type self-check measurements, except that ROTL does not do the FE part of the test.

102 type transmission test

The 102 type routine interacts with a 102 type test line and can receive the following test request:

- 1004 Hz at 0 dBm far-to-near insertion loss measurements
- self-check counterpart for the above test

The sequence of events is:

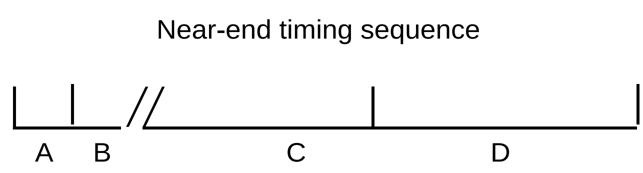
- The control I/F receives commands from CAROT, and tells the director what test to perform.
- The director performs the required measurements and sends the results to the control I/F, which relays them to CAROT.
- 102 type transmission test starts when the director detects a 1004 Hz tone sent by the slave.
- Some 102 type test lines only provide one nine-second 1004 Hz tone interval and then become quiet.
- The director tells the control I/F to send 0.5 seconds of TPT, followed by 0.5 seconds of quiet interval, followed by 0.5 seconds of TPT, to CAROT.
- It tells the control I/F to start its 52A responder emulation.
- The NE is now ready to accept a request.

52A responder emulation, later in this chapter, describes the 52A responder emulation as implemented in the DTH/ROTL system.

Far-to-near insertion loss measurement

The only valid request the control I/F can receive is to ask the director to measure the far-to-near loss with the 1004 Hz signal being sent by the slave. A timing diagram, Figure 8-14, describes the NE states during the loss measurement.

Figure 8-14
102 type loss measurement timing



- A - The control I/F sends the request to the director.
- B - The director tells the control I/F to send the guard tone to CAROT.

- C - It detects the test tone from the slave and performs far-to-near loss measurement for 375 ms.
- D - It sends result of the far-to-near loss to the control I/F. The control I/F relays the result to CAROT with a data tone. The control I/F sends 50 ms of guard tone to CAROT.
- // - There is a 2.56 second time-out interval before this event occurs.

Near-end self-check measurements

When testing to a 102 type test line, the NE can also do self-check measurements. The timing is the same as for 105 type self-check measurements, except that ROTL does not do the FE part of the test.

103 type operational test

The 103 type routine interacts with a 103 type operational test line. The control I/F receives commands from CAROT, and tells the director what test to perform. The director performs the required tests and sends the results to the control I/F, which relays them to CAROT.

The 103 type test routine performs the following functions:

- On-hook/off-hook detection - When the director detects any off-hook condition, it tells the control I/F to return TPT to CAROT. When the director detects any on-hook condition, it tells the control I/F to remove TPT from CAROT. The control I/F does this with minimum time distortion.
- Ring forward - The control I/F detects any ring forward signal from CAROT and tells the directors to provide an on-hook flash on the TUT for 100 ms. Figure 8-14 describes the ring forward tone specifications

Table 8-14
CAROT ring forward tone specifications

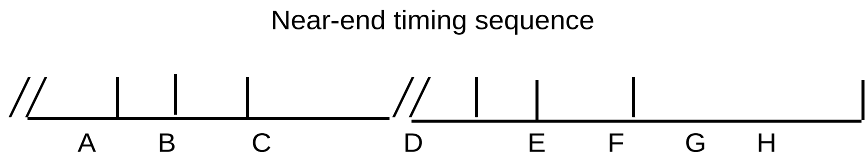
Frequency	1300 Hz
Duration	100 ms
Minimum duration	50 ms
Maximum duration	50 ms

A timing diagram (Figure 8-15) describes the NE sequence during a 103 type test on successful connection with the FE test line (see “Access to trunk and far-end test line detection”).

CAROT sends two ring forward signals. The first puts the FE on-hook, and the second makes it send off-hook/on-hook sequences at a rate of 120 ipm.

If the DTH does not receive the ring forward requests or the FE conditions within the allowed time-out periods, the test fails. The DTH can send a maximum of 11 tone bursts (including the one from the FE detection) to CAROT. Then ROTL starts an 18 second time-out, waiting for a release and make busy command. If time out occurs, the ROTL recycles.

Figure 8-15
103 type test near-end timing



- A - The control I/F receives the ring forward request from CAROT.
- B - It relays the ring for ward request to the director.
- C - The director provides on-hook flash on the trunk.
- D - It detects the FE on-hook and tells the control I/F. The control I/F removes TPT to CAROT.
- E - It receives the ring forward request from CAROT.
- F - It relays the ring forward request to the director.
- G - It provides on-hook flash on the trunk.
- H - It detects 120 ipm on-hook flash from the FE. The control I/F sends TPT and quiet to CAROT, according to the state of the FE detected by the director. This step repeats 10 times unless CAROT sends a disconnect signal.
- //- There is an overall time-out before this event occurs.

Synchronous operational test

The synchronous routine interacts with a synchronous operational test line. The director performs the required tests and sends the results to the control I/F, which relays them to CAROT.

The synchronous test routine performs the following functions:

- On-hook/off-hook detection - When the director detects any off-hook condition, it tells the control I/F to return TPT to CAROT. When the director detects any on-hook condition, it tells the control I/F to remove TPT from CAROT. Do this with minimum time distortion.
- Audible ringing detection - When the director detects any audible ringing period, it must tell the control I/F to return TPT to CAROT with minimum

tone distortion. Specifications of audible ringing and detection are in Table 8-15.

Table 8-15
Audible ringing specification

Frequency	440 and 480 Hz
Level per frequency	-19 dBm0
Detection	Single bandpass filter, centered at 460 Hz
Bandwidth	+/-100 Hz
Level	+3, -37.5 dBm0

The director must properly detect the sequence of hook transitions and audible ringing. It must then relay the appropriate information to the control I/F. It can generate a maximum of 10 tone bursts (including the one from FE detection) towards CAROT. Then ROTL starts an 18 second time-out waiting for a release-and-make-busy command. If time out occurs, ROTL recycles.

Non-synchronous operational test

The non-synchronous routine interacts with non-synchronous operational test line. The director performs the required tests. It sends the results to the control I/F that relays them to CAROT.

The non-synchronous test routine performs the following functions:

- On-hook/off-hook detection - When the director detects any off-hook condition, it tells the control I/F to return TPT to CAROT. When the director detects any on-hook condition, it tells the control I/F to remove TPT from CAROT. This occurs with a minimum time distortion.
- Audible ringing detection - When the director detects any audible ringing period, it must tell the control I/F to return TPT to CAROT with minimum tone distortion.

The director must properly detect the sequence of hook transitions and audible ringing, and relay the appropriate information to the control I/F. The DTH can generate a maximum of 10 tone bursts (including the one from the FE detection) towards CAROT. Then ROTL starts an 18 second time-out, waiting for a release-and-make-busy command. If time out occurs, ROTL recycles.

Terminal balance and long term (BALT) test

The BALT routine interacts with a manual interrogator. It can receive a 1004 Hz at 0 dBm near-to-far insertion loss measurement request. The manual interrogator is a device that emulates CAROT. A manual interrogator can perform any test the CAROT performs.

The sequence of events is:

- The manual interrogator accesses the control I/F and sends priming digits as CAROT would.The TUT is between the ROTL-equipped office and the office with the manual interrogator.
- The DTH/ROTL goes through the same steps as the ones discussed in and.
- The test begins upon detection of a 1004 Hz tone sent by the manual interrogator FE.
- The director tells the control I/F to transmit two 0.5 second TPT bursts (FE and NE ready) over the access port.

Table 8-16
BALT test tone specifications

Frequency	1004 Hz
Level	0 dBmO
Accuracy	+/- 0.1 dB
Duration	10 seconds

- The director sends a test tone to allow the manual interrogator to measure the loss. Table 8-16 describes the test tone specifications.
- It puts a quiet termination on the TUT.
- The control I/F waits for a disconnect command or until the end of a 20 min. time-out.
- Then it disconnects from the access line.
- It rejects recycle commands when the director becomes quiet.
- While the test port is quiet (which may last up to 20 min.), the other access line must remain parked.

Connection appraisal test

Connection appraisal test routines are similar to the 100 type, 102 type, and 105 type routines except for the following differences:

- There is different priming information. Instead of specifying the trunk to be tested and the test line number to call at the other end of the trunk, the ROTL receives a subscriber number.
- The disposition code that normally refers to the trunk refers instead to the originating line.
- The DTH measures the overall connection, instead of a particular trunk.
- There is no make-busy capability.

Home office test line test

Home office test line routines verify that the test lines in the equipped office are accessible, and that they perform properly. This verification includes the six 105 type test lines on the DTH/ROTL itself.

The DTH executes the home office test line routines similarly to the transmission and operational test routines, except for the following differences:

- the trunk disposition signal and the FE disposition signal are combined
- there is no make-busy capability

Table 8-17 shows the signals that must be sent to CAROT, corresponding to the disposition codes the director receives for transmission tests.

Table 8-17
Home office operational test line disposition codes

C0	C1	C2	C3	Meaning	Signal sent to CAROT
1	0	0	1	Available	quiet
1	0	1	0	Not available	four second 60 ipm low tone
1	1	0	0	Priming error or office busy	four second 120 ipm low tone

If the home office test line is available, the control I/F tells the director to listen for the FE as in the case for a regular trunk test.

For operational tests, the control I/F first sends 0.5 seconds of TPT to CAROT to show that the NE operational test equipment is ready.

Far-end functions

Six 105 type test lines perform the FE or slave functions of DTH/ROTL.

105 type transmission test line emulation

The 105 type test line emulation routine interacts with a 105 type test director, and can receive the following test requests:

- insertion loss measurement
- NE and FE C-message noise measurement
- C-notched noise (or noise-with-tone) measurement
- echo return loss measurement
- singing return loss high and low measurements
- self-check counterpart of all the above tests

The 105 type test lines have two test engines. A test engine can emulate up to three 105 type test lines served by a single 52A responder, see .

Only one test line can interact with a director. The DTH parks the other two lines, if they are performing tests, and must wait until the responder is free.

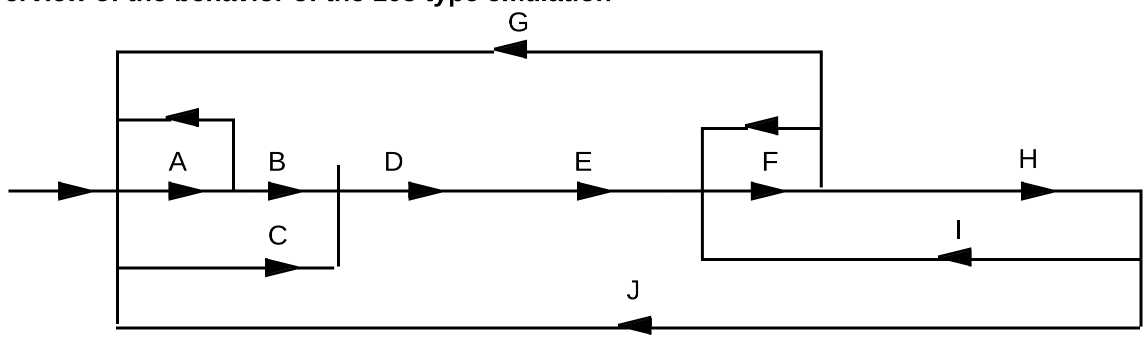
The emulation function includes:

- listening for ringing
- establishing a connection,
- supplying a TPT, waiting until the responder is free
- providing the appropriate termination to the originating end when MF signal commands are received

A list of the MF signal command codes appears in Table 8-18.

Figure 8-16 shows the 105 type test line emulation sequence.

Figure 8-16
Overview of the behavior of the 105 type emulation



- A - Detect a ringing condition on one of the lines. If no ringing is detected, start over on the other line.
- B - 300 ms of quiet termination
- C - Skip part A and B if the line was parked.
- D - There is three seconds of TPT.
- E - If responder is busy, continue to send TPT on this line and continue to serve the line using the responder. If the responder is available, remove TPT.
- F - There is 18 second time-out waiting for a MF signal command.
- G - If the DTH receives no MF command before time-out, release the connection. Start the process again on the other line.

- H - Serve the MF signal commands starting at layer two.
- I - Wait for the next MF command.
- J - If the DTH receives the Release command, release the connection. Start the process again on the other line.

C-message noise measurement

Timing diagrams describe the slave states during noise measurements.

Noise-with-tone measurement

The noise-with-tone measurement is made similarly to loss measurement. However, the received signal is weighted with the C-message filter and a filter having a deep 1004 Hz notch filter. The transmitted tone is always 1004 Hz at 16 dBm.

Return loss measurement

A timing diagram (Figure 8-6) describes the slave states during return measurements.

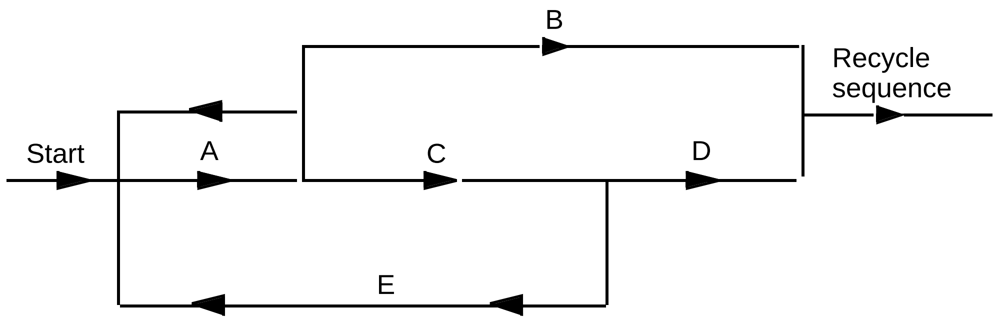
Self-check measurements

The timing for self-check measurements is the similar to regular measurements. The only difference is that the signal is not transmitted over a trunk. At the far-end, the signal is looped through the VF card during measurement.

52A responder emulation

The control I/F and the director execute the 52A responder emulation as a NE function when testing to a 100, a 102, or 105 type transmission test line. The 105 type test line emulation also executes 52A responder emulation as a FE function. Figure 8-17, shows the sequence when the control I/F and the director act as a near-end 52A responder.

Figure 8-17
52A near-end responder sequence



- A - The control I/F 18 second time-out waiting for MF signal commands.

- B - If it receives no MF command before the time-out, the NE behaves as with a recycle command.
- C - The control I/F decodes the MF signal command, starting at layer 0, and sends the appropriate request to the director. If testing to a 105 type test line, the director relays the MF command to the slave.
- D - Upon receipt of the release command, the control I/F behaves as with a recycle command.
- E - The control I/F waits for the next MF signal commands.

The 18 second time-out interval keeps the NE from waiting indefinitely for data that may not be sent due to a transmission or CAROT failure.

Table 8-18 shows the allocation of the tests that a DTH can perform with a fully equipped 52A responder. The number of tests it can perform depends on the type of test line the director interacts with. The interpretation of the MF commands it receives relates to the current layer state of the responder. The 52A responder that DTH/ROTL emulates has five logical layers that determine the MF signal command interpretation.

Table 8-18
Interpretation of MF commands

MF signals	Layer Logic Circuit Information Codes				
(Hz)	LAY0	LAY1	LAY2	LAY3	LAY4
700+900	600, 0, 105	-	LSC	SHISC	-
700+1100	600,0,102	-	L	SHI	-
700+1300	600,0,100	-	NSC	ManL	-
700+1500	900,2,100	-	PAR	PARSC	-
700+1700	900,0,102	-	ERL	ERLSC	-
900+1100	900,0,105	-	N	-	-
900+1300	Release	Release	Release	Release	Release
900+1500	900,2,102	-	SRL	SRLSC	-
900+1700	900, 0,1 00	-	L10	LSC10	-
1100+1300	600,2,105	-	L4	LSC4	-
1100+1500	600,2,102	-	RNSC	BadSC	-
1100+1700	Layer	Layer	Layer	Layer	Layer

Table 8-18
Interpretation of MF commands

MF signals	Layer Logic Circuit Information Codes				
(Hz)	LAY0	LAY1	LAY2	LAY3	LAY4
1300+1500	600,2,100	-	RN	-	-
1300+1700	900,2,105	-	L28	LSC28	-
1500+1700	-	-	NT	NTSC	-

Upon receipt of an MF signal command, the 52A responder emulation can behave in six ways:

1. If the signal command is layer (1100 and 1700 Hz), the next layer becomes true and the responder emulation interprets further signal commands accordingly. Layer 1 is never true and is always skipped. When operating as a FE responder, layer 0 is never true and layer 2 becomes effective.

   If it receives a layer command while layer 4 is true, the emulation program goes back to the first effective layer (0 for NE, 2 for FE).

2. If the NE responder receives a signal command other than layer or release is received when layer 0 is true, it sets the transmission level point (0 or 2 dBm). It ignores the type of automatic test line at the FE of the trunk, as it should be the same as the one specified in the priming information.

   The VF interface card design implies that it performs measurements are only into a 900 ohm impedance (as viewed by the codec). Therefore, it must interpret layer 0 commands so that they ignore any impedance setting requirement. When it receives a layer 0 command, the responder skips to layer 2.

3. If the signal command is release, 900 and 1300 Hz, the responder emulation drops the connection and branches back to the calling routine.
4. If the signal command is one of the following shown in Table 8-19 when layer 2 is true, it performs the requested test.

Table 8-19
Signal command when layer 2 is true

Loss measurement at 1004 Hz and -16 dBm	900 and 1700 Hz
Loss measurement at 1004 Hz and 0 dBm	700 and 1100 Hz
Far-end noise measurement	900 and 1100 Hz
Near-end noise measurement	300 and 1500 Hz

Table 8-19
Signal command when layer 2 is true

Loss measurement at 404 Hz and -16 dBm	100 and 1300 Hz
Loss measurement at 2804 Hz and -16 dBm	300 and 1700 Hz
Noise-with-tone measurement	500 and 1700 Hz
Loss self-check measurement at 1004 Hz and 0 dBm	700 and 900 Hz
Far-end noise self-check measurement	700 and 1300 Hz
Near-end noise self-check measurement	1100 and 1500 Hz
Echo return loss measurement	700 and 1700 Hz
Singing return loss measurement	900 and 1500 Hz

If the signal command is one of those shown in Table 8-20,when layer 3 is true, it performs the requested test.

Table 8-20
Signal command when layer 3 is true

Loss self -check measurement at 1004 Hz and -16 dBm	900 and 1700 Hz
Loss self-check measurement at 404 Hz and -16 dBm	1100 and 1300 Hz
Loss self -check measurement at 2804 Hz and -16 dBm	1300 and 1700 Hz
Noise-with-tone self-check measurement	1500 and 1700 Hz
Echo return loss self-check measurement	700 and 1700 Hz
Singing return loss high self -check measurement	700 and 900 Hz
Singing return loss high measurement	700 and 1100 Hz
Singing return loss low self-check measurement	900 and 1500 Hz

If the NE is testing to a 100 or a 102 type test line that can not perform the requested test, the NE responder returns a not equipped signal. The signal consists of one second of 1200 Hz guard, one second of 2200 Hz data and 50 ms of 1200 Hz guard.

5. If the signal command represents a test that the responder does not emulate, the responder returns a not equipped signal.
6. If the signal command does not have a test allocated to it, the responder returns a not equipped signal.

When two responders are doing measurements, the NE responder must relay commands it receives to the FE responder, except when layer 0 is true. Then, it must send ‘Release’ must to the FE responder.

Measurement specifications

The measurement specifications shown in Table 8-21 apply for measurements discussed in this document.

Table 8-21
Measurement specifications

Precision tone generation	0.1 dB and +/- 1 Hz
Tone generation	1 dB and +/- 1 Hz
Level measurement	0.1 dB between + 4.5 and -37.0 dBm
C-Message noise measurement	1 dB between 15 and 90 dBmC
C-Notched noise measurement	+/- 1 dB between 34 and 90 dBmC for received holding tone level of -15 dBm and lower
Return loss measurement	+/- 1 dB between 0 and 40 dB

Digital call origination

For digital trunk testing, digital call origination provides a means of placing a call to type 108 test lines at a FE office. The 108 test line is a specific test line used to loop back information to the transmitting end. The primary use of the test line is to measure the integrity of the digital data transmitted between digital exchanges.

The loopback function is a FE function, accessed by a directory number pulsed over a trunk from the NE switch.

The switch interface feature provides both NE and FE functions. At the NE, the DTH originates calls. A DTH at the FE office answers incoming calls and provides a non-inverting digital loopback.

Accessing the near-end switch

The DTH signals an off-hook condition and waits for a wink start from the switch. If it receives wink, the DTH outpulses the MF digits specified. These digits indicate the trunk group, trunk group member, and FE test line number. The DTH then waits for an off-hook indication from the FE indicating that there is a connection. The result appears at the NTSC or local terminal.

If the connection fails, meaning that the DTH has detected either a 60 ipm, 120 ipm, or time-out, the corresponding status appears.

108 test line termination at the far-end switch

The DTH must answer a call coming in on a 108 test line provisioned channel by providing an off-hook indication. The incoming call is then immediately looped back upon itself. That is, taking the data from the incoming receive and looping it back on its corresponding transmit channel.

This function instructs a test engine to listen for off-hook, and go off-hook in response. Upon connection, the test engine invokes digital loopback on that channel.

108 test line provisioning

The DTH has one or more channels reserved for 108 test line termination. The number is set through the local terminal. Configuration is done at installation and infrequently from then on. The provisioner selects which DS0 channels are for 108 test line functionality. Those lines are then not available for any other uses. The maximum number of lines that the DTH can dedicate depends upon the number of test engines available, DS0 cards in use, and the number of channels available to the DTH in its local configuration.

108 test line answer

After provisioning, the DTH monitors any designated 108 test line channel for an off-hook indication from the switch. After accessing a provisioned test line channel, the DTH returns an off-hook answer supervision signal. If all test lines are occupied, the DTH returns an off-hook indication to the switch according to the normal signaling for the circuit.

Variable 108 test line disconnect timer

The 108 test line is a specific test line that loops back information to the transmitting end. The primary use of the test line is to measure the integrity of the digital data between digital exchanges.

To avoid the possibility of holding a TAP, trunk, and/or test line up for and extended period of time, the DTH monitors the amount of time a 108 test line is off-hook. If the off-hook time is longer than the timer's value (a default of 20 min., 15 maximum test time and 5 min. calling grace period), the DTH provides on-hook, signaling to automatically disconnect the line.

The maximum timer duration permitted is 10 days, or 864 999 sec. You may enter a maximum value of 9 days, 23 hrs, 59 min, and 59 seconds (863 999 sec.).

Access the mechanism for setting this value through the Configuration, Diagnostics, and Control functionality. Only an administrator can change this value.

108 test line provisioning

The DTH provides digital loopback line capability by looping the incoming 56 kb/s circuit Receive onto its corresponding transmit channel. The 108 digital loopback test line accepts binary signals (bits), and loops back received octets (8 bits, 1byte). After loopback, the DTH re-transmits the bytes for preservation of so the positions of the bits in the byte\. This means that the most significant bit (MSB) of the re-transmitted octet corresponds to the MSB of the received octet. In this manner, digital services can pass digital test signals and digitally encoded analog test signals through the test line.

DTH/DTT interface to digital switch

Here is a description of the TAD interface between the DTH and the DMS - 100 switch.

Test access digroup

The physical interface between the DTH and the switch is a D1 link which serves as a TAD. At the DTH, you can configure this link for either SF or ESF framing, with either AMI, ZCS or B8ZS coding. The DTH provides five equalization settings, covering distances up to 199.64 m (655 ft). For link qualification purposes, the switch should provide a remote loopback capability at its DS1 interface card. Configure the individual DS0 channels as either TAPs or test lines.

Call origination through a test access path

Access the NE switch through one or more TAPs. These are digital trunks have the configuration shown in Table 11-1.

Table 11-1
TAP configuration

TAP Configuration	
Direction	One-way incoming (to the switch
Start signal	Wink
Supervision	E&M (A&B-bit)
Pulsing	MF
Special Features	Second wink upon selection of outgoing trunk; ROTL-type digit sequence

Since E&M supervision reduces the data carrying capacity of the digital trunk, the present capacity of each TAP is 56 kb/s.

A special feature of the TAP is the use of a second wink to indicate the selection of the outgoing trunk by the NE switch. Hence, any tone treatments (60 ipm busy and 120 ipm re-order) are either pre- or post-selection. Refer to the description of, Pre-selection and Post-selection errors outcomes later in this document.

The dialing plan, similar to that used for ROTL, indicates the type of test call, the TUT, and the directory number of the FE test line. Table 11-2, Table 11-3, and Table 11-4, shows the possible sequences.

Table 11-2
Test of idle trunk

Test of idle trunk	
KP	Start-of-pulsing
08	Indicates test of idle trunk
xxxx	Four digit trunk group number
xxxx	Four digit trunk member number
NXX-XXXX	Test line number to be outpulsed to far-end
ST	End-of-pulsing

Table 11-3
Test of Trunk in Maintenance Busy state

Test of trunk In maintenance-Busy state	
KP	Start-of-pulsing
18	Indicate test with override of maintenance busy state
xxxx	four digit trunk group number
xxxx	four digit trunk member number
NPA NXX-XXXX	Test line number to be outpulsed to far-end
ST	End-of-pulsing

Table 11-4
Test of home off ice test line

Test of home off ice test line	
KP	Start-of-pulsing
78	Indicates test of 108 home off ice test line
xxxx	four digit trunk group number

Test of home off ice test line	
xxxx	Four digit trunk member number
NPA NXX-XXXX	Test line number to be outpulsed to far-end
ST	End-of-pulsing

Answer detection

After digit pulsing, the DTH recognizes a sustained off-hook as an answer signal. After answer signal detection, the DTH proceeds with trunk testing.

Test access path errors

The DTH reports the following error outcomes which could occur in connection with the DTH attempt to seize a TAP to the NE switch:

- Test access path locked out (TAP Lock Out) - The DTH detects sustained off-hook supervision from the switch. No calls are possible until the switch goes on-hook.
- Test access path wink failure (TAP Wink Fail) - After going off-hook to seize the TAP toward the switch, the DTH is unable to detect a wink from the switch within a prescribed interval.

Pre-selection errors

Error outcomes which occur following start of digit outpulsing from the DTH to the NE switch, but before the second wink, that is, before the switch completes selection (routing) to the trunk-under-test, include:

- Trunk busy (Trunk Busy) - The DTH detected 60 ipm busy tone. The NE switch translated digits identifying the TUT, and determined that the specified trunk is carrying traffic. Had the trunk been available, the switch would have selected the trunk and returned a second wink to the DTH.

  If the trunk is in the maintenance busy state, the switch applies a 120 ipm reorder tone (rather than busy tone). However, for the maintenance busy override digit sequence KP18XXX ST, the DTH does not apply reorder and the call proceeds.

- Reorder, near-end (Reord, NE) - The DTH detected 120 ipm reorder tone. After attachment of an MF receiver to collect digits from the DTH, the NE switch encountered an error and can not select the outgoing trunk. Possible errors include
  - — an invalid or incomplete digit sequence
  - — an out-of-range trunk group number or member number
  - — an attempt to select a faulty trunk

Ordinarily, there would be selection of the specified trunk and a return of second wink to the DTH.

- Time-out, near-end (TmOut,NE) - After outpulsing to the NE switch, the DTH receives no other response (for example, second wink, off-hook answer, 60 ipm busy, or 120 ipm reorder). The interval is approximately 30 seconds. It is possible the switch never received end of pulsing (ST) from the DTH. There may also have been an error in switch call processing after end-of-pulsing.

Post-selection errors

Error outcomes which occur as or after the NE switch attempts to seize and outpulse to the TUT include:

- Far-end test line busy (FETL Busy) - The NE DTH, after detecting second wink, detected 60 ipm busy tone. The FE switch translated digits identifying the FE test line group, and determined that all test lines in the group are busy. Had a test line been available, the DTH would receive an off-hook answer signal.
- Reorder, far-end (Reord, FE) - The NE DTH, after detection of second wink, detected a 120 ipm reorder tone. An error exists either in trunk signaling or in the FE switch. An example of a signaling error is wink failure in the TUT. An example of a FE error is digit translation resulting in an invalid route.
- Time-out, far-end (TmOut, FE) - After detection of second wink, the DTH receives no other response (for example, off-hook answer, 60 ipm busy, or 120 ipm reorder). The interval is approximately 30 sec. It is possible the NE switch never sent end-of-pulsing (ST) to the NE switch. Also, that after end-of-pulsing, there was an error in switch call processing. Possibly, after test line selection at the FE switch, there was no off-hook answer signal from the test line.
- Early release, towards the near-end (Early Disc.) - If the FE test line, or either switch, releases call before the DTH completes the specified BERT, the test result contains this indication. Early disconnect does not invalidate any interim test results. However, for nightly routine testing of trunks, such an outcome is considered an incomplete test.

Call termination to DTH 108 test line

The switch accesses DTH type 108 test lines through one or more digital trunks configured as shown in Table 11-5.

Table 11-5
108-test line configuration

108-Test Line Configuration	
Direction	One-way outgoing (to the DTH)
Start signal	Immediate dial
Supervision	E&M (A&B-bit)
Pulsing	None

From the perspective of the switch, each type 108 test line is a member of a one-way, outgoing trunk group on the DS1link to the DTH. Members of the trunk group comprise a hunt group accessed by a single directory number. When all members are busy, calls receive busy tone (60 ipm).

Network Test Systems

Digital Test Head

General Description

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