ISDN PROGRAMMER'S MANUAL

September 1990
Version 2.0

ISDN D–CHANNEL MONITOR/EMULATION

Version 2.0

1.1 Enhancements

✓ **Message Set Support**
Layer 3 message sets are now distributed as independent files that can be loaded by the ISDN Monitor or Emulation applications. Message sets are now selected on the Message Set Selection Menu under the **MessageSet** topic.

✓ **Report Format**
In complete display format, octets are numbered by octet identifier (eg. octet 3a) instead of an incrementing number. String parameters can be displayed in text format using ASCII, EBCDIC, or hex character sets. The call reference value is padded with leading 00 bytes (if necessary) to indicate the call reference length.

✓ **Message Builder**
The message builder now supports any defined layer 3 message set. The IE Selection Menu displays mandatory, optional, and other IE's for each message on separate screens. Undefined values can be specified on one screen to indicate which entries use two pool buffers. The *Insert* function key has been added to the buffer editor.

✓ **Test Script Message Builder**
Temporary IE buffers can now be used in automatic mode when building messages from within test scripts. Information elements, from more than two different codesets, can be built for a single message.

✓ **X.25 Support**
SAPI 16 I frame information is decoded according to the X.25 (1984) Recommendation. Filter and trigger support for X.25 packets has also been added.

✓ **State Machine Behaviour with Continuous Mode Enabled**
When continuous queuing procedure is selected and the emulation state machine enters state 8 (timer recovery state) and returns to state 7 (multi frame operation), data transmission now resumes automatically.

✓ **National Message Set Support**
Using MDL (message description language), all message sets, including the latest national message sets, are now supported in monitor and layer 3 simulation.

✓ **Basic Rate Emulation**
X.25 PLP (packet layer procedure) emulation is now included (i.e. both keyboard and test script operation).

1.2 Changes

✓ **Monitor Configuration Menu**
Frame Sequence Number Modulo has been replaced by *Modulus Mode.* Valid selections are *NORMAL* and *EXTENDED* instead of *MOD 8* and *MOD 128.*

✓ **Test Script Incompatibility**
Due to changes in the message builder, some test scripts that start by selecting a specific message set from within a test manager state, are not compatible with this release.

Workaround:
The LOAD_MESSAGE_SET command must be included prior to defining any of the test manager states.

Example:
In the AT&T test script ATT_NET.F, the AT&T message set is loaded by using the LOAD_MESSAGE_SET command.

```
TCLR                                ( Initialize the test manager )
" ATT_5E6" LOAD_MESSAGE_SET         ( Switch to AT&T message set )
" ATT.P"   LOAD_MESSAGES            ( Load the message pool )
```

1.3 Problems Fixed

PR **Trace Format**
When trace display format is selected, data is no longer displayed along with trace statements.

PR **Send Data Source Menu**
The transmit mode on the Send Data Source Menu is now correctly displayed as continuous when the CONT_ON command is executed.

PR **Message Builder Values**
The **MessageBuilder** topic is no longer related to connection data structures (eg. *COD). Thus, changing the protocol discriminator, call reference, selected information elements, and parameter values has no effect on simulation scripts that use connections.

PR **Data Source Menu**
Messages selected from the Send Data Source Menu and transmitted from the **Send** topic are now correct for the currently selected message set.

PR **Selective Playback**
The data file header of a multi-channel data recording is now displayed during playback, even if a single channel of the recording is selected for display.

PR **Bit Rate (WAN)**
Transmitting continuous information frames at speeds less than 1800 bps no longer results in merged frames.

External Clock (WAN)
When the tester is configured as User and clocking is provided by the interface (External Clock Off), the bit rate can only be measured. When clocking is provided by the tester (External Clock On), the bit rate must be selected.

When the tester is configured as Network and clocking is provided by the interface (External Clock On), the bit rate can only be measured. When clocking is provided by the tester (External Clock Off), the bit rate must be selected.

S/T Bus Power Supply (Basic Rate)
The PS1 and PS2 commands, which controlled the application of power supplies, are no longer interchanged (i.e. PS1 commands controlling PS2 and vice versa). Consequently, test scripts written to control these power supplies must be similarly modified.

State Traces (Basic Rate & WAN)
Layer 2 states 1, 2, 3, and 4 are now reported during the TEI assignment procedures after the STATE_ON command is executed.

TEI User Request (Basic Rate & WAN)
When two (or more) user applications request TEI's from the network simultaneously, two different reference numbers (Ri) in the ID request message are randomly assigned.

Layer 1 Filters and Triggers (Primary Rate)
Layer 1 filters and triggers for facility error indications have been removed from the Layer 1 Filter Setup Menu and the Layer 1 Event Menu.

Monitoring High Throughput Timeslots (Primary Rate)
The tester no longer hangs-up or produces a bus error when monitoring high throughput data channels in complete display format.

1.4 Known Problems

C/R Bit Settings
The layer 2 emulation can incorrectly accept frames that have a C/R bit error.

Triggering
If a trigger is set up for both a data window display message and highlighting, only the data window display message will be displayed; no highlighting occurs.

Selective Playback
If data is captured to disk midway through another capture being performed by a different channel, data may appear between the two lines composing the header, indicating the start of the second capture to disk.

Interface Speed (WAN)
The interface speed 128000 b/s is not supported.

- **V.36 (RS−449) Interface (WAN)**
  In Emulation mode, when an unterminated cable is connected to the V.36 interface, changing the emulation type (eg. TO DTE or TO DCE) can cause the tester to lock-up.

  Workaround:
  Disconnect the cable, select the emulation type, and then reconnect the cable.

  NOTE
  Connecting cable(s) of any other type (i.e. V.35, V.11 etc.) or selecting any interface type from the Configuration Menu will not cause a lock up if a V.36 physical cable is not connected.

- When the emulation is running in the backgroiund, an incorrect result is displayed when trying to measure response times in playback RAM.

- The maximum length of the pool entry name on the Message Pool Menus is longer than the Overview Window can display, resulting in truncated names on the Overview Menu.

  Workaround:
  The *Next* or *Previous* function keys must be used to scroll through all messages. This displays the current name used in the *Pool Entry* item.

- When displaying messages within the message builder and complete report format is selected, lines containing RED FG graphic characters are displayed after scrolling down and back up again. This only occurs when the emulation is running in background.

PREFACE

This manual is intended to provide a programmer's guide to the ISDN Monitor/Emulation programs. General programming information is provided in the Programmer's Reference Manual. Information contained in this manual is machine independent.

This manual is not intended to provide basic user instruction, but rather addresses the issues of writing test programs using the Interactive Test Language (ITL). Refer to the machine specific User Manual for a quick reference to the basic operation of the protocol tester.

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INTRODUCTION

The ISDN Monitor is implemented in accordance with the following specifications:

Layer 2:

Link Establish, Link Release and Data Transfer Phases
CCITT Rec. Q.921 Red Book, Oct. 1984

TEI Assignment Procedure
CCITT Rec. Q.921 COM XI Contribution 40-E, July 1985
(Boulder, Colorado)

XID Procedure
CCITT Rec. Q.921 COM XI Report R12-E, Dec. 1985, Appendix IV

DL-ESTABLISH-CONFIRM and DL-RELEASE-CONFIRM primitives
CCITT Rec. Q.921 COM XI Contribution 40-E, July 1985
(Boulder, Colorado)

Layer 3:

CCITT Message Decoding
CCITT Rec. Q.931 Blue Book, Nov. 1988

The ISDN Monitor is not a state-driven monitor, i.e. it does not have the knowledge of expected events. Rather, it decodes the data and reports information on received layer 1 events, frames, and messages. Filters, triggers, RAM capture, and disk recording are also available.

The ISDN layer 2 emulation is a state-driven protocol emulation together with an integral protocol monitor. The emulation can be driven as:

- an automatic emulation;
- a semi-automatic tester. The test manager is used to build and execute test scenarios.
- a manual tester. The test is controlled from the user's keyboard.

The layer 2 emulation can emulate on up to eight links simultaneously.

The layer 3 simulation provides the tools necessary to build and transmit or receive and decode layer 3 messages. These tools are:

- menu driven message building utility for building, editing and saving layer 3 messages;
- menu driven selection of default layer 3 messages; and
- test manager tools for constructing layer 3 messages inside a test script.

The layer 3 simulation can maintain the data associated with eight separate calls simultaneously.

All user test scripts are written in the ITL language. Test programs are made up of sequences of ITL commands (or 'words') which exchange data and parameters via a Last In First Out (LIFO) stack. All commands consume zero or more parameters from the stack (input) and/or leave results on the stack (output). These commands have a stack effect comment shown beside the definition of the command to define its input and output parameters.

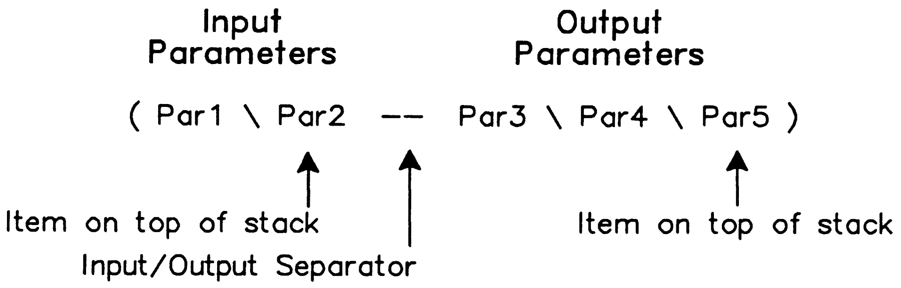


Figure 1-1 Sample Stack Comment

NOTE
See Appendix B for further explanation of stack parameters.

2
MONITOR ARCHITECTURE

The ISDN D–Channel Monitor program monitors live data, saves data to capture RAM or disk, and displays data in a number of different formats. Data can be passed through filters which limit the displayed, captured, or recorded data. Triggers perform specific actions when a specified event occurs.

2.1 Live Data

The monitor application receives events from the interface or from the internal timer and processes them as shown in Figure 2–1.

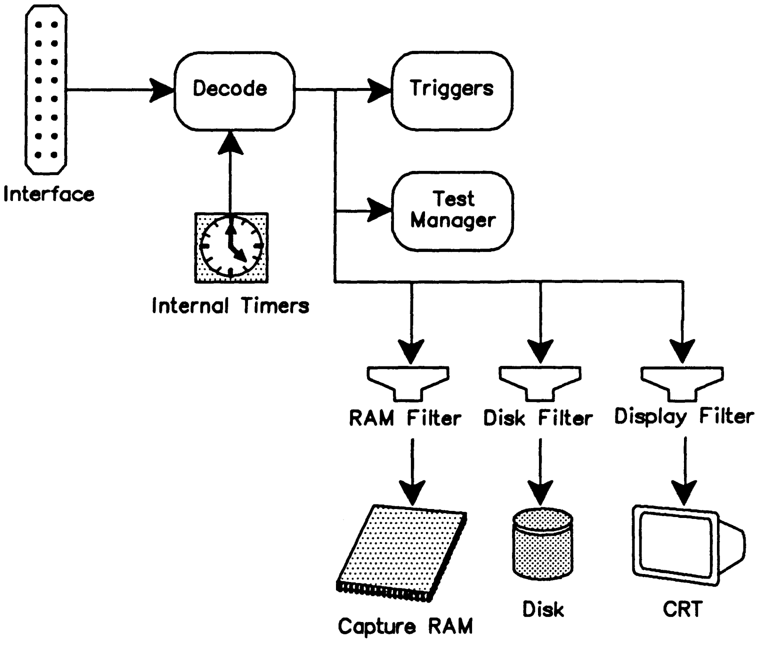


Figure 2–1 ISDN Monitor Data Flow Diagram – Live Data

Display topic
Live Data function key

MONITOR (--)
Selects the live data mode of operation. All incoming events are decoded and displayed in real–time.

2.2 Playback

Data (both protocol and lead information) can be examined in an offline mode using either capture RAM or a disk file as the data source.

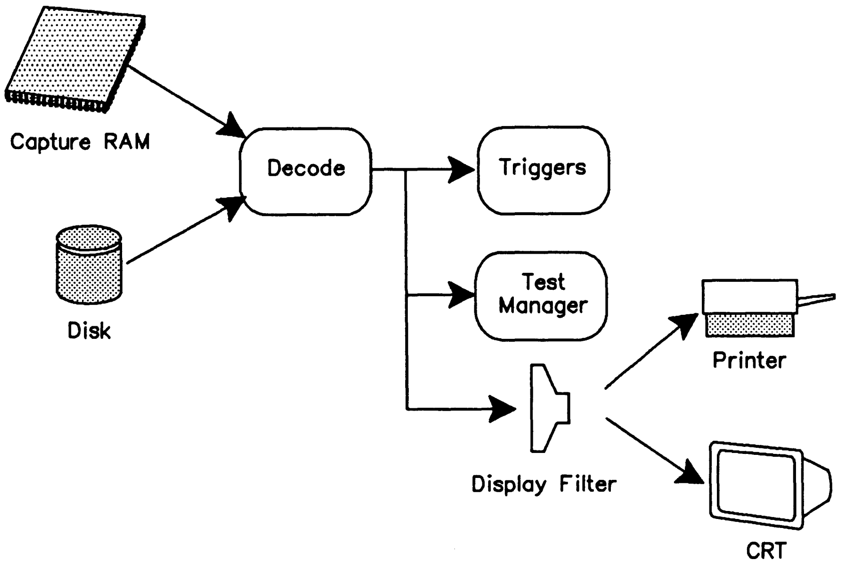


Figure 2–2 ISDN Monitor Data Flow Diagram – Offline Processing

FROM_CAPT HALT
Display topic
Playback RAM function key

FROM_DISK HALT PLAYBACK
Display topic
Playback Disk function key

HALT (--)
Selects the playback mode of operation. Data is retrieved from capture RAM or a disk file, decoded, and displayed or printed. Capture RAM is suspended in this mode.

FROM_CAPT (--)
Selects the capture buffer as the source for data transfer.

FROM_DISK (--)
Selects a disk file as the source for data transfer.

PLAYBACK (--)

Opens a data recording file for playback. When used in the Command Window, the filename can be specified as part of the command.

Example:

```
PLAYBACK DATA1
```

NOTE
When PLAYBACK is used in a test script, the filename must be specified with =TITLE.

=TITLE (filename --)

Specifies the name of the file to be opened for disk recording or disk playback.

Example:
Obtain playback data from disk.

```
FROM_DISK                    ( Identifies disk file as data source )
HALT                         ( Place the monitor in playback mode )
" DATA3"  =TITLE             ( Create title for next data file to be opened )
PLAYBACK                     ( Playback data )
```

Playback Control

The following commands control display scrolling.

FORWARD or **F** (--)

Scrolls one line forward on the screen.

⌨ ⇓ (Down arrow)

BACKWARD or **B** (--)

Scrolls one line backward on the screen.

⌨ ⇑ (Up arrow)

SCRN_FWD or **FF** (--)

Scrolls one page forward on the screen.

⌨ CTRL ⇓

SCRN_BACK or **BB** (--)

Scrolls one page backward on the screen.

⌨ CTRL ⇑

TOP (--)

Positions the display at the beginning of the playback source.

⌨ CTRL SHIFT ⇑

BOTTOM (--)
Positions the display at the end of the playback source.

📝 CTRL SHIFT ⇓

2.3 Simultaneous Live Data and Playback

Live data can be recorded to disk while playing back data from capture RAM.

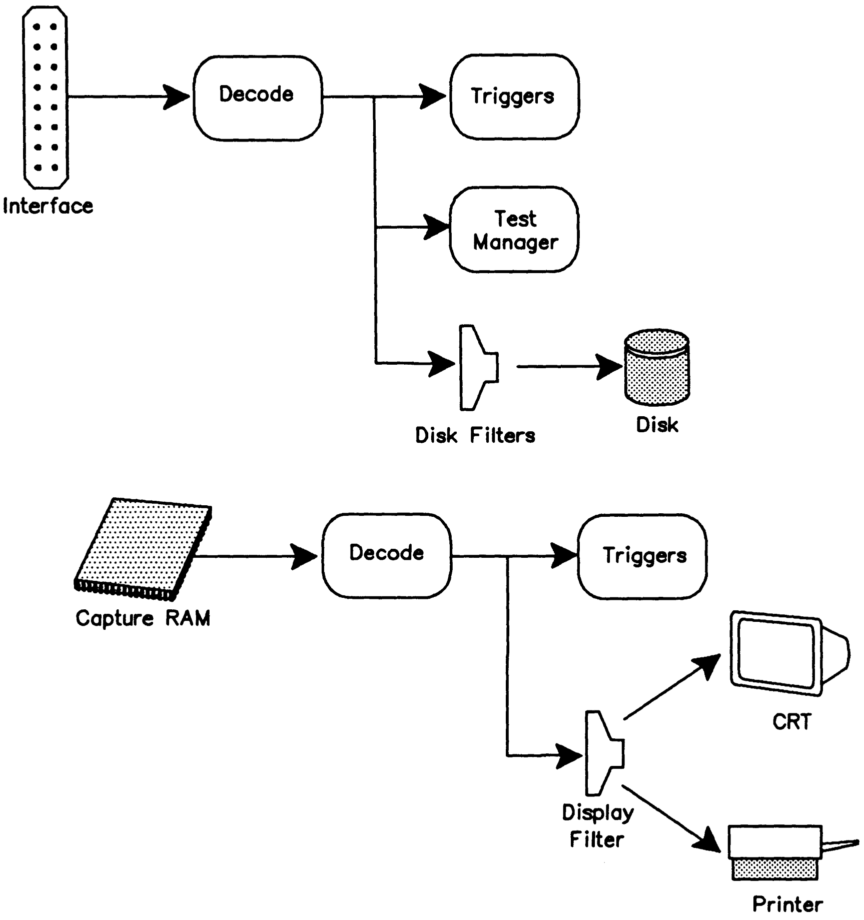


Figure 2–3 ISDN Monitor Data Flow Diagram – Freeze Mode

📝 FROM_CAPT FREEZE
Capture topic
Record to Disk function key
Display topic
Playback RAM function key

FREEZE (--)
Enables data to be recorded to disk while data from capture RAM is played back.

3
MONITOR CONFIGURATION

ISDN D-Channel data can be monitored on a WAN, Basic Rate, or Primary Rate interface. This section describes configuration commands for layers 1, 2, and 3.

3.1 Layer 1

This section describes commands to configure the physical layer for each interface type.

Basic Rate

The Basic Rate interface is configured on the Home processor prior to loading the D-Channel Monitor application. However, commands exist within the application for interface configuration.

Each application processor is associated with a serial port which has a port identifier. This port identifier is used in most of the Basic Rate layer 1 configuration commands.

PORT_BRID (-- port id)
Returns the port identifier for the Basic Rate D-Channel port (Port A for BRA/BRA tester).

PORT_BRID2 (-- port id)
Returns the port identifier for the Basic Rate D-Channel Port B (BRA/BRA tester).

The S/T bus can be configured for point-to-point operation (one TE device attached) or point to multipoint operation (up to eight TE devices attached).

PPMP (port\connect mode --)
Where: connect mode = P2P point-to-point mode (default)
P2MP point to multipoint

Establishes the bus configuration of the unit.

Example 1:
Configure the S/T bus for point-to-point operation.

```
PORT_BRID P2P  PPMP
```

Example 2:
Configure the S/T bus for Port B of a BRA/BRA tester for point to multipoint operation.

```
PORT_BRID2 P2MP PPMP
```

When a phone is connected to the tester, the voice encoding method is either A-law or μ-law.

CODE_TYPE (port\voice code --)
Where: voice code =U-LAW μ-law voice encoding (default)
A-LAW A-law voice encoding

Selects the type of voice encoding.

Example:
Select μ-law voice encoding.

```
PORT_BRID  U-LAW  CODE_TYPE
```

When no data is displayed or passed to the test manager, the S/T bus could be inactive (appropriate LED's all red). The state of the S/T bus can be determined by the following three commands:

ACTIVATED? (-- flag)
Returns true if the bus is activated.

DEACTIVATED? (-- flag)
Returns true if the bus is deactivated.

INTERRUPTED? (-- flag)
Returns true if the bus is interrupted (lost framing).

Each B-Channel data stream is always routed to an application processor and the associated external connector for monitoring. To monitor data, one B-Channel can be routed to CODEC.

BCHAN_SRC (port\source\Bchan --)
Where: source = VOICE (CODEC)
PP1 (AP #1 / AP #4 for Port B of BRA/BRA)
PP2 (AP #2 / AP #5 for Port B of BRA/BRA)
Bchan = BCHAN1 (B1-Channel)
BCHAN2 (B2-Channel)

Selects the source of monitored data for the specified B-Channel. By default, AP #1 (AP #4 for Port B of BRA/BRA) monitors B1-Channel data. AP #2 (AP #5 for Port B of BRA/BRA) monitors B2-Channel data. Data routed to AP #1 (AP #4) is also routed to the external connector #1 and data routed to AP #2 (AP #5) is also routed to the external connector #2.

Example 1:
Route the B1-Channel data to AP #2.

```
PORT_BRID  PP2  BCHAN1  BCHAN_SRC
```

Example 2:
Route the B2-Channel data to the voice CODEC.

```
PORT_BRID VOICE  BCHAN2  BCHAN_SRC
```

Example 3:
Route the B2-Channel data on Port B of a BRA/BRA tester to AP #4.

```
PORT_BRID2  PP1  BCHAN2  BCHAN_SRC
```

By default, B-Channels are connected to application processors and external connectors. The data flow to these connectors can be turned off/on.

DROUTING (port\route -- flag)
Where: route = DRT_OFF - turn off the flow of data to the application processors
DRT_SERIAL - route B-Channels to the application processors (default)

Connects the B-Channels to an application processor and returns true if successful.

Example:
Configure the tester to connect the B-Channels through to the application processors.

```
1 SEQ{
    PORT_BRID PP1 BCHAN1 BCHAN_SRC              ( route B1-Channel to AP#1 )
    PORT_BRID PP2 BCHAN2 BCHAN_SRC              ( route B2-Channel to AP#2 )
    PORT_BRID DRT_SERIAL DROUTING               ( connect B-Channels )
    IF
        " B-Channels are connected to application processors."
    ELSE
        " Bus not activated.  B-Channels are not connected."
    ENDIF
    W.NOTICE
  }SEQ
```

B-Channel data can be connected to or disconnected from the external connector.

EXTERNAL_OUT (port \ external connector \ state --)
Where: external connector = EXT_1 (B-Channel) or EXT_2 (B2-Channel)
state = YES (on)
NO (off)

Connects/disconnects the B-Channels to/from the external connector.

NOTE
If the B-Channels are swapped, EXT_1 will be associated with the B2-Channel and EXT_2 with the B1-Channel.

Example:
Connect the B1-Channel data to the external connector #1.

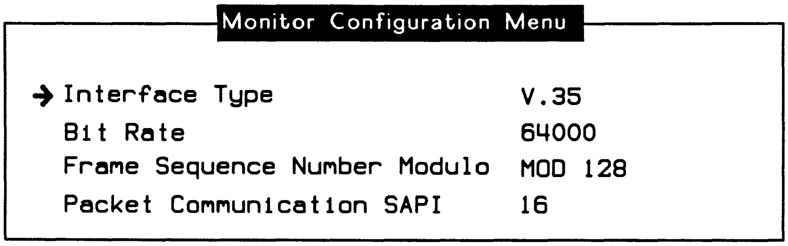
```
PORT_BRID  PP1  BCHAN1  BCHAN_SRC              ( Route B1-Channel Data to AP#1
                                                 and external #1 )
PORT_BRID  EXT_1  YES  EXTERNAL_OUT            ( Connect B1-Channel data)
```

Primary Rate

The Primary Rate interface is configured on the Home processor prior to loading the D-Channel Monitor application. Corresponding configuration commands do not exist in the application.

WAN

The WAN interface is configured on the application processor after loading and switching to the D-Channel Monitor.



```
Monitor Configuration Menu

→ Interface Type                  V.35
  Bit Rate                        64000
  Frame Sequence Number Modulo    MOD 128
  Packet Communication SAPI       16
```

Figure 3–1 Monitor Configuration Menu (WAN)

INTERFACE_WAKEUP (--)
Configures the physical interface.

→ *Interface Type*
IF=V28 (--)
Selects the V.28 connector and electrically isolates the other connectors on the port.

RS232C/V.28 function key

IF=V11 (--)
Selects the V.11 connector and electrically isolates the other connectors on the port.

RS422/V.11 function key

IF=V35 (--)
Selects the V.35 (default) connector and electrically isolates the other connectors on the port.

V.35 function key

IF=V36 (--)
Selects the V.36 connector and electrically isolates the other connectors on the port.

RS449/V.36 function key

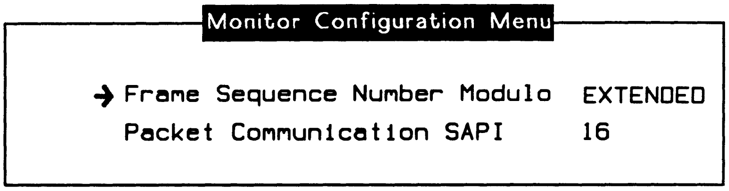
NOTE
A WAN tester has a V.28, V.11, and either a V.35 or V.36 connector. These commands are only applicable if the program is running on a WAN interface.

→ *Bit Rate*
The interface speed is measured, in bits per second, directly from the physical line.

INTERFACE–SPEED (-- address)
Contains the current bit rate (default value is 64000) and is used by the monitor to calculate throughput measurements.

3.2 Layer 2

This section describes the various commands and variables used for layer 2 configuration. Layer 2 configuration is identical for all interface types.



```
Monitor Configuration Menu

→ Frame Sequence Number Modulo   EXTENDED
  Packet Communication SAPI      16
```

Figure 3–2 Monitor Configuration Menu (Basic Rate)

→ *Frame Sequence Number Modulo*
L2=MOD128 (--)
Selects modulo 128 (default) method of decoding.

EXTENDED function key

L2=MOD8 (--)
Selects modulo 8 method of decoding.

NORMAL function key

MMODE–FLAG* (-- address)
Contains a value identifying modulo 8 (0) or modulo 128 (1) method of decoding.

→ *Packet Communication SAPI*
Layer 3 information within layer 2 I or UI frames with a specified SAPI value is decoded according to X.25.

NOTE
This SAPI value cannot be changed within test scripts. Use the Monitor Configuration Menu to modify this SAPI.

DATACOM–SAPI# (-- value)
Returns the current value of the data communications (packet data) SAPI (default value is 16).

4
CAPTURE RAM

This section describes the data flow diagram for capture to RAM and lists the commands available for test scripts. Data stored in either capture RAM or disk can be played back as described in Section 2.2. Data stored in capture RAM can be transferred to a disk file.

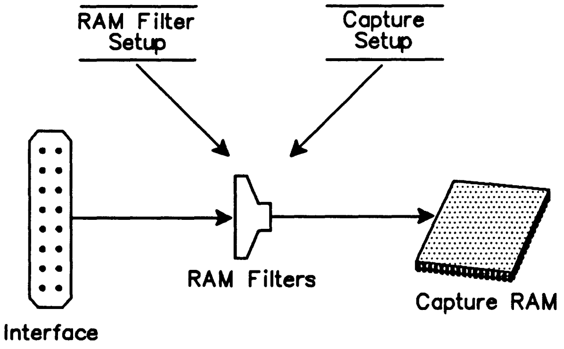


Figure 4–1 ISDN Data Flow Diagram – Capture to RAM

4.1 Capturing to RAM

CAPT_ON (--)
Saves live data in capture RAM (default).

Capture topic
Capture to RAM function key (highlighted)

CAPT_OFF (--)
Live data is not saved in capture RAM.

Capture topic
Capture to RAM function key (not highlighted)

CAPT_WRAP (--)
Initializes capture RAM so that new data overwrites (default) old data after the capture buffer is filled (endless loop recording).

Capture topic
Recording Menu
→ *When Buffer Full*
WRAP function key

CAPT_FULL (--)
Initializes capture RAM so that capturing stops when the capture buffer is full.

Capture topic
Recording Menu
→ *When Buffer Full*
STOP function key

WARNING
CAPT_WRAP and CAPT_FULL erase all data in the capture RAM.

CLEAR_CAPT (--)
Erases all data currently in capture RAM.

Capture topic
Clear function key

4.2 Transferring from RAM

Data can be transferred from capture RAM to disk, and printed as it is played back. To transfer data to disk, a data recording must be opened using the RECORD and CTOD_ON commands prior to using TRANSFER. To transfer data from capture RAM to the printer, the PRINT_ON command must first be issued. The data being transferred is displayed on the screen.

TRANSFER (--)
Transfers data from the selected data source.

Capture topic
Save RAM to Disk function key (highlighted)

QUIT_TRA (--)
Abruptly terminates the transfer of data from capture RAM to disk.

Capture topic
Save RAM to Disk function key (not highlighted)

TRA_ALL (--)
Transfers the entire contents of capture RAM (default) when the TRANSFER command is used.

Capture topic
Save RAM to Disk function key
All function key

TRA_START (--)

Selects the starting block for transfer and is used with TRA_END when a partial transfer is desired. Use the cursor keys to locate the desired starting block prior to calling TRA_START. TRA_START selects the last scrolled block as the initial starting block for transfer.

Capture topic
Save RAM to Disk function key
Set Start function key

TRA_END (--)

Selects the final block for transfer and is used with TRA_START when a partial transfer is desired. Use the cursor keys to locate the desired final block prior to calling TRA_END. TRA_END selects the last scrolled block as the final starting block for transfer.

Capture topic
Save RAM to Disk function key
Set End function key

SEE_TRA (--)

Displays the timestamps for the initial and final blocks selected for transfer in the Command and Test Script Windows.

Example:
Open a data file with the filename 'DATA1' and transfer all data from capture RAM to disk. After the transfer is complete, turn off data recording.

```
FROM_CAPT                    ( Designate capture RAM as data source )
HALT                         ( Enter playback mode )
" DATA1"  =TITLE             ( Assign filename DATA1 )
RECORD                       ( Open data recording )
CTOD_ON                      ( Enable capture transfer to disk )
TRA_ALL                      ( Transfer all data )
TRANSFER                     ( Transfer data from capture to disk )
DISK_OFF                     ( Turn off data recording )
```

To Disk

CTOD_ON (--)

Enables transfer of data from capture RAM to disk when data source is playback RAM and a data recording file is open.

CTOD_OFF (--)

Disables transfer of data from capture RAM to disk (default) when data source is playback RAM.

To Printer

PRINT_ON (--)

Prints data lines as displayed during playback from either capture RAM or disk. No printout is made when the source is live data. The printer must be configured from the Printer Port Setup Menu under the **Setup** topic on the Home processor.

Print topic
Print On function key

PRINT_OFF (--)

Data is not printed during playback (default).

Print topic
Print Off function key

Example:
Transfer all data from capture RAM to the printer.

```
FROM_CAPT               ( Designate capture RAM as data source )
HALT                    ( Enter playback mode )
PRINT_ON                ( Enable printing )
TRA_ALL                 ( Transfer all )
TRANSFER                ( Transfer data to printer )
```

5
DISK RECORDING

Live data from the interface can be recorded to either a floppy or hard disk. Data stored in either capture RAM or disk can be played back as described in Section 2.2. Data stored in capture RAM can be transferred to disk as described in Section 4.2.

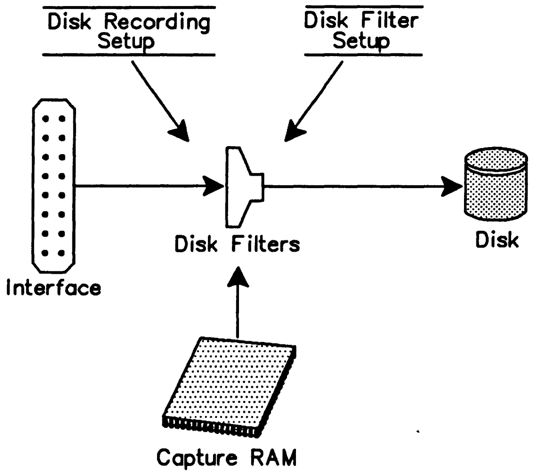


Figure 5–1 ISDN Data Flow Diagram – Recording to Disk

DISK_WRAP (--)
Selects disk recording overwrite (default).

Capture topic
Recording Menu
→ *When File Full*
WRAP function key

DISK_FULL (--)
Turns off disk recording overwrite. Recording continues until the data recording file is full.

Capture topic
Recording Menu
→ *When File Full*
STOP function key

WARNING
DISK_WRAP and DISK_FULL must be called prior to opening a recording with the RECORD command. If called while recording is in process, the status of the disk recording overwrite for this recording session will not change.

RECORD (--)

Opens a data recording file. When used in the Command Window, the filename can be specified as part of the command.

Example:

```
RECORD DATA1
```

Capture topic

Record to Disk function key (highlighted)

NOTE

When RECORD is used in a test script, the filename must be specified with =TITLE. Because of the relatively long time required to open a disk file (especially on a floppy drive), RECORD should not be used within time critical portions of a test script.

Trace report lines are included in the data file when an application requests start and end recording. The information in these traces identifies the traffic type and application program used while the data was being recorded.

Example:

```
Recording Start : ISDN Emul USR    D Channel
V2.0-2.0 Rev 0                     PT500 - 24     SN# 01-261

Recording End   : ISDN Emul USR    D Channel
V2.0-2.0 Rev 0                     PT500 - 24     SN# 01-261
```

DISK_OFF (--)

Live data is not recorded to disk. The current disk recording is closed.

Capture topic

Record to Disk function key (not highlighted)

NOTE

Refer to the Programmer's Reference Manual for multi-processor disk recording.

DIS_REC (--)

Momentarily suspends disk recording. The data recording file remains open but no data is saved to disk.

Capture topic

Record to Disk function key (highlighted)
Suspend Recording function key (highlighted)

ENB_REC (--)

Enables data recording. The data recording file remains open and live data is recorded to disk.

Capture topic

Record to Disk function key (highlighted)
Suspend Recording function key (not highlighted)

6
DISPLAY FORMAT

The ISDN D–Channel Monitor and Emulation applications can display data from the line (live data), from capture RAM, or from a disk recording in a variety of formats.

The data flow diagram for displaying and printing data, as well as commands available for test scripts, are described in this section.

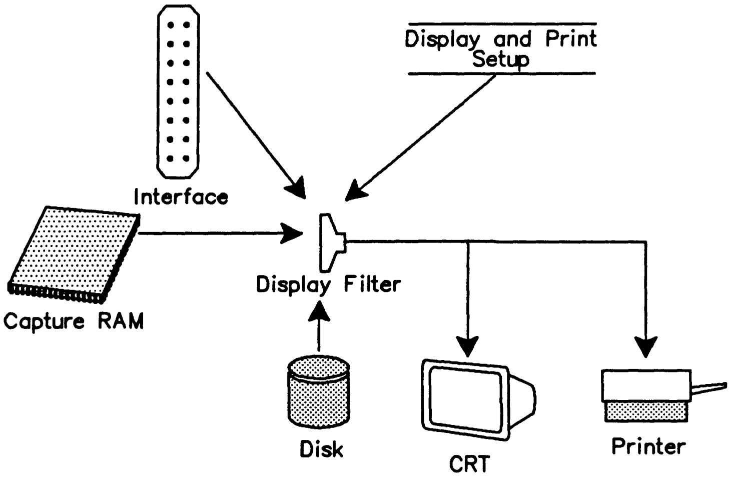
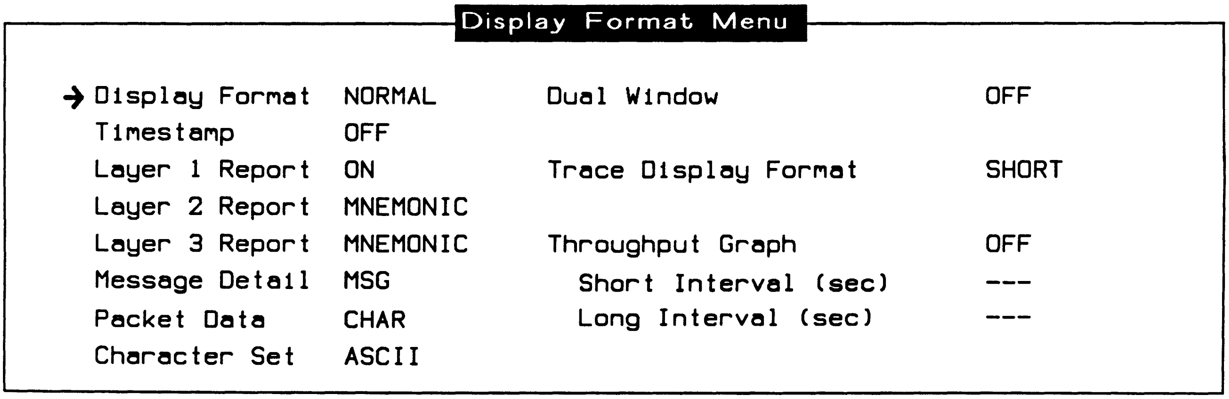


Figure 6–1 ISDN Data Flow Diagram – Display and Print

NOTE
Data can only be printed in playback mode.



```
                         Display Format Menu

  → Display Format   NORMAL      Dual Window              OFF
    Timestamp        OFF
    Layer 1 Report   ON          Trace Display Format     SHORT
    Layer 2 Report   MNEMONIC
    Layer 3 Report   MNEMONIC    Throughput Graph         OFF
    Message Detail   MSG           Short Interval (sec)   ---
    Packet Data      CHAR          Long Interval (sec)    ---
    Character Set    ASCII
```

Figure 6–2 Display Format Menu

→ *Display Format*
The default display is normal format. *Timestamp, Layer 1 Report, Layer 2 Report,* and *Layer 3 Report* can only be modified when *Display Format* is set to *NORMAL.*

REP_NORMAL (--)
Turns on data display (default).

Format topic
NORMAL function key

REP_OFF (--)
Turns off data display.

OFF function key

REP_SPLIT (--)
Displays data with a split screen display. The screen is divided in half vertically, with frames sent from the network displayed on the left and frames sent from the user on the right.

Format topic
SPLIT function key

NOTE
Only the first 38 characters of a trace statement are displayed when split display format is selected.

REP_TRACE (--)
Displays only trace statements.

TRACE function key

→ *Timestamp*

TIME_OFF (--)

Timestamps are not displayed (default). Block sequence numbers for each received frame or physical event are displayed.

✍ *OFF* function key

TIME_ON (--)

Displays the start and end of timestamps as minutes, seconds, and tenths of milliseconds. Block sequence numbers for received frames or physical events are not displayed.

✍ *MM:SS.ssss* function key

TIME_DAY (--)

Displays the start and end of timestamps as days, hours, minutes, and seconds. Block sequence numbers for received frames or physical events are not displayed.

✍ *DD HH:MM:SS* function key

BLOCK_ON (--)

Displays block sequence numbers for each received frame or physical event. BLOCK_ON is functionally identical to TIME_OFF.

✍ *OFF* function key

→ *Layer 1 Report*

Reports physical interface (layer 1) events to the data display as they occur.

L1_OFF (--)

Layer 1 events are not displayed.

✍ *OFF* function key

L1_COMP (--)

Displays layer 1 events in complete format (default).

✍ *ON* function key

→ *Layer 2 Report*

Reports received frames in a variety of display formats.

FRM_OFF (--)

Received frames are not displayed.

✍ *OFF* function key

FRM_COMP (--)

Displays received frames in complete format. The SAPI, TEI, C/R bit, P/F bit, and frame type of each received frame is displayed. The NR and NS values are displayed for I frames. Management UI frames, FRMR, and XID frames are also completely decoded and displayed.

L.2 Comp function key

FRM_MNEM (--)

Displays received frames in mnemonic format (default). Only the SAPI, TEI, C/R bit, and frame type of each received frame is displayed.

L.2 Mnem function key

FRM_HEX (--)

Displays received frames in hexadecimal format. Each byte of the layer 2 frame is displayed as two hexadecimal digits.

HEX function key

FRM_CHAR (--)

Displays received frames in the currently selected character set.

TEXT function key

→ *Layer 3 Report*

Reports the information fields of received layer 2 I frames as layer 3 messages in a variety of display formats.

MSG_OFF (--)

Layer 3 messages are not displayed.

OFF function key

MSG_COMP (--)

Displays layer 3 messages in complete format. The layer 3 message is decoded as completely as possible. The protocol discriminator, call reference (value and flag), and message type fields are displayed, followed by a line-by-line listing of each parameter of each information element in the message. The value and meaning of each parameter is displayed.

L.3 Comp function key

NOTE

Because of the amount of detail this display outputs, it is not recommended for displaying live data.

MSG_MNEM (--)

Displays layer 3 messages in mnemonic format (default). The protocol discriminator, call reference (value and flag), and message type fields are displayed. The message type is displayed as a mnemonic name. For example, the 'CALL PROCeeding' message is displayed as 'CALL_PROC'.

✍ *L.3 Mnem* function key

MSG_HEX (--)

Displays layer 3 messages in hexadecimal format. Each byte of the layer 3 message is displayed as two hexadecimal digits.

✍ *HEX* function key

MSG_CHAR (--)

Displays layer 3 messages in the currently selected character set.

✍ *TEXT* function key

→ *Message Detail*

Selects the amount of detail for a layer 3 message displayed in mnemonic, text, or hexadecimal format.

MSG (--)

Selects only the message header for display. Decodes and displays the protocol discriminator, call reference (value and flag), and message type fields.

✍ *MSG* function key

MSG+IE (--)

Selects the message header and information element headers for display. Decodes and displays the protocol discriminator, call reference (value and flag), message type fields, and the information element code for each IE in the message.

✍ *MSG+IE* function key

MSG+IE+PA (--)

Selects the message header, information element headers, and information element parameter fields for display. Decodes and displays the protocol discriminator, call reference (value and flag), message type fields, and the parameter fields of each IE in the message.

✍ *MSG+IE+PA* function key

→ *Packet Data*
Selects the display format for X.25 data contained in a SAPI 16 I frame.

DATA_OFF (--)
Packet data is not displayed.

OFF function key

DATA_HEX (--)
Displays packet data in hexadecimal format.

HEX function key

DATA_CHAR (--)
Displays packet data in the currently selected character set.

CHAR function key

→ *Character Set*
Selects the character set for layer 2 or layer 3 data display.

CS=ASCII (--)
Sets the character set for data display to ASCII (default).

ASCII function key

CS=EBCDIC (--)
Sets the character set for data display to EBCDIC.

EBCDIC function key

CS=HEX (--)
Sets the character set for data display to hex.

HEX function key

CS=JIS8 (--)
Sets the character set for data display to JIS8.

JIS8 function key

→ *Dual Window*
If two applications have been loaded, the screen can be divided horizontally to display data from both applications. The current application is always displayed in the top window.

FULL (--)
Uses the entire Data Display Window for the current application.

Dual window commands vary depending on the machine configuration. Table 6-1 shows the relationship between machine configuration, application processors, and dual window commands.

Machine Type	Command	Dual Window AP #	
WAN/WAN	DUAL_1+2	AP #1	AP #2
BRA/WAN	DUAL_1+2	AP #1	AP #2
	DUAL_1+7	AP #1	AP #3
	DUAL_2+7	AP #2	AP #3
PRA	DUAL_3+4	AP #1	AP #2
PRA/BRA/WAN	DUAL_1+2	AP #1	AP #2
	DUAL_1+3	AP #1	AP #4
	DUAL_1+4	AP #1	AP #5
	DUAL_1+7	AP #1	AP #3
	DUAL_2+3	AP #2	AP #4
	DUAL_2+4	AP #2	AP #5
	DUAL_2+7	AP #2	AP #3
	DUAL_3+4	AP #4	AP #5
	DUAL_3+7	AP #4	AP #3
	DUAL_4+7	AP #5	AP #3
BRA/BRA	DUAL_1+2	AP #1	AP #2
	DUAL_1+3	AP #1	AP #4
	DUAL_1+4	AP #1	AP #5
	DUAL_1+5	AP #1	AP #6
	DUAL_1+7	AP #1	AP #3
	DUAL_2+3	AP #2	AP #4
	DUAL_2+4	AP #2	AP #5
	DUAL_2+5	AP #2	AP #6
	DUAL_2+7	AP #2	AP #3
	DUAL_3+4	AP #4	AP #5
	DUAL_3+5	AP #4	AP #6
	DUAL_3+7	AP #4	AP #3
	DUAL_4+5	AP #5	AP #6
	DUAL_4+7	AP #5	AP #3
	DUAL_5+7	AP #6	AP #3
PRA/WAN	DUAL_1+3	AP #1	AP #2
	DUAL_1+4	AP #1	AP #3
	DUAL_3+4	AP #2	AP #3

Table 6–1 Dual Window Commands

→ *Trace Display Format*
Selects the display format for trace statements.

TRACE_SHORT (--)
Displays the trace statement on one line (short format) containing only user–defined text.

SHORT function key

TRACE_COMP (--)
Displays the trace statement on two lines (complete format). Block sequence numbers or timestamps are displayed on the first line, and user–defined text on the second line.

COMPLETE function key

→ *Throughput Graph*
The throughput rate can be calculated, displayed as a bar graph, and printed out. The ISDN Monitor calculates throughput by counting the number of bytes on each side of the line during two intervals – one short, one long. This figure is divided by the time interval to arrive at a bits per second figure for each time interval (for both user and network data).

NOTE
For accurate throughput measurement, the bit rate (line speed) must be set to match the actual line speed. For WAN applications, set the speed on the Monitor/Emulation Configuration Menu.

INTERFACE–SPEED (-- address)
Contains the current bit rate (default value is 16000 for Basic Rate applications, and 64000 for Primary Rate and WAN applications).

Example:
In the WAN application, set the throughput measurement speed to 2400.

```
2400 INTERFACE-SPEED !
TPR_ON
```

TPR_ON (--)
Calculates and displays the throughput rate as a bar graph.

DISPLAY function key

WARNING
If the short interval, long interval, or speed is changed, TPR_ON must be called after the changes are made.

TPR_OFF (--)
The throughput rate is not calculated or displayed.

OFF function key

PRINT_TPR (--)

Calculates and displays the throughput rate as a bar graph, and prints the long term interval measurements.

✍ *DISPLAY AND PRINT* function key

→ *Short Interval (sec)*

Sets the short time interval, in seconds, for measuring, displaying, and printing the throughput results.

SHORT–INTERVAL (-- address)

Contains the current duration of the short interval (default value is 10 seconds).

Example:

Set the short interval to 20 seconds.

```
20 SHORT-INTERVAL !
TPR_ON
```

✍ *Modify Short Interval* function key

→ *Long Interval (sec)*

Sets the long time interval, in seconds, for measuring, displaying, and printing the throughput results.

LONG–INTERVAL (-- address)

Contains the current duration of the long interval (default value is 600 seconds).

Example:

Set the long interval to 300 seconds.

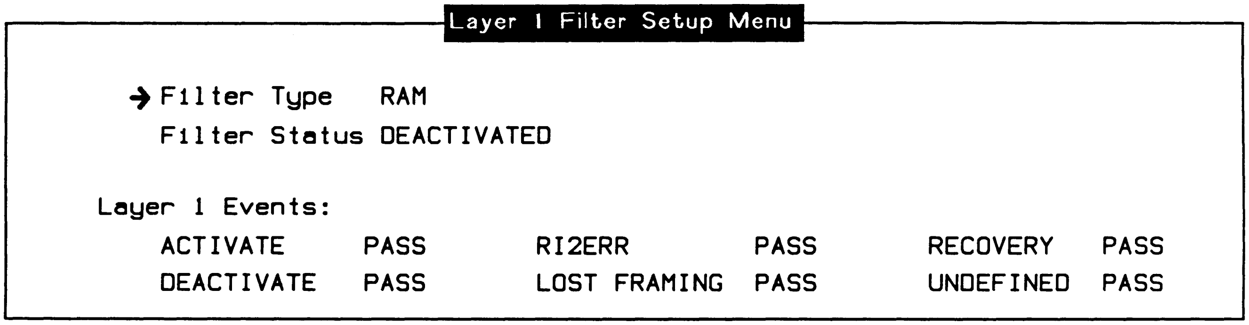
```
300 LONG-INTERVAL !
TPR_ON
```

✍ *Modify Long Interval* function key

7
FILTERS

Filters provide the capability of passing or blocking specific events from the display, capture RAM, or disk recording. These three filters act independently. This section describes the commands used to pass or block individual events, and activate or deactivate each of the three filters.

7.1 Layer 1



```
                          Layer 1 Filter Setup Menu

       → Filter Type    RAM
         Filter Status DEACTIVATED

     Layer 1 Events:
         ACTIVATE      PASS         RI2ERR          PASS         RECOVERY    PASS
         DEACTIVATE    PASS         LOST FRAMING    PASS         UNDEFINED   PASS
```

Figure 7–1 Layer 1 Filter Setup Menu (Basic Rate)

→ *Filter Type*
There are three separate filter processes which act independently of each other: *DISPLAY, RAM,* and *DISK.*

→ *Filter Status*
Filters can be deactivated (default) or activated at any time.

When a filter is deactivated, the pass or block settings for individual events are ignored so that all events are passed. When a filter is activated, any previous settings are in effect.

ACTIVATE_REPORT (--)
Activates the display (report) filter.

Filters topic
Activate Display Filter function key (highlighted).

DEACTIVATE_REPORT (--)
Deactivates the display filter.

Filters topic
Activate Display Filter function key (not highlighted)

ACTIVATE_RAM (--)
Activates the capture RAM filter.

Filters topic
Activate RAM Filter function key (highlighted)

DEACTIVATE_RAM (--)
Deactivates the capture RAM filter.

Filters topic
Activate RAM Filter function key (not highlighted)

ACTIVATE_DISK (--)
Activates the disk filter.

Filters topic
Activates Disk Filter function key (highlighted)

DEACTIVATE_DISK (--)
Deactivates the disk filter.

Filters topic
Activate Disk Filter function key (not highlighted)

Layer 1 Events:
Physical (layer 1) events can be blocked or passed (default).

NOTE
Commands to change filter status are prefixed with 'R' for display filters, 'C' for capture RAM filters, and 'D' for disk recording filters.

R1=NONE (--)
Blocks layer 1 events from the display.

R1=ALL (--)
Passes layer 1 events to the display.

C1=NONE (--)
Blocks layer 1 events from capture RAM.

C1=ALL (--)
Passes layer 1 events to capture RAM.

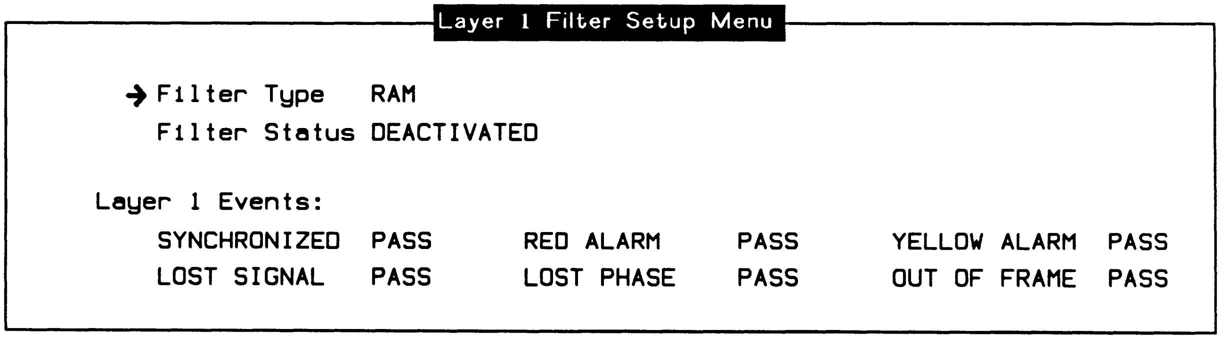
D1=NONE (--)
Blocks layer 1 events from disk.

D1=ALL (--)
Passes layer 1 events to disk.

Table 7-1 summarizes the layer 1 filter commands for the Basic Rate interface. Table 7-2 summarizes the layer 1 filter commands for the Primary Rate interface. There are no layer 1 filter commands for the WAN interface.

Description		Display	RAM	Disk
Activated	Pass	R1+ACTIVATED	C1+ACTIVATED	D1+ACTIVATED
	Block	R1-ACTIVATED	C1-ACTIVATED	D1-ACTIVATED
Deactivated	Pass	R1+DEACTIVATED	C1+DEACTIVATED	D1+DEACTIVATED
	Block	R1-DEACTIVATED	C1-DEACTIVATED	D1-DEACTIVATED
Lost Framing	Pass	R1+LSTFRM	C1+LSTFRM	D1+LSTFRM
	Block	R1-LSTFRM	C1-LSTFRM	D1-LSTFRM
Recovery	Pass	R1+RECOVERY	C1+RECOVERY	D1+RECOVERY
	Block	R1-RECOVERY	C1-RECOVERY	D1-RECOVERY
INFO 2 Error	Pass	R1+RI2ERR	C1+RI2ERR	D1+RI2ERR
	Block	R1-RI2ERR	C1-RI2ERR	D1-RI2ERR
Undefined	Pass	R1+UNDEFINED	C1+UNDEFINED	D1+UNDEFINED
	Block	R1-UNDEFINED	C1-UNDEFINED	D1-UNDEFINED

Table 7-1 Basic Rate Layer 1 Filter Commands



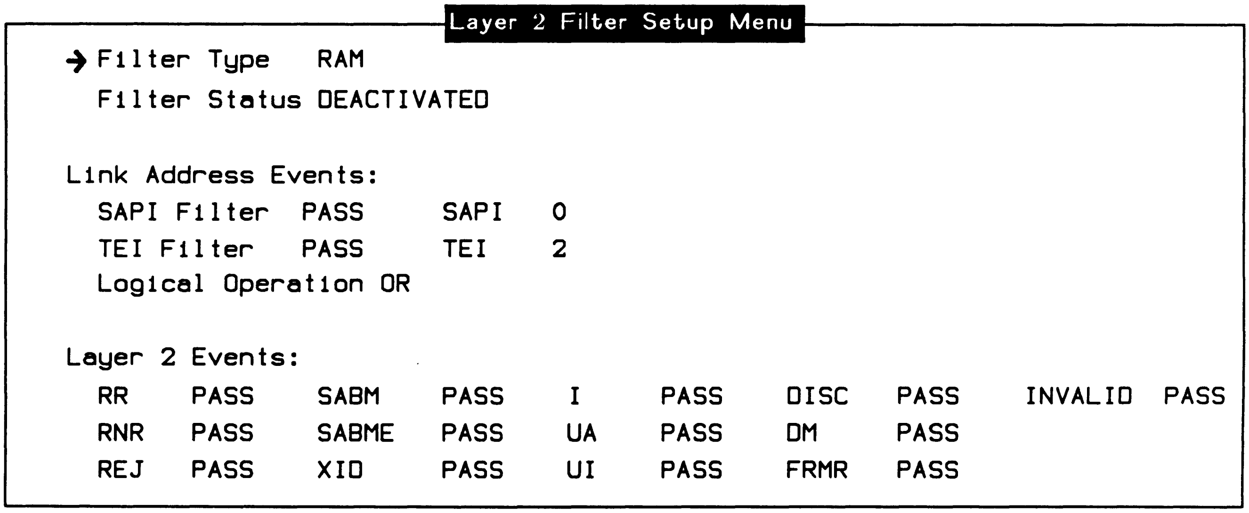
```
                       Layer 1 Filter Setup Menu

    → Filter Type   RAM
      Filter Status DEACTIVATED

  Layer 1 Events:
      SYNCHRONIZED  PASS     RED ALARM     PASS     YELLOW ALARM  PASS
      LOST SIGNAL   PASS     LOST PHASE    PASS     OUT OF FRAME  PASS
```

Figure 7-2 Layer 1 Filter Setup Menu (Primary Rate)

Description		Display	RAM	Disk
Red Alarm	Pass	R1+RED_ALARM	C1+RED_ALARM	D1+RED_ALARM
	Block	R1-RED_ALARM	C1-RED_ALARM	D1-RED_ALARM
Yellow Alarm	Pass	R1+YEL_ALARM	C1+YEL_ALARM	D1+YEL_ALARM
	Block	R1-YEL_ALARM	C1-YEL_ALARM	D1-YEL_ALARM
Lost Signal	Pass	R1+LST_SIGL	C1+LST_SIGL	D1+LST_SIGL
	Block	R1-LST_SIGL	C1-LST_SIGL	D1-LST_SIGL
Lost Phase	Pass	R1+LST_PLOCK	C1+LST_PLOCK	D1+LST_PLOCK
	Block	R1-LST_PLOCK	C1-LST_PLOCK	D1-LST_PLOCK
Synchronized	Pass	R1+NORMAL	C1+NORMAL	D1+NORMAL
	Block	R1-NORMAL	C1-NORMAL	D1-NORMAL
Out of Frame	Pass	R1+OUT_OF_FRM	C1+OUT_OF_FRM	D1+OUT_OF_FRM
	Block	R1-OUT_OF_FRM	C1-OUT_OF_FRM	D1-OUT_OF_FRM

Table 7-2 Primary Rate Layer 1 Filter Commands

7.2 Layer 2



```
                          Layer 2 Filter Setup Menu
  → Filter Type   RAM
    Filter Status DEACTIVATED

  Link Address Events:
    SAPI Filter  PASS     SAPI   0
    TEI Filter   PASS     TEI    2
    Logical Operation OR

  Layer 2 Events:
    RR     PASS     SABM     PASS     I      PASS     DISC     PASS     INVALID  PASS
    RNR    PASS     SABME    PASS     UA     PASS     DM       PASS
    REJ    PASS     XID      PASS     UI     PASS     FRMR     PASS
```

Figure 7–3 Layer 2 Filter Setup Menu

Link Address Events:
A filter condition can be set to pass or block on a specific SAPI or TEI value. The SAPI and TEI conditions can be logically combined to provide complex filtering capabilities. There are no commands available; use the function keys to set SAPI and TEI conditions.

Layer 2 Events:
Frame (layer 2) events can be blocked or passed (default).

R2=NONE (--)
Blocks layer 2 events from the display.

R2=ALL (--)
Passes layer 2 events to the display.

C2=NONE (--)
Blocks layer 2 events from capture RAM.

C2=ALL (--)
Passes layer 2 events to capture RAM.

D2=NONE (--)
Blocks layer 2 events from disk.

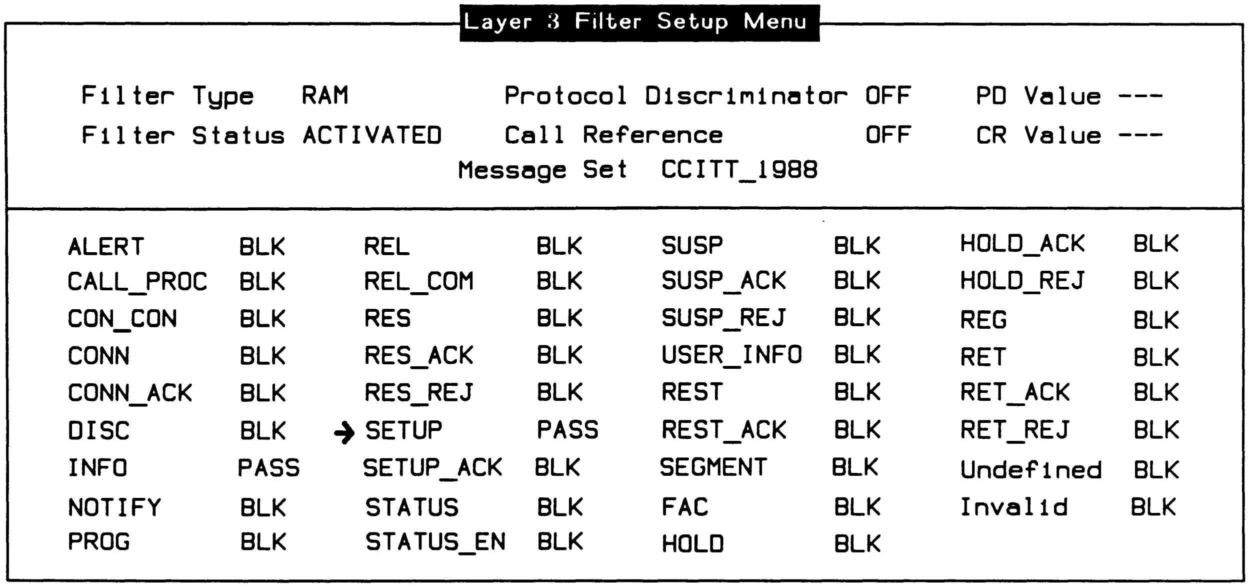
D2=ALL (--)
Passes layer 2 event reports to disk.

Table 7-3 summarizes the layer 2 filter commands.

Description		Display	RAM	Disk
Set Asynchronous Balanced Mode	Pass	R2+SABM	C2+SABM	D2+SABM
	Block	R2-SABM	C2-SABM	D2-SABM
Set Asynchronous Balance Mode Extended	Pass	R2+SABME	C2+SABME	D2+SABME
	Block	R2-SABME	C2-SABME	D2-SABME
Unnumbered Acknowledgement	Pass	R2+UA	C2+UA	D2+UA
	Block	R2-UA	C2-UA	D2-UA
Information	Pass	R2+I	C2+I	D2+I
	Block	R2-I	C2-I	D2-I
Disconnect Mode	Pass	R2+DISC	C2+DISC	D2+DISC
	Block	R2-DISC	C2-DISC	D2-DISC
Reject	Pass	R2+REJ	C2+REJ	D2+REJ
	Block	R2-REJ	C2-REJ	D2-REJ
Receive Not Ready	Pass	R2+RNR	C2+RNR	D2+RNR
	Block	R2-RNR	C2-RNR	D2-RNR
Receive Ready	Pass	R2+RR	C2+RR	D2+RR
	Block	R2-RR	C2-RR	D2-RR
Frame Reject	Pass	R2+FRMR	C2+FRMR	D2+FRMR
	Block	R2-FRMR	C2-FRMR	D2-FRMR
Disconnect Mode	Pass	R2+DM	C2+DM	D2+DM
	Block	R2-DM	C2-DM	D2-DM
Unnumbered Information	Pass	R2+UI	C2+UI	D2+UI
	Block	R2-UI	C2-UI	D2-UI
Exchange Identification	Pass	R2+XID	C2+XID	D2+XID
	Block	R2-XID	C2-XID	D2-XID
Invalid	Pass	R2+INV	C2+INV	D2+INV
	Block	R2-INV	C2-INV	D2-INV

Table 7-3 Layer 2 Filter Commands

7.3 Layer 3



```
                         Layer 3 Filter Setup Menu

 Filter Type   RAM           Protocol Discriminator OFF    PD Value ---
 Filter Status ACTIVATED     Call Reference         OFF    CR Value ---
                          Message Set  CCITT_1988

 ALERT       BLK    REL         BLK    SUSP        BLK    HOLD_ACK    BLK
 CALL_PROC   BLK    REL_COM     BLK    SUSP_ACK    BLK    HOLD_REJ    BLK
 CON_CON     BLK    RES         BLK    SUSP_REJ    BLK    REG         BLK
 CONN        BLK    RES_ACK     BLK    USER_INFO   BLK    RET         BLK
 CONN_ACK    BLK    RES_REJ     BLK    REST        BLK    RET_ACK     BLK
 DISC        BLK  → SETUP       PASS   REST_ACK    BLK    RET_REJ     BLK
 INFO        PASS   SETUP_ACK   BLK    SEGMENT     BLK    Undefined   BLK
 NOTIFY      BLK    STATUS      BLK    FAC         BLK    Invalid     BLK
 PROG        BLK    STATUS_EN   BLK    HOLD        BLK
```

Figure 7–4 Layer 3 Filter Setup Menu

→ *Protocol Discriminator*
The protocol discriminator of layer 3 messages can be filtered. The type of filter must be selected first.

F–PD (--)
Ignores the message protocol discriminator when filtering.

OFF function key

F+PD (--)
Passes data with the specified protocol discriminator.

PASS function key

=F_PD (value --)
Where: value = protocol discriminator

Specifies the protocol discriminator value. Only messages with this protocol discriminator value are passed if the protocol discriminator filter is on.

→ *Call Reference*
The call reference fields of layer 3 messages can be filtered. The type of filter must be selected first.

F−CR (--)
Ignores the message call reference when filtering.

✍ *OFF* function key

F+CR (--)
Passes data with the specified call reference.

✍ *PASS* function key

=F_CR (value --)
Where: value = call reference value

Specifies the call reference value. Only messages with this call reference value are passed if the call reference filter is on.

Layer 3 Messages
Message (layer 3) events can be blocked or passed (default). The layer 2 I frame filter must be set to pass for the layer 3 filters to have any effect.

The commands to pass or block individual messages differ from the layer 1 and layer 2 filter commands. The type of filter (display, capture RAM, or disk) must be selected first. Individual messages can then be set to pass or block for each filter.

R_FILTER (--)
Selects the display (report) filter.

C_FILTER (--)
Selects the capture RAM filter.

D_FILTER (--)
Selects the disk recording filter.

F3=NONE (--)
Blocks all layer 3 messages from passing through the selected filter.

F3=ALL (--)
Passes all layer 3 messages through the selected filter.

F−MSG (message identifier --)
Blocks the specified message from passing through the selected filter. Valid message identifiers are listed in each message set manual.

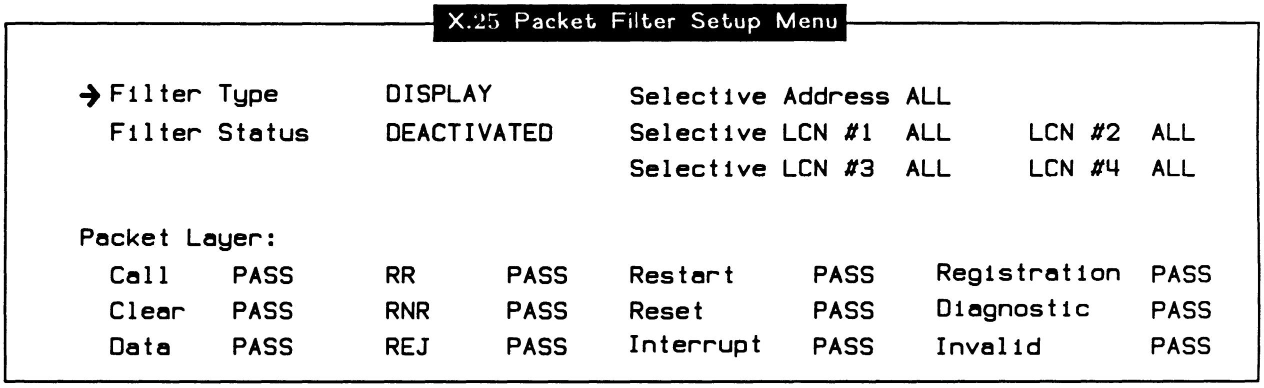
F+MSG (message identifier --)
Passes the specified message through the selected filter.

Example:
Set the display filter to pass SETUP messages only (CCITT message set).

```
R_FILTER
F3=NONE
M#SETUP   F+MSG
```

NOTE
The special message identifiers M#INVALID and M#UNDEF may be used to filter invalid or undefined messages respectively.

7.4 X.25 Layer 3



```
                          X.25 Packet Filter Setup Menu

  → Filter Type      DISPLAY        Selective Address ALL
    Filter Status    DEACTIVATED    Selective LCN #1  ALL     LCN #2  ALL
                                    Selective LCN #3  ALL     LCN #4  ALL

  Packet Layer:
    Call    PASS     RR     PASS    Restart     PASS    Registration  PASS
    Clear   PASS     RNR    PASS    Reset       PASS    Diagnostic    PASS
    Data    PASS     REJ    PASS    Interrupt   PASS    Invalid       PASS
```

→ *Selective Address*
If filters are activated and a specific address has been entered, no SAPI 16 I frames are displayed until a call request/incoming call packet with that called or calling address is received. The call request/incoming call is shown and all subsequent SAPI 16 I frames and X.25 layer 3 packets with a PASS status, received on that LCN, are displayed until a clear request/indication packet on that LCN is received. After the clear request/indication packet, no further SAPI 16 I frames are displayed until another call request/incoming call containing the specified address is received.

WARNING
If a second call request/incoming call, containing the specified called/calling address, is received on a different LCN, only traffic on the new LCN is displayed.

NOTE
If a selective address is specified, the selective LCN's cannot be used.

RTRIG_ON (--)

Activates call address filtering for display filters. All X.25 packets in SAPI 16 I frames are blocked until a call request/incoming call packet is received containing the specified address. All packets on the same LCN are then passed until a clear request/indication packet is received on the same LCN. After this packet is passed, all packets in SAPI 16 I frames are blocked again. Signalling information in SAPI 0 I frames is not affected by this filter.

→ *Filter Type*
DISPLAY function key
→ *Selective Address*
ONE function key
→ *Filter Status*
ACTIVATED function key

CTRIG_ON (--)

Activates call address filtering for capture RAM filters. See description under RTRIG_ON.

→ *Filter Type*
RAM function key
→ *Selective Address*
ONE function key
→ *Filter Status*
ACTIVATED function key

DTRIG_ON (--)

Activates call address filtering for disk filters. See description under RTRIG_ON.

→ *Filter Type*
DISK function key
→ *Selective Address*
ONE function key
→ *Filter Status*
ACTIVATED function key

RTRIG_OFF (--)

Turns off call address filtering for display filters.

→ *Filter Type*
DISPLAY function key
→ *Selective Address*
ALL function key

CTRIG_OFF (--)

Turns off call address filtering for capture RAM filters.

→ *Filter Type*
RAM function key
→ *Selective Address*
ALL function key

DTRIG_OFF (--)
Turns off call address filtering for disk filters.

→ *Filter Type*
DISK function key
→ *Selective Address*
ALL function key

R-WCALLED (-- address)
Contains a 16 byte string identifying the display selective address. The first byte of the string contains the length of the address.

Example:
Set the display filter selective address to 43042001.

```
" 43042001"                    ( Define the selective address )
COUNT 15 MIN                   ( No more than 15 characters allowed )
DUP R-WCALLED C!               ( Store count at first byte )
R-WCALLED 1+ SWAP CMOVE        ( Move characters to R-WCALLED )
RTRIG_ON                       ( Use Display selective address filter )
ACTIVATE_REPORT                ( Activate Display filter )
```

→ *Filter Type*
DISPLAY function key
→ *Selective Address*
ONE function key
→ *Filter Status*
ACTIVATED function key

NOTE
Use this variable to define a display filter selective address within a test script.

C-WCALLED (-- address)
Contains a 16 byte string that identifying the RAM filter selective address. The first byte of the string contains the length of the address. See example under R-WCALLED.

D-WCALLED (-- address)
Contains a 16 byte string that identifying the disk filter selective address. The first byte of the string contains the length of the address. See example under R-WCALLED.

→ *Selective LCN*
If display filters are activated and a specific LCN is entered, only packets that have a PASS status on that LCN are displayed. Up to four LCN's can be selected.

NOTE
Commands for display filters and selective LCN #1 are described here as an example. For a complete list of commands, see Table 7-4.

RLCN=ALL (--)
Passes packets, on all LCN's, to the display.

→ *Filter Type*
DISPLAY function key
→ *Selective LCN #1*
ALL function key

=RLCN1 (LCN value --)
Specifies the logical channel for which packets are passed to the display.

Example:
Specify logical channel number 5 for Selective LCN #1.

```
5 =RLCN1
```

→ *Filter Type*
DISPLAY function key
→ *Selective LCN #1*
Modify function key

RLCN1=SEL (--)
Passes packets to the display on the specified logical channel, as defined with the =RLCN1 command (default value is 0).

Example:
Set Selective LCN #1 to pass all packets on logical channel 20.

```
20 =RLCN1       ( Define selective LCN )
RLCN1=SEL       ( Use selective LCN#1 )
```

→ *Filter Type*
DISPLAY function key
→ *Selective LCN #1*
Select function key

RLCN1=OFF (--)
Selective LCN #1 is not used for display filters.

→ *Filter Type*
DISPLAY function key
→ *Selective LCN #1*
OFF function key

Description	Display	RAM	Disk
All LCNs passed	RLCN=ALL	CLCN=ALL	DLCN=ALL
Sets Selective LCN #1	=RLCN1	=CLCN1	=DLCN1
Uses Selective LCN #1 for filters	RLCN1=SEL	CLCN1=SEL	DLCN1=SEL
Selective LCN #1 not used for filters	RLCN1=OFF	CLCN1=OFF	DLCN1=OFF
Sets Selective LCN #2	=RLCN2	=CLCN2	=DLCN2
Uses Selective LCN #2 for filters	RLCN2=SEL	CLCN2=SEL	DLCN2=SEL
Selective LCN #2 not used for filters	RLCN2=OFF	CLCN2=OFF	DLCN2=OFF
Sets Selective LCN #3	=RLCN3	=CLCN3	=DLCN3
Uses Selective LCN #3 for filters	RLCN3=SEL	CLCN3=SEL	DLCN3=SEL
Selective LCN #3 not used for filters	RLCN3=OFF	CLCN3=OFF	DLCN3=OFF
Sets Selective LCN #4	=RLCN4	=CLCN4	=DLCN4
Uses Selective LCN #4 for filters	RLCN4=SEL	CLCN4=SEL	DLCN4=SEL
Selective LCN #4 not used for filters	RLCN4=OFF	CLCN4=OFF	DLCN4=OFF

Table 7–4 Selective Filter Commands

Packet Layer:
If display filters are activated, any packet with a PASS status is displayed unless the selective address or a selective LCN has been set to a specific value. See the description under *Selective Address* and *Selective LCN.*

NOTE
If the I frame has been blocked, a filter at the packet layer is inappropriate. This is indicated by the dashes shown beside the individual packet layer items.

NOTE
Commands for display filters and call packets are described here as an example. For a complete list of commands, see Table 7-5.

R3+CALL (--)
Passes call request/incoming call and call connected/accepted packets to the display.

→ *Filter Type*
DISPLAY function key
→ *Call*
PASS function key

R3–CALL (--)

Blocks call request/incoming call and call connected/accepted packets from the display.

✎ → *Filter Type*
DISPLAY function key
→ *Call*
BLOCK function key

R3=ALL (--)

Passes all packets (default) to the display.

✎ → *Filter Type*
DISPLAY function key
→ *Call*
ALL PACKETS function key

R3=NONE (--)

Blocks all packets from the display.

✎ → *Filter Type*
DISPLAY function key
→ *Call*
NO PACKETS function key

Description		Display	RAM	Disk
All	Pass (default)	R3=ALL	C3=ALL	D3=ALL
	Block	R3=NONE	C3=NONE	D3=NONE
Call Request Call Connect	Pass	R3+CALL	C3+CALL	D3+CALL
	Block	R3–CALL	C3–CALL	D3–CALL
Clear Request Clear Confirmation	Pass	R3+CLEAR	C3+CLEAR	D3+CLEAR
	Block	R3–CLEAR	C3–CLEAR	D3–CLEAR
Reset Request Reset Confirmation	Pass	R3+RESET	C3+RESET	D3+RESET
	Block	R3–RESET	C3–RESET	D3–RESET
Restart Request Restart Confirmation	Pass	R3+RESTART	C3+RESTART	D3+RESTART
	Block	R3–RESTART	C3–RESTART	D3–RESTART
Interrupt Interrupt Confirmation	Pass	R3+INT	C3+INT	D3+INT
	Block	R3–INT	C3–INT	D3–INT
Data	Pass	R3+DATA	C3+DATA	D3+DATA
	Block	R3–DATA	C3–DATA	D3–DATA
Receive Ready	Pass	R3+RR	C3+RR	D3+RR
	Block	R3–RR	C3–RR	D3–RR
Receive Not Ready	Pass	R3+RNR	C3+RNR	D3+RNR
	Block	R3–RNR	C3–RNR	D3–RNR
Reject	Pass	R3+REJ	C3+REJ	D3+REJ
	Block	R3–REJ	C3–REJ	D3–REJ
Registration Request Registration Confirmation	Pass	R3+REG	C3+REG	D3+REG
	Block	R3–REG	C3–REG	D3–REG
Diagnostic	Pass	R3+DIAG	C3+DIAG	D3+DIAG
	Block	R3–DIAG	C3–DIAG	D3–DIAG
Invalid	Pass	R3+INV	C3+INV	D3+INV
	Block	R3–INV	C3–INV	D3–INV

Table 7–5 X.25 Layer 3 Filter Commands

8
TRIGGERS

Triggers perform specific actions when a certain event occurs. There are four independent triggers. This section describes the commands to set the events and actions for each trigger.

8.1 Trigger Control

TR1_ON (--)
Turns on trigger 1.

✍ **Triggers** topic
Arm Trig #1 function key (highlighted)

TR2_ON (--)
Turns on trigger 2.

✍ **Triggers** topic
Arm Trig #2 function key (highlighted)

TR3_ON (--)
Turns on trigger 3.

✍ **Triggers** topic
Arm Trig #3 function key (highlighted)

TR4_ON (--)
Turns on trigger 4.

✍ **Triggers** topic
Arm Trig #4 function key (highlighted)

TR1_OFF (--)
Turns off trigger 1.

✍ **Triggers** topic
Arm Trig #1 function key (not highlighted)

TR2_OFF (--)
Turns off trigger 2.

✍ **Triggers** topic
Arm Trig #2 function key (not highlighted)

TR3_OFF (--)
Turns off trigger 3.

📝 **Triggers** topic
Arm Trig #3 function key (not highlighted)

TR4_OFF (--)
Turns off trigger 4.

📝 **Triggers** topic
Arm Trig #4 function key (not highlighted)

8.2 Trigger Conditions

A trigger must be selected before the conditions can be specified. Trigger conditions can be specified for a specific event or any combination of events.

TR1 (--)
Selects trigger 1.

TR2 (--)
Selects trigger 2.

TR3 (--)
Selects trigger 3.

TR4 (--)
Selects trigger 4.

The selected trigger can be set to trigger on events from the network, the user, or both. The trigger can also be set to trigger on data played back from capture RAM or disk.

=NET (--)
Triggers on events from the NT interface direction.

Example:
Set trigger 2 to trigger on events from the network side.

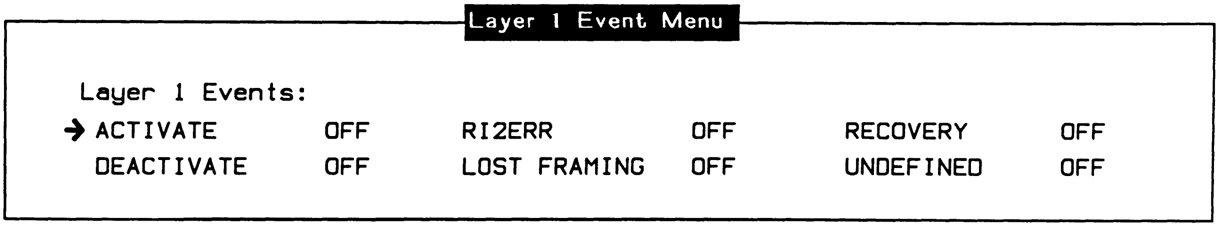
```
TR2 =NET
```

=USR (--)
Triggers on events from the TE interface direction.

=BOTH (--)
Triggers on events from both interface directions.

=PLAYBACK (--)
Triggers on events played back from capture RAM or disk.

Layer 1



```
                         Layer 1 Event Menu

  Layer 1 Events:
→ ACTIVATE      OFF    RI2ERR          OFF    RECOVERY     OFF
  DEACTIVATE    OFF    LOST FRAMING    OFF    UNDEFINED    OFF
```

Figure 8–1 Layer 1 Event Menu (Basic Rate)

There are two trigger commands associated with each layer 1 event. Commands to set the event trigger are prefixed with '+'; commands to clear the event trigger are prefixed with '–'. There are no layer 1 trigger commands for the WAN interface.

Event Type	Set Trigger	Clear Trigger
Activated	+ACTIVATED	–ACTIVATED
Deactivated	+DEACTIVATED	–DEACTIVATED
Lost Framing	+LSTFRM	–LSTFRM
Recovery	+RECOVERY	–RECOVERY
INFO 2 Error	+RI2ERR	–RI2ERR
Undefined	+UNDEFINED	–UNDEFINED

Table 8–1 Basic Rate Layer 1 Trigger Commands

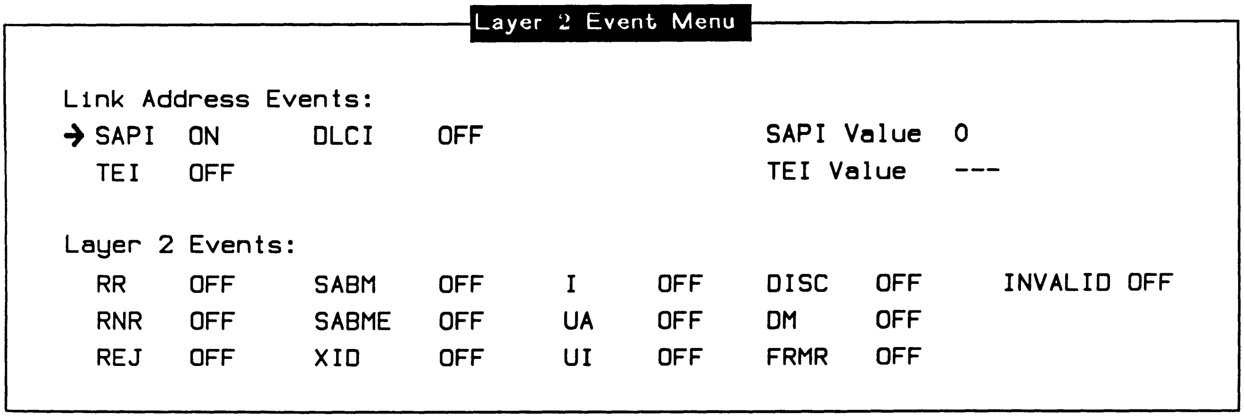
Event Type	Set Trigger	Clear Trigger
Red Alarm	+RED_ALARM	–RED_ALARM
Yellow Alarm	+YEL_ALARM	–YEL_ALARM
Lost Signal	+LST_SIGL	–LST_SIGL
Out of Frame	+OUT_OF_FRM	–OUT_OF_FRM
Lost Phase	+LST_PLOCK	–LST_PLOCK
Synchronized	+NORMAL	–NORMAL

Table 8–2 Primary Rate Layer 1 Trigger Commands

Example:
Set the conditions for trigger 3 to execute when an activation or deactivation event occurs.

```
TR3
+ACTIVATED
+DEACTIVATED
```

Layer 2



```
                              Layer 2 Event Menu

  Link Address Events:
 → SAPI   ON       DLCI      OFF                   SAPI Value  0
   TEI    OFF                                      TEI Value   ---

  Layer 2 Events:
   RR     OFF      SABM      OFF     I     OFF     DISC    OFF     INVALID OFF
   RNR    OFF      SABME     OFF     UA    OFF     DM      OFF
   REJ    OFF      XID       OFF     UI    OFF     FRMR    OFF
```

Figure 8–2 Layer 2 Event Menu

There are two trigger commands associated with each layer 2 frame. Commands to set the frame trigger are prefixed with '+'; commands to clear the frame trigger are prefixed with '–'.

Frame Type	Set Trigger	Clear Trigger
SABM	+SABM	–SABM
SABME	+SABME	–SABME
UA	+UA	–UA
I	+I	–I
DISC	+DISC	–DISC
REJ	+REJ	–REJ
RNR	+RNR	–RNR
RR	+RR	–RR
FRMR	+FRMR	–FRMR
DM	+DM	–DM
UI	+UI	–UI
XID	+XID	–XID
Invalid	+INVF	–INVF

Table 8–3 Layer 2 Trigger Commands

Additionally, the SAPI and TEI values of a frame can be set as trigger conditions.

=SAPI (SAPI value --)
Sets the value of the SAPI trigger.

+SAPI (--)
Sets the SAPI trigger.

−SAPI (--)
Clears the SAPI trigger.

=TEI (TEI value --)
Sets the value of the TEI trigger.

+TEI (--)
Sets the TEI trigger.

−TEI (--)
Clears the TEI trigger.

+DLCI (--)
Sets both SAPI and TEI triggers. The trigger is activated when both the SAPI and TEI values of the incoming frame match the values set by =SAPI and =TEI.

−DLCI (--)
Clears both SAPI and TEI triggers.

Example:
Set the conditions for trigger 4 to execute when a TEI assignment frame (SAPI 63 and TEI 127) is received.

```
TR4
63 =SAPI
127 =TEI
+DLCI
```

A specific string of characters with the received frame can be used as a trigger condition.

=STRING (string --)
Specifies the string to trigger on. The string must be defined by enclosing the text characters in quotes or enclosing hex characters in quotes with a leading 'X' character. The maximum length is 64 characters.

Example:

```
" ABC" =STRING
```

or

```
X" 0104" =STRING
```

+STRING (--)
Sets the string trigger.

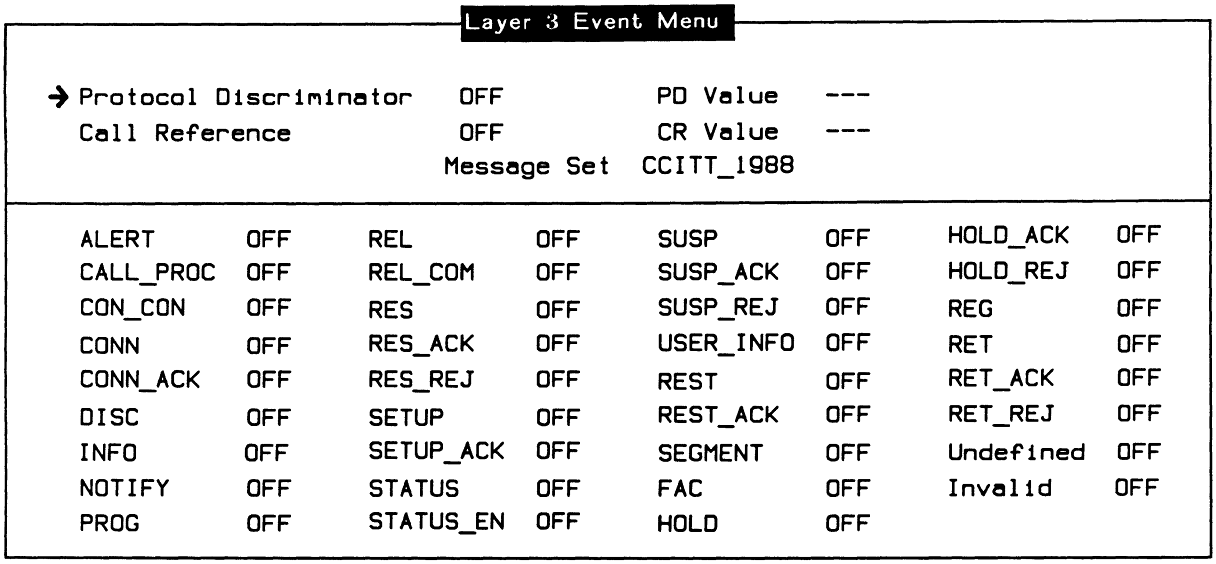
−STRING (--)
Clears the string trigger.

=MASK (string --)
Specifies the string mask. Bits are set to 0 to indicate "don't care" character positions. Each byte of the compare string and the received frame is ANDed with the corresponding byte of the string mask before they are compared.

Example:
Set the conditions for trigger 1 to execute when a valid frame with the C/R bit set to 1 is received.

```
TR1
X" 0301" =MASK          ( only compare C/R bit and EA bits of octets 1 and 2 )
X" 0201" =STRING        ( check for C/R = 1 and EA bits of 0 and 1 )
+STRING
```

Layer 3



```
                              Layer 3 Event Menu

   → Protocol Discriminator   OFF         PD Value    ---
     Call Reference           OFF         CR Value    ---
                            Message Set   CCITT_1988

     ALERT       OFF    REL         OFF    SUSP        OFF    HOLD_ACK    OFF
     CALL_PROC   OFF    REL_COM     OFF    SUSP_ACK    OFF    HOLD_REJ    OFF
     CON_CON     OFF    RES         OFF    SUSP_REJ    OFF    REG         OFF
     CONN        OFF    RES_ACK     OFF    USER_INFO   OFF    RET         OFF
     CONN_ACK    OFF    RES_REJ     OFF    REST        OFF    RET_ACK     OFF
     DISC        OFF    SETUP       OFF    REST_ACK    OFF    RET_REJ     OFF
     INFO        OFF    SETUP_ACK   OFF    SEGMENT     OFF    Undefined   OFF
     NOTIFY      OFF    STATUS      OFF    FAC         OFF    Invalid     OFF
     PROG        OFF    STATUS_EN   OFF    HOLD        OFF
```

Figure 8–3 Layer 3 Event Menu

T+MSG (message identifier --)

Sets the message trigger for the specified message. The single input parameter is a message identifier. Valid message identifiers are listed in each message set manual.

NOTE

The special message identifiers M#INVALID or M#UNDEF may be used to trigger on invalid or undefined messages respectively.

Example:
Set the conditions for trigger 2 to execute when a SETUP message is received.

```
TR2
M#SETUP   T+MSG
```

T–MSG (message identifier --)

Clears the message trigger for the specified message.

The protocol discriminator and call reference fields of layer 3 messages can be used as trigger conditions.

=T_PD (protocol discriminator value --)
Selects the protocol discriminator trigger value.

T+PD (--)
Sets the protocol discriminator trigger.

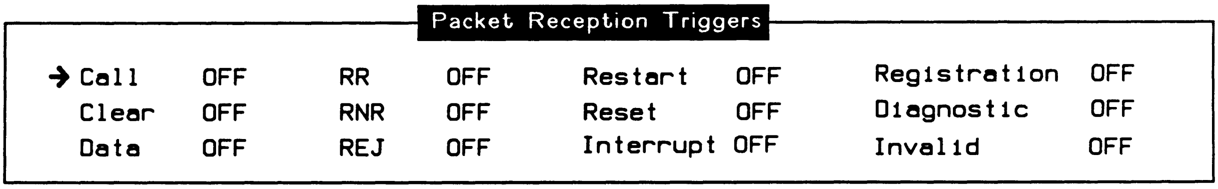
T−PD (--)
Clears the protocol discriminator trigger.

=T_CR (call reference value --)
Selects the call reference trigger value.

T+CR (--)
Sets the call reference trigger.

T−CR (--)
Clears the call reference trigger.

X.25 Layer 3



```
                         Packet Reception Triggers

 → Call   OFF     RR    OFF     Restart   OFF     Registration  OFF
   Clear  OFF     RNR   OFF     Reset     OFF     Diagnostic    OFF
   Data   OFF     REJ   OFF     Interrupt OFF     Invalid       OFF
```

Figure 8−4 Packet Reception Triggers

There are two trigger commands associated with each layer 3 frame. Commands to set the frame trigger are prefixed with '+'; commands to clear the frame trigger are prefixed with '–'.

Packet Type	Set Trigger	Clear Trigger
Call Request	+CALLR	–CALLR
Call Connect	+CALLC	–CALLC
Clear Request	+CLEARR	–CLEARR
Clear Confirmation	+CLEARC	–CLEARC
Reset Request	+RESETR	–RESETR
Reset Confirmation	+RESETC	–RESETC
Restart Request	+RESTARTR	–RESTARTR
Restart Confirmation	+RESTARTC	–RESTARTC
Interrupt	+INTR	–INTR
Interrupt Confirmation	+INTC	–INTC
Data	+DATA	–DATA
Receive Ready	+RRP	–RRP
Receive Not Ready	+RNRP	–RNRP
Reject	+REJP	–REJP
Registration Request	+REGR	–REGR
Registration Confirmation	+REGC	–REGC
Diagnostic	+DIAG	–DIAG
Invalid	+INVP	–INVP

Table 8–4 X.25 Layer 3 Trigger Commands

Other Triggers

+CAPT_FULL (--)
Sets the capture RAM trigger. The trigger is activated when the capture RAM is full.

–CAPT_FULL (--)
Clears the capture RAM trigger.

+DISK_FULL (--)
Sets the disk trigger. The trigger is activated when the disk recording file is full.

–DISK_FULL (--)
Clears the disk trigger.

=TIME (year\month\day\hour\minute --)
Specifies the time trigger values. The trigger is activated when the specified minute is reached.

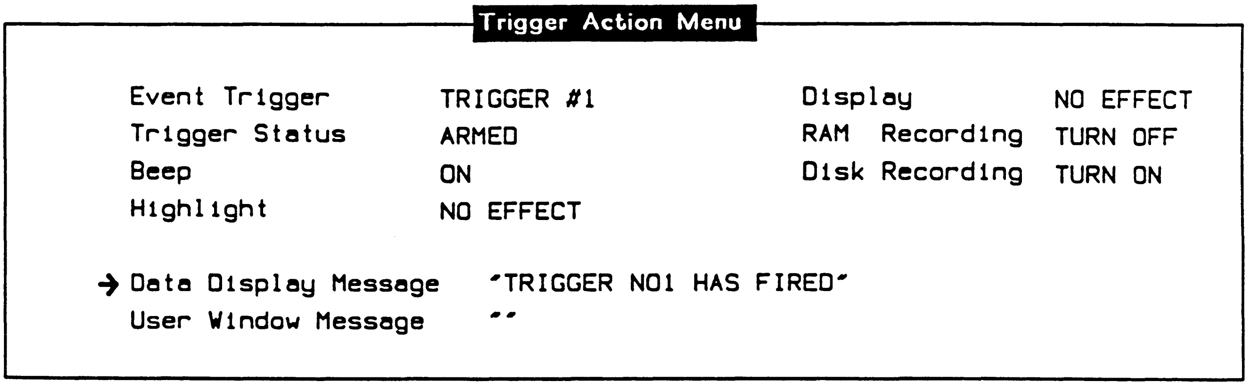
+TIME (--)
Sets the time trigger.

–TIME (--)
Clears the time trigger.

=NONE (--)
Clears all layer 1 and layer 2 triggers. Additionally, the string, time, DLCI, capture RAM, and disk triggers are each cleared.

=ALL (--)
Sets all layer 1 and layer 2 triggers.

8.3 Trigger Actions



```
                         Trigger Action Menu

      Event Trigger       TRIGGER #1          Display          NO EFFECT
      Trigger Status      ARMED               RAM  Recording   TURN OFF
      Beep                ON                  Disk Recording   TURN ON
      Highlight           NO EFFECT

    → Data Display Message   "TRIGGER NO1 HAS FIRED"
      User Window Message    ""
```

Figure 8–5 Trigger Action Menu

Trigger actions are specified by assigning commands to DOER words with the MAKE command (see the Programmer's Reference Manual for a complete description of DOER and MAKE). Each trigger has an associated DOER word for the action to execute when a trigger event occurs.

TA1 (--)
Performs the actions for trigger #1.

Example:
Set the action for trigger 1 to sound an audible alarm and start capture to RAM.

```
MAKE TA1  BEEP CAPT_ON ;
```

TA2 (--)
Performs the actions for trigger #2.

TA3 (--)
Performs the actions for trigger #3.

TA4 (--)
Performs the actions for trigger #4.

The frame or event which causes the trigger action to execute can be highlighted in the Data Display Window.

HIGHLIGHT (--)
Highlights the report in the Data Display Window.

HIGHLIGHT=RED (--)
Selects the red background color for highlighting reports.

HIGHLIGHT=BLUE (--)
Selects the blue background color for highlighting reports.

Example:
Set the action for trigger 2 to highlight the frame event.

```
MAKE TA2  HIGHLIGHT ;
```

9
LAYER 1 DECODER

Live or playback data is decoded by each protocol layer before it is displayed and before the test manager is executed. Each decoding layer stores information in a pool of variables for later use by either a test program or other parts of the application.

The layer 1 decoder decodes physical events and places them into variables for later access. These variables are set when a physical (layer 1) event occurs.

L1–ID* (-- address)
Contains an identifier for the layer 1 event. Possible values are:

Basic Rate Interface:

R#ACTIVATE	Bus activation
R#DEACTIVATE	Bus deactivation
R#LSTFRM	Lost framing
R#RECOVERY	Recovery from previous error
R#RI2ERR	Receive INFO2 frame error
R#UNDEFINED	Error undefined by CCITT

Primary Rate Interface:

R#NORMAL	Synchronized signal
R#REDALM	Red alarm
R#YELALM	Yellow alarm
R#LSTSIGL	Lost signal
R#LSTPLOCK	Lost phase
R#OOFALM	Out of frame

BLOCK–COUNT (-- address)
Contains the block sequence number for the layer 1 event. Every received layer 1 event is assigned a unique sequence number. BLOCK–COUNT initially contains 0 and is incremented by one each time a layer 1 event is decoded.

PORT–ID (-- address)
Contains a 2 byte value identifying the received direction for the layer event. The lower byte indicates the network (hex value 08) or user (hex value 20) receive stream. The upper byte indicates the application processor that received the frame.

START–TIME (-- address)
Contains the 48 bit timestamp when the layer 1 event occurred. Use with the GET_TSTAMP_MILLI or GET_TSTAMP_MICRO commands. See the Programmer's Reference Manual.

10
LAYER 2 DECODER

The layer 2 decoder decodes data link layer events and places them into variables for later access. These variables are set each time a layer 2 frame is received.

L2–POINTER (-- address)
Contains the pointer to the memory address (first byte) in the received frame.

L2–LENGTH (-- address)
Contains the length of the received frame. This does not include the FCS (frame check sequence) bytes.

PORT–ID (-- address)
Contains a 2 byte value identifying the received direction for data. The lower byte indicates the network (hex value 08) or user (hex value 20) receive stream. The upper byte indicates the application processor that received the frame.

BLOCK–COUNT (-- address)
Contains the block sequence number for live data. Every received frame is assigned a unique sequence number. BLOCK-COUNT contains 0 and is incremented by one each time a new block is received.

START–TIME (-- address)
Contains the 48 bit start of frame timestamp. Use with the GET_TSTAMP_MILLI or GET_TSTAMP_MICRO commands. See the Programmer's Reference Manual.

END–TIME (-- address)
Contains the 48 bit end of frame timestamp. Use with the GET_TSTAMP_MILLI or GET_TSTAMP_MICRO commands.

MADDR1* (-- address)
Contains the first byte of the address field (octet 2) of the frame.

MADDR2* (-- address)
Contains the second byte of the address field (octet 3) of the frame.

MCONTROL1* (-- address)
Contains the first byte of the control field (octet 4) of the frame.

MCONTROL2* (-- address)
Contains the second byte of the control field (octet 5) of the frame. This byte is only present for frames received in modulus 128 operation.

MSAPI* (-- address)
Contains the SAPI value of the frame. Valid values are 0 through 63.

MTEI* (-- address)
Contains the TEI value of the frame. Valid values are 0 through 127.

MC/R–BIT* (-- address)
Contains the command/response bit value of the frame.

CMND/RESP* (-- address)
Contains a 1 for command frames, and 0 for response frames.

MP/F–BIT* (-- address)
Contains the poll/final bit value of the frame.

MNR* (-- address)
Contains the N(R) receive sequence number of the frame.

MNS* (-- address)
Contains the N(S) send sequence number of the frame.

MMODE–FLAG* (-- address)
Contains a 0 for frame modulo 8, and 1 for frame modulo 128. MMODE–FLAG* is set to 0 when a SABM is decoded, and 1 when a SABME is decoded.

FRAME–ID (-- address)
Contains the frame identifier for the last decoded frame. Possible values are:

Frame Identifiers	Description
R#SABM	Set asynchronous balanced mode frame
R#SABME	Set asynchronous balanced mode extended frame
R#I	Information frame
R#UI	Unnumbered information frame
R#RR	Receive ready frame
R#RNR	Receive not ready frame
R#REJ	Reject frame
R#DISC	Disconnect frame
R#UA	Unnumbered acknowledgement frame
R#FRMR	Frame reject frame
R#DM	Disconnected mode frame
R#XID	XID frame
R#INVFRM	Invalid frame
R#INVCRC	Invalid CRC in received frame
R#SHORTFRM	Short frame

STATUS_ERR? (-- flag)
Returns true if any error occurred in the last received frame. The following commands can be used to detect specific errors.

Command	Error Type
CRC_ERR?	CRC error
ABORT_ERR?	Aborted frame
OVERRUN_ERR?	Receiver overrn
SHORT_FRM_ERR?	Frame is shorter than 4 bytes (including 2 CRC bytes)
CTRL_BYTE_ERR?	Invalid control byte(s)
ADDR_BYTE_ERR?	Invalid address byte(s)
LENGTH_ERR?	Invalid frame length
XID_INFO_ERR?	Invalid information field in XID frame
FRMR_INFO_ERR?	Invalid information field in FRMR frame

10.1 FRMR Frames

The following variables can be set when an FRMR frame is decoded.

FRMR-CNTL1* (-- address)
Contains the first byte of the control field (octet 5) of the FRMR information field.

FRMR-CNTL2* (-- address)
Contains the second byte of the control field (octet 6) of the FRMR information field.

FRMR-VR* (-- address)
Contains the value of the V(R) state variable field of the FRMR information field.

FRMR-VS* (-- address)
Contains the value of the V(S) state variable field of the FRMR information field.

FRMR-C/R-BIT* (-- address)
Contains the value of the C/R bit of the FRMR information field.

FRMR-W-BIT* (-- address)
Contains the value of the W bit of the FRMR information field.

FRMR-X-BIT* (-- address)
Contains the value of the X bit of the FRMR information field.

FRMR-Y-BIT* (-- address)
Contains the value of the Y bit of the FRMR information field.

FRMR-Z-BIT* (-- address)
Contains the value of the Z bit of the FRMR information field.

10.2 UI Frames

The following variables are set when a UI frame is decoded.

UI-TYPE* (-- address)
Contains the UI frame identifier. Possible values are:

TEI-ASSIGN#	SAPI = 63 and TEI = 127
MDL-UNIT-DATA#	SAPI = 63 and TEI ≠ 127
DL-UNIT-DATA#	SAPI ≠ 63

MANAGEMENT-ID* (-- address)
Contains the management entity identifier of the TEI assignment UI frame.

RI* (-- address)
Contains the reference number of the TEI assignment UI frame.

MESSAGE-TYPE* (-- address)
Contains the message type of the TEI assignment UI frame. Possible values are:

ID-REQ#	Identity request
ID-ASSGN#	Identity assigned
ID-DENIED#	Identity denied
ID-CHK-REQ#	Identity check request
ID-CHK-RESP#	Identity check response
ID-REMOVE#	Identity remove
ID-VERIFY#	Identity verify

AI* (-- address)
Contains the action indicator of the TEI assignment UI frame.

10.3 XID Frames

The following variables are set when an XID frame is decoded.

XID-TX-N201* (-- address)
Contains the value of the transmit N201 field of the XID frame.

XID-RX-N201* (-- address)
Contains the value of the receive N201 field of the XID frame.

XID-K* (-- address)
Contains the value of the transmit window size field of the XID frame.

XID-T200* (-- address)
Contains the value of the retransmission timer field of the XID frame.

11
LAYER 3 DECODER

The layer 3 message decoder disassembles signalling messages and stores the decoded protocol information into variables. This protocol information includes the protocol discriminator, call reference, message type, and all parameters contained in each information element within the received message.

Messages can contain information elements, some of which are mandatory and others which are optional or not allowed. The sequence of information elements for a particular codeset is pre-defined but can be interspersed with information elements from other codesets. Furthermore, multiple information elements of the same type can occur in a message and can have a variable structure depending on inclusion or exclusion of particular octets. To simplify the method by which this information is obtained, the layer 3 decoder provides functions to determine:

- if all mandatory information elements are present within a message;
- if any optional information elements are present within a message;
- if any unexpected information elements are present within a message;
- if all information elements occur in the correct order within the message;
- how often a particular information element occurs within a message;
- if it is possible to decode the n^{th} occurrence of an information element;
- if a particular octet was present in the information element; and
- the type of error that occurred while decoding the information element.

The decoded value for each field of every information element can be accessed by a unique identifier. Additionally, the layer 3 decoder uses pre-defined constants to identify particular information element field values. These field identifiers and constants are unique for each message set.

11.1 Variables

The following variables contain layer 3 information for the received message.

L3-POINTER (-- address)
Contains the memory address of the first byte in the received message.

L3-LENGTH (-- address)
Contains the length of the received message.

$MSG-ERROR (-- address)
Contains an error code identifying the error that occurred when decoding the last received message. It can be one of the following defined constants:

NO-ERROR#	No error was detected
SHORT-MSG#	Received message was too short. Each message header must have a protocol discriminator, call reference, and message type field
INV-DISCR#	Unknown protocol discriminator
INV-CALLREF#	Call reference has invalid format
SHIFT-ERR#	Shift IE after non-locking shift detected
RANGE-ERR#	Information element exceeds message range
NO-MSG#	No message received. The value of L3-LENGTH is zero

NOTE
Depending on the value of $MSG-ERROR, not all decoder variables contain valid information (i.e. when the protocol discriminator is unknown, there is no valid entry in $MSG-TYPE).

$MSG-DISCR (-- address)
Contains the protocol discriminator value of the received message.

$MSG-CRLEN (-- address)
Contains the call reference length of the received message.

$MSG-CRFLAG (-- address)
Contains the call reference flag of the received message. Possible values are #ORIG (0) and #DEST (1).

$MSG-CRVALUE (-- address)
Contains the call reference value of the received message.

$MSG-ID (-- address)
Contains the message identifier of the received message. A complete list of possible message identifiers is given in the appropriate message set manual.

NOTE
This value is different from the message type. The message identifier is a constant that uniquely identifies the message; the message type is the actual value that appears in the message header.

$MSG-TYPE (-- address)
Contains the message type of the received message. This is the actual bit value of the received message.

11.2 Commands

The following commands determine the type and content of received layer 3 messages.

?L3_MSG (message identifier -- flag)

Returns true if the specified message is received. The message is identified by a symbolic name or by one of three special identifiers:

M#ANY	Any message
M#INVALID	Invalid message
M#UNDEF	Undefined message

Example:
Check for the reception of a PROGRESS message (CCITT message set).

```
...
M#PROGRESS ?L3_MSG
ACTION[
      < perform action required if PROGRESS message received >
      ....
]ACTION
```

?L3_VALID_MSG (message identifier -- flag)

Returns true if the specified message was the last one received and was coded correctly. A message is accepted as correctly coded if the order of information elements is correct, no mandatory IE's are missing, no unexpected IE's are present, and the message type is valid for the received direction.

NOTE
The special message identifiers M#ANY, M#INVALID, and M#UNDEF may only be used with the ?L3_MSG and ?L3_VALID_MSG commands. M#ANY is used as a 'wildcard' value for any message with a valid message header.

?L3_MATCH (string -- flag)

Returns true if the user-defined key string is found in the layer 3 message.

This is an *anchored* match, i.e. a byte-for-byte match starting at the first byte of the received message.

NOTE
To accommodate "don't care" character positions, the question mark character for ASCII or hex 3F character can be used. The received message can be longer than the specified key string.

Example:
Format for string matching within messages.

```
" key string" ?L3_MATCH
ACTION[
      .
      < action to be taken if string matches >
      .
]ACTION
```

?L3_SEARCH (string -- flag)
Returns true if the user-defined key string is found in the layer 3 message.

This is an *unanchored* match, i.e. searches for an exact match anywhere in the received message regardless of the position.

?L3_IE_ORDER (-- flag)
Returns true if all information elements occur in correct order within the received message. If multiple IE's of the one type occur within the message, they must be grouped together.

?L3_MAND_IE (message identifier -- flag)
Returns true if all mandatory information elements were found for the specified message.

?L3_OPT_IE (message identifier -- flag)
Returns true if at least one optional information element was found for the specified message type.

?L3_UNEXP_IE (message identifier -- flag)
Returns true if at least one unexpected information element was found for the specified message type. An information element is considered to be unexpected when it is neither mandatory nor optional, or when it is mandatory or optional but illegally occurs multiple times within a message.

Example:
Check IE occurrences within a received message.

```
M#SETUP ?L3_UNEXP_IE          ( Check for unexpected IEs )
?L3_IE_ORDER 0= OR            ( Or wrong sequence of IEs )
IF
   < handle Setup message containing unexpected or badly placed IEs >
ELSE
   M#SETUP ?L3_MAND_IE 0=     ( Check for missing mandatory IEs )
   IF
      < handle Setup message with missing mandatory IEs >
   ELSE
      < handle Setup message with all required IEs >
      M#SETUP ?L3_OPT_IE      ( Check for optional IEs )
      IF
         < handle optional IEs of Setup message >
      ENDIF
   ENDIF
ENDIF
```

NOTE
Shift IE's are not considered to be unexpected.

?L3_MAND_ERROR (message identifier -- flag)
Returns true if there was an error in one of the mandatory IE's for the specified message.

?L3_OPT_ERROR (message identifier -- flag)
Returns true if there was an error in one of the optional IE's for the specified message.

?L3_MSG_DIR (message identifier -- flag)
Returns true if the specified message was received in the correct direction (user -> network or network ->user).

?L3_IECOUNT (IE identifier -- count)
Returns the number of times the specified information element was found in the received message.

Example:
Check the presence of the Bearer Capability IE (CCITT message set).

```
I#BEARER_CAP ?L3_IECOUNT 0=
IF
   < Bearer Capability IE was not present in message >
ELSE
   < Process Bearer Capability IE >
ENDIF
```

?L3_IE (IE identifier\n -- flag)
Returns true if the specified information element occurs at least 'n' times in the message. If present, the n^th occurrence of the IE is decoded for later access of parameter values.

Example:
Decode the third Cause IE.

```
I#CAUSE 3 ?L3_IE
IF
   < perform action required if 3rd CAUSE information element found >
ELSE
   < perform action required if 3rd CAUSE information element not found >
ENDIF
```

NOTE
?L3_IE must be used before parameter values of an information element can be accessed.

?L3_IE_ERROR (IE identifier -- code)

Returns an error code indicating which error occurred while decoding the specified information element. Possible values are:

NO-IE-ERROR#	No error occurred
IE-EMPTY#	IE length is zero
IE-TOO-SHORT#	IE content is too short
IE-TOO-LONG#	IE content is too long
UNEXP-EXTEND#	Expected extension bit was not set
EXP-EXTEND#	Unexpected extension bit
PARAM-WRONG-LEN#	String parameter exceeds maximum length

?L3_OCTET (IE identifier \ octet identifier -- n)

Returns the number of times the specified octet occurred within the specified information element. For octets that do not repeat in an information element, this value will be 0 or 1. Valid octet identifiers for the 1988 CCITT Blue Book message set are listed below:

OCTET_3 **OCTET_3A** **OCTET_3B** **OCTET_3.1** **OCTET_3.2**
OCTET_3.3 **OCTET_4** **OCTET_4A** **OCTET_4B** **OCTET_5**
OCTET_5A **OCTET_5B** **OCTET_5C** **OCTET_5D** **OCTET_6**
OCTET_6A **OCTET_7** **OCTET_7A** **OCTET_8**

Example:
Check if octet 4b is present in BEARER_CAP.

```
I#BEARER_CAP OCTET_4B ?L3_OCTET
IF
   < process Symmetry and Transfer Rate field values >
ENDIF
```

NOTE
?L3_OCTET must be used to verify the presence of the specified octet(s) before parameter values can be accessed.

Example:
Access the parameters in the Cause IE (CCITT message set).

```
I#CAUSE ?L3_IECOUNT                ( Check if cause IE is present )
IF
   I#CAUSE 1 ?L3_IE                ( If yes, decode first occurrence )
   IF
      *DEC ->C_LOCATION @          ( Process location code )
      ...
      I#CAUSE OCTET_3A ?L3_OCTET   ( Check if octet 3a was included )
      IF
         *DEC ->C_RECOMMENDATION @ ( Process recommendation parameter )
         ...
      ENDIF
      *DEC ->C_CAUSE_VALUE @       ( Process cause value )
      ...
   ELSE
      < handle decoding error >
   ENDIF
ELSE
   < handle absence of Cause information element >
ENDIF
```

***DEC** (-- address)

Returns the base address of the decoder parameter structure. *DEC is used in conjunction with the parameter selector commands to access the decoded parameter values.

The parameter value may be compared to one of several pre-defined constants defined for that parameter field. Some parameter fields represent string values. These strings can be printed out using the standard output commands or copied to other buffers. See the Strings section in the Programmer's Reference Manual for more information.

Selector commands and pre-defined constants are unique for each message set. See the corresponding ISDN Message Sets Reference Manual or Section 14 of this manual for more information.

Example 1:
Determine the B-Channel allocated to a voice call, as specified within the Channel ID information element, for a CCITT message. This example uses identifiers from the CCITT message set.

```
*DEC ->CID_INFO_CHAN_SEL  @              ( Get constant value )
DOCASE
      CASE #NO_CHANNEL
      {
          T." No channel is available"  TCR
      }
      CASE #B1_CHANNEL
      {
          T." Channel number 1 selected"  TCR
      }
      CASE #B2_CHANNEL
      {
          T." Channel number 2 selected"  TCR
      }
      CASE DUP
      {
          T." Channel not explicitly identified"  TCR
      }
ENDCASE
```

Example 2:
Print the value of the calling number.

```
T." The number is: "
*DEC ->CLGN_NUMBER COUNT T.TYPE  TCR
```

NOTE
?L3_IE must be used to decode the information element before parameter values can be accessed. Also, it must be used to verify the presence of the specified octet(s) before parameter values can be accessed.

Some octets in certain IE's can be repeated. The parameter values for these octets are stored in an array and must be accessed with the [ ] command.

Example:
Print the feature status values from the Feature Indication IE in the AT&T 5E6 message set.

```
OCTET_5 ?L3_OCTET 2 =
IF
    *DEC ->FI_STATUS 1 [] @ T.
    *DEC ->FI_STATUS 2 [] @ T.
ENDIF
```

NOTE
The array index for repeated parameter values starts at 1. The following expressions are identical for accessing the first value in the array:
**DEC ->FI_STATUS or *DEC ->FI_STATUS 1 [] @.*

12
X.25 LAYER 3 DECODER

Monitored layer 3 information in SAPI 16 I frames is decoded as X.25 layer 3 information. This decoding is applicable only to Basic Rate applications.

The layer 3 decode operation saves information concerning a packet's logical group and channel number, Q and D bits, packet identifier, and fields pertinent to specific packets. The pointer to and the length of the data field is determined for data packets.

M–GFI (-- address)
Contains the GFI (general format identifier) value of the received packet. Valid values are 1 for packet modulo 8, and 2 for a packet modulo 128. These are bits 5 through 8 of the first packet octet.

M–Q (-- address)
Contains the Q (qualifier) bit of a received data packet (0 or 1). This is bit 8 of the first data packet octet.

M–D (-- address)
Contains the D (delivery confirmation) bit of a received data packet, call request/incoming call, or call accepted/confirmed packet (0 or 1). This is bit 7 of the first packet octet.

M–LCG (-- address)
Contains the logical group number of the received packet. Valid values are 0 through 15. These are bits 1 through 4 of the first packet octet.

M–LCB (-- address)
Contains the logical channel number of the received packet. Valid values are 0 through 255. This is the second packet octet.

M–LCN (-- address)
Contains the combined logical group identifier and logical channel number of the received packet. Valid values are 0 through 4095. These are bits 1 through 4 of the first packet octet and all bits of the second packet octet.

M–REC–PKT–ID (-- address)
Contains the packet type identifier. This is the third packet octet. See Table B–2 for possible values.

M–RCAUSE (-- address)
Contains the cause byte. Valid values are 0 through 255. This is octet 4 of the following packets:

- Clear request/indication
- Reset request/indication
- Restart request/indication

M-RDIAG (-- address)
Contains the diagnostic byte of the received packet. Valid values are 0 through 255. This is octet 5 of the following packets:

- Clear request/indication
- Reset request/indication
- Restart request/indication

M-MORE (-- address)
Contains the more bit of a received data packet (0 or 1). Bit 5 of the third octet of data packet for modulo 8, and bit 1 of the fourth octet of data packet for modulo 128.

M-PS (-- address)
Contains the P(S) (send sequence) count of the received packet. Valid values are 0 through 7 for packet modulo 8, and 0 through 127 for packet modulo 128. The P(S) counts are bits 2 through 4 of the third octet of data packet for modulo 8, and bits 2 through 8 of the third octet of data packet for modulo 128.

M-PR (-- address)
Contains the P(R) (received sequence) count of the received packet. Valid values are 0 through 7 for packet modulo 8, and 0 through 127 for packet modulo 128. The P(R) counts are bits 6 through 8 of the third octet of data, RR, RNR, and REJ packets for modulo 8, and bits 2 through 8 of the fourth octet of data, RR, RNR, and REJ packets for modulo 128.

DATA-POINTER (-- address)
Contains the pointer to the first character of the data field in any layer 4 or user data present in a data packet.

DATA-LENGTH (-- address)
Contains the length of the data field in a received data packet.

M-RCALLED (-- address)
Contains a 16 byte string identifying the called address field of the received packet. See M-RCALLING for an example; string contents and handling are similar.

M-RCALLING (-- address)

Contains a 16 byte string identifying the calling address field of the received packet.

Example:
Check whether the CALLING number of the last received call request packet matches a pre-defined number: 43042001. The ?MATCH command is used to determine if the calling address in a received call request packet matches the defined address.

```
TCLR

#IFNOTDEF MATCH-CALL
      0  VARIABLE MATCH-CALL  12  ALLOT
#ENDIF                  ( MATCH-CALL will contain the desired calling address )

0 STATE_INIT{
      " 43042001"
      COUNT                 ( Obtain # of digits in calling address )
      15 MIN                ( Set maximum to 15 digits )
      DUP  MATCH-CALL  C!   ( Write # of digits to first byte of matching string )
      MATCH-CALL 1  +  SWAP CMOVE     ( Write calling address in matching string )
  }STATE_INIT

0 STATE{
      R*CALLREQ 1 ?RX
      ACTION{
          M-RCALLING        ( Get this calling address )
          COUNT             ( Get # of digits in this calling address )
          MATCH-CALL        ( Get desired matching address )
          ?MATCH            ( Compare addresses )
          IF
              BEEP          ( Notify user )
              T." Address Match has occurred."  TCR
          ENDIF
      }ACTION
  }STATE
```

M-RFAC (-- address)

Contains a 128 byte string identifying the facility field of the last received call request/incoming call, call accept/connect, clear request/indication, or clear confirmation packet.

The first byte of this string contains the length of the facility field. Valid values are 0 through 63 for 1980, and 0 through 109 for 1984.

Example:
The tester receives a call request packet with a facility field that contains eight characters, i.e. the hex characters 02AA420808430303.

Obtain the length of the facility field (8 in this case).

```
M-RFAC C@
```

Obtain the first octet of the first facility (hex 02 in this case). This indicates:

- the first facility is a Class A facility, i.e. it is followed by a single octet parameter field; and
- the first facility is throughput class negotiation.

```
M-RFAC 1 + C@
```

Obtain the throughput class octet (hex AA in this case). This indicates that the throughput class for the called DTE and calling DTE is 9600 bits.

```
M-RFAC 2 + C@
```

Obtain the first octet of the second facility (hex 42 in this case). This indicates:

- the second facility is a Class B facility, i.e. it is followed by a 2 octet parameter field; and
- the second facility is packet size.

```
M-RFAC 3 + C@
```

Obtain the packet size for the called DTE (hex 08 in this case). This indicates a packet size of 256.

```
M-RFAC 4 + C@
```

Obtain the packet size for the calling DTE (hex 08 in this case). This indicates a packet size of 256.

```
M-RFAC 5 + C@
```

Obtain the first octet of the third facility (hex 43 in this case). This indicates:

- the third facility is a Class B facility, i.e. it is followed by a 2 octet parameter field; and
- the third facility is window size.

```
M-RFAC 6 + C@
```

Obtain the window size of the called DTE (hex 03 in this case). This indicates a window size of 3.

```
M-RFAC 7 + C@
```

Obtain the window size of the calling DTE (hex 03 in this case). This indicates a window size of 3.

```
M-RFAC 8 + C@
```

NOTE
Refer to CCITT X.25 (1984) Recommendation, Section 7, formats for facility fields and registration fields for further information on decoding facilities.

M–RCUD (-- address)
Contains a 256 byte string identifying the call user data of the received packet. Valid values are 0 through 128 if fast select facility is selected, and 0 through 16 if not selected.

Example:
The tester receives a call request packet with a call user field that contains eleven characters, i.e. the hex characters C000000003010025800064. M–RCUD can be used to obtain the following information.

Obtain the length of the call user data field (11 in this case).

```
M-RCUD C@
```

If the call user data field is present, its use and format are determined by bits 7 and 8 of the first octet.

```
M-RCUD 1 + C@
```

NOTE
Refer to CCITT 1984 Recommendation X.244 for further information on call user data.

13
MESSAGE SETS

A variety of message sets can be used for layer 3 message decoding and building (transmission). Message sets contain identifiers for defined message types and information elements. Additionally, selector words for each parameter field, and pre-defined constants for each parameter value are contained in the message set.

Message sets are stored in binary files unique for each application and are automatically suffixed with filename extensions. Tables 13-1 and 13-2 list the extensions for monitor and emulation, respectively, depending on the application processor and machine configuration.

Customized message sets can be created with MDL (Message Description Language) and saved to binary files for future use. Refer to the ISDN MDL Programmer's Manual for more information.

	WAN	WAN/WAN	BRA/WAN	PRA	PRA/BRA /WAN	BRA/BRA	PRA/WAN
AP #1	Mm1	Mm1	Mm1	Mm3	Mm1		Mm1
AP #2		Mm2		Mm4			Mm3
AP #3			Mm7		Mm7	Mm7	Mm4
AP #4					Mm3		
AP #5					Mm4		
AP #6						Mm5	

Table 13-1 Message Set Filename Extensions - Monitor Applications

	WAN	WAN/WAN	BRA/WAN	PRA	PRA/BRA /WAN	BRA/BRA	PRA/WAN
AP #1	Me1	Me1	Me1	Me3	Me1		Me1
AP #2		Me2		Me4			Me3
AP #3			Me7		Me7	Me7	Me4
AP #4					Me3		
AP #5					Me4		
AP #6						Me5	

Table 13-2 Message Set Filename Extensions - Emulation Applications

Example:
The filename for the CCITT_1988 message set for the ISDN Monitor application for AP#3 of a BRA/WAN tester is CCITT_1988.Mm7.

Use LOAD_MESSAGE_SET at the beginning of a layer 3 simulation test script to ensure the correct message set is loaded before the remainder of the test script is compiled.

LOAD_MESSAGE_SET (string --)

Loads the specified message set from disk. If not found, the error message 'could not be located on any drive' will be displayed.

Example:

```
TCLR
" ATT_5E6" LOAD_MESSAGE_SET
```

NOTE

Do not specify the filename extension in the string.

MCLR (--)

Clears the current message set from memory.

14
CCITT_1988
CCITT Q.931/I.451 Network Layer, Blue Book (1988)
R01

The CCITT message set is implemented in accordance with: CCITT Recommendations Q.931 and Q.932 as described in the Volume VI - Fascicle VI.11 Blue Book (Nov. 1988).

The CCITT (1988) Message Set is the default message set loaded when the application starts, and contains unique identifiers which can be used in ISDN test scripts to reference received and transmitted messages. These identifiers are divided into three categories:

- Message Type Identifiers
- Information Element Identifiers
- Information Element Structures (including parameter field selectors and associated field values constants)

The message set name (eg. CCITT_1988), description, and release number (as indicated above) uniquely identify the message set variation. The message set name is used with the LOAD_MESSAGE_SET command or the *Load Message Set* function key under the **MessageSet** topic. This name is also displayed on various menus and is used to identify the message set variation when layer 3 complete report format is selected.

The next three sections provide some examples illustrating the use of each of these types of identifiers. The remaining sections contain:

- message identifiers;
- IE identifiers; and
- IE structures.

14.1 Using Message Identifiers

Message identifiers uniquely identify a message type in both received and transmitted messages, and are expressed in the following form:

M#xxxx (eg. M#SETUP)

In addition, the following default identifiers (specific received messages only) are also included with each message set:

- M#ANY (any valid message)
- M#INVALID (an invalid message)
- M#UNDEF (an unknown/undefined message type)

Example 1:
After receiving a Setup message, perform an action (eg. send a Setup Acknowledge response, increment a counter, etc.).

```
M#SETUP ?L3_MSG
ACTION{
      ( code specifying action taken if Setup message received )
}ACTION
```

Example 2:
Send an Alert message in an I frame complete with desired information elements.

```
M#ALERT MESSAGE>
      I#DISPLAY
      I#SIGNAL
<SEND
```

Message identifiers can also be used for filter/trigger management from within a script.

Example 3:
Set the display/report filter to only pass Setup and Connect messages.

```
R_FILTER            ( Select the display filter )
F3=NONE             ( Block all message types )
M#SETUP  F+MSG      ( Pass Setup messages )
M#CONN   F+MSG      ( Pass Connect messages )
```

14.2 Using IE Identifiers

IE identifiers uniquely identify an information element in both received and transmitted messages, and are expressed in the following form:

I#xxxx (eg. I#CAUSE)

Example 1:
Determine if the Cause IE appears in the last received message at least once.

```
I#CAUSE 1 ?L3_IE
IF
      ( code specifying action taken if the first Cause IE is found )
ELSE
      ( code specifying action taken if the first Cause IE is not found;
        ie: none present )
ENDIF
```

Example 2:
Prepare a Cause IE for later inclusion and transmission within a message.

```
I#CAUSE ELEMENT>
      ALL_EXCLUDED
      OCTET_3 INCLUDED
      OCTET_4 INCLUDED
      OCTET_5 INCLUDED
<ELEMENT
```

Also in this group are octet identifiers which uniquely identify an octet number that can be used for any IE that contains that octet number. Octet identifiers are used in both received and transmitted messages and are expressed in the following form:

OCTET_xx (eg. OCTET_3.1)

Example 1:
Determine if Octet 3A is present in the Cause IE of the latest message received.

```
I#CAUSE OCTET_3A ?L3_OCTET
IF
    ( code specifying action taken if the octet is present;
      ie: process the specified Recommendation )
ENDIF
```

14.3 Using IE Structures

Information element structures consist of the information element parameter field selectors and the associated field value identifiers.

The parameter field selectors are expressed in the following form:

->xxx_yyyy (eg. ->BC_CODING_STANDARD)

where: xxx = the information element associated with that parameter field (eg: Bearer Capability)
yyyy = the parameter field (either a string or a bit field)

The field value identifiers are expressed in the following form:

#xxxxx (eg. #INTERNATIONAL = 0b00000001)

All parameter field selectors are used with the *DEC and *COD structure indicators. *DEC provides the base address of the decoder parameter structure. When used with a field selector, decoded parameter values can be accessed. *COD complements *DEC and provides the base address of the coder parameter structure for the current connection. The contents of specific parameter fields can then be changed prior to transmission.

Example 1:
Depending on the contents of the received Bearer Capability Coding Standard parameter field (Octet 3, 2 bits), perform one of two different actions.

```
*DEC ->BC_CODING_STANDARD @      ( Obtain the received value )
#CCITT =                         ( Compare with identifier )
IF
      T." Coding Standard is CCITT" TCR
ELSE
      T." Coding Standard is not CCITT" TCR
ENDIF
```

NOTE
The preceding example uses a bit field and @ (fetch); ! (store) and T. (print value) can also be used. If the parameter is a string (a sequence of one or more characters), !STRING or T.TYPE can be used.

Example 2:
Set the appropriate values of the two parameter fields of Octet 4 of the Bearer Capability IE prior to transmission.

```
#CIRCUIT_MODE *COD ->BC_TRANSFER_MODE !
#384KBIT/S    *COD ->BC_TRANSFER_RATE !
```

14.4 Message Identifiers

Q.931 Protocol Discriminator (value = 0X08)

M#ALERT	Alerting
M#CALL_PROC	Call Proceeding
M#CONN	Connect
M#CONN_ACK	Connect Acknowledge
M#CON_CON	Congestion Control
M#DISC	Disconnect
M#FAC	Facility
M#HOLD	Hold
M#HOLD_ACK	Hold Acknowledge
M#HOLD_REJ	Hold Reject
M#INFO	Information
M#NOTIFY	Notify
M#PROG	Progress
M#REG	Register
M#REL	Release
M#REL_COM	Release Complete
M#RES	Resume
M#REST	Restart
M#REST_ACK	Restart Acknowledge

M#RES_ACK	Resume Acknowledge
M#RES_REJ	Resume Reject
M#RET	Retrieve
M#RET_ACK	Retrieve Acknowledge
M#RET_REJ	Retrieve Reject
M#SEGMENT	Segment
M#SETUP	Setup
M#SETUP_ACK	Setup Acknowledge
M#STATUS	Status
M#STATUS_ENQ	Status Enquiry
M#SUSP	Suspend
M#SUSP_ACK	Suspend Acknowledge
M#SUSP_REJ	Suspend Reject
M#USER_INFO	User Information

14.5 IE Identifiers

Codeset 0

I#BEARER_CAP	Bearer Capability
I#CALLED_NUM	Called Party Number
I#CALLED_SAD	Called Party Subaddress
I#CALLING_NUM	Calling Party Number
I#CALLING_SAD	Calling Party Subaddress
I#CALL_ID	Call Identity
I#CALL_STATE	Call State
I#CAUSE	Cause
I#CHANNEL_ID	Channel Identification
I#CONG_LEVEL	Congestion Level
I#DATE/TIME	Date/time
I#DISPLAY	Display
I#END-END_DELAY	End-to-end Transit Delay
I#ENDPOINT_ID	Endpoint Identifier
I#FACILITY	Facility
I#FEAT_ACT	Feature Activation
I#FEAT_IND	Feature Indication
I#HI_LAY_COMP	High Layer Compatibility
I#INFO_RATE	Information Rate
I#INFO_REQ	Information Request
I#KEYPAD	Keypad
I#LOW_LAY_COMP	Low Layer Compatibility
I#MORE_DATA	More Data
I#NETWORK_FACIL	Network Facilities
I#NOTIFIC_IND	Notification Indicator
I#PKT_PARAMS	Packet Layer Binary Parameters
I#PKT_SIZE	Packet Size
I#PKT_WINDOW	Packet Layer Window Size
I#PROGRESS_IND	Progress Indicator
I#REDIRING_NUM	Redirecting Number

I#REPEAT_IND	Repeat Indicator
I#RESTART_IND	Restart Indicator
I#SEGMENT	Segmented Message
I#SEND_COMP	Sending Complete
I#SHIFT	Shift
I#SIGNAL	Signal
I#SPID	Service Profile Id.
I#SWITCHHOOK	Switchhook
I#TRANS_DEL_SEL	Transit Delay Selection
I#TRANS_NW_SEL	Transit Network Select
I#UU_INFO	User-user Information

Codeset 5

I#SHIFT	Shift

Codeset 6

I#SHIFT	Shift

Codeset 7

I#SHIFT	Shift

14.6 IE Structures

Bearer Capability IE (I#BEARER_CAP)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4, OCTET_4A, OCTET_4B, OCTET_5, OCTET_5A, OCTET_5B, OCTET_5C, OCTET_5D, OCTET_6, OCTET_7

->BC_CODING_STANDARD	Coding standard, Octet 3
#CCITT	*CCITT*
#INTERNATIONAL	*other international standards*
#NATIONAL	*national standard*
#NETWORK_SPECIFIC	*standard defined for the network*

->BC_TRANSFER_CAP	Info. trans. cap., Octet 3
#SPEECH	*speech*
#UNRESTRICTED	*unrestricted digital information*
#RESTRICTED	*restricted digital information*
#3.1KHZ_AUDIO	*3.1 kHz audio*
#7KHZ_AUDIO	*7 kHz audio*
#VIDEO	*video*
->BC_TRANSFER_MODE	Transfer mode, Octet 4
#CIRCUIT_MODE	*circuit mode*
#PACKET_MODE	*packet mode*
->BC_TRANSFER_RATE	Info. transfer rate, Octet 4
#PACKET	*packet mode call*
#64KBIT/S	*64 kbit/s*
#2x64KBIT/S	*2 x 64 kbit/s*
#384KBIT/S	*384 kbit/s*
#1536KBIT/S	*1536 kbit/s*
#1920KBIT/S	*1920 kbit/s*
->BC_STRUCTURE	Structure, Octet 4a
#DEFAULT	*default*
#8KHZ_INTEGRITY	*8 kHz integrity*
#SDU_INTEGRITY	*service data unit integrity*
#UNSTRUCTURED	*unstructured*
->BC_CONFIGURATION	Configuration, Octet 4a
#POINT_TO_POINT	*point-to-point*
->BC_ESTABLISHMENT	Establishment, Octet 4a
#DEMAND	*demand*
->BC_SYMMETRY	Symmetry, Octet 4b
#BIDIRECT_SYMMETRIC	*bidirectional symmetric*
->BC_TRANSFER_RATE_4B	Info. transfer rate, Octet 4b
#PACKET	*packet mode call*
#64KBIT/S	*64 kbit/s*
#2x64KBIT/S	*2 x 64 kbit/s*
#384KBIT/S	*384 kbit/s*
#1536KBIT/S	*1536 kbit/s*
#1920KBIT/S	*1920 kbit/s*
->BC_LAYER1_ID	Layer identifier, Octet 5
(numeric value)	*valid value: 1*
->BC_L1_PROTOCOL	Layer 1 protocol, Octet 5
#RATE_ADAPTION	*CCITT rate adaption V.110/X.30*
#G.711_ULAW	*Rec. G.711 u-law*
#G.711_ALAW	*Rec. G.711 A-law*
#G.721_ADPCM	*Rec. G.721 32 kbits/s ADPCM*
#G.7XX_AUDIO	*Rec. G.722 and G.724 7kHz audio*
#G.7XX_VIDEO	*Rec. G.7XX 384 kbit/s video*
#NON-CCITT	*non-CCITT rate adaption*
#V.120	*CCITT rate adaption V.120*
#X.31_HDLC	*CCITT rate adaption X.31 HDLC*
->BC_SYNC/ASYNC	Sync/Async, Octet 5a
#SYNCHRONOUS	*synchronous*
#ASYNCHRONOUS	*asynchronous*

->BC_NEGOTIATION	Negotiation, Octet 5a
#NEG_NOT_POSSIBLE	*in−band negotiation not possible*
#NEG_POSSIBLE	*in−band negotiation possible*
->BC_USER_RATE	User rate, Octet 5a
#E_BITS	*indicated by E−bits Rec. I.460*
#0.6KBIT/S	*0.6 kbit/s Rec V.6 and X.1*
#1.2KBIT/S	*1.2 kbit/s Rec V.6*
#2.4KBIT/S	*2.4 kbit/s Rec V.6 and X.1*
#3.6KBIT/S	*3.6 kbit/s Rec V.6*
#4.8KBIT/S	*4.8 kbit/s Rec V.6 and X.1*
#7.2KBIT/S	*7.2 kbit/s Rec V.6*
#8KBIT/S	*8 kbit/s Rec I.460*
#9.6KBIT/S	*9.6 kbit/s Rec V.6 and X.1*
#14.4KBIT/S	*14.4 kbit/s Rec V.6*
#16KBIT/S	*16 kbit/s Rec I.460*
#19.2KBIT/S	*19.2 kbit/s Rec V.6*
#32KBIT/S	*32 kbit/s Rec I.460*
#48KBIT/S	*48 kbit/s Rec V.6 and X.1*
#56KBIT/S	*56 kbit/s Rec V.6*
#0.1345KBIT/S	*0.1345 kbit/s Rec. X.1*
#0.100KBIT/S	*0.100 kbit/s Rec. X.1*
#0.075/1.2KBIT/S	*0.075/1.2 kbit/s Rec. V.6 and X.1*
#1.2/0.075KBIT/S	*1.2/0.075 kbit/s Rec. V.6 and X.1*
#0.050KBIT/S	*0.050 kbit/s Rec. V.6 and X.1*
#0.075KBIT/S	*0.075 kbit/s Rec. V.6 and X.1*
#0.110KBIT/S	*0.110 kbit/s Rec. V.6 and X.1*
#0.150KBIT/S	*0.150 kbit/s Rec. V.6 and X.1*
#0.200KBIT/S	*0.200 kbit/s Rec. V.6 and X.1*
#0.300KBIT/S	*0.300 kbit/s Rec. V.6 and X.1*
#12KBIT/S	*12 kbit/s Rec. V.6*
->BC_INTERIM_RATE	Intermediate rate, Octet 5b
#INT_NOT_USED	*not used*
#INT_8KBIT/S	*8 kbit/s*
#INT_16KBIT/S	*16 kbit/s*
#INT_32KBIT/S	*32 kbit/s*
->BC_NIC_ON_TX	NIC on Tx, Octet 5b
#DATA_NOT_REQUIRED	*data not required*
#DATA_REQUIRED	*data required*
->BC_NIC_ON_RX	NIC on Rx, Octet 5b
#CANNOT_ACCEPT_DATA	*cannot accept data*
#CAN_ACCEPT_DATA	*can accept data*
->BC_FLOW_CTRL_TX	Flow Control on Tx, Octet 5b
#NOT_REQUIRED	*not required*
#REQUIRED	*required*
->BC_FLOW_CTRL_RX	Flow Control on Rx, Octet 5b
#NOT_ACCEPT	*cannot accept*
#ACCEPT	*can accept*
->BC_RATE_HEADER	Rate adaption, Octet 5b
#NOT_INCLUDED	*header not included*
#INCLUDED	*header included*

->BC_MULTI_FRAME	Multiple frame est., Octet 5b
#NOT_SUPPORTED	*not supported*
#SUPPORTED	*supported*
->BC_OPER_MODE	Operation mode, Octet 5b
#BIT_TRANSPARENT	*bit transparent mode*
#PROT_SENSITIVE	*protocol sensitive mode*
->BC_LLI_NEG	LLI negotiation, Octet 5b
#DEFAULT	*default, LLI = 256 only*
#FULL_NEGOTIATION	*full protocol negotiation*
->BC_ASSIG	Assignor/Assignee, Octet 5b
#ASSIGNEE	*message orig. is default assignee*
#ASSIGNOR	*message orig. is assignor only*
->BC_BAND_NEG	In-band/out-band, Octet 5b
#WITH_INFO	*neg. is done with INFO messages*
#WITH_LL0	*neg. is done with logical link zero*
->BC_STOP_BITS	Number of stop bits, Octet 5c
#NOT_USED	*not used*
#1_STOP_BIT	*1 bit*
#1.5_STOP_BITS	*1.5 bits*
#2_STOP_BITS	*2 bits*
->BC_DATA_BITS	Number of data bits, Octet 5c
#NOT_USED	*not used*
#5_DATA_BITS	*5 bits*
#7_DATA_BITS	*7 bits*
#8_DATA_BITS	*8 bits*
->BC_PARITY	Parity, Octet 5c
#ODD_PARITY	*odd*
#EVEN_PARITY	*even*
#NO_PARITY	*none*
#FORCED_TO_0	*forced to 0*
#FORCED_TO_1	*forced to 1*
->BC_DUPLEX_MODE	Duplex mode, Octet 5d
#HALF_DUPLEX	*half duplex*
#FULL_DUPLEX	*full duplex*
->BC_MODEM_TYPE	Modem type, Octet 5d
(numeric value)	*range 0 through 63*
->BC_LAYER2_ID	Layer identifier, Octet 6
(numeric value)	*valid value: 2*
->BC_L2_PROTOCOL	Layer 2 protocol, Octet 6
#Q.921	*Rec. Q.921 (I.441)*
#X.25_LINK	*Rec. X.25, link level*
->BC_LAYER3_ID	Layer identifier, Octet 7
(numeric value)	*valid value: 3*
->BC_L3_PROTOCOL	Layer 3 protocol, Octet 7
#Q.931	*Rec. Q.931 (I.451)*
#X.25_PACKET	*Rec. X.25, packet layer*

Called Party Number IE (I#CALLED_NUM)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4

->CLDN_NUMBER_TYPE	Type of number, Octet 3
#UNKNOWN	*unknown*
#INTERNATIONAL	*international number*
#NATIONAL	*national number*
#NETWORK_SPECIFIC	*network specific number*
#LOCAL_DIRECTORY	*subscriber number*
#ABBREVIATED	*abbreviated number*
->CLDN_NUMBERING_PLAN	Numbering plan, Octet 3
#UNKNOWN_PLAN	*unknown*
#ISDN_PLAN	*ISDN numbering plan Rec. E.164*
#DATA_PLAN	*data numbering plan Rec. X.121*
#TELEX_PLAN	*telex numbering plan Rec. F.69*
#NATIONAL_PLAN	*national standard numbering plan*
#PRIVATE_PLAN	*private numbering plan*
->CLDN_NUMBER	Number, Octet 4 *
(IA5 characters)	*max. length 32 octets*

Called Party Subaddress IE (I#CALLED_SAD)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4

->CLDS_ADDRESS_TYPE	Type of subaddress, Octet 3
#NSAP	*NSAP (X.213 / ISO 8348 AD2)*
#USER_SPECIFIC	*user specific*
->CLDS_ODD/EVEN	Odd/even indicator, Octet 3
#EVEN_NUMBER	*even number of address digits*
#ODD_NUMBER	*odd number of address digits*
->CLDS_ADDRESS	Subaddress, Octet 4 *
(IA5 characters)	*max. length 20 octets*

Calling Party Number IE (I#CALLING_NUM)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_3A, OCTET_4

->CLGN_NUMBER_TYPE	Type of number, Octet 3
#UNKNOWN	*unknown*
#INTERNATIONAL	*international number*
#NATIONAL	*national number*
#NETWORK_SPECIFIC	*network specific number*
#LOCAL_DIRECTORY	*subscriber number*
#ABBREVIATED	*abbreviated number*
->CLGN_NUMBERING_PLAN	Numbering plan, Octet 3
#UNKNOWN_PLAN	*unknown*
#ISDN_PLAN	*ISDN numbering plan Rec. E.164*
#DATA_PLAN	*data numbering plan Rec. X.121*
#TELEX_PLAN	*telex numbering plan Rec. F.69*
#NATIONAL_PLAN	*national standard numbering plan*
#PRIVATE_PLAN	*private numbering plan*
->CLGN_PRESENTATION	Presentation ind., Octet 3a
#PRESENT_ALLOWED	*presentation allowed*
#PRESENT_RESTRICTED	*presentation restricted*
#NUMBER_UNAVAIL	*not available due to interworking*
->CLGN_SCREENING	Screening indicator, Octet 3a
#UNSCREENED	*user–provided, not screened*
#VERIFY_PASSED	*user–provided, verified and passed*
#VERIFY_FAILED	*user–provided, verified and failed*
#NETWORK_PROVIDED	*network provided*
->CLGN_NUMBER	Number, Octet 4 *
(IA5 characters)	*max. length 32 octets*

Calling Party Subaddress IE (I#CALLING_SAD)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4

->CLGS_ADDRESS_TYPE	Type of subaddress, Octet 3
#NSAP	*NSAP (X.213 / ISO 8348 AD2)*
#USER_SPECIFIC	*user specific*
->CLGS_ODD/EVEN	Odd/even indicator, Octet 3
#EVEN_NUMBER	*even number of address digits*
#ODD_NUMBER	*odd number of address digits*
->CLGS_ADDRESS	Subaddress, Octet 4 *
(IA5 characters)	*max. length 20 octets*

Call Identity IE (I#CALL_ID)

Possible octet inclusions/exclusions:

OCTET_3

->CI_CALL_ID	Call identity, Octet 3 *
(hex characters)	*max. length 8 octets*

Call State IE (I#CALL_STATE)

Possible octet inclusions/exclusions:

OCTET_3

->CS_CODING_STANDARD	Coding standard, Octet 3
#CCITT	*CCITT*
#INTERNATIONAL	*other international standards*
#NATIONAL	*national standard*
#NETWORK_SPECIFIC	*standard defined for the network*
->CS_CALL_STATE	Call state, Octet 3
#NULL	*Null*
#CALL_INIT	*Call Initiated*
#OVERLAP_SENDING	*Overlap Sending*
#OUTGOING_CALL_PROC	*Outgoing Call Proceeding*
#CALL_DELIVERED	*Call Delivered*
#CALL_PRESENT	*Call Present*
#CALL_RECEIVED	*Call Received*
#CONNECT_REQUEST	*Connect Request*
#INCOMING_CALL_PROC	*Incoming Call Proceeding*
#ACTIVE	*Active*
#DISC_REQUEST	*Disconnect Request*
#DISC_INDICATION	*Disconnect Indication*
#SUSPEND_REQUEST	*Suspend Request*
#RESUME_REQUEST	*Resume Request*
#RELEASE_REQUEST	*Release Request*
#CALL_ABORT	*Call Abort*
#OVERLAP_RECEIVING	*Overlap Receiving*
#RESTART_REQUEST	*Restart Request*
#RESTART	*Restart*

Cause IE (I#CAUSE)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_3A, OCTET_4, OCTET_5

->C_CODING_STANDARD	Coding standard, Octet 3
#CCITT	*CCITT*
#INTERNATIONAL	*other international standards*
#NATIONAL	*national standard*
#NETWORK_SPECIFIC	*standard defined for the network*
->C_LOCATION	Location, Octet 3
#USER	*user*
#LOCAL_PRIVATE	*private network serving local user*
#LOCAL_PUBLIC	*public network serving local user*
#TRANSIT	*transit network*
#REMOTE_PUBLIC	*public network serving remote user*
#REMOTE_PRIVATE	*private network serving remote user*
#INTERNAT_NETWORK	*international network*
#BEYOND_INTERWORK	*network beyond interworking point*
->C_RECOMMENDATION	Recommendation, Octet 3a
#REC_Q.931	*Q.931*
#REC_X.21	*X.21*
#REC_X.25	*X.25*
->C_CAUSE_VALUE	Cause value, Octet 4
#UNASSIGNED_NUMBER	*Unassigned number*
#NO_ROUTE_TO_TRANSIT	*No route to transit network*
#NO_ROUTE_TO_DEST	*No route to destination*
#CHANNEL_UNACCEPTABLE	*Channel unacceptable*
#CALL_AWARDED	*Call awarded*
#NORMAL_CLEARING	*Normal call clearing*
#USER_BUSY	*User busy*
#NO_USER_RESPOND	*No user responding*
#NO_ANSWER_FROM_USER	*No answer from user*
#CALL_REJECTED	*Call rejected*
#NUMBER_CHANGED	*Number changed*
#NON-SELECTED_CLEARING	*Non−selected user clearing*
#OUT_OF_SERVICE	*Destination out of order*
#INVALID_NUMBER_FORMAT	*Invalid number format*
#FACILITY_REJECTED	*Facility rejected*
#STATUS_ENQ_RESPONSE	*Response to STATUS ENQUIRY*
#NORMAL_UNSPECIFIED	*Normal, unspecified*
#NO_CHANNEL_AVAIL	*No circuit/channel available*
#OUT_OF_ORDER	*Network out of order*
#TEMPORARY_FAILURE	*Temporary failure*
#SWITCH_CONGESTION	*Switching equipment congestion*
#ACCESS_INFO_DISCARD	*Access information discarded*
#CIRCUIT_UNAVAIL	*Requested circuit not available*
#RESOURCES_UNAVAIL_UNSPEC	*Resources unavailable, unspecified*

#QUALITY_UNAVAILABLE	*Quality of service unavailable*
#NOT_SUBSCRIBED	*Requested facility not subscribed*
#BEARER_NOT_AUTHOR	*Bearer capability not authorized*
#BEARER_UNAVAIL	*Bearer capability not available*
#SERVICE_UNAVAIL_UNSPEC	*Service not available*
#BEARER_SERVICE_UNIMPL	*Bearer capability not implemented*
#CHANNEL_TYPE_UNIMPL	*Channel type not implemented*
#REQ_FACILITY_UNIMPL	*Requested facility not implemented*
#ONLY_RESTRICTED	*Only restricted dig. info avail.*
#SERVICE_UNIMPL_UNSPEC	*Service not implemented*
#INVALID_CALL_REF	*Invalid call reference value*
#CHANNEL_NONEXISTENT	*Identified channel does not exist*
#CALL_ID_NONEXISTENT	*Call identity does not exist*
#CALL_ID_IN_USE	*Call identity in use*
#NO_CALL_SUSPENDED	*No call suspended*
#CALL_ID_CLEARED	*Call identity has been cleared*
#INCOMPATIBLE_DEST	*Incompatible destination*
#INV_TRANS_NW_SEL	*Invalid transit network selection*
#INVALID_MESSAGE_UNSPEC	*Invalid message, unspecified*
#MAND_IE_MISSING	*Mandatory IE is missing*
#MESSAGE_TYPE_UNIMPL	*Message type non–existent*
#MESSAGE_INCOMPAT	*Message not compatible*
#IE_UNIMPL	*IE non–existent*
#INVALID_IE_CONTENTS	*Invalid IE contents*
#MESSAGE_UNDEFINED	*Message not compatible with state*
#TIMER_EXPIRY	*Recovery on timer expiry*
#PROTOCOL_ERROR_UNSPEC	*Protocol error, unspecified*
#INTERWORK_UNSPEC	*Interworking, unspecified*
->C_DIAGNOSTIC	Diagnostic(s), Octet 5 *
(hex characters)	*max. length 27 octets*

Channel Identification IE (I#CHANNEL_ID)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_3.1, OCTET_3.2, OCTET_3.3

->CID_INT_PRESENT	Interface ident., Octet 3
#IMPLICIT	*implicitly identified*
#EXPLICIT	*explicitly identified*
->CID_INT_TYPE	Interface type, Octet 3
#BASIC_INTERFACE	*basic interface*
#OTHER_INTERFACE	*other interface*
->CID_PREF/EXCL	Preferred/Exclusive, Octet 3
#PREFERRED	*preferred*
#EXCLUSIVE	*exclusive*
->CID_DCHANNEL	D-channel indicator, Octet 3
#NOT_D_CHANNEL	*not D–channel*
#D_CHANNEL	*D–channel identified*

->CID_INFO_CHAN_SEL	Info. chan. sel., Octet 3
#NO_CHANNEL	*no channel*
#AS_INDICATED	*as indicated*
#ANY_CHANNEL	*any channel*
->CID_INT_ID	Interface ident., Octet 3.1 *
(hex characters)	*max. length 8 octets*
->CID_CODING_STANDARD	Coding standard, Octet 3.2
#CCITT	*CCITT*
#INTERNATIONAL	*other international standards*
#NATIONAL	*national standard*
#NETWORK_SPECIFIC	*standard defined for the network*
->CID_NUMBER/MAP	Number/Map, Octet 3.2
#NUMBER	*number*
#MAP	*map*
->CID_CHANNEL/MAP_TYPE	Chan./Map type, Octet 3.2
#B_CHANNEL_UNITS	*B-channel units*
#H0_CHANNEL_UNITS	*H0-channel units*
#H11_CHANNEL_UNITS	*H11-channel units*
#H12_CHANNEL_UNITS	*H12-channel units*
->CID_MAP	Slot map, Octet 3.3 *
(hex characters)	*max. length 4 octets*
->CID_NUMBER	Channel number, Octet 3.3
(numeric value)	*range 0 through 127*

Congestion Level IE (I#CONG_LEVEL)

->CL_CONGESTION_LEVEL	Congestion level
#RECEIVER_READY	*receiver ready*
#RECEIVER_NOT_READY	*receiver not ready*

Date/time IE (I#DATE/TIME)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4, OCTET_5, OCTET_6, OCTET_7, OCTET_8

->DT_YEAR	Year, Octet 3
(numeric value)	*range 0 through 255*
->DT_MONTH	Month, Octet 4
(numeric value)	*range 0 through 255*
->DT_DAY	Day, Octet 5
(numeric value)	*range 0 through 255*
->DT_HOUR	Hour, Octet 6
(numeric value)	*range 0 through 255*
->DT_MINUTE	Minute, Octet 7
(numeric value)	*range 0 through 255*
->DT_SECOND	Second, Octet 8
(numeric value)	*range 0 through 255*

Display IE (I#DISPLAY)

Possible octet inclusions/exclusions:

OCTET_3

->D_DISPLAY	Display information, Octet 3 *
(IA5 characters)	*max. length 80 octets*

End-to-end Transit Delay IE (I#END-END_DELAY)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_3A, OCTET_3B, OCTET_4, OCTET_4A, OCTET_4B, OCTET_5, OCTET_5A, OCTET_5B

->EE_CUMUL_DELAY	Cum. transit delay, Octet 3, 3a, & 3b
(numeric value)	*range 0 through 64536*
->EE_REQ_DELAY	Req. end-end delay, Octet 4, 4a, & 4b
(numeric value)	*range 0 through 64536*
->EE_MAX_DELAY	Max. end-end delay, Octet 5, 5a, & 5b
(numeric value)	*range 0 through 64536*

Endpoint Identifier IE (I#ENDPOINT_ID)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4

->EP_USID	User service id., Octet 3
(numeric value)	*range 0 through 127*
->EP_INTERPRETER	Interpreter, Octet 4
#MATCHES_USID+TID	*matches USID and TID*
#MATCHES_USID	*matches USID and not TID*
->EP_TID	Terminal identifier, Octet 4
(numeric value)	*range 0 through 63*

Facility IE (I#FACILITY)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4, OCTET_5, OCTET_6

->FC_SERVICE_DISCR	Service discr., Octet 3
#SUPP_SERVICES	*supplementary service applications*
->FC_CLASS	Class, Octet 4
#UNIVERSAL	*universal*
#APPLICATION-WIDE	*application-wide*
#CONTEXT-SPECIFIC	*context-specific*
#PRIVATE_USE	*private use*
->FC_FORM	Form, Octet 4
#PRIMITIVE	*primitive*
#CONSTRUCTOR	*constructor*
->FC_COMP_TAG	Component tag, Octet 4
#INVOKE	*invoke*
#RETURN_RESULT	*return result*
#RETURN_ERROR	*return error*
#REJECT	*reject*
->FC_LENGTH_FMT	Length format, Octet 5
#ONE_OCTET	*one octet*
->FC_COMP_LENGTH	Length of component, Octet 5
(numeric value)	*range 0 through 127*
->FC_COMPONENT	Component, Octet 6 *
(hex characters)	*max. length 32 octets*

Feature Activation IE (I#FEAT_ACT)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_3A

->FA_FEAT_NUM	Feature ID number, Octet 3 & 3a
(numeric value)	*range 0 through 16384*

Feature Indication IE (I#FEAT_IND)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_3A, OCTET_4

->FI_FEAT_NUM	Feature ID number, Octet 3 & 3a
(numeric value)	*range 0 through 16384*
->FI_STATUS	Status indicator, Octet 4
#DEACTIVATED	*feature is in the deactivated state*
#ACTIVATED	*feature is in the active state*
#PROMPT	*feature prompt (waiting for input)*
#PENDING	*feature is pending*

High Layer Compatibility IE (I#HI_LAY_COMP)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4, OCTET_4A

->HL_CODING_STANDARD	Coding standard, Octet 3
#CCITT	*CCITT*
#INTERNATIONAL	*other international standards*
#NATIONAL	*national standard*
#NETWORK_SPECIFIC	*standard defined for the network*
->HL_INTERPRETATION	Interpretation, Octet 3
#FIRST_CHARACTER	*first HL characteristics to be used*
->HL_PRESENTATION	Presentation method, Octet 3
#PROTOCOL_PROFILE	*high layer protocol profile*
->HL_CHARACTER	HL characteristics, Octet 4
#TELEPHONY	*telephony Rec. G.711*
#FAX_GROUP_2/3	*fax group 2/3 Rec. T.62*
#FAX_GROUP_4	*fax group 4 Rec. T.503*
#MIXED_MODE	*mixed mode Rec. T.501*
#PROC_FORM	*processable form Rec. T.502*
#TELETEX	*teletext Rec. T.62 & T.70*
#VIDEOTEX	*videotex Rec. T.504*
#TELEX	*telex*
#MHS	*Message Handling Systems Rec. X.400*
#OSI_APPLICATION	*OSI application Rec. X.200*

->HL_EX_CHARACTER	HL characteristics, Octet 4a
#TELEPHONY	*telephony Rec. G.711*
#FAX_GROUP_2/3	*fax group 2/3 Rec. T.62*
#FAX_GROUP_4	*fax group 4 Rec. T.503*
#MIXED_MODE	*mixed mode Rec. T.501*
#PROC_FORM	*processable form Rec. T.502*
#TELETEX	*teletext Rec. T.62 & T.70*
#VIDEOTEX	*videotex Rec. T.504*
#TELEX	*telex*
#MHS	*Message Handling Systems Rec. X.400*
#OSI_APPLICATION	*OSI application Rec. X.200*

Information Rate IE (I#INFO_RATE)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4, OCTET_5, OCTET_6

->IR_INCOMING	Information rate, Octet 3
#75BIT/S	*75 bits/s*
#150BIT/S	*150 bits/s*
#300BIT/S	*300 bits/s*
#600BIT/S	*600 bits/s*
#1200BIT/S	*1200 bits/s*
#2400BIT/S	*2400 bits/s*
#4800BIT/S	*4800 bits/s*
#9600BIT/S	*9600 bits/s*
#19200BIT/S	*19200 bits/s*
#48000BIT/S	*48000 bits/s*
->IR_OUTGOING	Information rate, Octet 4
#75BIT/S	*75 bits/s*
#150BIT/S	*150 bits/s*
#300BIT/S	*300 bits/s*
#600BIT/S	*600 bits/s*
#1200BIT/S	*1200 bits/s*
#2400BIT/S	*2400 bits/s*
#4800BIT/S	*4800 bits/s*
#9600BIT/S	*9600 bits/s*
#19200BIT/S	*19200 bits/s*
#48000BIT/S	*48000 bits/s*

->IR_INCOMING_MIN	Information rate, Octet 5
#75BIT/S	*75 bits/s*
#150BIT/S	*150 bits/s*
#300BIT/S	*300 bits/s*
#600BIT/S	*600 bits/s*
#1200BIT/S	*1200 bits/s*
#2400BIT/S	*2400 bits/s*
#4800BIT/S	*4800 bits/s*
#9600BIT/S	*9600 bits/s*
#19200BIT/S	*19200 bits/s*
#48000BIT/S	*48000 bits/s*
->IR_OUTGOING_MIN	Information rate, Octet 6
#75BIT/S	*75 bits/s*
#150BIT/S	*150 bits/s*
#300BIT/S	*300 bits/s*
#600BIT/S	*600 bits/s*
#1200BIT/S	*1200 bits/s*
#2400BIT/S	*2400 bits/s*
#4800BIT/S	*4800 bits/s*
#9600BIT/S	*9600 bits/s*
#19200BIT/S	*19200 bits/s*
#48000BIT/S	*48000 bits/s*

Information Request IE (I#INFO_REQ)

Possible octet inclusions/exclusions:

OCTET_3

->IRQ_INDICATOR	Info. request ind., Octet 3
#INFO_REQ_COMPL	*information request completed*
#PROMPT_INFO	*prompt for additional information*
->IRQ_INFO_TYPE	Type of information, Octet 3
#UNDEFINED	*undefined*
#AUTH_CODE	*authorization code*
#ADDRESS_DIGITS	*address digits*
#TERMINAL_ID	*terminal identification*

Keypad IE (I#KEYPAD)

Possible octet inclusions/exclusions:

OCTET_3

->K_KEYPAD	Keypad information, Octet 3 *
(IA5 characters)	*max. length 32 octets*

Low Layer Compatibility IE (I#LOW_LAY_COMP)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_3A, OCTET_4, OCTET_4A, OCTET_4B, OCTET_5, OCTET_5A, OCTET_5B, OCTET_5C, OCTET_5D, OCTET_6, OCTET_6A, OCTET_7, OCTET_7A

->LL_CODING_STANDARD	Coding standard, Octet 3
#CCITT	*CCITT*
#INTERNATIONAL	*other international standards*
#NATIONAL	*national standard*
#NETWORK_SPECIFIC	*standard defined for the network*
->LL_TRANSFER_CAP	Info. trans. cap., Octet 3
#SPEECH	*speech*
#UNRESTRICTED	*unrestricted digital information*
#RESTRICTED	*restricted digital information*
#3.1KHZ_AUDIO	*3.1 kHz audio*
#7KHZ_AUDIO	*7 kHz audio*
#VIDEO	*video*
->LL_NEG_IND	Negotiation ind., Octet 3a
#NEG_NOT_POSSIBLE	*out–band negotiation not possible*
#NEG_POSSIBLE	*out–band negotiation possible*
->LL_TRANSFER_MODE	Transfer mode, Octet 4
#CIRCUIT_MODE	*circuit mode*
#PACKET_MODE	*packet mode*
->LL_TRANSFER_RATE	Info. transfer rate, Octet 4
#PACKET	*packet mode call*
#64KBIT/S	*64 kbit/s*
#2x64KBIT/S	*2 x 64 kbit/s*
#384KBIT/S	*384 kbit/s*
#1536KBIT/S	*1536 kbit/s*
#1920KBIT/S	*1920 kbit/s*
->LL_STRUCTURE	Structure, Octet 4a
#DEFAULT	*default*
#8KHZ_INTEGRITY	*8 kHz integrity*
#SDU_INTEGRITY	*service data unit integrity*
#UNSTRUCTURED	*unstructured*
->LL_CONFIGURATION	Configuration, Octet 4a
#POINT_TO_POINT	*point–to–point*
->LL_ESTABLISHMENT	Establishment, Octet 4a
#DEMAND	*demand*
->LL_SYMMETRY	Symmetry, Octet 4b
#BIDIRECT_SYMMETRIC	*bidirectional symmetric*
->LL_TRANSFER_RATE_4B	Info. transfer rate, Octet 4b
#PACKET	*packet mode call*
#64KBIT/S	*64 kbit/s*
#2x64KBIT/S	*2 x 64 kbit/s*
#384KBIT/S	*384 kbit/s*
#1536KBIT/S	*1536 kbit/s*
#1920KBIT/S	*1920 kbit/s*

->LL_LAYER1_ID	Layer identifier, Octet 5
(numeric value)	*valid value: 1*
->LL_L1_PROTOCOL	Layer 1 protocol, Octet 5
#RATE_ADAPTION	*CCITT rate adaption V.110/X.30*
#G.711_ULAW	*Rec. G.711 u-law*
#G.711_ALAW	*Rec. G.711 A-law*
#G.721_ADPCM	*Rec. G.721 32 kbits/s ADPCM*
#G.7XX_AUDIO	*Rec. G.722 and G.724 7kHz audio*
#G.7XX_VIDEO	*Rec. G.7XX 384 kbit/s video*
#NON-CCITT	*non-CCITT rate adaption*
#V.120	*CCITT rate adaption V.120*
#X.31_HDLC	*CCITT rate adaption X.31 HDLC*
->LL_SYNC/ASYNC	Sync/Async, Octet 5a
#SYNCHRONOUS	*synchronous*
#ASYNCHRONOUS	*asynchronous*
->LL_NEGOTIATION	Negotiation, Octet 5a
#NEG_NOT_POSSIBLE	*in-band negotiation not possible*
#NEG_POSSIBLE	*in-band negotiation possible*
->LL_USER_RATE	User rate, Octet 5a
#E_BITS	*indicated by E-bits Rec. I.460*
#0.6KBIT/S	*0.6 kbit/s Rec V.6 and X.1*
#1.2KBIT/S	*1.2 kbit/s Rec V.6*
#2.4KBIT/S	*2.4 kbit/s Rec V.6 and X.1*
#3.6KBIT/S	*3.6 kbit/s Rec V.6*
#4.8KBIT/S	*4.8 kbit/s Rec V.6 and X.1*
#7.2KBIT/S	*7.2 kbit/s Rec V.6*
#8KBIT/S	*8 kbit/s Rec I.460*
#9.6KBIT/S	*9.6 kbit/s Rec V.6 and X.1*
#14.4KBIT/S	*14.4 kbit/s Rec V.6*
#16KBIT/S	*16 kbit/s Rec I.460*
#19.2KBIT/S	*19.2 kbit/s Rec V.6*
#32KBIT/S	*32 kbit/s Rec I.460*
#48KBIT/S	*48 kbit/s Rec V.6 and X.1*
#56KBIT/S	*56 kbit/s Rec V.6*
#0.1345KBIT/S	*0.1345 kbit/s Rec. X.1*
#0.100KBIT/S	*0.100 kbit/s Rec. X.1*
#0.075/1.2KBIT/S	*0.075/1.2 kbit/s Rec. V.6 and X.1*
#1.2/0.075KBIT/S	*1.2/0.075 kbit/s Rec. V.6 and X.1*
#0.050KBIT/S	*0.050 kbit/s Rec. V.6 and X.1*
#0.075KBIT/S	*0.075 kbit/s Rec. V.6 and X.1*
#0.110KBIT/S	*0.110 kbit/s Rec. V.6 and X.1*
#0.150KBIT/S	*0.150 kbit/s Rec. V.6 and X.1*
#0.200KBIT/S	*0.200 kbit/s Rec. V.6 and X.1*
#0.300KBIT/S	*0.300 kbit/s Rec. V.6 and X.1*
#12KBIT/S	*12 kbit/s Rec. V.6*
->LL_INTERIM_RATE	Intermediate rate, Octet 5b
#INT_NOT_USED	*not used*
#INT_8KBIT/S	*8 kbit/s*
#INT_16KBIT/S	*16 kbit/s*
#INT_32KBIT/S	*32 kbit/s*

->LL_NIC_ON_TX	NIC on Tx, Octet 5b
#DATA_NOT_REQUIRED	*data not required*
#DATA_REQUIRED	*data required*
->LL_NIC_ON_RX	NIC on Rx, Octet 5b
#CANNOT_ACCEPT_DATA	*cannot accept data*
#CAN_ACCEPT_DATA	*can accept data*
->LL_FLOW_CTRL_TX	Flow Control on Tx, Octet 5b
#NOT_REQUIRED	*not required*
#REQUIRED	*required*
->LL_FLOW_CTRL_RX	Flow Control on Rx, Octet 5b
#NOT_ACCEPT	*cannot accept*
#ACCEPT	*can accept*
->LL_RATE_HEADER	Rate adaption, Octet 5b
#NOT_INCLUDED	*header not included*
#INCLUDED	*header included*
->LL_MULTI_FRAME	Multiple frame est., Octet 5b
#NOT_SUPPORTED	*not supported*
#SUPPORTED	*supported*
->LL_OPER_MODE	Operation mode, Octet 5b
#BIT_TRANSPARENT	*bit transparent mode*
#PROT_SENSITIVE	*protocol sensitive mode*
->LL_LLI_NEG	LLI negotiation, Octet 5b
#DEFAULT	*default, LLI = 256 only*
#FULL_NEGOTIATION	*full protocol negotiation*
->LL_ASSIG	Assignor/Assignee, Octet 5b
#ASSIGNEE	*message orig. is default assignee*
#ASSIGNOR	*message orig. is assignor only*
->LL_BAND_NEG	In-band/out-band, Octet 5b
#WITH_INFO	*neg. is done with INFO messages*
#WITH_LL0	*neg. is done with logical link zero*
->LL_STOP_BITS	Number of stop bits, Octet 5c
#NOT_USED	*not used*
#1_STOP_BIT	*1 bit*
#1.5_STOP_BITS	*1.5 bits*
#2_STOP_BITS	*2 bits*
->LL_DATA_BITS	Number of data bits, Octet 5c
#NOT_USED	*not used*
#5_DATA_BITS	*5 bits*
#7_DATA_BITS	*7 bits*
#8_DATA_BITS	*8 bits*
->LL_PARITY	Parity, Octet 5c
#ODD_PARITY	*odd*
#EVEN_PARITY	*even*
#NO_PARITY	*none*
#FORCED_TO_0	*forced to 0*
#FORCED_TO_1	*forced to 1*
->LL_DUPLEX_MODE	Duplex mode, Octet 5d
#HALF_DUPLEX	*half duplex*
#FULL_DUPLEX	*full duplex*

->LL_MODEM_TYPE	Modem type, Octet 5d
(numeric value)	*range 0 through 63*
->LL_LAYER2_ID	Layer identifier, Octet 6
(numeric value)	*valid value: 2*
->LL_L2_PROTOCOL	Layer 2 protocol, Octet 6
#ISO_1745	*basic mode ISO 1745*
#Q.921	*Rec. Q.921 (I.441)*
#X.25_LINK	*Rec. X.25, link level*
#X.25_MULTI	*Rec. X.25 Multilink*
#EXT_LAPB	*extended LAPB (T.71)*
#HDLC_ARM	*HDLC ARM (ISO 4335)*
#HDLC_NRM	*HDLC NRM (ISO 4335)*
#HDLC_ABM	*HDLC ABM (ISO 4335)*
#LAN_LLC	*LAN LLC (ISO 8802/2)*
#X.75_SLP	*Rec. X.75, SLP*
->LL_L2_INFO	Optional layer 2, Octet 6a
(numeric value)	*range 0 through 127*
->LL_LAYER3_ID	Layer identifier, Octet 7
(numeric value)	*valid value: 3*
->LL_L3_PROTOCOL	Layer 3 protocol, Octet 7
#Q.931	*Rec. Q.931 (I.451)*
#X.25_PACKET	*Rec. X.25, packet layer*
#ISO_8208	*ISO 8208*
#ISO_8348	*ISO 8348*
#ISO_8473	*ISO 8473*
#T.70	*Rec. T.70, minimum network layer*
->LL_L3_INFO	Optional layer 3, Octet 7a
(numeric value)	*range 0 through 127*

More Data IE (I#MORE_DATA)

NOTE
There are no selectors for this information element.

Network Facilities IE (I#NETWORK_FACIL)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_3.1, OCTET_3.2, OCTET_4

->NF_NET_ID_LENGTH	Network id. length, Octet 3
(numeric value)	*range 0 through 255*
->NF_NET_ID_TYPE	Network id. type, Octet 3.1
#USER_SPECIFIED_ID	*user specified*
#NAT_NET_ID	*national network identification*
#INT_NET_ID	*international network ident.*
->NF_NET_ID_PLAN	Network id. plan, Octet 3.1
#UNKNOWN	*unknown*
#CARRIER_ID_CODE	*Carrier Identification Code*
#DATA_ID_CODE	*Data network id. code (Rec. X.121)*
->NF_NET_ID	Network ident., Octet 3.2 *
(IA5 characters)	*max. length 16 octets*
->NF_FACILITY_CODE	Network facilities, Octet 4 *
(hex characters)	*max. length 32 octets*

Notification Indicator IE (I#NOTIFIC_IND)

Possible octet inclusions/exclusions:

OCTET_3

->NI_DESCRIPTION	Notification desc., Octet 3
#USER_SUSPENDED	*user suspended*
#USER_RESUMED	*user resumed*
#BEARER_CHANGE	*bearer service change*

Packet Layer Binary Parameters IE (I#PKT_PARAMS)

Possible octet inclusions/exclusions:

OCTET_3

->PP_FAST_SELECT	Fast select, Octet 3
#NOT_REQUESTED	*not requested*
#NO_RESTRICTIONS	*requested with no restrictions*
#RESTRICTIONS	*requested with restrictions*
->PP_EXP_DATA	Expedited data, Octet 3
#REQUEST_DENIED	*no request/request denied*
#REQUEST_ACCEPTED	*request indicated/request accepted*

->PP_DEL_CONF	Delivery conf., Octet 3
#LINK-BY-LINK	*link–by–link confirmation*
#END-TO-END	*end–to–end confirmation*
->PP_MODULUS	Modulus, Octet 3
#MODULUS8	*modulus 8 sequencing*
#MODULUS128	*modulus 128 sequencing*

Packet Size IE (I#PKT_SIZE)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4

->PS_FORWARD	Forward value, Octet 3
(numeric value)	*range 0 through 127*
->PS_BACKWARD	Backward value, Octet 4
(numeric value)	*range 0 through 127*

Packet Layer Window Size IE (I#PKT_WINDOW)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4

->PW_FORWARD	Forward value, Octet 3
(numeric value)	*range 0 through 127*
->PW_BACKWARD	Backward value, Octet 4
(numeric value)	*range 0 through 127*

Progress Indicator IE (I#PROGRESS_IND)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4

->PI_CODING_STANDARD	Coding standard, Octet 3
#CCITT	*CCITT*
#INTERNATIONAL	*other international standards*
#NATIONAL	*national standard*
#NETWORK_SPECIFIC	*standard defined for the network*

->PI_LOCATION	Location, Octet 3
#USER	*user*
#LOCAL_PRIVATE	*private network serving local user*
#LOCAL_PUBLIC	*public network serving local user*
#REMOTE_PUBLIC	*public network serving remote user*
#REMOTE_PRIVATE	*private network serving remote user*
#BEYOND_INTERWORK	*network beyond interworking point*
->PI_DESCRIPTION	Progress desc., Octet 4
#NOT_END_TO_END	*call is not end–to–end ISDN*
#DEST_NON_ISDN	*destination address is non–ISDN*
#ORIG_NON_ISDN	*origination address is non–ISDN*
#RETURNED_TO_ISDN	*call has returned to the ISDN*
#INBAND_INFO_AVAIL	*in–band info. now available*

Redirecting Number IE (I#REDIRING_NUM)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_3A, OCTET_3B, OCTET_4

->RDGN_NUMBER_TYPE	Type of number, Octet 3
#UNKNOWN	*unknown*
#INTERNATIONAL	*international number*
#NATIONAL	*national number*
#NETWORK_SPECIFIC	*network specific number*
#LOCAL_DIRECTORY	*subscriber number*
#ABBREVIATED	*abbreviated number*
->RDGN_NUMBERING_PLAN	Numbering plan, Octet 3
#UNKNOWN_PLAN	*unknown*
#ISDN_PLAN	*ISDN numbering plan Rec. E.164*
#DATA_PLAN	*data numbering plan Rec. X.121*
#TELEX_PLAN	*telex numbering plan Rec. F.69*
#NATIONAL_PLAN	*national standard numbering plan*
#PRIVATE_PLAN	*private numbering plan*
->RDGN_PRESENTATION	Presentation ind., Octet 3a
#PRESENT_ALLOWED	*presentation allowed*
#PRESENT_RESTRICTED	*presentation restricted*
#NUMBER_UNAVAIL	*not available due to interworking*
->RDGN_SCREENING	Screening indicator, Octet 3a
#UNSCREENED	*user–provided, not screened*
#VERIFY_PASSED	*user–provided, verified and passed*
#VERIFY_FAILED	*user–provided, verified and failed*
#NETWORK_PROVIDED	*network provided*

->RDGN_REASON	Redirection reason, Octet 3b
#CALL_FORWARD_BUSY	*call forwarding or called DTE busy*
#NO_REPLY	*call forwarding no reply*
#DTE_OUT_OF_ORDER	*called DTE out of order*
#CALL_FWD_BY_DTE	*call forwarding by the called DTE*
#UNCONDITIONAL	*call forwarding unconditional*
->RDGN_NUMBER	Number, Octet 4 *
(IA5 characters)	*max. length 32 octets*

Repeat Indicator IE (I#REPEAT_IND)

->RP_REPEAT_IND	Repeat indicator
#PRIORITIZED	*prioritized list*

Restart Indicator IE (I#RESTART_IND)

Possible octet inclusions/exclusions:

OCTET_3

->RI_CLASS	Class, Octet 3
#INDICATED_CHANNEL	*indicated channels*
#SINGLE_INTERFACE	*single interface*
#ALL_INTERFACES	*all interfaces*

Segmented Message IE (I#SEGMENT)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4

->SG_FIRST_IND	First segment ind., Octet 3
#SUBSEQUENT	*subsequent segment to first*
#FIRST_SEGMENT	*first segment*
->SG_REMAINING	Segments remaining, Octet 3
(numeric value)	*range 0 through 127*

->SG_MESSAGE_TYPE	Message type, Octet 4
#ALERT	*Alerting*
#CALL_PROC	*Call proceeding*
#PROG	*Progress*
#SETUP	*Setup*
#CONN	*Connect*
#SETUP_ACK	*Setup acknowledge*
#CONN_ACK	*Connect acckowledge*
#USER_INFO	*User information*
#SUSP_REJ	*Suspend reject*
#RES_REJ	*Resume reject*
#HOLD	*Hold*
#SUSP	*Suspend*
#RES	*Resume*
#HOLD_ACK	*Hold acknowledge*
#SUSP_ACK	*Suspend acknowledge*
#RES_ACK	*Resume acknowledge*
#HOLD_REJ	*Hold reject*
#RET	*Retrieve*
#RET_ACK	*Retrieve acknowledge*
#RET_REJ	*Retrieve reject*
#DISC	*Disconnect*
#REST	*Restart*
#REL	*Release*
#REST_ACK	*Restart acknowledge*
#REL_COM	*Release complete*
#SEGMENT	*Segment*
#FAC	*Facility*
#REG	*Register*
#NOTIFY	*Notify*
#STATUS_ENQ	*Status enquiry*
#CON_CON	*Congestion control*
#INFO	*Information*
#STATUS	*Status*

Sending Complete IE (I#SEND_COMP)

NOTE
There are no selectors for this information element.

Shift IE (I#SHIFT)

->SH_TYPE	Shift type
#LOCKING	*locking*
#NON_LOCKING	*non-locking*
->SH_CODESET	Codeset ident.
#CODESET0	*I.451 (Q.931) IE*
#CODESET5	*national use IE*
#CODESET6	*local network specific IE*
#CODESET7	*user specific IE*

Signal IE (I#SIGNAL)

Possible octet inclusions/exclusions:

OCTET_3

->SI_VALUE	Signal value, Octet 3
#DIAL_ON	*dial tone on*
#RING_BACK_ON	*ring back tone on*
#INTERCEPT_ON	*intercept tone on*
#CONGESTION_ON	*network congestion tone on*
#BUSY_ON	*busy tone on*
#CONFIRM_ON	*confirm tone on*
#ANSWER_ON	*answer tone on*
#CALL_WAITING_ON	*call waiting tone on*
#OFF_HOOK_ON	*off-hook warning tone on*
#TONES_OFF	*tones off*
#ALERTING_ON_0	*alerting on - pattern 0*
#ALERTING_ON_1	*alerting on - pattern 1*
#ALERTING_ON_2	*alerting on - pattern 2*
#ALERTING_ON_3	*alerting on - pattern 3*
#ALERTING_ON_4	*alerting on - pattern 4*
#ALERTING_ON_5	*alerting on - pattern 5*
#ALERTING_ON_6	*alerting on - pattern 6*
#ALERTING_ON_7	*alerting on - pattern 7*
#ALERTING_OFF	*alerting off*

Service Profile Id. IE (I#SPID)

Possible octet inclusions/exclusions:

OCTET_3

->SPID	SPID, Octet 3 *
(IA5 characters)	*max. length 30 octets*

Switchhook IE (I#SWITCHHOOK)

Possible octet inclusions/exclusions:

OCTET_3

->SW_VALUE	Switchhook value, Octet 3
#ON_HOOK	*on-hook*
#OFF_HOOK	*off-hook*

Transit Delay Selection IE (I#TRANS_DEL_SEL)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_3A, OCTET_3B

->TDS_VALUE	Transit delay, Octet 3
(numeric value)	*range 0 through 3*
->TDS_VALUE	Transit delay, Octet 3a
(numeric value)	*range 0 through 127*
->TDS_VALUE	Transit delay, Octet 3b
(numeric value)	*range 0 through 127*

Transit Network Select IE (I#TRANS_NW_SEL)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4

->TR_NET_ID_TYPE	Network id. type, Octet 3
#USER_SPECIFIED_ID	*user specified*
#NAT_NET_ID	*national network identification*
#INT_NET_ID	*international network ident.*
->TR_NET_ID_PLAN	Network id. plan, Octet 3
#UNKNOWN	*unknown*
#CARRIER_ID_CODE	*Carrier Identification Code*
#DATA_ID_CODE	*Data network id. code (Rec. X.121)*
->TR_NET_ID	Network ident., Octet 4 *
(IA5 characters)	*max. length 16 octets*

User–user Information IE (I#UU_INFO)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4

->UU_PROTOCOL_DISCR	Protocol discr., Octet 3
(numeric value)	*range 0 through 255*
->UU_USER_INFO	User information, Octet 4 *
(hex characters)	*max. length 254 octets*

15
EMULATION ARCHITECTURE

The ISDN D-Channel Emulation program has the functionality of the ISDN D-Channel Monitor and layer 2 emulation and layer 3 simulation capabilities.

Layer 2 Emulation The ISDN D-Channel Emulation can maintain up to eight different links simultaneously. A link is uniquely identified by its SAPI (service access point identifier) and its TEI (terminal endpoint identifier). The layer 2 emulation maintains this information for each of the eight links along with other link specific information (eg. timer durations, data field lengths, window size, retransmission counters, modulus mode, state variables, and the layer 2 state). The emulation determines the applicable link when a layer 2 event occurs and selects the appropriate set of parameters.

Layer 3 Simulation The ISDN D-Channel Simulation can maintain up to eight simultaneous connections. A connection is uniquely identified by its call reference value. The layer 3 simulation maintains information relevant to the connection in separate data structures for each of the eight connections.

The data structure contains all the different parameters used to construct information elements for a connection. It also holds information relevant to the connection (i.e. information element parameter values, channel types, call states, etc.).

The test manager supports layer 3 connection multiplexing. When a message is received, the call reference value identifies the connection, selects the appropriate data structure, and starts the test manager. If a new call reference value is received, the active test manager state is saved at the current state number and the test manager is restarted using the new data structure.

The previously saved test manager state resumes where it left off if a message with the original call reference value is received again. Consequently, eight different connections can be managed by the test manager, using a separate data structure for each test script.

15.1 Live Data

Data is passed to the monitor decode and then through to the triggers or the test manager. Based on the trigger selection, data is passed through to the filters. The filters permit or restrict the flow of data into the capture RAM, disk, or display.

The test manager, if active, processes the received data and generates a response. The test manager can utilize the services of the message builder in order to generate a layer 3 response.

Finally, outgoing data is framed by the layer 2 emulation and sent out to the physical interface.

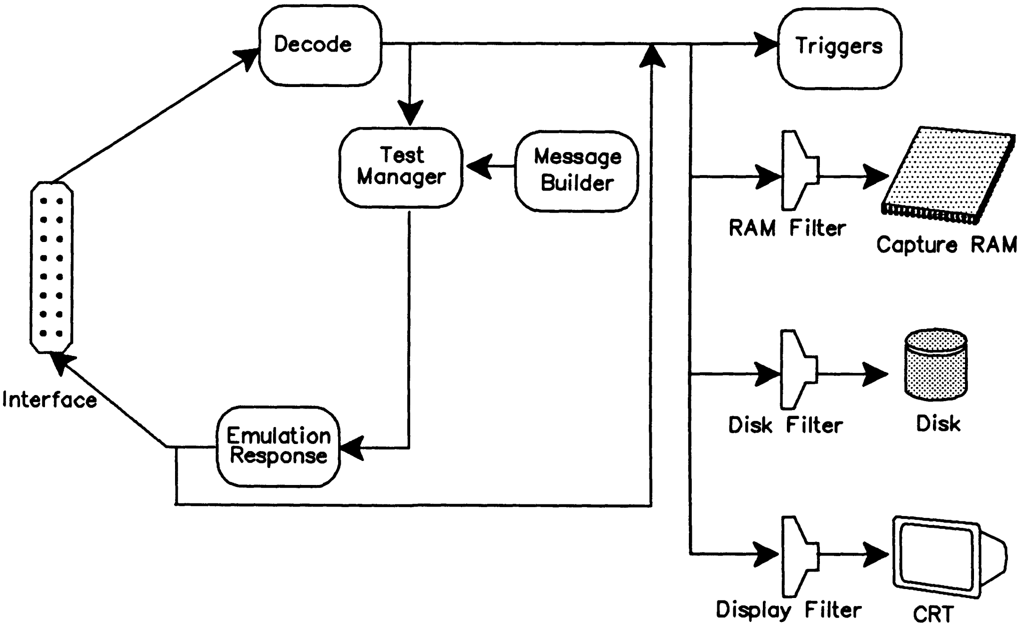


Figure 15–1 ISDN Emulation Data Flow Diagram – Live Data

Display topic
Live Data function key

MONITOR (--)
Selects the live data mode of operation. All incoming events and transmitted frames are decoded and displayed in real-time.

15.2 Playback

Data can be played back from either capture RAM or disk without interfering with an active test (i.e. dropping the link) as shown in Figure 15-2.

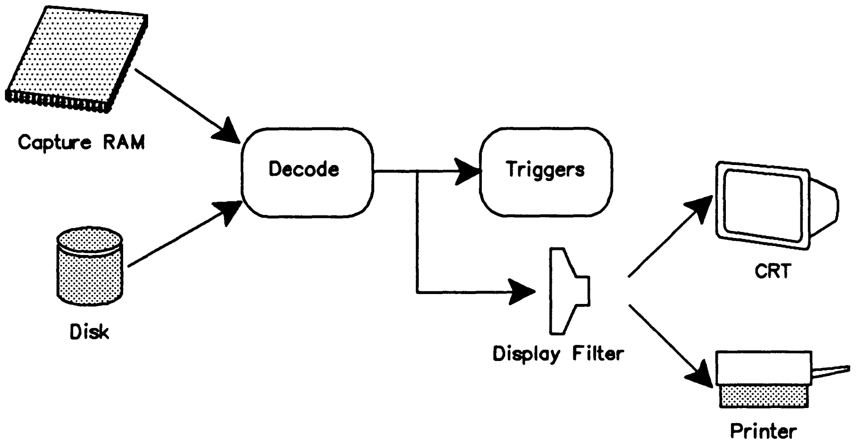


Figure 15–2 ISDN Emulation Data Flow Diagram – Offline Processing

FROM_CAPT HALT
Display topic
Playback RAM function key

FROM_DISK HALT PLAYBACK
Display topic
Playback Disk function key

HALT (--)

Selects the playback mode of operation. Data is retrieved from capture RAM or a disk file, decoded, and then displayed or printed. Capture to RAM is suspended in this mode.

15.3 Simultaneous Live Data and Playback

Live data can be recorded to disk while playing back data from capture RAM.

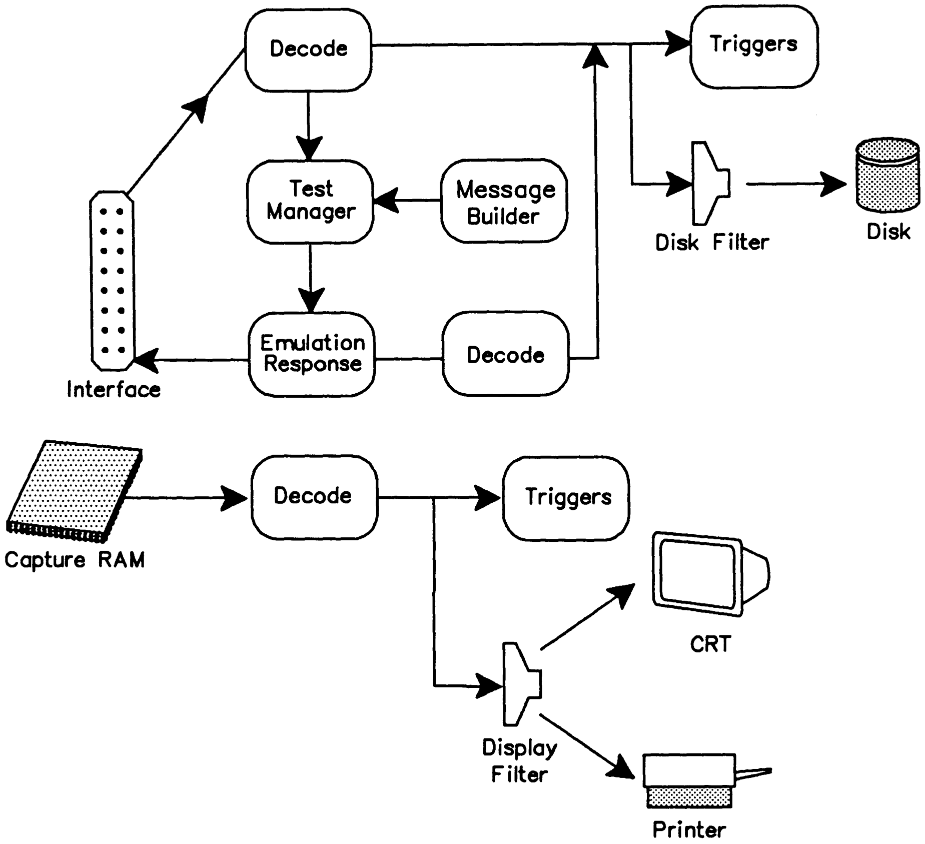


Figure 15–3 ISDN Emulation Data Flow Diagram – Freeze Mode

FROM_CAPT FREEZE
Capture topic
Record to Disk function key
Display topic
Playback RAM function key

FREEZE (--)
Enables data to be recorded to disk while data from capture RAM is played back.

16
EMULATION CONFIGURATION

IDACOM testers can emulate D-Channel data on a WAN, Basic Rate, or Primary Rate interface. This section describes configuration commands for layers 1, 2, and 3.

The tester can emulate a user (TE) or network (NT).

USER_EMUL (--)
Selects user emulation.

Emulation topic
User function key

NTWK_EMUL (--)
Selects network emulation.

Emulation topic
Ntwk function key

NOTE
For basic rate, user and network are selected on the Home processor.

USR*NET (-- address)
Contains the emulation state. Valid values are:

TE	Terminal emulation
NT	Network emulation

Example:
Change from a user emulation to a network emulation.

```
USR*NET   @           ( Obtain current configuration )
TE =                  ( Is configuration user? )
IF                    ( Yes )
  NTWK_EMUL           ( Change to a network emulation )
ENDIF
```

16.1 Layer 1

The section describes commands to configure the physical layer for each interface type.

Basic Rate

The Basic Rate interface is configured on the Home processor prior to loading the D-Channel Emulation application. However, commands exist within the emulation for interface configuration.

Each application processor is associated with a serial port which has a port identifier. This port identifier is used in most of the Basic Rate layer 1 configuration commands.

PORT_BRID (-- port id)
Returns the port identifier for the Basic Rate D-Channel port (Port A for BRA/BRA tester).

PORT_BRID2 (-- port id)
Returns the port identifier for the Basic Rate D-Channel Port B (BRA/BRA tester).

The S/T bus can be configured for point-to-point operation (one TE device attached) or point to multipoint operation (up to eight TE devices attached).

PPMP (port\connect mode --)
Where: connect mode = P2P point-to-point mode (default)
P2MP point to multipoint

Establishes the bus configuration of the unit.

Example 1:
Configure the S/T bus for point-to-point operation.

```
PORT_BRID P2P  PPMP
```

Example 2:
Configure the S/T bus for Port B of a BRA/BRA tester for point to multipoint operation.

```
PORT_BRID2 P2MP PPMP
```

When a phone is connected to the tester, the voice encoding method is either A-law or μ-law.

CODE_TYPE (port\voice code --)
Where: voice code =U-LAW μ-law voice encoding (default)
A-LAW A-law voice encoding

Selects the type of voice encoding.

Example:
Select μ-law voice encoding.

```
PORT_BRID  U-LAW  CODE_TYPE
```

The voice CODEC can be set to generate tones over the voice channel.

TONE_TYPE (port\tone --)

Where: tone = AUD_RING **Audible Ring**
440Hz/480Hz
Repeat tones 1 second on, 3 seconds off.

SPECIAL_AR **Special Audible Ring**
Tones on for 1 second, followed by single 440 Hz tone on for 200 milliseconds, then off for 3 seconds. Repeat.

BUSY **Busy**
480Hz/620Hz
Tones on 500 ms, off 500 ms. Repeat.

BUSY_VFY **Busy Verify**
One burst tone 1.75 seconds before attendant intrudes, followed by burst of 650 ms on 8 to 20 seconds apart as long as the call lasts.

CONFIRM **Confirm**
350Hz/440Hz
Burst on 100 ms. Burst off 100 ms. Repeat three times.

CALL_WAIT **Call wait**
440Hz/OFF
One burst for 250 ms.

DIAL **Dial**
350Hz/440Hz
Steady tone.

EXEC_OVD **Exec. Override**
440Hz/OFF
One burst tone 3 seconds before override occurs.

INTERCEPT **Intercept**
440Hz/620Hz
First tone on 250 ms followed by second tone on for 250 ms. Repeat.

RECALL_DIAL **Recall Dial**
350Hz/440Hz
On 100 ms. Off 100 ms. Repeat three times, followed by a steady tone.

REORDER **Reorder**
480Hz/620Hz
Tone on 250 ms. Tone off 250 ms. Repeat.

OFF **Turn tone off**
Turns repetitive tones, such as a dial tone, off.

Selects the tone generated over the voice channel.

Example:
Configure the tester so that a voice channel on B2-Channel is connected to the CODEC. Tones are sent over the voice channel.

```
PORT_BRID BCHAN2 VOICE BCHAN_SRC      ( Connect B2-Channel to the voice codec )
PORT_BRID U-LAW CODE_TYPE             ( Select mu law voice encoding )
PORT_BRID DRT_SERIAL DROUTING DROP    ( Place the B-Channel on line )
PORT_BRID DIAL TONE_TYPE              ( Send a dial tone )
```

When emulating a network, the terminal device might require power to be supplied from the network.

SET_PS (port/state --)

Where: state =	PS1_OFF	power supply 1 off
	PS1+	power supply 1 forward power
	PS1-	power supply 1 reverse power
	PS2_OFF	power supply 2 off
	PS2+	power supply 2 forward power
	PS2-	power supply 2 reverse power

Sets the power supply to the indicated state.

GET_PS (port -- power supply 1 state\power supply 2 state)

Where: state =	PS1_OFF	power supply 1 off
	PS1+	power supply 1 forward power
	PS1-	power supply 1 reverse power
	PS1_ERROR	error in setting power supply 1 (opposite end is providing power)
	PS2_OFF	power supply 2 off
	PS2+	power supply 2 forward power
	PS2-	power supply 2 reverse power
	PS2_ERROR	error in setting power supply 2 (opposite end is providing power)

Returns the state of the two power supplies.

Example:
Configure the tester for point-to-point, forward power, and network emulation to power supply 1.

```
PORT_BRID P2P PPMP           ( Point-to-point bus configuration )
PORT_BRID PS1+ SET_PS        ( Provide forward power )
PORT_BRID GET_PS DROP        ( Drop power supply 2 state )
PS1_ERROR =                  ( Check for error )
IF
    T." Error - Check other ends power supply." TCR
ENDIF
NTWK_EMUL                    ( Select network emulation configuration )
```

The B-Channel data stream can be protocol data routed to another application processor for analysis, voice channel routed to the external telephone connector, or protocol data directed to the external port.

BCHAN_SRC (port\source\channel --)
Where: source = BCHAN1 (B1-Channel)
BCHAN2 (B2-Channel)
PP1 (AP #1 / AP #4 for Port B of BRA/BRA)
PP2 (AP #2 / AP #5 for Port B of BRA/BRA)
EXT_1 (external connector 1)
EXT_2 (external connector 2)
VOICE (codec)
channel = BCHAN1 (B1-Channel)
BCHAN2 (B2-Channel)

Selects the source of transmitted data for the specified B-Channel. The BCHAN_SRC command can perform single and cross channel loopback, as well as routing data to the application processors (see the examples following DROUTING command in this section).

DROUTING (port\route -- flag)
Where: route = DRT_OFF - turn off the flow of data to the application processors.
DRT_SERIAL - route B-Channels to the application processors.

Connects the B-Channels to an application processor and returns true if successful.

📝 **BRI–Config** topic
Online function key

Example 1:
Configure the tester to connect the B-Channels through to the application processors.

```
1 SEQ{
    PORT_BRID PP1 BCHAN1 BCHAN_SRC
    PORT_BRID PP2 BCHAN2 BCHAN_SRC
    PORT_BRID DRT_SERIAL DROUTING
    IF
        " B-Channels are connected to application processors."
    ELSE
        " Bus not activated.  B-Channels are not connected."
    ENDIF
    W.NOTICE
  }SEQ
```

Example 2:
Configure the tester with B1-Channel in self loopback mode (see Figure 16-1).

```
PORT_BRID BCHAN1 DUP BCHAN_SRC          ( Put B1-Channel in self loopback )
PORT_BRID DRT_SERIAL DROUTING           ( Enable flow of data to B-Channels )
IF                                      ( Routing successful? )
    " B-Channels are looped back."
ELSE
    " Bus not activated.  B-Channels are not looped back."
ENDIF
W.NOTICE
```

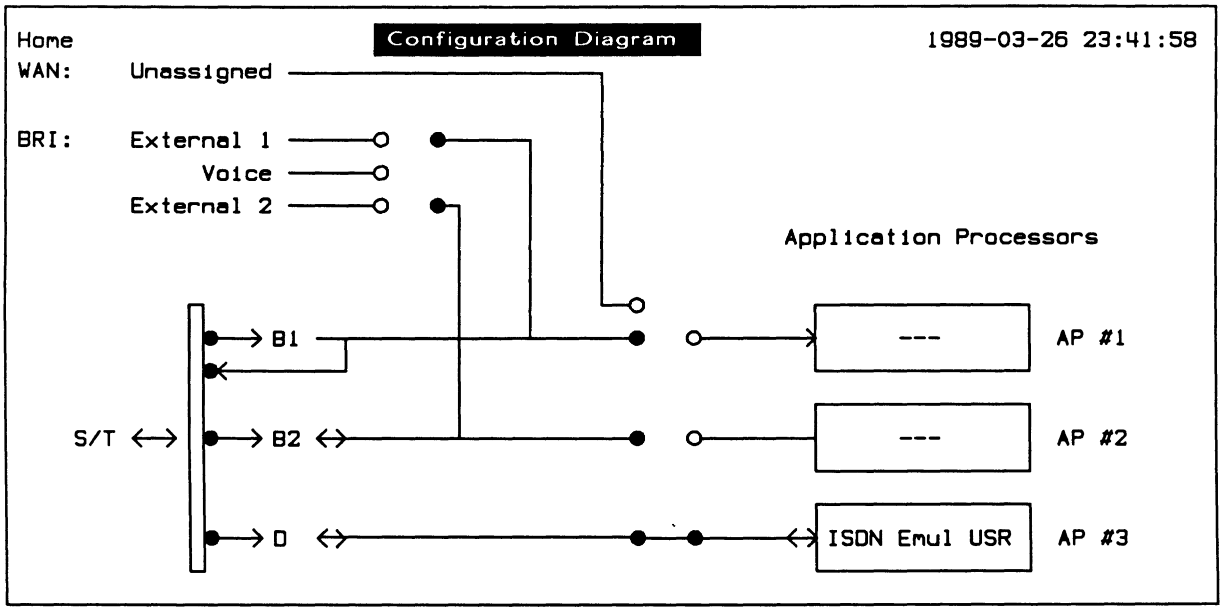


Figure 16-1 Selfloop Configuration Diagram

Example 3:
Create a sequence that crossloops the B-Channels (i.e. connects B1-Channel to B2-Channel and vice versa). See Figure 16-2.

```
3 SEQ{
    PORT_BRID BCHAN1 BCHAN2 BCHAN_SRC
    PORT_BRID BCHAN2 BCHAN1 BCHAN_SRC
    PORT_BRID DRT_SERIAL DROUTING
    IF
        " B-Channels are cross connected."
    ELSE
        " Bus not activated.  B-Channels are not cross connected."
    ENDIF
    W.NOTICE
  }SEQ
```

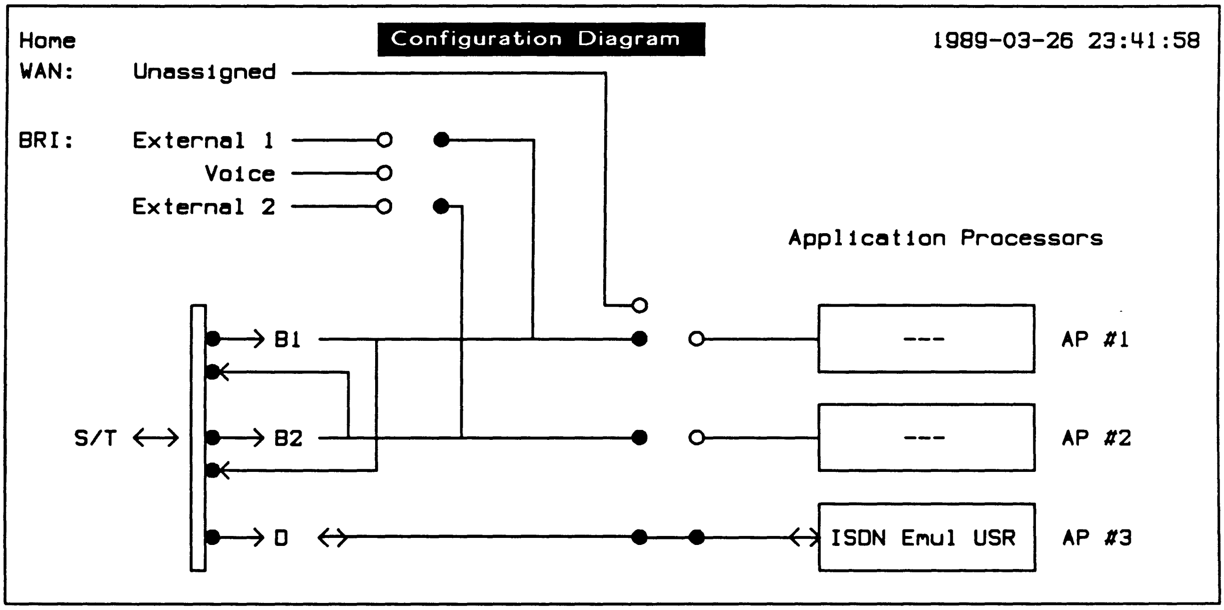


Figure 16-2 Crossloop Configuration Diagram

Example 4:
Configure the tester to connect B1-Channel to External #1 and B2-Channel to voice (see Figure 16-3).

```
PORT_BRID EXT_1 BCHAN1 BCHAN_SRC    ( Route B1 to external 1 )
PORT_BRID VOICE BCHAN2 BCHAN_SRC    ( Route B2 to voice )
PORT_BRID DRT_SERIAL DROUTING       ( Enable flow of data to B-Channel )
IF
     " B1 routed to external #1.  B2 routed to voice."
ELSE
     " Bus not activated."
ENDIF
W.NOTICE
```

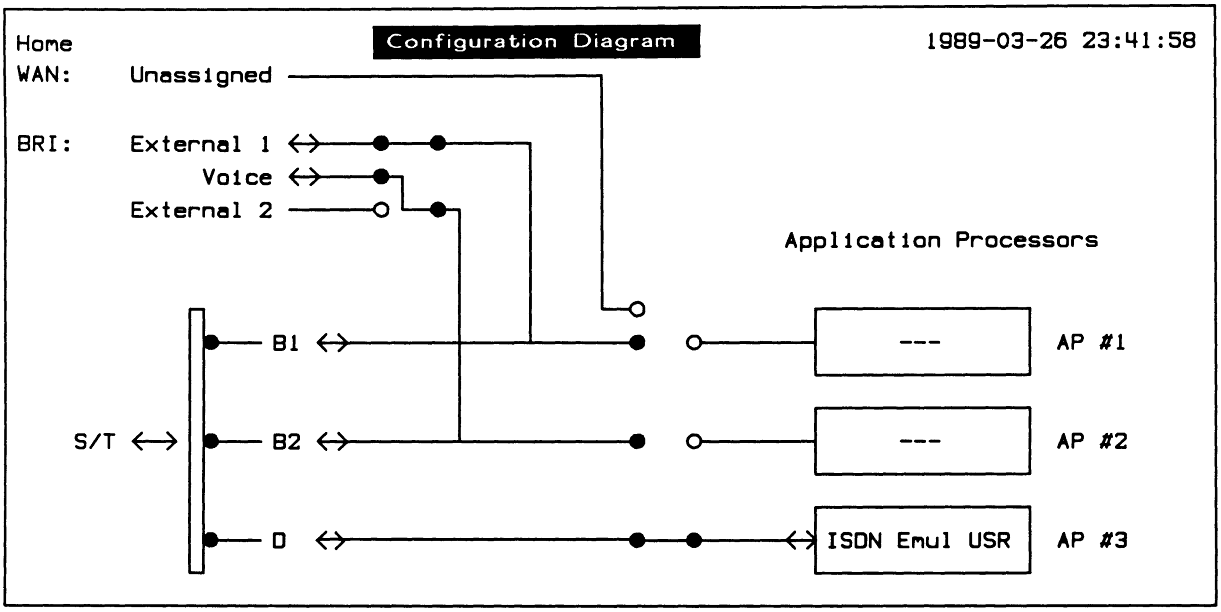


Figure 16–3 B1 to External 1, B2 to Voice Configuration Diagram

Example 5:
Create a sequence that disconnects the B-Channels.

```
4 SEQ[
    PORT_BRID DRT_OFF DROUTING
    IF
        " B-Channels disconnected."
    ELSE
        " Bus not activated.  B-Channels are already disconnected."
    ENDIF
    W.NOTICE
  ]SEQ
```

The S/T bus can be activated/deactivated in the emulation.

L1_ACTIVATE (--)
Activates the bus.

Emulation topic
Activate function key

L1_DEACTIVATE (--)
Deactivates the bus.

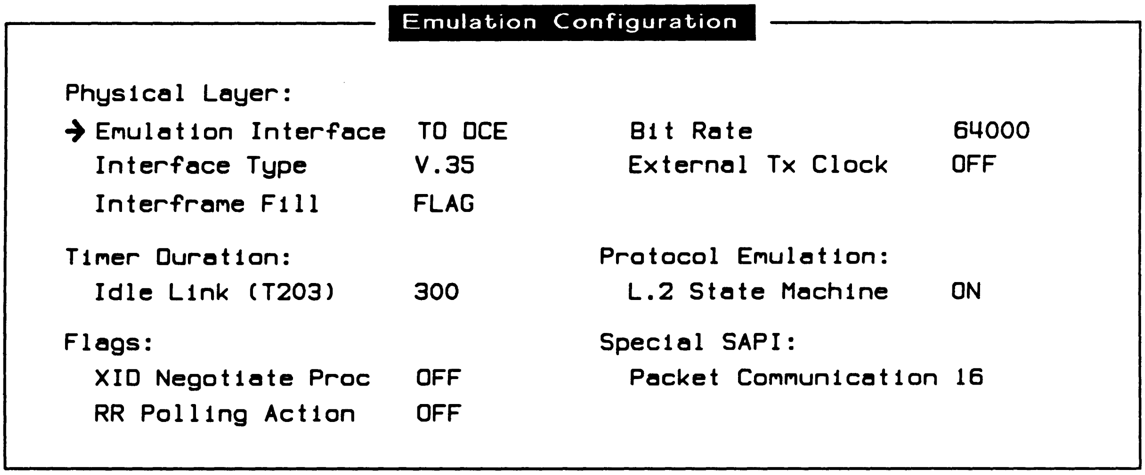
Emulation topic
Deactivate function key

Primary Rate

The Primary Rate interface is configured on the Home processor prior to loading the D-Channel Emulation application. Corresponding configuration commands do not exist in the application.

WAN

The WAN interface is configured on the application processor after loading the D-Channel Emulation and switching to the application processor.



```
                    Emulation Configuration

 Physical Layer:
 → Emulation Interface   TO DCE        Bit Rate             64000
   Interface Type        V.35          External Tx Clock    OFF
   Interframe Fill       FLAG

 Timer Duration:                     Protocol Emulation:
   Idle Link (T203)      300           L.2 State Machine    ON

 Flags:                              Special SAPI:
   XID Negotiate Proc    OFF           Packet Communication 16
   RR Polling Action     OFF
```

Figure 16–4 Emulation Configuration Menu (WAN)

INTERFACE_WAKEUP (--)
Configures the physical interface.

NOTE
Use INTERFACE_WAKEUP once after all physical layer changes are made.

Physical Layer:
→ *Emulation Interface*
Selects the physical type of emulation and determines whether the tester generates clocking or expects to receive clocking, as well as setting which pins transmit and receive data.

NOTE
Refer to Table 16-1 for clocking selections depending on the emulation interface.

INTERFACE (-- address)
Contains the physical interface type. Valid values are:

0	to DCE connector	Clocking must be supplied by the attached equipment.
1	to DTE connector	Tester supplies all clocking information to the interface connection.

Example:
Select the 'to DTE' interface.

```
1 INTERFACE !
INTERFACE_WAKEUP
```

→ *Interface Type*
IF=V28 (--)
Selects the V.28/RS-232C connector and electrically isolates the other connectors on the port.

RS232C/V.28 function key

IF=V11 (--)
Selects the V.11/X.21 connector and electrically isolates the other connectors on the port.

RS422/V.11 function key

IF=V35 (--)
Selects the V.35 connector (default) and electrically isolates the other connectors on the port.

V.35 function key

IF=V36 (--)
Selects the V.36 (RS-449) connector and electrically isolates the other connectors on the port.

RS449/V.36 function key

NOTE
A WAN tester has a V.28, V.11, and either a V.35 or V.36 connector. These commands are only applicable if the program is running on a WAN interface.

→ *Interframe Fill*
Selects the bit pattern transmitted between blocks of data.

INTERFRAME–FILL (-- address)
Contains the interframe fill character.

Examples:
Set interframe fill to MARK.

```
MRK INTERFRAME-FILL !
```

MARK function key

Set interframe fill to FLAG (default).

```
SYNC INTERFRAME-FILL !
```

FLAG function key

→ *Bit Rate*
The interface speed can be selected from preset values on the Interface Port Speed Menu or set to a user-defined speed. The bit rate of the ISDN line can also be measured. The following table lists the associated action depending on the emulation interface and clocking selections.

Clocking	TO DTE	TO DCE
OFF	Select	Measure
ON	Measure	Select

Table 16–1 Effect of Clocking and Emulation Interface Selections on Bit Rate

NOTE
Clocking is provided by the attached equipment when the bit rate can be selected.

INTERFACE–SPEED (-- address)
Contains the current bit rate (default is 64000).

Modify Value function key
Enter Interface Port Speed (50 to 128000):

NOTE
Integer values must be written to INTERFACE–SPEED. Thus, to obtain a bit rate of 134.5, either 134 or 135 can be written to INTERFACE–SPEED.

→ *External Tx Clock*
Enables/disables external clocking.

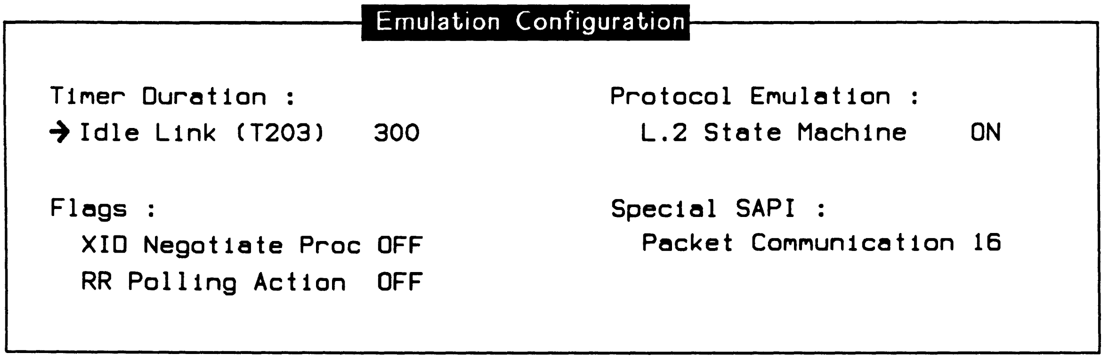
IF–CLOCK (-- address)
Contains the state of the external clock. Valid values are:

YES	enable external clock
NO	disable external clock

16.2 Layer 2

This section describes the various commands and variables used for layer 2 configuration. Layer 2 configuration is identical for all interface types.

The ISDN D–Channel Emulation supports automatic emulation of up to eight layer 2 data links. Layer 2 configuration is divided into link independent and dependent commands. The following parameters are link independent and affect the operation of the layer 2 emulation as a whole.



```
                         Emulation Configuration

   Timer Duration :                    Protocol Emulation :
  → Idle Link (T203)   300               L.2 State Machine      ON

   Flags :                             Special SAPI :
     XID Negotiate Proc OFF              Packet Communication 16
     RR Polling Action  OFF
```

Figure 16–5 Emulation Configuration Menu (Basic Rate)

Timer Duration:
→ *Idle Link (T203)*
The T203 timer starts after a frame has been transmitted and stops when a frame is received. The duration of the T203 timer is the maximum time on the link without exchange of frames.

T203–DUR# (–– value)
Returns the value, in tenths of seconds, of the T203 timer.

T203 (value ––)
Sets the value, in tenths of seconds, of the T203 timer.

Example:
If the value of T203 is less than 30 seconds, set to 30 seconds.

```
T203-DUR#  300 <
IF 300 T203 ENDIF
```

Modify Value function key

Flags:

→ *XID Negotiate Proc*
Establishes common values for the data field length (N201), the window size, and the retransmission timer (T200) between two peers.

XID_ON (--)
Enables the XID negotiation procedure.

ENABLE function key

XID_OFF (--)
Disables the XID negotiation procedure.

OFF function key

?XID_ON (-- flag)
Returns true if the XID negotiation procedure is enabled.

Example:
Disable XID negotiation if XID negotiation is enabled.

```
?XID_ON                     ( Is XID negotiation enabled? )
IF                          ( Yes )
    XID_OFF                 ( Disable )
ENDIF
```

→ *RR Polling Action*
Detects faulty data link connections. Receiver ready frames are transmitted when the T203 timer expires. If receiver ready frames are in turn received, then the link is up.

RR_POLL_ON (--)
Enables the receiver ready polling action.

ENABLE function key

RR_POLL_OFF (--)
Disables the receiver ready polling action.

OFF function key

?RR_POLL_ON (-- flag)
Returns true if the receiver ready polling action is enabled.

Protocol Emulation:

→ *L.2 State Machine*

The following commands control the operation of the layer 2 data link state machine and the user management layer or the network assignment source procedure. The layer 2 state machine can be turned off to send a response to a layer 2 received frame.

L2_ON (--)
Enables the layer 2 data link state machine.

L2_OFF (--)
Disables the layer 2 data link state machine.

?L2_ON (-- flag)
Returns true if the layer 2 data link state machine is enabled.

ML_ON (--)
Enables the operation of the user management layer or the network assignment source procedure layer.

ML_OFF (--)
Disables the operation of the user management layer or the network assignment source procedure layer.

?ML_ON (-- flag)
Returns true if the user management layer or the network assignment source procedure layer is enabled.

Example:
Enable layer 2 data link state machine, and user management layers.

```
L2_ON
ML_ON
```

ON function key

Special SAPI:

→ *Packet Communication*

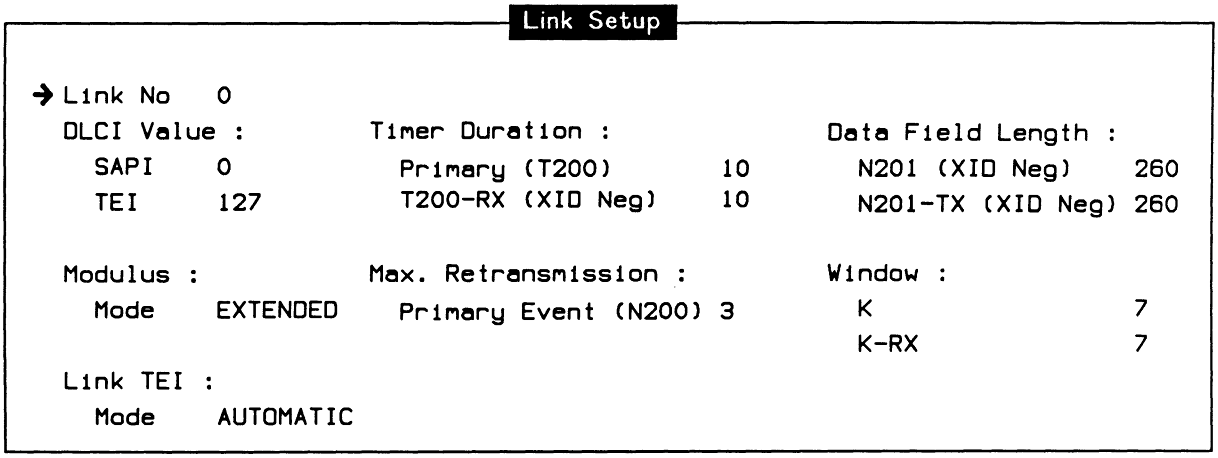
Decodes layer 3 information within layer 2 I or UI frames with a specified SAPI value according to the X.25 (1980/1984) protocol.

NOTE
This SAPI value cannot be changed within test scripts. Use the Emulation Configuration Menu to modify this SAPI.

DATACOM−SAPI# (-- value)
Returns the value of the data communications (packet data) SAPI (default value is 16).

Link Setup

The following commands and variables apply only to the selected link.



```
                                    Link Setup

→ Link No    0
  DLCI Value :          Timer Duration :                Data Field Length :
    SAPI      0           Primary (T200)         10       N201 (XID Neg)      260
    TEI       127         T200-RX (XID Neg)      10       N201-TX (XID Neg)   260

  Modulus :             Max. Retransmission :           Window :
    Mode      EXTENDED    Primary Event (N200) 3          K                   7
                                                          K-RX                7
  Link TEI :
    Mode      AUTOMATIC
```

Figure 16–6 Link Setup Menu

→ *Link No*
Specifies a particular link CES (connection endpoint suffix).

CES* (-- address)
Contains the current CES. Valid values are 0 through 7.

SA (value --)
Selects a particular link CES. Valid values are 0 through 7.

Modify Value function key

DLCI Value:
→ *SAPI*
Sets the SAPI (service access point identifier) for the selected link.

SAPI* (-- address)
Contains the SAPI for the currently selected link. Standard values include:

0	Used for call setup signaling.
16	Used for D–Channel packet communication (X.25).
63	Used for management / ASP layer.

SAPI (value --)
Sets the SAPI for the selected link.

Example:
Set the SAPI for the current link to 63.

```
63 SAPI
```

Modify Value function key

→ *TEI*
Sets the TEI (terminal endpoint identifier) for the selected link.

VTEI* (-- address)
Contains the TEI for the currently selected link.

TEI or **FTEI** (value --)
Sets the current TEI without affecting the layer 2 state machine. Valid values are 0 through 127. The layer 2 state machine is not affected. Default values include:

127	Basic Rate (TEI not yet assigned).
0–7	Primary Rate and WAN.

Example:
Set the TEI for the current link to 1.

```
1 TEI
```

Modify Value function key

ATEI (value --)
Assigns the current TEI to 'value'. For the user, both the layer 2 and management layer states are changed to the TEI assigned state (state 4). For the network, the layer 2 state is changed to the TEI assigned state (state 4). Valid values are 0 through 126.

Modulus:
→ *Mode*
Determines whether normal (modulo 8) or extended (modulo 128) frame operation is used.

MODE (value --)
Where: value = 0 – normal (modulo 8)
1 – extended (modulo 128)

Sets the modulus operation mode.

MODE–FLG* (-- address)
Contains the current setting of the modulus mode. 0 indicates normal mode (default) and 1 indicates extended mode.

MODULUS* (-- address)
Contains the modulus value for the currently selected link. Valid values are 8 or 128.

Link TEI:

→ *Mode*

The link TEI mode can be either manual or automatic. Manual mode is used, for example, when testing equipment has a 'hard-wired' TEI. When the link TEI mode is set to manual, the TEI request procedure is disabled and the TEI value in VTEI* is set.

PREF-TEI* (-- address)

Contains the current setting of the link TEI mode. 0 indicates automatic mode (default) and 1 indicates manual mode. After setting the preferred TEI setting, the MDL_ASSIGN_R command (see Section 17) should be executed to indicate to the management layer entity that the specified TEI should be associated with the current link. This link will then be in state 4 (TEI assigned).

Timer Duration:

→ *Primary (T200)*

T200-DUR* (-- address)

Contains the current value, in tenths of seconds, for the T200 timer (default is 1 second).

T200 (value --)

Specifies the time, in tenths of seconds, between SABM/E retransmissions during link setup. It also sets the value of the T201 timers equal to that of the T200 timer and sets the T202 timer to twice that of the T200 timer (default is 1 second).

Example:
If the T200 timer is set for less than 2 seconds, set to 2 seconds.

```
T200-DUR* @ 20 <
IF
  20 T200
ENDIF
```

✍ *Modify Value* function key

The T200 timer can be set to a preferred value without setting values in the T201 and T202 timers.

T200-DUR# (-- value)

Returns the preferred value, in tenths of seconds, of the T200 timer (default is 1 second).

PT-T200 (value --)

Sets the preferred value, in tenths of seconds, of the T200 timer.

Example:
If the preferred value of the T200 timer is less than 1 second, set to 1 second.

```
T200-DUR# 10 <
IF
  10 PT-T200
ENDIF
```

→ *T200-RX (XID Neg)*
Specifies the maximum length of a received I or UI frame for the XID negotiate procedure.

T200-RX* (-- address)
Contains the value, in tenths of seconds, for the T200 timer during XID negotiation (default is 1 second).

T200RX (value --)
Sets the value, in tenths of seconds, of T200 timer for XID negotiation (default is 1 second).

Example:
When the T200 timer for XID negotiation is less than 1 second, set to 1 second.

```
T200-RX* @ 10 <
IF
  10 T200RX
ENDIF
```

✎ *Modify Value* function key

Max. Retransmission:
→ *Primary Event (N200)*
The maximum number of times that a frame is retransmitted after the expiry of the T200 timer is determined by N200.

N200* (-- address)
Contains the current setting of N200 (default value is 3).

N200 (value --)
Sets the value of N200.

✎ *Modify Value* function key

Data Field Length:
→ *N201 (XID Neg)*
N201 represents the maximum number of octets in an I frame information field.

N201* (-- address)
Contains the value for N201 (default is 260).

N201 (value --)
Sets the value of N201. Valid values are 0 through 286.

Example:
If N201 does not equal 260, set to 260.

```
N201* @ 260 = 0=
IF
  260 N201
ENDIF
```

✎ *Modify Value* function key

N201# (-- value)
Returns the preferred maximum receive packet size.

PT-N201 (value --)
Sets the preferred maximum receive packet size (default is 260).

Example:
When the preferred maximum receive packet size is less than 260, set to 260.

```
N201# 260 <
IF
  260 PT-N201
ENDIF
```

→ *N201-TX (XID Neg)*
Specifies the maximum length of the information field in transmitted I or UI frames.

N201-TX* (-- address)
Contains the value of N201 for transmit frames (default is 260).

N201TX (value --)
Sets the value of N201 for transmit frames.

✎ *Modify Value* function key

N201 can be set to a preferred value for outgoing frames.

N201-TX# (-- value)
Returns the preferred maximum outgoing packet size.

PT-N201TX (value --)
Sets the preferred maximum outgoing packet size.

Window:
→ *K*
Specifies the maximum number of I frames that can be transmitted before a response is received.

K* (-- address)
Contains the current setting of the window size (default is 7).

K (value --)
Sets the window size.

✎ *Modify Value* function key

The window size can be set to a preferred value.

K# (-- value)
Returns the preferred value of the window size.

PT-K (value --)
Sets the preferred value of the window size.

→ *K-RX*
Specifies the requested value of k (transmit window) for the peer. Used during XID negotiate procedures.

K-RX* (-- address)
Contains the current setting of the window size received from the peer following an XID negotiation (default value is 7).

KRX (value --)
Sets the preferred value of K transmitted in an XID frame.

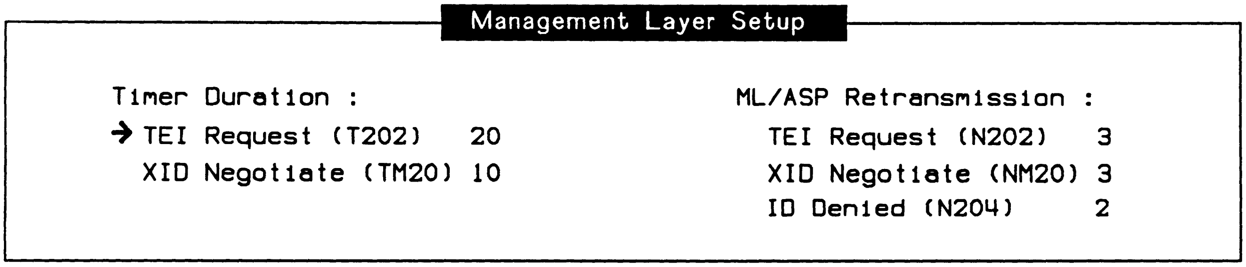
✎ *Modify Value* function key

MAX* (-- address)
Contains the maximum number of outstanding I frames.

W (value --)
Sets the window parameters. Sets K to equal 'value' and sets MAX* to 'value - 1'.

Management Layer/Assignment Source Procedure Setup

The management layer/assignment source procedure setup specifies the parameters used during TEI assignment and XID negotiation.



```
                         Management Layer Setup

    Timer Duration :                       ML/ASP Retransmission :
  → TEI Request (T202)   20                  TEI Request (N202)    3
    XID Negotiate (TM20) 10                  XID Negotiate (NM20) 3
                                             ID Denied (N204)      2
```

Figure 16–7 Management Layer Setup Menu

Timer Duration:

→ *TEI Request (T202)*
Specifies the minimum time between retransmission of the TEI identity request messages. The value of T202 should be set to 4 * T200 seconds.

T202-DUR# (-- value)
Returns the value, in tenths of seconds, of T202 (default is 2 seconds).

T202 (value --)
Sets the value, in tenths of seconds, of T202.

Example:
If T202 is less than 2 seconds, set to 2 seconds.

```
T202-DUR# 20 <
IF
  20 T202
ENDIF
```

→ *XID Negotiate (TM20)*
Specifies the response time of a peer to an XID frame. If a response is not received prior to the expiry of TM20, the XID frame is retransmitted.

TM20-DUR# (-- value)
Returns the value, in tenths of seconds, of TM20 (default is 1 second).

TM20 (value --)
Sets the duration, in tenths of seconds, of the XID procedure timer.

ML/ASP Retransmission:

→ *TEI Request (N202)*
Specifies the maximum number of TEI assignment requests retransmissions.

N202* (-- address)
Contains the value of N202 (default is 3).

N202 (value --)
Sets the value of N202.

→ *XID Negotiate (NM20)*
Specifies the maximum number of XID command frame retransmissions.

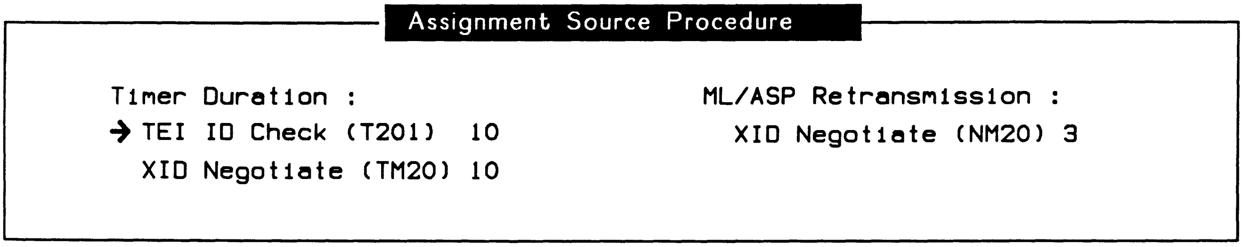
NM20* (-- address)
Contains the value of NM20.

NM20 (value --)
Sets the value of NM20 (default is 3).

→ *ID Denied (N204)*
Specifies the maximum number of times that a user attempts to acquire a TEI due to ID denials from the network.

N204* (-- address)
Contains the value of N204.

N204 (value --)
Sets the value of N204 (default is 2).



```
                        Assignment Source Procedure

    Timer Duration :                         ML/ASP Retransmission :
  → TEI ID Check (T201)  10                    XID Negotiate (NM20) 3
    XID Negotiate (TM20) 10
```

Figure 16–8 Assignment Source Procedure Menu

Timer Duration:
→ *TEI ID Check (T201)*
Specifies the minimum time between network retransmission of the TEI identity check message.

T201–DUR# (-- value)
Returns the value, in tenths of seconds, of the T201 timer (default is 1 second).

T201 (value --)
Sets the value, in tenths of seconds, of the T201 timer (default is 1 second).

NOTE
See the Management Layer Setup Menu for descriptions of the XID Negotiate items.

17
LAYER 2 EMULATION

This section describes commands used during layer 2 emulation.

Section 17.1 describes commands that can be used inside or outside of the state machine. These commands change the state of the state machine or modify the outgoing frame appropriately.

Section 17.2 describes the in-state commands, such as state machine control, layer 2 services, and the in-state send commands. These commands are used under the control of the state machine.

Section 17.3 describes the out-of-state commands. These commands can be used in any state that the state machine can be in. A number of commands are provided as support to the out-of-state words. These commands can change the fields inside the outgoing frame, as well as changing the state of the machine. In essence, it is possible to change any parameter of the outgoing frame as needed.

Section 17.4 describes transmit mode commands, i.e. continuous or repetitive information frame transmission.

17.1 State–Independent Commands

The following commands can be used inside or outside of the state machine. In either case, they change the outgoing frame appropriately or change the state of the state machine.

BROADCAST (--)
Sets the layer 2 emulation for broadcast mode. UI frames use a TEI of 127.

PT_TO_PT (--)
Sets the layer 2 emulation to use the current TEI for transmitted UI frames.

Command/Response Bits

CMND* (-- address)
Contains the value of the command bit (0 or 1).

✎ Control Field Setup Menu
→ *C Bit*

RESP* (-- address)
Contains the value of the response bit (0 or 1).

✎ Control Field Setup Menu
→ *R Bit*

State Variables

State variables are used to keep track of frames transmitted between peers with sequence numbers cycling through the number of frames (as set by the MODE command, see Section 16).

VS (value --)
Specifies the V(S) (send state variable) count identifying the sequence number of the next information frame transmitted by the tester. Valid values are 0 through n – 1, where n is the modulus number.

✎ Send Link Setup Menu
→ *VS*

VS* (--address)
Contains the current V(S).

✎ Send Link Setup Menu
→ *VS*

VA (value --)
Specifies the V(A) (acknowledge state variable) count identifying the sequence number of the last acknowledged frame. Valid values are 0 through n – 1, where n is the modulus number.

✎ Send Link Setup Menu
→ *VA*

VA* (--address)
Contains the current V(A).

✎ Send Link Setup Menu
→ *VA*

VR (value --)
Specifies the V(R) (receive state variable) count identifying the sequence number of the next in sequence information frame expected to be received. Valid values are 0 through n - 1, where n is the modulus number.

✎ Send Link Setup Menu
→ *VR*

VR* (--address)
Contains the current V(R).

✎ Send Link Setup Menu
→ *VR*

FRMR Bits

The frame reject response indicates to the peer that it is unable to recover from an error in transmission. The error cannot be recovered by merely retransmitting the frame. The reason for rejecting the frame is carried in four bits: W, X, Y, and Z bits.

The W bit, when set to 1, indicates that the received control field was undefined or not implemented. The bad control field is returned in octets 5 and 6 of the FRMR frame.

The X bit, when set to 1, indicates that the received control field was invalid because a received information field was not valid with that frame, or the frame was a supervisory or unnumbered frame with an invalid length.

The Y bit, when set to 1, indicates that the length of the received information field exceeded the length set in N201.

The Z bit, when set to 1, indicates that the N(R) value was invalid.

W0 (--)
Sets the W bit to 0.

✎ Control Field Setup Menu
→ *W Bit (0)*

W1 (--)
Sets the W bit to 1.

✎ Control Field Setup Menu
→ *W Bit (1)*

FRMRW* (--address)
Contains the value of the W bit.

X0 (--)
Sets the X bit to 0.

✎ Control Field Setup Menu
→*X Bit (0)*

X1 (--)
Sets the X bit to 1.

✎ Control Field Setup Menu
→*X Bit (1)*

FRMRX* (--address)
Contains the value of the X bit.

Y0 (--)
Sets the Y bit to 0.

✎ Control Field Setup Menu
→*Y Bit (0)*

Y1 (--)
Sets the Y bit to 1.

✎ Control Field Setup Menu
→*Y Bit (1)*

FRMRY* (--address)
Contains the value of the Y bit.

Z0 (--)
Sets the Z bit to 0.

✎ Control Field Setup Menu
→*Z Bit (0)*

Z1 (--)
Sets the Z bit to 1.

✎ Control Field Setup Menu
→*Z Bit (1)*

FRMRZ* (--address)
Contains the value of the Z bit.

Example:
Send a frame reject indicating that the received information field exceeded the maximum field length (specified by N201).

```
W0
X0
Y1
Z0

FRMR
```

Retransmission Counters

The retransmission counters are used by the state machine to count the number of times that a frame has been retransmitted.

NOTE
The state machine clears the counters when it begins retransmission. However, a counter can be set to a desired value inside a test script.

RC (value --)
Specifies the RC (retransmission counter) identifying the number of times a particular poll sequence has been transmitted to the peer.

Send Link Setup Menu
→ *Retransmission (RC)*

Example:
Without changing the value of N200, change the retransmission count of SABME's sent to a non-responding peer.

```
SABME     ( sends SABMEs )
```

After the first SABME is transmitted, type:

```
1 RC
```

This has the effect of only sending one retransmission of the SABME.

RC* (-- address)
Contains the retransmission counter value.

Send Link Setup Menu
→ *Retransmission (RC)*

PRC (value --)
Specifies the PRC (poll/response counter) identifying the current number of outstanding polls.

Send Link Setup Menu
→ *Poll/Response (PRC)*

APC (value --)
Sets the advance poll counter. The advance poll counter specifies the current number of unacknowledged outstanding polls transmitted in advance of an information frame.

APC* (-- address)
Contains the advance poll counter value.

RC20 (value --)
Sets the value of the XID retransmission counter.

RC20* (-- address)
Contains the XID retransmission counter value.

RC201 (value --)
Sets the value of the 201 retransmission counter. This counter is used only by the network assignment source procedure during an identification check request sequence.

RC201* (-- address)
Contains the value of the 201 retransmission counter.

RC-ML1* (-- address)
Contains the number of TEI assignment requests.

RC-ML2* (-- address)
Contains the number of attempts to acquire a TEI value, due to ID denials from the network.

Miscellaneous

XIDV (N201 TX\N201\K\T200 --)
Sets the XID variables N201-TX*, N201*, K-RX*, and T200-RX* respectively. These values are used in the next XID frame that is transmitted.

Link Setup Menu
→ *N201-TX (XID Neg)*
→ *N201 (XID Neg)*
→ *K-RX*
→ *T200-RX (XID Neg)*

Example:
Send an XID frame indicating a field length of 260 for both the transmitter and receiver, 7 for the transmit window size, and a 1 second duration for the retransmission timer.

```
260             ( N201 TX )
260             ( N201 )
7               ( K )
10              ( T200 in tenths of seconds )
XIDV            ( Defines XID variables)
XIDC            ( Sends the XID command frame )
```

NRVALID* (-- address)
Contains a flag which is true if the incoming frame has a valid N(R).

K-CCITT* (-- address)
Contains the CCITT default value of K.

17.2 In-State Commands

The following commands are executed under control of the layer 2 state machine. All frames sent as a result of these commands use values for NR, NS, P, F, W, X, Y, and Z that are determined totally by the state machine.

State Machine Control

The following commands change the state of the application.

L2ST (value --)
Sets the data link layer state of the currently selected link. Refer to Table 17-1 for valid layer 2 state values.

✍ Send Link Setup Menu
→ *L.2 State*

STATE-L2* (--address)
Contains the layer 2 state for the currently selected link.

✍ Send Link Setup Menu
→ *L2 State*

MLST (value --)
Sets the state of the user management layer for the currently selected link. Refer to Table 17-2 for the valid management state values.

STATE-ML* (--address)
Contains the management layer state for the currently selected link.

ASPST (value --)
Sets the state of the network assignment source procedure. Refer to Table 17-3 for valid ASP state values.

STATE-ASP* (--address)
Contains the assignment source procedure state for the currently selected link.

Layer 2 States		
State	CCITT	Description
1	1	TEI unassigned
2	2	TEI being assigned
3	3	Awaiting TEI and establishment
4	4	TEI assigned
5	5	Waiting for establishment
6	6	Release waiting
		Normal States
70	7.0	Normal
71	7.1	Reject
72	7.2	Own receiver busy
73	7.3	Own receiver busy and reject
74	7.4	Peer receiver busy
75	7.5	Peer receiver busy and reject
76	7.6	Peer receiver and own receiver busy
77	7.7	Peer receiver and own receiver busy and reject
		Timer Recovery States
80	8.0	Normal
81	8.1	Reject
82	8.2	Own receiver busy
83	8.3	Own receiver busy and reject
84	8.4	Peer receiver busy
85	8.5	Peer receiver busy and reject
86	8.6	Peer receiver and own receiver busy
87	8.7	Peer receiver and own receiver busy and reject

Table 17–1 Layer 2 States

Management States	
State	Description
1	TEI unassigned
2	TEI being assigned
3	XID response waiting
4	TEI assigned

Table 17–2 Management States

ASP States	
State	**Description**
1	Idle
2	TEI being assigned
3	TEI checking

Table 17–3 ASP States

Services

The layer 2 services are primitive operations provided between the data link layer and the management layer.

Primitives prefixed with 'DL' are used for communication between the data link layer and layer 3.

Primitives prefixed with 'MDL' are used for communication between the management layer and the data link layer.

These commands are executed under the control of the layer 2 state machine.

DL_ESTABLISH (--)
Establishes a layer 2 connection. If the bus is not activated (BRA only), then DL_ESTABLISH activates the bus. If a TEI is not already assigned, then the TEI assignment procedure is executed (user side only) and if the XID (exchange identification) process is enabled, then it is executed. An SABM or SABME is sent and the emulation waits for a UA response.

Services topic
Establish function key

DL_RELEASE (--)
Releases a layer 2 connection. A DISC (disconnect) frame is sent. When a UA frame is received, the link goes into the TEI assigned state.

Services topic
Release function key

MDL_ASSIGN_R (TEI --)
Associates the current link with the given TEI.

NOTE
This command is used only in states 1 or 3 for the network, 2 or 3 for the user.

MDL_ASSIGN_I (--)
Used by the data link layer to indicate to the layer management entity, the need for a TEI to be associated with the CES specified in the primitive message unit.

MDL_REMOVE (--)

Used by the layer management to request that the data link layer remove the association between the current TEI value with the specified CES. The sub-address specifies the data link from which the TEI is to be removed.

RESET_BUSY (--)

If the layer 2 state machine is in an 'own receiver busy' state, then issuing this command causes the emulation to send out a RR frame. The layer 2 emulation then changes to a state to accept information frames.

If the layer 2 state machine is not in an 'own receiver busy' state, then no action occurs.

Services topic
Unbusy function key

MAKE_BUSY (--)

The emulation sends out a RNR frame, with the poll bit set to 1 if the layer 2 state machine is not in an 'own receiver busy' state. The layer 2 state machine then goes into an 'own receiver busy' state.

If the peer sends a RR frame, the layer 2 state machine responds with a RNR frame.

If the layer state machine is already in an 'own receiver busy' state, then no action occurs.

Services topic
Busy function key

?OWN_BUSY (-- flag)

Returns true if the layer 2 state machine is in one of the 'own receiver busy' states.

Send Commands

The following commands operate under the control of the layer 2 state machine. Consequently, the sent frames use values for the C/R bit, the P/F bit, N(R), N(S), W, X, Y, and Z that are determined by the state machine. The current values of these variables prior to executing the commands are ignored, even though they might have been changed. The transmitted SAPI and TEI values are the current values.

SABM (--)

Transmits a SABM (set asynchronous balance mode) frame. The emulation expects a UA frame in response, otherwise it will transmit the SABM frame N200 times. After receiving a UA frame, the emulation will be in the information transfer state (state 7.0).

Sending a SABM sets the MODE flag to 0 (normal mode).

Send topic
SABM function key

SABME (--)

Transmits a SABME (set asynchronous balance mode extended) frame. The emulation expects a UA frame in response, otherwise it will retransmit the SABME frame N200 times. After receiving a UA frame, the emulation will be in the information transfer state.

Transmitting a SABME sets the MODE flag to 1 (extended mode).

Send topic
SABME function key

UA (--)

Transmits a UA (unnumbered acknowledge) frame.

Send topic
UA function key

RRC (--)

Transmits an RR (receiver ready frame) with the command bit set.

Send topic
RR function key

RNRC (--)

Transmits a RNR (receiver not ready) frame with the command bit set.

Send topic
RNR function key

REJC (--)

Transmits a REJ (reject) frame with the command bit set.

Send topic
REJ function key

DISC (--)

Transmits a DISC (disconnect) frame. The emulation expects a UA response. When the UA frame is received, the emulation will go into the disconnect mode.

Send topic
DISC function key

DM (--)

Transmits a DM (disconnected mode) frame. This indicates to the peer that the data link layer is in a state where multiframe operation cannot be performed.

Send topic
DM function key

FRMR (--)

Transmits an FRMR (frame reject) frame. The values for the W, X, Y, and Z bits are taken from the values set by W0, W1, X0, X1, etc.

Send topic
FRMR function key

XIDC (--)

Initiates the XID (exchange identification) procedure and transmits an XID frame with the parameters N201 transmit, N201 receive, K, and T200 set to the preferred values.

Send topic
XID function key

SEND_I (address\length --)

Transmits a single information frame.

Example:
Transmit a layer 3 ALERT message.

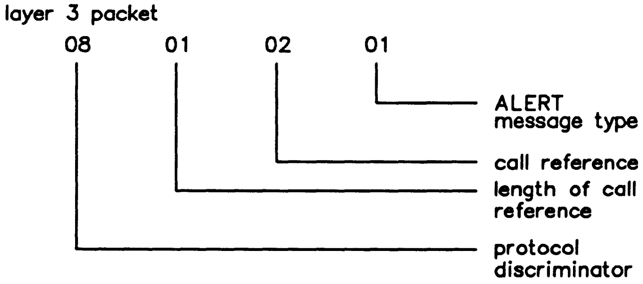


Figure 17–1 Alert Message

```
X" 08010201"          ( X" signifies hex data )
COUNT                 ( Returns the length of the string )
SEND_I
```

Send topic
I function key

SEND_UI (address\length --)

Transmits an unnumbered layer 3 I frame.

Send topic
L.3 UI function key

SEND_MUI (address\length --)

Transmits an unnumbered management layer/assignment source procedure I frame. The SAPI value used is 63.

Send topic
ML UI function key

Commands Using Data Buffers

Data buffers can only be used with the DL_DATA, DL_UDATA or MDL_UDATA in-state commands or with the SENDF, S:DATA, S:UDATA or S:MUDATA out-of-state commands (see Section 17.3). The data buffers hold user specified data.

PKT (value --)
Specifies the buffer used as the data source for a send command. Valid buffers are 1 through 8. If the specified buffer is 0, keyboard entry is used.

PKT? (-- value)
Returns the buffer used as the data source for a send command. A 0 indicates that keyboard entry is used.

MD1, MD2, MD3, MD4, MD5, MD6, MD7, MD8 (address--)
Sets the contents of the buffers 1 through 8 to the specified string. See the example following DL_DATA.

DL_DATA (address --) or (--)
Transmits a layer 3 packet using acknowledged operation.

This command expects either a string address or nothing on the stack. If PKT has been set to a buffer number, the contents of the buffer is sent. If PKT is set to 0, a string address must be specified.

Example:
Send a layer 3 call proceeding packet.

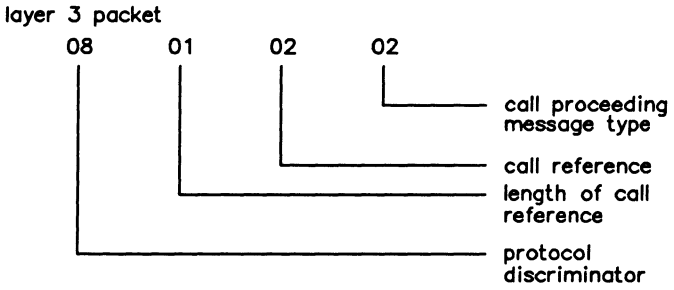


Figure 17–2 Call Proceeding Message

```
X" 08010202"  MD1        ( Stores string in MD1 )
1 PKT                    ( Use buffer MD1 )
DL_DATA
```

DL_UDATA (address --) or (--)
Transmits a layer 3 packet using unacknowledged operation.

NOTE
This command is used in the same way as DL_DATA.

MDL_UDATA (address --) or (--)
Transmits a management layer (or assignment source procedure) packet using unacknowledged operation.

NOTE
This command is used in the same way as DL_DATA.

17.3 Out–of–State Commands

The following commands send frames outside the layer 2 state machine.

These commands use the existing values of SAPI, TEI, NR, NS, P, F, W, X, Y, and Z as needed. Since these values can be changed, the frames differ from those sent under the control of the layer 2 state machine.

Sequence Numbers

Sequence numbers are state variable numbers that are transmitted inside the frame. N(R) is the expected send sequence number of the next received information frame. N(S) is the send sequence number of transmitted information frames.

NR (value --)
Sets the value of N(R). Valid values are 0 through n – 1, where n is the modulus number (8 or 128).

Control Field Setup Menu
→ *NR*

MNR* (-- address)
Contains the value of N(R).

NS (value --)
Sets the value of N(S).

Control Field Setup Menu
→ *NS*

MNS* (-- address)
Contains the value of N(S).

P/F Bit

In command frames, the P/F bit is referred to as the P (poll) bit; in response frames, it is referred to as the F (final) bit. The P bit is set to 1 in order to solicit a response from the peer. The F bit set to 1 indicates that the frame is being sent in response to a poll.

F1 (--)
Sets the F bit to 1.

✍ Control Field Setup Menu
→ *F Bit (1)*

F0 (--)
Sets the F bit to 0.

✍ Control Field Setup Menu
→ *F Bit (0)*

P1 (--)
Sets the P bit to 1.

✍ Control Field Setup Menu
→ *P Bit (1)*

P0 (--)
Sets the P bit to 0.

✍ Control Field Setup Menu
→ *P Bit (0)*

Send Commands

SENDF (address --) or (--)
Transmits a user-defined string as a layer 2 frame. The entire frame, including the header, is defined inside the string. SENDF uses the data buffers, as described in Section 17.2.

Example:
Transmit a SABME using the SENDF command.

```
X" 00817F"  MD1
1 PKT
SENDF
```

S:SABME (--)
Transmits a SABME (set asynchronous balanced mode extended) command frame.

S:SABM (--)
Transmits a SABM (set asynchronous balance mode) command frame.

S:UA (--)
Transmits a UA (unnumbered acknowledge) command frame.

S:RRC (--)
Transmits an RR (receiver ready) command frame.

S:RR (--)
Transmits an RR (receiver ready) response frame.

S:RNRC (--)
Transmits an RNR (receiver not ready) command frame.

S:RNR (--)
Transmits an RNR (receiver not ready) response frame.

S:REJC (--)
Transmits an REJ (reject) command.

S:REJ (--)
Transmits an REJ (reject) response.

S:DISC (--)
Transmits a DISC (disconnect) command.

S:DM (--)
Transmits a DM (disconnected mode) response.

S:FRMR (--)
Transmits an FRMR (frame reject) response.

S:XIDC (--)
Transmits an XID (exchange identification) command.

S:XID (--)
Transmits an XID (exchange identification) response.

S:XID0 (--)
Transmits an XID (exchange identification) response with an information field length of zero.

S:XID4 (--)
Transmits an XID (exchange identification) response with the first four header bytes of the XID packet.

S:XIDC0 (--)
Transmits an XID (exchange identification) command with an information field length of zero.

S:XIDC4 (--)
Transmits an XID (exchange identification) command with the first four header bytes of the XID packet.

S:I (address\length --)
Transmits an I (information) frame. The layer 3 data is specified by the given address and length.

S:UI (address\length --)
Transmits a UI (unnumbered information) frame.

S:MUI (address\length --)
Transmits a UI (unnumbered information) frame, but with a SAPI of 63 for layer 2 management procedures.

NOTE
The SEND_I, SEND_UI, SEND_MUI, S:I, S:UI, and S:MUI send commands are usually used in conjunction with a layer 3 data source command. See Section 18.1 for a description of the data source commands.

S:DATA (address --) or (--)
Transmits a layer 3 packet in an I frame using acknowledged operation. S:DATA uses the data buffers as described in Section 17.2.

S:UDATA (address --) or (--)
Transmits a layer 3 packet in a UI frame using unacknowledged operation. S:UDATA uses the data buffers as described in Section 17.2.

S:MUDATA (address --) or (--)
Transmits a management layer (or assignment source procedure) packet in a UI frame with SAPI 63 using unacknowledged operation. S:MUDATA uses the data buffers as described in Section 17.2.

17.4 Transmit Mode

PKTS (value --)
Specifies the number of times to transmit an information frame.

Send Data Source Menu
→ *Queuing Procedure*
Repetitive function key

CONT_ON (--)
Sets the continuous information frame transmit mode.

Send Data Source Menu
→ *Queuing Procedure*
Continuous function key

CONT_OFF (--)
Turns off the continuous information frame transmit mode.

17.5 Frame Errors

Frames and messages can be sent with correct or incorrect CRC's (FCS), or can be aborted during transmission.

CRC_ERROR (--)
Transmits the next frame or message with a CRC error. Subsequent frames and messages will be sent correctly.

DO_ABORT (--)
Aborts the next transmitted frame or message. Subsequent frames and messages will be sent correctly.

GOOD_CRC (--)
Transmits the next frame or message correctly.

18
LAYER 3 SIMULATION

The ISDN D-Channel layer 3 simulation is used to create either correct or incorrect layer 3 messages. The sequence of these messages can be controlled by received events, keyboard commands, timers, other programs, etc. Simulation differs from emulation in that emulation provides a full and correct implementation of either the network or user side of the protocol. The emulation does not send any incorrect or out of sequence messages.

The simulation environment provides functions which, when used in conjunction with the test manager, give a very powerful and flexible base for simulation of ISDN D-Channel signalling. This section presents an overview of the commands that can be used to provide ISDN simulation.

Simulation of the D-Channel layer 3 protocol can be implemented in various degrees of complexity depending on the requirement and experience of the user.

18.1 Layer 3 Data Source

Several data sources are used for layer 3 send commands. Transmitted data can be a pre-defined raw data packet, a layer 3 default message or the contents of a message pool buffer.

RAW (type -- address\length)

Where: type = 1 consecutive integers
2 all 1s (hex FF)
3 all 0s (hex 00)
4 alternating 1s and 0s (hex 55)

Returns the address and length of a buffer containing data. This raw data can subsequently be sent inside an information frame.

✎ Send Data Source Menu
→ *Data Source*
Predefined Packets function key

BYTES (value --)

Sets the number of bytes (maximum is 260) to be transmitted in a raw information frame.

Example:
Transmit a layer 3 packet, 20 bytes long, containing all 1s.

```
20 BYTES        ( Length of I frame )
2 RAW           ( Select data type )
SEND_I          ( Send the I frame )
```

POOL (string -- address \ length)
Returns the address and length of the specified pool buffer. See Section 18.5 for a description of managing pool buffers.

Example:

```
" SETUP#1" POOL SEND_UI
```

MESG (message identifier -- address \ length)
Returns the address and length of a pre-defined layer 3 message of the specified message type. See Section 18.4 for a description of the message builder.

Example:

```
M#REL MESG SEND_I
```

Command Type	Frame Type	In-State	Out-of-State
General (addr \ count --)	I	SEND_I	S:I
	UI	SEND_UI	S:UI
	MUI	SEND_MUI	S:MUI
Command/MD buffer (string --) or (--)	I	DL_DATA	S:DATA
	UI	DL_UDATA	S:UDATA
	MUI	MDL_UDATA	S:MUDATA
Message (message id --)	I	MESG SEND_I	MESG S:I
	UI	MESG SEND_UI	MESG S:UI
	MUI	MESG SEND_MUI	MESG S:MUI
Pool (string --)	I	POOL SEND_I	POOL S:I
	UI	POOL SEND_UI	POOL S:UI
	MUI	POOL SEND_MUI	POOL S:MUI
Raw (n --)	I	RAW SEND_I	RAW S:I
	UI	RAW SEND_UI	RAW S:UI
	MUI	RAW SEND_MUI	RAW S:MUI

Table 18–1 Send Commands

The data source buffer can be modified before sending to use a specific call reference value and flag.

ALTER_CR (address \ length -- address \ length)
Modifies the call reference in the specified layer 3 message.

DEST_SIDE (--)
Sets the call reference flag of subsequent messages modified with ALTER_CR to 1 (destination side).

ORIG_SIDE (--)
Sets the call reference flag of subsequent messages modified with ALTER_CR to 0 (origination side).

RX-CALLREF (-- address)
Contains the call reference value used when the message is sent from the call destination side.

TX-CALLREF (--)
Contains the call reference value used when the message is sent from the call origination side.

Example:
Use a call reference value of 10 for a connect message sent from the call origination side.

```
10 TX-CALLREF !
ORIG_SIDE
M#CONN MESG ALTER_CR SEND_I
```

18.2 Connection Management

Layer 3 simulation supports signalling procedures for up to eight simultaneous connections (CN's). Connections are distinguished from each other by their call reference value. When a layer 3 message is received, the call reference is compared against all connections. If matched, the data structure for that connection is made 'active', and the data it contains is used in generating the simulator's response to the event.

There are eight identical data structures which contain data for each connection. At any one time, only one of these connections (and hence only one of the data structures) is 'active', and any reading or writing of connection-related data is done using the active data structure.

#CN0, #CN1, #CN2, #CN3, #CN4, #CN5, #CN6, #CN7 (-- value)
Identifies the connection.

=CN (CN --)
Sets the active connection.

Example:

```
#CN3 =CN     ( Makes connection 3 the current connection )
```

?CN (-- currently active CN)
Returns the currently active connection.

CN0, CN1, CN2, CN3, CN4, CN5, CN6, CN7 (--)
Sets the active connection.

The following commands are used to manipulate the data for each connection.

CLEAR_CN (--)
Clears the data structure associated with the current connection. The data structure can then be reused for a new connection.

CLEAR_ALL_CNS (--)
Resets all data for all connections.

WARNING
Use this command with caution.

CN_DEALLOC (--)
Flags the current connection as being unused.

?CN_FREE (-- flag)
Returns true if the current connection is unused.

?CN_ALLOC (-- CN\1) or (-- 0)
Searches for an unused connection. If found, the connection is cleared, flagged as being in use, and the connection number and a true flag are returned. If no unused connections exist, a false flag is returned.

COPY_CN (src CN\dest CN --)
Copies the connection data from one connection to another.

CN_INIT (flag\SAPI --)

Where: flag =	#ORIG	origination side
	#DEST	destination side

Sets the SAPI, call reference flag, and call reference value for the current connection. In addition, this command sets the default information element field values, and generates default parameter values for all information elements for the current connection.

If the call reference flag is specified as the destination side, then the call reference value for this connection is automatically set to the last decoded message. The call reference value is taken from $MSG-CRVALUE.

If the call reference flag is specified as the origination side, then the call reference value for this connection can be set using the SELECT_CR command.

Connection Related Data Management

The following data is kept for each connection:

- An 'in use' flag.
- The current test manager state number.
- The channel type in use for the connection (B or D-Channel).
- The channel number in use for the connection (only valid when channel type is B).
- The national and international protocol discriminators.
- The SAPI (service access point identifier).
- The CES (connection endpoint suffix).
- The call reference flag.
- The call reference value.
- A set of all the information element parameters used in coding layer 3 messages.
- A set of pre-coded IE's.

=CN_TM_STATE (state --)
?CN_TM_STATE (-- state)
Sets or reads the state of the connection test manager state.

NOTE
See Section 20.6 for a description of how the layer 3 connection multiplexer manages the connection test manager state.

=CN_CHANNEL_TYPE (type --)
?CN_CHANNEL_TYPE (-- type)

Where: type =	#D_CHAN	D-Channel
	#B_CHAN	B-Channel

Sets or reads the channel type of the current connection.

NOTE
Setting or clearing the channel type does not affect connection management. Rather, these commands provide a convenient location to store and access the channel type.

Example:
Specify that the channel being used for the current connection is a D-Channel.

```
#D_CHAN =CN_CHANNEL_TYPE
```

=CN_CHANNEL_NUM (number --)
?CN_CHANNEL_NUM (-- number)
Sets or reads the channel number.

NOTE
Setting or clearing the channel number does not affect connection management. Rather, these commands provide a convenient location to store and access the channel number.

=CN_INT_PD (pd --)
?CN_INT_PD (-- pd)
Sets or reads the international protocol discriminator. If set, this value will be used for all international (single octet message type) messages built with the MESSAGE> and MESG commands. The default protocol discriminator for each message type will be used if this value is not set.

=CN_NAT_PD (pd --)
?CN_NAT_PD (-- pd)
Sets or reads the national protocol discriminator. If set, this value will be used for all national (two octet message type) messages built with the MESSAGE> and MESG commands. The default protocol discriminator for each message type will be used if this value is not set.

=CN_CEI (SAPI\CES --)
?CN_CEI (-- SAPI\CES)
Sets or reads the SAPI and CES for the current connection.

Call Reference Management

=CN_CR_FLAG (flag --)
?CN_CR_FLAG (-- flag)
Where: flag =#ORIG origination side
#DEST destination side

Sets or reads the connection call reference flag. The call reference flag identifies the end of the logical link that originated the call. This value will be used for all messages built with the MESSAGE> and MESG commands.

=CN_CR_VALUE (value --)
?CN_CR_VALUE (-- value)
Sets or reads the connection call reference value. Each layer 3 connection is associated with a call reference value, used in the header of layer 3 signalling messages. This value will be used for all messages built with the MESSAGE> and MESG commands.

=CR_LENGTH (length --)
?CR_LENGTH (-- length)
Sets or reads the call reference length.

NOTE
The call reference length setting applies to all connections. It is not possible to have a separate call reference length for each connection.

CR_VAL_MAX (-- value)
Returns the maximum call reference value based on the current call reference length.

SELECT_CR (-- value)
Returns a call reference value between 1 and CR_VAL_MAX which is not currently in use for an outgoing call. 0 is returned if none are available.

CLEAR_CR (--)
Sets the call reference value for the active connection to #CREF_UNUSED, indicating that the call reference has been released.

Information Element Management

A set of all parameters used to construct information elements is kept for each connection. These parameters are used when response messages are created by the tester. In addition, a set of buffers is kept for each connection for storing generated IE's.

COPY_PARAMS (source CN\destination CN --)
Copies the parameters for all IE's from one connection to another.

COPY_IE (source CN\destination CN\IE identifier --)
Copies parameters, relating to a specified IE, from one connection to another.

NOTE
COPY_PARAMS and COPY_IE can be used to copy parameter values from the decoder instead of a connection by specifying #DECODER as the copy source. Using #DECODER specifies the IE's of the last decoded layer 3 message.

Example:
Copy the parameters in the Bearer Capability IE of the last received message from the decoder into the current connection.

```
#DECODER ?CN I#BEARER_CAP COPY_IE
```

INIT_IE_BUFFERS (--)
Clears the contents of all IE buffers for the active connection. One buffer exists for each IE type. All IE buffers default to a 40 byte length.

LONG_BUFFER (IE identifier --)
Extends a buffer to 120 bytes. If an attempt is made to extend the buffers of more than three IE's, an error message is displayed.

Example:
Assign a long buffer to the 'Display' IE for the active connection.

```
I#DISPLAY LONG_BUFFER
```

RESET_IE_MAP (--)
Resets all IE's to the default (40 byte) length for the *active* connection.

RESET_ALL_IE_MAPS (--)
Resets all IE's to the default length for *all* connections.

?CN_IE_BUFFER (IE identifier -- address of buffer or 0)
Returns the address of the buffer for the specified IE for the active connection. 0 is returned if the specified IE identifier is unknown.

COPY_BUFFERS (source CN\dest CN --)
Copies all buffers for generated IE's from one connection to another.

COPY_IE_BUF (source CN\dest CN\IE identifier --)
Copies only a single IE buffer. If #DECODER is specified as the source, COPY_IE_BUF copies the complete IE from the last decoded message (if it was present in that message) to the destination connection.

Example:
Copy the Bearer Capability IE, if it was present in the last decoded layer 3 message, from the decoder to connection 7.

```
#DECODER #CN7 I#BEARER_CAP COPY_IE_BUF
```

Connection Timer Management

Each connection in a layer 3 simulation can use four timers. The first timer is used exclusively for the CCITT timer T312. The second timer is used for the CCITT defined timers. The third and fourth timers are general purpose timers.

The first timer, CCITT timer T312, is started when the network side of the interface has sent a broadcast SETUP message and is waiting for a valid response. This timer is specified by using the identifier:

Timer Identifier	Default Duration
#T312	#T312_DUR - 4 seconds

The second timer is used for the other CCITT defined timers. The length of this timer is specified by using one of the following identifiers:

Timer Identifier	Default Duration
#T302	#T302_DUR - 10 seconds
#T303	#T303_DUR - 4 seconds
#T304	#T304_DUR - 15 seconds
#T305	#T305_DUR - 30 seconds
#T306	#T306_DUR - 120 seconds
#T307	#T307_DUR - 180 seconds
#T308	#T308_DUR - 4 seconds
#T309	#T309_DUR - 90 seconds
#T310	#T310_DUR - 10 seconds
#T313	#T313_DUR - 4 seconds
#T318	#T318_DUR - 4 seconds
#T319	#T319_DUR - 4 seconds

Note that these timers refer to the same timer; only one of these timers can be used at once. The general purpose timers can be used as required and are specified by the following identifiers:

Timer Constant	Default Duration
#USER1	#USER1_DUR - 10 seconds
#USER2	#USER2_DUR - 10 seconds

CN_DEFAULT_TIMERS (--)
Resets all timer durations for the active connection to their default values.

INIT_DEFAULT_TIMERS (--)
Resets all timer durations for all connections to their default values.

=TIMER_DUR (timer identifier\time --)
Sets the specified timer, in tenths of seconds, for all connections.

=CN_TIMER_DUR (timer identifier\time --)
Sets the timer duration, in tenths of seconds, for the specified timer for the active connection.

?CN_TIMER_DUR (timer identifier -- time)
Returns the timer duration, in tenths of seconds, associated with the given timer identifier.

CN_START_TIMER (timer identifier --)
Starts the indicated timer.

CN_STOP_TIMER (timer identifier --)
Stops the indicated timer.

?CN_TIMER (timer identifier -- flag)
Returns true when the timer associated with the given timer identifier has expired.

CN_STOP_ALL_TIMERS (--)
Stops all four of the current connection timers.

?CN_LAST_TIMER (-- timer identifier)
Returns the timer identifier of the last timer that was started.

Example 1:
For the current connection, set the duration for timer T302 to 8 seconds and start the timer.

```
#T302 80 =CN_TIMER_DUR
#T302 CN_START_TIMER
```

Example 2:
Find out the duration of timer T302, and if it has expired.

```
#T302 ?CN_TIMER_DUR          ( Leaves the duration on the stack )
#T302 ?CN_TIMER              ( Leaves a flag on the stack indicating if the timer
                               has expired )
```

Example 3:
For the current connection, start timer T312, T303, and the two user timers - one for 20 seconds, the other for 30 seconds.

```
#T312 CN_START_TIMER
#T303 CN_START_TIMER
#USER1 200 =CN_TIMER_DUR
#USER1 CN_START_TIMER
#USER2 300 =CN_TIMER_DUR
#USER2 CN_START_TIMER
```

18.3 B–Channel Management

The ISDN D-Channel protocol performs the signalling and negotiation for voice or data calls between the network and terminal. These calls are carried by a B–Channel which must be allocated and deallocated by the system as required.

The following commands do not connect or disconnect B–Channels to application processors. They simply provide a convenient mechanism for test scripts to manage the B–Channel.

BC_INIT (--)
Marks all B–Channels as free (unallocated).

BC_ALLOC (B–Channel --)
Flags the specified B–Channel as allocated.

BC_DISC (B–Channel --)
Flags the specified B–Channel as disconnected.

BC_FREE (B–Channel --)
Marks the B–Channel as free and disconnected.

BC_CONN (B–Channel --)
Marks the B–Channel as connected and allocated.

NOTE
The distinction between a channel being allocated and connected is that an allocated channel might not yet be connected, but it prevents that channel from being used by any other connection.

?BC_CONN (B–Channel -- flag)
Returns true if the specified B–Channel is connected.

?BC_ALLOC (B–Channel -- flag)
Returns true if the specified B–Channel is allocated.

?BC_SELECT (-- B–Channel)
Returns the number of a B–Channel marked as free. If all B–Channels are in use, 0 is returned.

SET_INTERFACE (interface --)

Where: interface =	#BASIC	Basic Rate (2 B–Channels)
	#PRIMARY	Primary Rate (30 B–Channels)

Sets the number of B–Channels, the call reference, length, and marks all channels free. For the Primary Rate interface, the call reference length is two octets and the number of B–Channels is 30, whereas for the Basic Rate interface, the call reference length is one octet and the number of B–Channels is 2.

NOTE
For Primary Rate, 30 channels are set even though North American T1 uses only 24.

18.4 Message Builder

ISDN layer 3 messages are complex. The message builder is used to create layer 3 messages. Such user-generated messages (whether valid or deliberately invalid) can be used to test the response of ISDN equipment.

Generating Messages

The programming method of message generation can dynamically build layer 3 messages. The message type and included information elements are specified when the message is created. Parameter field values, specific for the current connection, are used when each information element is built. Individual octets of an information element can be included or excluded when the IE is built. Thus, correct and incorrect messages can be generated and transmitted.

Messages built using the programming method or the interactive method (described in the basic User Manual) can be saved in a message pool for future retrieval and transmission. Messages built using the programming method can be transmitted immediately in a layer 2 I frame or UI frame.

There are two programming methods of message generation. In the first method, all IE's to be included in the message are specified.

MESSAGE> (message identifier --)

Generates messages by specifying the message identifier and all desired information element identifiers. MESSAGE> is paired with <STORE to save the message into a pool buffer or with <SEND or <SEND_UNIT to send the message in a layer 2 I frame or UI frame respectively. The IE identifiers are listed between MESSAGE> and <STORE, <SEND, or <SEND_UNIT. The pool buffer name string must be specified for <STORE.

NOTE
The information element buffer for each specified IE is used to build the message. Therefore, each element must be built before the message is built.

NOTE
The call reference value and call reference flag used when messages are built are sent with the =CN_CR_VALUE and =CN_CR_FLAG commands.

Example:
Build a setup message with the Bearer Capability, Channel Identification, and Called Party Number IE's and save the message into a buffer named SETUP#1.

```
M#SETUP MESSAGE>
    I#BEARER_CAP
    I#CHANNEL_ID
    I#CALLED_NUM
" SETUP#1" <STORE
```

Example:
Send a status message with the cause and call state IE's in a UI frame.

```
M#STATUS MESSAGE>
    I#CAUSE
    I#CALL_STATE
<SEND_UNIT
```

The message builder can function in automatic mode (IE's are sorted into the correct order with Shift IE's as required), or manual mode (IE's of a message are included in a specified order).

AUTO_MODE (--)
Selects automatic mode (default) for message generation. Information elements are sorted in the correct order before the message is built. Any required Shift IE's are included in the message.

NOTE
Locking Shift IE's are included if elements from codeset 5, 6, or 7 are included. Manual mode must be used to build the message if non-locking Shift IE's are desired.

MAN_MODE (--)
Selects manual mode for message generation. Information elements are built into the message in the order they appear between MESSAGE> and <STORE, <SEND, or <SEND_UNIT.

NOTE
Shift IE's must be included if required. Temporary IE buffers can be used to build multiple occurrences of the same IE in a message.

An alternate method of message generation is to include all mandatory IE's and any selected optional IE's when the message is built. The message can then be sent as part of a layer 2 frame.

MESG (message identifier -- address \ count)
Builds the indicated message, including all mandatory information elements and any previously selected optional or other information elements. The returned address and count are suitable for use with SEND_I or SEND_UI.

Send Data Source Menu
→ *Data Source*
L.3 Default Message function key
Modify Type function key

ALL_SELECT (--)
Includes all optional IE's in the message.

ALL_UNSELECT (--)
No optional IE's are included in the message.

SELECT (IE identifier --)
Includes the specified IE in the message.

UNSELECT (IE identifier --)
The specified IE is not included in the message.

Example:
Send an alert message with all mandatory IE's and the channel identification IE in a layer 2 I frame.

```
ALL_UNSELECT
I#CHANNEL_ID SELECT
M#ALERT MESG SEND_I
```

Example:
Send a congestion control message with all mandatory and optional IE's in a layer 2 UI frame.

```
ALL_SELECT
M#CON_CON MESG SEND_UI
```

NOTE
The set of selected IE's is connection dependent.

Generating Information Elements

Information elements are generated in a similar way to which messages are generated. The included octets are specified when the IE is constructed. The parameter field values can be changed using meaningfully named identifiers.

Each connection has an associated data structure of parameter values that does not change unless specifically altered. Thus, it is possible to generate unique messages for each connection.

The parameter field data can be examined and modified using the *COD identifier in conjunction with the field selectors used for the current message set.

***COD** (-- address)
Returns the base address of the coder parameter field data structure for the current connection.

NOTE
**COD is the message builder complement of the layer 3 decoder *DEC identifier.*

Example:
Modify the Shift IE parameters.

```
#LOCKING *COD ->SH_TYPE !
#CODESET7 *COD ->SH_CODESET !
```

!STRING (source string \ dest string --)
Copies the source string to the destination string address.

Example:
Modify the display IE parameter.

```
" IDACOM calling" *COD ->D_DISPLAY !STRING
```

Once the parameter field values have been modified as applicable, the IE can be built.

ELEMENT> <ELEMENT (IE identifier --)
Builds the specified information element.

Octets are specified for inclusion or exclusion from the IE by using the following commands between ELEMENT> and <ELEMENT.

The information element is built into the buffer associated with the IE for the current connection. The ?CN_IE_BUFFER command can be used to access this buffer.

NOTE
All desired information elements must be built with this command before they can be built into a message with the MESSAGE> or MESG commands.

ALL_INCLUDED (--)
Includes all applicable octets in the IE.

ALL_EXCLUDED (--)
No octets are included in the IE. The IE consists of only the IE identifier and IE length (0).

INCLUDED (octet identifier --)
Includes the specified octet when the IE is generated. The octet identifiers given for the ?L3_OCTET command are also used for this command.

EXCLUDED (octet identifier --)
The specified octet is not included when the IE is generated.

NUM_INCLUDED (octet identifier \ n --)
Includes the specified octet the given number of times. This command should only be used for octets that may be repeated.

Example:
Build a cause information element.

```
I#CAUSE ELEMENT>
    ALL_EXCLUDED
    OCTET_3 INCLUDED
    OCTET_4 INCLUDED
    OCTET_5 INCLUDED
<ELEMENT
```

Multiple occurrences of the same information element can be built. However, since only one IE can be stored in the current connection's buffer for each IE type, temporary buffers must be used to store other occurrences.

LOAD_IE_BUFFER (temp buffer --)

Saves the generated IE in the specified temporary buffer. LOAD_IE_BUFFER must be used between ELEMENT> and <ELEMENT. There are 8 temporary buffers: I#TEMP0 to I#TEMP7.

Example:
Build two keypad IE's. Store one in the I#TEMP0 buffer and the other in the I#KEYPAD buffer.

```
I#KEYPAD ELEMENT>
    ALL_INCLUDED
    X" 1" *COD ->K_KEYPAD !STRING
    I#TEMP0 LOAD_IE_BUFFER
<ELEMENT

I#KEYPAD ELEMENT>
    ALL_INCLUDED
    X" 2" *COD ->K_KEYPAD !STRING
<ELEMENT
```

Some information elements, such as undefined IE's, cannot be built with the message builder. It is still possible to create these IE's and save them in the current connection's buffers.

DEFINE_IE (string \ IE identifier --)

Stores the specified string in the IE buffer for the current connection. Usually, the temporary IE buffers are used with this command. The string must contain the entire contents of the IE including the IE code and length octets.

Example:
Build a user-defined information element.

```
X" 0103010203" I#TEMP0 DEFINE_IE
```

TEMP_CODESET (codeset \ temp buffer --)

Associates the IE in the specified temporary buffer with the given codeset. TEMP_CODESET must be used when building messages with temporary buffers in automatic mode. The IE's are sorted by codeset in automatic mode.

Example:
Send an INFO message with the user-defined information element in temporary buffer 0.

```
AUTO_MODE
7 I#TEMP0 TEMP_CODESET
M#INFO MESSAGE>
    I#TEMP0
<SEND
```

The following example illustrates how to build three information elements and a message using these IE's.

Build a bearer capability IE with:

- CCITT coding standard;
- speech transfer capability;
- circuit transfer mode;
- 64 kbit/s transfer rate;
- default structure;
- point-to-point configuration;
- demand establishment; and
- bidirectional symmetry.

```
I#BEARER_CAP ELEMENT>                ( Build Bearer Cap with octets 3, 4, 4a & 4b )

             ( Specify IE structure )

      ALL_EXCLUDED                   ( Exclude all possible octets )
      OCTET_3 INCLUDED               ( Octet 3 )
      OCTET_4 INCLUDED               ( Octet 4 )
      OCTET_4A INCLUDED              ( Octet 4A )
      OCTET_4B INCLUDED              ( Octet 4B )

             ( Modify IE field data )

      #CCITT  *COD ->BC_CODING STANDARD !           ( Octet 3 )
      #SPEECH  *COD  ->BC_TRANSFER_CAP  !

      #CIRCUIT_MODE  *COD  ->BC_TRANSFER_MODE !     ( Octet 4 )
      #64KBIT/S  *COD  ->BC_TRANSFER_RATE !

      #DEFAULT  *COD  ->BC_STRUCTURE !               ( Octet 4a )
      #POINT_TO_POINT  *COD  ->BC_CONFIGURATION !
      #DEMAND  *COD  ->BC_ESTABLISHMENT !

      #BIDIRECT_SYMMETRIC  *COD  ->BC_SYMMETRY !     ( Octet 4b)
      #64KBITS/S  *COD  ->BC_TRANSFER_RATE_4B !
<ELEMENT       ( Generates IE into Bearer Cap default IE buffer )
```

Build a channel identification IE using the existing values, but replace the channel map with the channel map in the last received message.

```
I#CHANNEL_ID ELEMENT>                ( Build Channel Id IE with only new channel map )

             ( Use previously specified IE structure )

      *DEC  ->CID_MAP                ( Address of channel map from received message )
      *COD  ->CID_MAP !STRING        ( Store in coder variable )
<ELEMENT       ( Generate IE into Channel Id Buffer )
```

Build a display information element IE using the existing values, but change the display string information and store it into a temporary buffer.

```
I#DISPLAY ELEMENT>                  ( Generate IE into a temporary buffer )

             ( Use previously specified IE structure )
      " Test string for Display IE"                ( Enter string to be stored )
      *COD  ->D_DISPLAY !STRING                    ( Modify Display information )

      I#TEMPO LOAD_IE_BUFFER        ( Specify temporary buffer 0 for IE generation )
      0 I#TEMP0 TEMP_CODESET        ( Specify codeset for temporary buffer 0 )
<ELEMENT      ( Generate Display IE into temporary buffer 0 )
```

Build a setup message using the IE's built in the previous three examples.

```
AUTO_MODE
M#SETUP MESSAGE>
    I#CHANNEL_ID
    I#BEARER_CAP
    I#TEMP0
" SETUP" <STORE
```

Connection Independent Management Message Transmission

This type of message is normally generated by the layer 3 management procedure. Therefore, a management message must be sent independently of the connection.

SM_MSG (message identifier --)

Transmits a layer 3 management message. The values used to build the message are independent of each connection. The message identifier is the identifier used in the current message set to refer to the desired management message type. Only the following message types should be used for management message types:

RESTART	call reference value: Global (0) call reference flag: Origination (0) channel identifier IE: only if restart class is 0 or 6 restart indicator IE
RESTART ACKNOWLEDGE	call reference value: Global (0) call reference flag: Destination (1) channel identifier IE: only if restart class is 0 or 6 restart indicator IE
RELEASE	call reference value: taken from last received message call reference flag: inverse of flag in last received message cause IE
RELEASE COMPLETE	call reference value: taken from last received message call reference flag: inverse of flag in last received message cause IE

RESUME REJECT	call reference value: taken from last received message call reference flag: inverse of flag in last received message cause IE
CONGESTION CONTROL	call reference value: taken from last received message call reference flag: inverse of flag in last received message congestion level IE cause IE
STATUS	call reference value: taken from last received message call reference flag: inverse of flag in last received message cause IE call state IE

The values used for the information elements sent in these management messages can be set with the following commands. Q.931 standard encoding is used for these information elements.

SYS_Q931_CAUSE (class \ value --)
Sets the cause class (octet 4, bits 5 through 7) and cause value (octet 4, bits 1 through 4) for the management Cause IE. Other fields are coded as follows:

Octets 3 and 4 are included.

Coding Standard	octet 3, bits 6, 7	0 (CCITT standardized coding)
Location	octet 3, bits 1-4	2 (public network serving the local user) network side 0 (user) - user side

NOTE
Some message sets combine the cause class and cause value into a single cause value field. The symbolic constants for the cause values cannot be used in these message sets.

SYS_Q931_REST_IND (restart class --)
Sets the restart class field (octet 3, bits 1 through 3) for the management Restart Indicator IE.

SYS_Q931_CHAN_ID (channel number --)

Sets the channel number for the management Channel Identification IE. This value corresponds to the information channel selection field (octet 3, bits 1 through 2) for Basic Rate or the channel number field (octet 3.3, bits 1 through 7) for Primary Rate. Other fields are coded as follows:

Basic Rate:
Only octet 3 is included.

Int. id. present	octet 3, bit 7	0 (implicitly identified)
Int. type	octet 3, bit 6	0 (basic interface)
Pref./Excl.	octet 3, bit 4	1 (exclusive)
D-channel ind.	octet 3, bit 3	0 (not the D-channel)

Primary Rate:
Octets 3, 3.2, and 3.3 are included.

Int. id. present	octet 3, bit 7	0 (implicitly identified)
Int. type	octet 3, bit 6	1 (other interface)
Pref./Excl.	octet 3, bit 4	0 (preferred)
D-channel ind.	octet 3, bit 3	0 (not the D-channel)
Info. chan. sel.	octet 3, bits 1-2	1 (as indicated)
Coding standard	octet 3.2, bits 6-7	0 (CCITT standardized coding)
Number/Map	octet 3.2, bit 5	0 (number)
Channel type	octet 3.2, bits 1-4	3 (B-channel units)

SYS_Q931_CONG_LVL (congestion level --)

Sets the congestion level field (octet 1, bits 1 through 4) for the management Congestion Level IE.

SYS_Q931_CALL_ST (call state --)

Sets the call state field (octet 3, bits 1 through 6) for the management Call State IE. The coding standard field is set to 0 (CCITT standardized coding).

Example:
Send a layer 3 management Congestion Control message using the CCITT message set.

```
#RECEIVER_NOT_READY SYS_Q931_CONG_LVL
2 10 SYS_Q931_CAUSE
M#CON_CON SM_MSG
```

18.5 Message Buffer Pool Management

The message buffer pool management manages a collection of layer 3 messages. An array of entries, each of which contains a name field (used to identify the message), a comment field, and a data field (containing the message itself), is called a message pool. Both the name and comment fields are stored in the pool entry as normal strings, while the data field uses the first two bytes to denote the message length. The maximum number of buffers in the message buffer pool is 60.

The length of a message that can be stored in a single buffer is 130 octets. However, an extension mechanism exists whereby two adjacent buffers can be used to store an extended message (up to 262 bytes). The operation of this mechanism is fully automatic, and occurs whenever a message is stored which is too large to fit in a single buffer. An empty buffer or a message contained in one or two buffers is called a pool entry.

The user interface to the message buffer pool management enables access to specific, pre-defined layer 3 messages in test manager scenarios. These pre-defined messages are made with the message builder and are stored to disk using the message buffer pool management.

Specifically, the message buffer pool provides commands to address the name, comment, and data fields of any entry in the message pool. It is possible to initialize single pool entries or the entire pool. Individual message strings can be loaded or recalled to the pool and the entire message pool can be stored or recalled from disk files.

?MESSAGE (string -- address or 0)
Returns the data field address of the first message pool entry that matches the specified name, or 0 if no match is found.

?MESSAGE_NUMBER (string -- n | -1)
Returns the number of the first message pool entry that matches the specified name, or -1 if no match is found.

NOTE
Message pool entries are numbered 0 through 59 although Pool Menu entries are numbered 1 through 60.

=MESSAGE_NAME (string\n --)
Assigns a name to the specified message pool entry.

Example:
Assign the name 'SETUP#5' to message pool entry 2.

```
" SETUP#5" 2 =MESSAGE_NAME
```

?MESSAGE_NAME (n -- address of nth name field or 0)
Returns the name field address of the specified message pool entry, or 0 if an invalid entry number is specified.

=MESSAGE_COMMENT (string\n --)
Assigns a comment to the specified message pool entry.

Example:

```
" Setup message with invalid Bearer Capability IE" 3 =MESSAGE_COMMENT
```

?MESSAGE_COMMENT (n -- address of nth comment field or 0)
Returns the comment field address of the specified message pool entry, or 0 if an invalid entry number is specified.

?MESSAGE_DATA (n -- address of nth data field or 0)
Returns the data field address of the specified message pool entry, or 0 if an invalid entry number is specified.

?MESSAGE_FREE (n -- flag)
Returns true if the specified message pool entry is currently unused (not occupied by either a complete or part of an extended message), or false if an invalid entry number is specified.

STORE_MESSAGE (address\length\n --)
Stores a message starting at 'address' and of 'length' bytes in the data field of the specified message pool entry. If the message is too larget ot fit in one buffer entry, the buffer is automatically extended to use the next entry. If the next entry is unavailable, an error message will be displayed and no part of the message will be stored.

Example:
following the receipt of an I frame with a layer 3 message (as determined from within a test script), save the data contents of the frame for later use as pool entry 3.

```
L3-POINTER @ L3-LENGTH @
3 STORE_MESSAGE
```

RECALL_MESSAGE (address\n -- length or -1)
Copies the data field of the specified message pool entry to the specified address and returns the length (in bytes) of the message, or -1 if an invalid entry number is specified.

CLEAR_MESSAGE (n --)
Clears the name, comment, and data fields of the specified message pool entry. If the message was automatically extended, the next entry will also be cleared.

SAVE_MESSAGES (filename --)
Saves the entire message buffer pool to the specified file.

Example:
Save the message buffer pool into the file 'POOL#2'.

```
" DR0:POOL#2" SAVE_MESSAGES
```

LOAD_MESSAGES (filename --)
Loads the message buffer pool from the specified file after checking the file size and type.

CLEAR_POOL (--)
Clears the name, comment, and data fields of all message pool entries.

WARNING
Use CLEAR_POOL with caution.

ALLOC_MESSAGE (flag -- n or -1)
For a flag value of 0, returns the number of the first unused pool entry, or -1 if no such entry can be found in the pool. A flag value of 1 indicating that a double length entry is required (for extended messages), returns the first of two successive unused pool entries, or -1 if none can be found.

COMPACT_POOL (-- n)
Moves all used message pool entries to the bottom of the pool (i.e. closer to entry 0) and returns the number of used message pool entries.

CONCAT_POOLS (filename --)
Compacts the existing message pool and concatenates the pool contained in the specified file to the existing one. If the two pools are too large to fit in one pool, the pool in the specified file will be truncated, and an error message is displayed.

INSERT_ENTRY (n --)
Inserts a blank pool entry before the specified message pool entry. The specified subsequent message pool entries are shuffled upwards in the pool. If the last entry in the pool is in use, or an invalid entry is specified, the pool will remain unaltered and an error message will be displayed.

COPY_MESSAGE (string\n --)
Copies the entire contents of the pool entry with the specified name into the specified message pool entry.

Example:
Copy the contents of the pool entry named 'ALERT#1' into message pool entry 4.

```
" ALERT#1" 4 COPY_MESSAGE
```

MOVE_MESSAGE (name string\n --)
Copies the entire contents of the pool entry with the specified name into the specified message pool entry and deletes the source entry.

=POOL_CR_VALUE (string\call ref value --)
Assigns a call reference value to the pool entry with the specified name. If the dummy call reference is in use for the specified message, the entry will remain unchanged and an error message will be displayed. The call reference value will be suitably truncated if the total number of octets available for the value is insufficient.

Example:

```
" CONNECT-MSG" 23 =POOL_CR_VALUE
```

?POOL_CR_VALUE (string -- call ref value)
Returns the call reference value used by the pool entry with the specified name. If the dummy call reference is in use for the specified message, an error message will be displayed.

=POOL_CR_FLAG (string\call ref flag --)
Where: call ref flag = #DEST - destination
#ORIG - origination

Sets the call reference flag for the pool entry with the specified name. If the dummy call reference is in use for the specified message, the entry will remain unchanged and an error message will be displayed.

Example:
Set the call reference flag to destination for the pool entry named 'RELEASE#2'.

```
" RELEASE#2" #DEST =POOL_CR_FLAG
```

?POOL_CR_FLAG (string -- call ref flag or -1)
Where: call ref flag = #DEST - destination
#ORIG - origination

Returns the call reference flag used by the pool entry with the specified name. If the dummy call reference is in use for the specified message, an error message will be displayed.

ALTER_CALL_REF (string\call ref. flag\call ref. value --)
Where: call ref flag = #DEST - destination
#ORIG - origination

Changes only the call reference value and flag of the pool entry with the specified name. If the dummy call reference is in use for the specified message, an error message will be displayed.

Example:

```
" SETUP#1" #ORIG 44 ALTER_CALL_REF
```

POOL (string -- address \ length)
Returns the address and length of the pool entry with the specified name.

Example 1:
Send a buffer named 'Alert' in an information frame.

```
" Alert" POOL SEND_I
```

Example 2:
Send a buffer named 'Alert' inside an unnumbered information frame.

```
" Alert" POOL SEND_UI
```

✍ Send Data Source Menu
→ *Data Source*
Message Pool function key
→ *Pool Entry Name*

The following example illustrates how to build a message containing information elements, and use the message pool.

Example:
Build an ALERT message with the following information elements:

Channel Identification IE
  Interface identifier: implicitly identified
  Interface type: Basic Rate
  Preferred/exclusive: exclusive, only the indicated channel is acceptable
  D-Channel indicator: the channel identified is not the D-Channel
  Information channel selection: B1-Channel

Called Party Number IE
  Number type: national number
  Numbering plan: ISDN numbering plan Rec. E.164
  Number: 555-1212

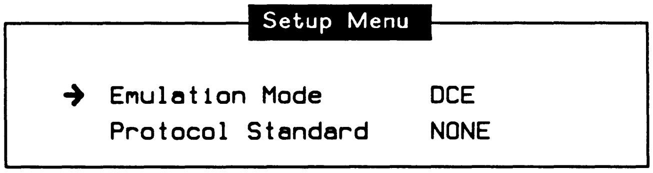
```
I#CHANNEL_ID  ELEMENT>
      ALL_EXCLUDED
      OCTET_3 INCLUDED

      #IMPLICIT   *COD   ->CID_INT_PRESENT !
      #BASIC_INTERFACE   *COD   ->CID_INT_TYPE !
      #EXCLUSIVE   *COD   ->CID_PREF/EXCL !
      #NOT_D_CHANNEL   *COD   ->CID_DCHANNEL !
      #B1_CHANNEL   *COD   ->CID_INFO_CHAN_SEL !

<ELEMENT

I#CALLED_NUM  ELEMENT>
      ALL_EXCLUDED
      OCTET_3 INCLUDED
      OCTET_4 INCLUDED

      #NATIONAL   *COD   ->CLDN_NUMBER_TYPE !
      #ISDN_PLAN   *COD   ->CLDN_NUMBERING_PLAN !
      " 5551212"   *COD   ->CLDN_NUMBER !STRING

<ELEMENT
```

19
X.25 LAYER 3 PLP EMULATION

The X.25 PLP (Packet Layer Procedure) Emulation operates as a layer 3 emulation connected to the ISDN Basic Rate D-Channel layer 2. The following features are supported to interface to the layer 2 emulation:

- One SAPI is assigned to X.25 packet mode operation. The default value for this SAPI is 16.
- 255 simultaneous logical channel connections.
- Each logical channel can be connected to any of the 8 link connections.

19.1 Emulation Configuration



```
Setup Menu

→ Emulation Mode       DCE
  Protocol Standard    NONE
```

Figure 19–1 Setup Menu

→ *Emulation Mode*

DTE_END (--)

Selects a logical DTE emulation mode. This is the default when the Basic Rate configuration is set as user.

⌨ *DTE* function key

DCE_END (--)

Selects a logical DCE emulation mode. This is the default when the Basic Rate configuration is set to network.

⌨ *DCE* function key

→ *Protocol Standard*

Selects a protocol standard for emulation.

STD=NONE (--)

Conforms to a combination of the CCITT X.25 (1980/1984) Recommendation. The behaviour can be modified by the user.

⌨ *NONE* function key

STD=X25(80) (--)

Conforms to the CCITT X.25 (1980) Recommendation and sets up all the appropriate system parameters.

X.25(1980) function key

STD=X25(84) (--)

Conforms to the CCITT X.25 (1984) Recommendation (default) and sets up all the appropriate system parameters.

X.25(1984) function key

NOTE

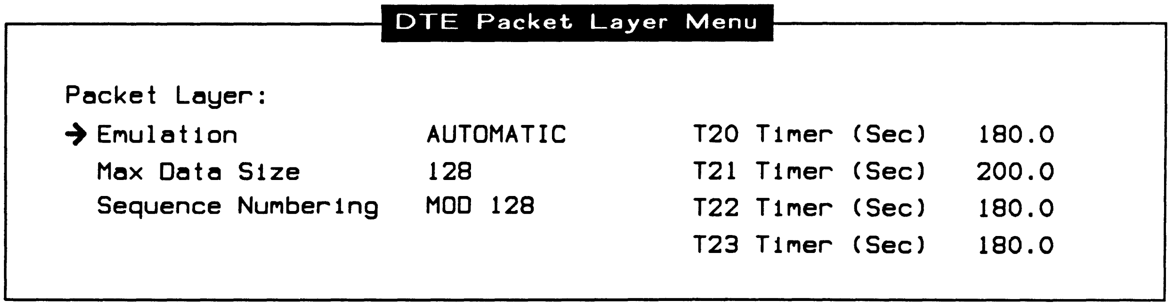
The protocol standard selection affects some emulation parameters and procedures. See Table 19–1 for a list of affected parameters/procedures.

Parameters/Procedures	NONE	X.25(1980)	X.25(1984)
Link Procedure	Single Link or Multi–link	Single Link	Single Link or Multi–link
Sequence Number	Modulo 8 or 128	Modulo 8	Modulo 8 or 128
Poll Bit for SABM, SABME, and DISC	P=0 or P=1	P=0	P=0 or P=1
Unsolicited DM	Supported or Not Supported	Not Supported	Supported
Maximum User Data in DATA Packet	4096 Octets	1024 Octets	4096 Octets
Facility Field Length	109 Octets	63 Octets	109 Octets
Call User Data	16 Octets 128 Octets with fast select facility	16 Octets	16 Octets 128 Octets with fast select facility
Call Connected Format	Basic or Extended	Basic	Basic or Extended
Clear Request Format	Basic or Extended	Basic	Basic or Extended
Clear Confirmation Format	Basic or Extended	Basic	Basic or Extended
Maximum Interrupt Data	32 Octets	1 Octet	32 Octets

Table 19–1 Protocol Standard Parameters/Procedures

Packet Layer

IDACOM's X.25 Emulation implements an automatic layer 3 state machine (refer to Section 19.3 for more information). Depending on the emulation mode selected, either the DCE or DTE Packet Layer Menu is displayed. DTE emulation uses timers T20 to T23; DCE emulation uses timers T10 to T13. All other configuration commands are used by both emulation modes.



```
                    DTE Packet Layer Menu

Packet Layer:
→ Emulation             AUTOMATIC       T20 Timer (Sec)    180.0
  Max Data Size         128             T21 Timer (Sec)    200.0
  Sequence Numbering    MOD 128         T22 Timer (Sec)    180.0
                                        T23 Timer (Sec)    180.0
```

Figure 19–2 DTE Packet Layer Menu

→ *Emulation*

L3_ON (--)

Activates the layer 3 state machine (default) resulting in automatic responses to received packets.

AUTOMATIC function key

L3_OFF (--)

Deactivates the layer 3 state machine resulting in no automatic responses to received packets.

MANUAL function key

→ *Max Data Size*

=SIZE (n --)

Specifies the maximum number of bytes in the data field of transmitted or received data packets for all logical channels. Valid values are 0 through 4100 (default is 128).

Example:
Set the maximum data field size to *256.*

```
256  =SIZE
```

NOTE

The maximum frame size should be sufficiently larger than the maximum data size to allow for the address and control fields plus the data packet header.

→ *Sequence Numbering*

PACKET_MOD8 (--)

Selects modulo 8 method of sequence numbering for the packet layer on all LCN's.

MOD 8 function key

PACKET_MOD128 (--)

Selects modulo 128 method of sequence numbering (default) for the packet layer on all LCN's.

MOD 128 function key

NOTE
When the monitor detects a GFI (general format identifier) of either modulo 8 or 128, the corresponding decoding and reporting mechanism is used.

When the emulation detects a GFI that does not match that set by these commands:

- *a DTE emulation ignores the received packet; and*
- *a DCE emulation responds with a diagnostic packet indicating the reception of an invalid GFI.*

The following timers are used for DTE emulation.

→ *T20 Timer (Sec)*
T20–VALUE (-- address)

Contains the duration, in tenths of seconds, of the T20 timer (default is 180 seconds). The T20 timer is started when the emulation is a DTE and a restart request is transmitted using T20–VALUE to set timeout. This timer is not used when the value is set to 0. For appropriate action by the DTE when this timer expires, see TABLE D–2/X.25 in the CCITT X.25 (1984) Recommendation.

Example:
Set the T20 timer to 240 seconds.

```
2400 T20-VALUE !
```

Modify T20 Restart Timer function key

→ *T21 Timer (Sec)*
T21–VALUE (-- address)

Contains the duration, in tenths of seconds, of the T21 timer (default is 200 seconds). The T21 timer is started when the emulation is a DTE and a call request is transmitted using T21–VALUE to set timeout. This timer is not used when the value is set to 0. For appropriate action by the DTE when this timer expires, see TABLE D–2/X.25 in the CCITT X.25 (1984) Recommendation.

Example:
Set the T21 timer to 240 seconds.

```
2400 T21-VALUE !
```

Modify T21 Call Timer function key

→ *T22 Timer (Sec)*
T22–VALUE (-- address)

Contains the duration, in tenths of seconds, of the T22 timer (default is 180 seconds). The T22 timer is started when the emulation is a DTE and a reset request is transmitted using T22–VALUE. This timer is not used when the value is set to 0. For appropriate action by the DTE when this timer expires, see TABLE D–2/X.25 in the CCITT X.25 (1984) Recommendation.

Example:
Set the T22 timer to 1 minute.

```
600 T22-VALUE !
```

Modify T22 Reset Timer function key

→ *T23 Timer (Sec)*

T23–VALUE (-- address)

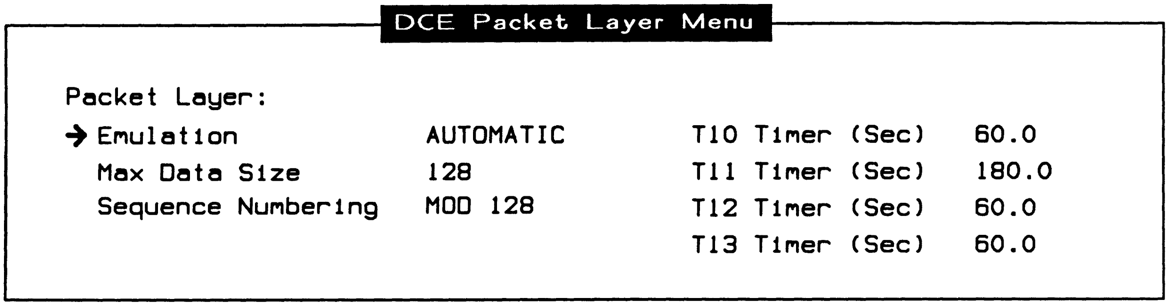
Contains the duration, in tenths of seconds, of the T23 timer (default is 180 seconds). The T23 timer is started when the emulation is a DTE and a clear request is transmitted using T23-VALUE. This timer is not used when the value is set to 0. For appropriate action by the DTE when this timer expires, see TABLE D-2/X.25 in the CCITT X.25 (1984) Recommendation.

Example:
Set T23 timer to 4 minutes.

```
2400 T23-VALUE !
```

Modify T23 Clear Timer function key

The following timers are used for DCE emulation.



```
DCE Packet Layer Menu

Packet Layer:
→ Emulation           AUTOMATIC      T10 Timer (Sec)   60.0
  Max Data Size       128            T11 Timer (Sec)   180.0
  Sequence Numbering  MOD 128        T12 Timer (Sec)   60.0
                                     T13 Timer (Sec)   60.0
```

Figure 19–3 DCE Packet Layer Menu

→ *T10 Timer (Sec)*

T10–VALUE (-- address)

Contains the duration, in tenths of seconds, of the T10 timer (default is 60 seconds). The T10 timer is started when the emulation is a DCE and a restart indication is transmitted using T10-VALUE to set timeout. This timer is not used when the value is set to 0. For appropriate action by the DCE when this timer expires, see TABLE D-1/X.25 in the CCITT X.25 (1984) Recommendation.

Example:
Set the T10 timer to 2 minutes.

```
1200 T10-VALUE !
```

Modify T10 Restart Timer function key

→ *T11 Timer (Sec)*

T11–VALUE (-- address)

Contains the duration, in tenths of seconds, of the T11 timer (default is 180 seconds). The T11 timer is started when the emulation is a DCE and an incoming call is transmitted using T11-VALUE to set the timeout. This timer is not used when the value is set to 0. For appropriate action by the DCE when this timer expires, see TABLE D-1/X .25 in the CCITT X.25 (1984) Recommendation.

Example:
Set the T11 timer to 200 seconds.

```
2000 T11-VALUE !
```

✎ *Modify T11 Call Timer* function key

→ *T12 Timer (Sec)*

T12–VALUE (-- address)

Contains the duration, in tenths of seconds, of the T12 timer (default is 60 seconds). The T12 timer is started when the emulation is a DCE and a reset indication is transmitted using T12-VALUE to set timeout. This timer is not used when the value is set to 0. For appropriate action by the DCE when this timer expires, see TABLE D-1/X.25 in the CCITT X.25 (1984) Recommendation.

Example:
Set the T12 timer to 30 seconds.

```
300 T12-VALUE !
```

✎ *Modify T12 Reset Timer* function key

→ *T13 Timer (Sec)*

T13–VALUE (-- address)

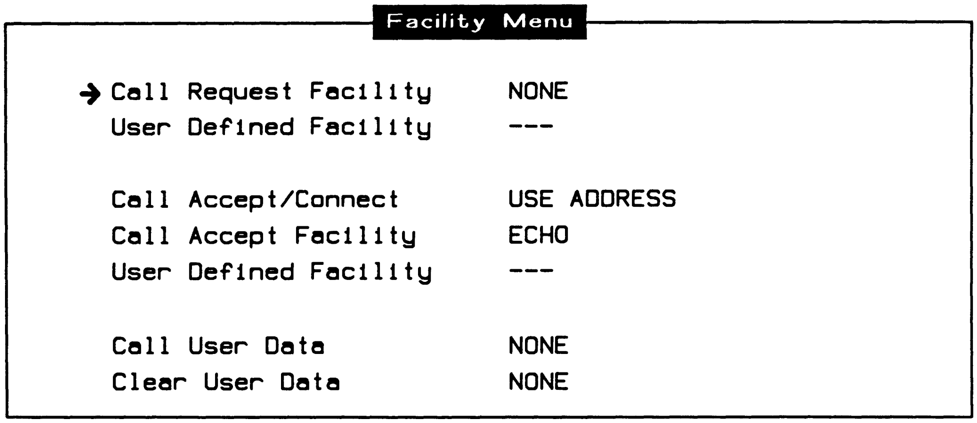
Contains the duration, in tenths of seconds, of the T13 timer (default is 60 seconds). The T13 timer is started when the emulation is a DCE and a clear indication is transmitted using T13-VALUE to set timeout. This timer is not used when the value is set to 0. For appropriate action by the DCE when this timer expires, see TABLE D-1/X.25 in the CCITT X.25 (1984) Recommendation.

Example:
Set the T13 timer to 90 seconds.

```
900 T13-VALUE !
```

✎ *Modify T13 Clear Timer* function key

Facilities



```
                        Facility Menu

  → Call Request Facility     NONE
    User Defined Facility     ---

    Call Accept/Connect       USE ADDRESS
    Call Accept Facility      ECHO
    User Defined Facility     ---

    Call User Data            NONE
    Clear User Data           NONE
```

Figure 19–4 Facility Menu

SET_FAC_LEN (n --)
Specifies the maximum facility length of the received packet. Valid values are 0 through 63 for the 1980 Recommendation, and 0 through 109 for the 1984 Recommendation.

→ *Call Request Facility*
NO_FAC (--)
No facility data is included on any of the 255 channels when transmitting call request/incoming call packets (default).

NONE function key

YES_FAC (--)
Automatically negotiates data packet size, packet window, throughput class, and fast select on all 255 channels when transmitting call request/incoming call packets.

NEGOTIATE function key

USER_FAC (--)
Enables facility negotiation on all 255 channels. Facility fields defined with the MAKE_FAC command are transmitted within call request/incoming call packets.

USER DEFINED function key

=CLASS (throughput class --)

Specifies the throughput facility class on all 255 channels. This facility is used in a call request/incoming call facility negotiation. It expects a numerical value as an input parameter and has no output parameters. Valid values are 75, 150, 300, 600, 1200, 2400, 4800, 9600 (default), 19200, and 48000.

Example:
Set the throughput facility class to 2400.

```
2400  =CLASS
```

→ *User Defined Facility*

MAKE_FAC (string --)

Specifies the facility field used in transmitted call request/incoming call packets when USER_FAC is called. The first byte in the string is the facility length, with following bytes used as facilities. These facilities should be defined in hex byte format as shown in the example. The maximum length of the facility field is 109 octets.

Example:
Define a facility for a packet size negotiation of 256.

```
X" 03420808"  MAKE_FAC
```

The first byte in the hex string (03) indicates that the following facility field has a length of 3 bytes.

The second byte (42) indicates that the facility being negotiated is the packet size.

Bytes 3 and 4 (0808) indicate that the packet size is 256 for both the called DTE and calling DTE.

✎ *Modify Facility* function key

→ *Call Accept/Connect*

YES_CA (--)

Uses the address field (default), received in call request/incoming call packets, as the address field in transmitted call accept/connect packets on all 255 channels.

✎ *USE ADDRESS* function key

NO_CA (--)

No address, facility, or call user data fields are used in transmitted call accept/connect packets.

✎ *NO ADDRESS* function key

→ *Call Accept Facility*

NO_CAFAC (--)

The facility field in call accept/connect packets is not used.

NONE function key

ECHO_CAFAC (--)

Echoes the facility field (default) received in call request/incoming call packets in the call accept/connect packet on all 255 channels.

ECHO function key

USER_CAFAC (--)

Enables facility negotiation on all 255 channels. Facility fields defined with the MAKE_CAFAC command are transmitted within call accept/connect packets.

USER DEFINED function key

→ *User Defined Facility*

MAKE_CAFAC (string --)

Specifies the facility field used in transmitted call accept/connect packets when USER_CAFAC is called. The first byte in the string is the facility length, with following bytes to be used as facilities. These facilities should be defined in hex byte format as shown in the example. The maximum length of the facility field is 63 octets for the 1980 Recommendation, and 109 octets for the 1984 Recommendation.

Example:
Define a facility for a packet size negotiation of 256 in call accept packets.

```
X" 03420808"  MAKE_CAFAC
```

The first byte in the hex string (03) indicates that the following facility field has a length of three bytes.

The second byte (42) indicates that the facility being negotiated is packet size.

Bytes 3 and 4 (0808) indicate that the packet size is 256 for both the called and calling DTE.

Modify Facility function key

→ *Call User Data*
MAKE_CUD (string --)

Specifies the call user data field used in transmitted call request/incoming call and call accept/connect packets on all 255 channels (maximum length is 64 bytes). This field is also used in clear request packets when extended format is used.

Example 1:
Define a call user data field that contains 11 characters.

```
X" C000000003010025800064"  MAKE_CUD
```

Example 2:
Clear the call user data field.

```
NO MAKE_CUD
```

✎ *Modify Call User Data* function key

→ *Clear User Data*
MAKE_CLRUD (string --)

Specifies the clear user data field used in transmitted clear request indication packets on all 255 channels (maximum length is 64 bytes).

Example 1:
Define a clear user data field that contains 11 characters.

```
X" C000000003010025800064"  MAKE_CLRUD
```

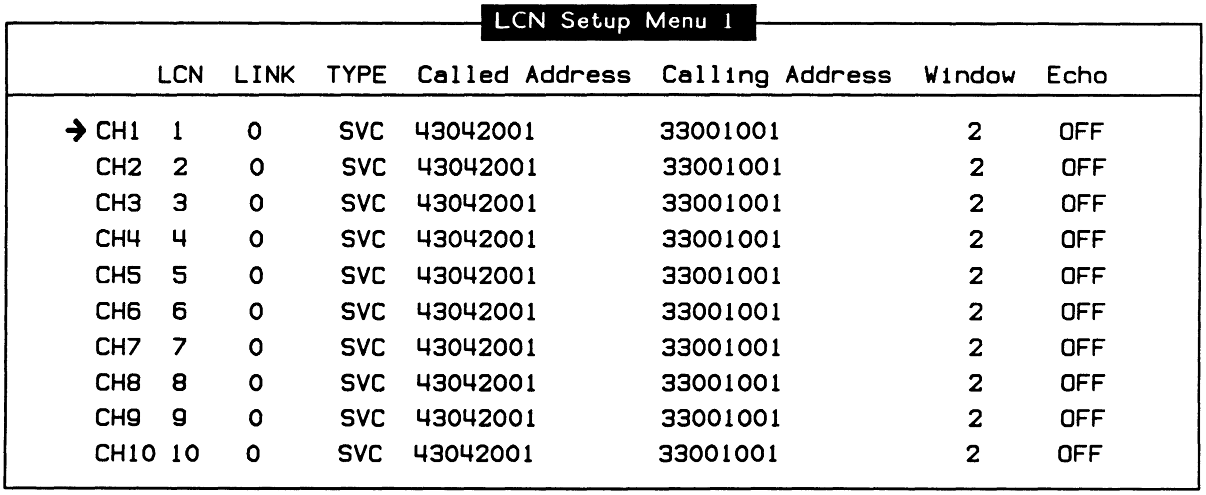
Example 2:
Clear the clear user data field.

```
NO MAKE_CLRUD
```

✎ *Modify Clear User Data* function key

LCN Setup

The X.25 Emulation supports 255 logical channels which can be set to any of 4096 LCN's (logical channel numbers). Logical channels are assigned and configured for link, SVC/PVC, called address, calling address, packet window size, and data echo from LCN Setup Menu 1.



```
                              LCN Setup Menu 1

        LCN  LINK  TYPE  Called Address  Calling Address  Window  Echo

  → CH1   1    0    SVC  43042001        33001001            2    OFF
    CH2   2    0    SVC  43042001        33001001            2    OFF
    CH3   3    0    SVC  43042001        33001001            2    OFF
    CH4   4    0    SVC  43042001        33001001            2    OFF
    CH5   5    0    SVC  43042001        33001001            2    OFF
    CH6   6    0    SVC  43042001        33001001            2    OFF
    CH7   7    0    SVC  43042001        33001001            2    OFF
    CH8   8    0    SVC  43042001        33001001            2    OFF
    CH9   9    0    SVC  43042001        33001001            2    OFF
    CH10 10    0    SVC  43042001        33001001            2    OFF
```

Figure 19–5 LCN Setup Menu 1

CH (logical channel --)
Specifies the logical channel to use as the current channel. Valid values are 1 through 255.

CH1 (--)
Uses logical channel 1 as the current channel. The CH2 to CH255 commands function in the same manner for selecting the 255 available channels.

The LCN of the currently selected logical channel can also be changed using the =LCN command.

NOTE
If more than one channel has the same LCN value, the automatic emulation uses the first one found on the LCN Setup Menus. Errors in protocol can be forced by sending out packets on a second channel with the same LCN by using the CH1 to CH255 commands.

=LCN (LCN --)
Specifies the LCN of the currently selected logical channel. Valid values are 0 through 4095.

Example:
Set the LCN on channel 30 to 225.

```
CH30  225  =LCN
```

Modify LCN function key

=LCNCES (link --)

Sets the link CES (connection endpoint suffix) for the currently selected channel.

Example:
Set the link CES on channel 30 to 1.

```
CH30 1 =LCNCES
```

Modify LINK function key

=ALL_LCNCES (link --)

Sets the link CES (connection endpoint suffix) for all 255 channels.

LCNCES (-- address)

Contains the link CES (connection endpoint suffix) for the currently selected channel. This value can be stored with the ! (store) or read with the @ (fetch) operations.

Example:

```
CH1 LCNCES @
```

In this case, the value of the link CES for channel 1 is left on the stack.

SVC (--)

Sets the currently selected channel as an SVC (switched virtual circuit).

Example:
Set channel 3 as SVC.

```
CH3 SVC
```

SVC function key

PVC (--)

Sets the currently selected channel as a PVC (permanent virtual circuit).

Example:
Set channel 2 as PVC.

```
CH2 PVC
```

PVC function key

The called and calling addresses can be changed using the =CALLED and =CALLING commands. The corresponding address fields can be cleared using the LCNCALLED and LCNCALLING strings.

=CALLED (" string" --)

Specifies the called address field for subsequent call request packets on the currently selected logical channel. Up to 15 decimal digits can be specified within the ASCII string.

Example:
Define a called address of 1234567890 on channel 2.

```
CH2  " 1234567890"  =CALLED
```

Modify Called function key

LCNCALLED (-- address)

Contains a 16 byte string identifying the called address field defined with the =CALLED command. The first byte of this string contains the length of the called digits.

In the previous example, where the called address is defined as 1234567890, LCNCALLED contains the following hex values:

0A31323334353637383930

The first byte is the length of the defined called address (hex 0A, decimal 10). The remaining bytes are the hex values for ASCII representation of decimal 1234567890.

Example:
Clear the called address field on channel 3 (by setting the length to 0).

```
CH3  0 LCNCALLED  !
```

✎ *Modify Called* function key

=CALLING (" string" --)

Specifies the calling address field for subsequent call request packets on the currently selected logical channel. Up to 15 decimal digits can be specified within the ASCII string.

Example:
Define a calling address of 1234567890 on channel 2.

```
CH2  " 1234567890"  =CALLING
```

✎ *Modify Calling* function key

LCNCALLING (-- address)

Contains a 16 byte string identifying the calling address field defined with the =CALLING command. In the previous example, where the calling address is defined as 1234567890, LCNCALLING contains the following hex values: 0A31323334353637383930.

The first byte of the length is the defined calling address (hex 0A, decimal 10). The remaining bytes are the hex values for ASCII representation of decimal 1234567890.

Example:
Clear the calling address field on channel 3.

```
CH3  0  LCNCALLING  !
```

✎ *Modify Calling* function key

=WINDOW (window size --)

Specifies the maximum packet window size of the currently selected logical channel. Valid values are 1 through 7 for modulo 8, and 1 through 127 for modulo 128 (default is 2).

Example:
Set the maximum packet window size to 7 for logical channel 10.

```
CH10  7  =WINDOW
```

✎ *Modify Window* function key

ECHO_ON (--)

Echoes the received data packet on the currently selected channel.

Example:
Echo all data packets on CH55.

```
CH55  ECHO_ON
```

ECHO ON function key

ECHO_OFF (--)

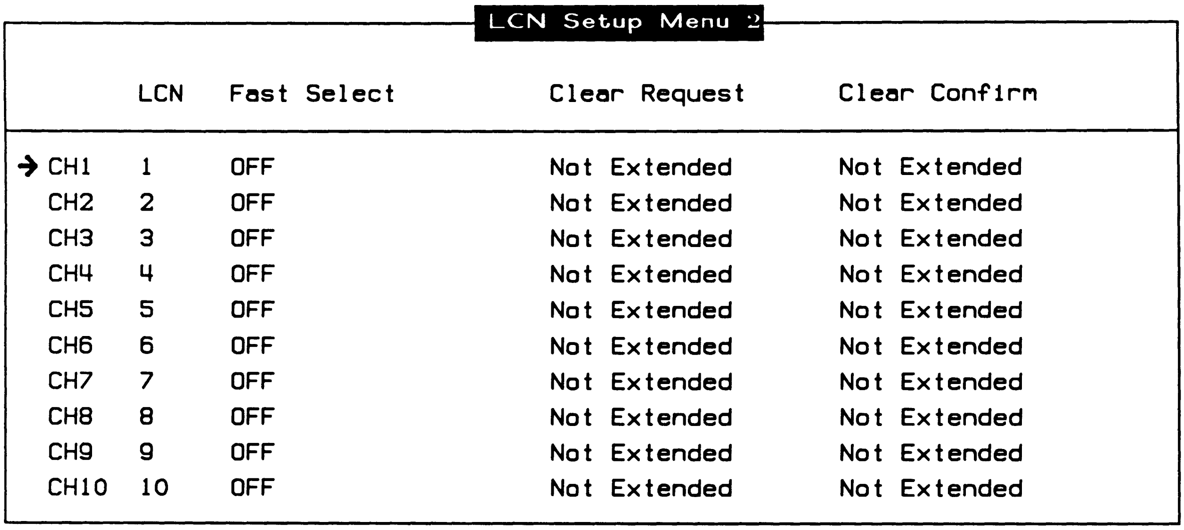
Disables the data packet echo (default) on the currently selected channel.

Example:
Turn off the data packet echo enabled in the previous example.

```
CH55  ECHO_OFF
```

ECHO OFF function key

Each of the 255 logical channels can be configured for fast select facility, clear request format, and clear confirm format from the LCN Setup Menu 2.



LCN Setup Menu 2

	LCN	Fast Select	Clear Request	Clear Confirm
→ CH1	1	OFF	Not Extended	Not Extended
CH2	2	OFF	Not Extended	Not Extended
CH3	3	OFF	Not Extended	Not Extended
CH4	4	OFF	Not Extended	Not Extended
CH5	5	OFF	Not Extended	Not Extended
CH6	6	OFF	Not Extended	Not Extended
CH7	7	OFF	Not Extended	Not Extended
CH8	8	OFF	Not Extended	Not Extended
CH9	9	OFF	Not Extended	Not Extended
CH10	10	OFF	Not Extended	Not Extended

Figure 19–6 LCN Setup Menu 2

The following commands define the use and format of facility fields.

FAST_SELECT_OFF (--)

Disables the fast select facility (default) on the currently selected logical channel.

Example:
Turn off the fast select facility on channel 2.

```
CH2  FAST_SELECT_OFF
```

FAST SELECT OFF function key

FAST_SELECT_ON (--)

Enables the fast select facility with no restrictions in call request packets on the currently selected logical channel.

Example:
Turn on the fast select facility for channel 2.

```
CH2  FAST_SELECT_ON
```

✎ *ON* function key

FAST_SELECT_RESTRICTION (--)

Enables the fast select facility with restriction on the currently selected logical channel. When the FAST_SELECT_RESTRICTION is active and a call request packet is received, the emulation transmits a clear request packet which contains address, facility, and user data fields.

Example:
Activate the fast select facility for channel 3.

```
CH3  FAST_SELECT_RESTRICTION
```

✎ *WITH RESTRICTION* function key

Clear request packets contain calling and called address fields, facility fields, and optional clear user data in fast select mode if the CLEARREQ_EXT command is issued.

CLEARREQ_NOT_EXT (--)

Extended format in the transmitted clear request packets is not used on the currently selected logical channel. This is the default mode for all logical channels and applies to both DCE and DTE ends.

Example:
Turn off extended format in clear request packets on channel 1 for transmission.

```
CH1  CLEARREQ_NOT_EXT
```

✎ *NOT EXTENDED* function key

CLEARREQ_EXT (--)

Uses extended format in the transmitted clear request packets on the currently selected logical channel. When this command is issued, the diagnostic code field, address length fields, and facility length fields must be present in the clear request packet. The clear user data field is optional.

This command is selected per channel and applies to both DTE and DCE ends. It remains in effect until CLEARREQ_NOT_EXT is issued.

Example:
Use extended format in clear request packets on channel 4.

```
CH4  CLEARREQ_EXT
```

CLEAR REQUEST EXTENDED function key

NOTE
If the emulation partner is also an IDACOM tester, this command should also be issued on the partner for the same logical channel.

Clear confirmation packets contain calling and called address fields and facility fields if the CLEARCONF_EXT command is issued.

CLEARCONF_NOT_EXT (--)

Extended format in the transmitted clear confirmation packets is not used on the currently selected logical channel. This is the default mode for all logical channels and applies to the DCE end.

Example:
Turn off extended format in clear confirmation packets on channel 1.

```
CH1  CLEARCONF_NOT_EXT
```

NOT EXTENDED function key

CLEARCONF_EXT (--)

Uses extended format in the transmitted clear confirmation packets on the currently selected logical channel. When this command is issued, the diagnostic code field, the address length fields, and the facility length fields must be present in the clear confirm packet.

The DTE side can receive, but not transmit, a clear confirm packet in extended format. The DCE side can receive or send clear confirm packets in extended format. This command remains in effect until CLEARCONF_NOT_EXT is issued.

Example:
Use extended format in clear confirmation packets on channel 4.

```
CH4  CLEARCONF_EXT
```

CLEAR CONFIRM EXTENDED function key

NOTE
If the emulation partner is also an IDACOM tester, this command should also be issued on the partner for the same logical channel.

19.2 Emulation Decode

This section describes the data flow diagram for the emulation decode and lists the variables in which decoded information is saved.

The X.25 Emulation operation follows the CCITT X.25 (1984) Recommendation.

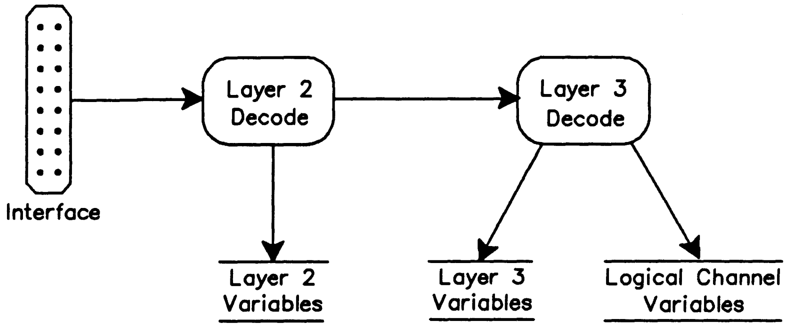


Figure 19–7 X.25 Emulation Data Flow Diagram – Decode

Communication Variables

This section describes both receive and transmit communication variables. Receive variables are set during the decode process, and contain protocol specific information as defined in the X.25 Recommendation. The emulation uses the information in these variables to determine the appropriate action to external events.

Transmit variables are used when transmitting a frame and can be used in test scripts to modify the emulation response.

NOTE
These variables can be read using the @ (fetch) operation.

PR (-- address)
Contains the P(R) (packet receive sequence number) of the last received data, RR, RNR, or REJ packet. Valid values are 0 through 7 for modulo 8, and 0 through 127 for modulo 128. Bits 6 to 8 of the packet identifier octet in data, RR, RNR, or REJ packets represent modulo 8. Bits 2 to 8 of octet 4 represent modulo 128.

PS (-- address)
Contains the P(S) (packet send sequence number) of the last received data packet. Valid values are 0 through 7 for modulo 8, and 0 through 127 for modulo 128. Bits 6 to 8 of the packet identifier octet in data packets for modulo 8. Bits 2 to 8 of octet 3 in data packets for modulo 128.

RCAUSE (-- address)

Contains the received cause byte. Octet 4 of the following packets:

- Clear request/indication
- Reset request/indication
- Restart request/indication

If the emulation is a DCE, the X.25 Emulation checks if the cause byte has a value of 0, or is between 128 and 255. See the CCITT X.25 (1984) Recommendation for defined values for specific packets.

RDIAG (-- address)

Contains the diagnostic byte of the received packet. Valid values are 0 through 255. Octet 5 of the following packets:

- Clear request/indication
- Reset request/indication
- Restart request/indication

NOTE
See the CCITT X.25 (1980/1984) Recommendations for defined values.

REC_PKT_ID (-- address)

Contains the received packet identifier byte. Used by the emulation to determine if this is an appropriate packet to receive for current LCN state. See Table B–2 for valid values.

RECD (-- address)

Contains the D (delivery confirmation) bit of a received data packet, call request/incoming call, or call accept/connect packet (0 or 1). Bit 7 of the first packet octet.

If this bit is set to 1 in any other packet type, the decode operation indicates an invalid GFI. If the emulation is a DCE, it responds with a diagnostic packet with a value of 40 as the diagnostic code indicating an invalid GFI.

RECM (-- address)

Contains the M (more) bit of a received data packet (0 or 1). Bit 5 of octet 3 of the data packet represents modulo 8, and bit 1 of octet 4 represents modulo 128. When the M bit is set to 1, more data will follow.

RECPKTMOD (-- address)

Contains the received packet modulo. Bits 5 and 6 of the first octet of the packet. RECPKTMOD contains the hex value 10 for modulo 8, and 20 for modulo 128. Any other value is decoded as an invalid GFI. If the emulation is a DCE, it responds with a diagnostic packet with a value of 40 as the diagnostic code indicating an invalid GFI.

RECQ (-- address)

Contains the Q (qualifier) bit of a received data packet (0 or 1). Bit 8 of the first data packet octet.

If this bit is set to 1 in any other packet type, the decode operation indicates an invalid GFI. If the emulation is a DCE, it responds with a diagnostic packet with a value of 40 as the diagnostic code indicating an invalid GFI.

RIUD (-- address)

Contains the user data byte in a received interrupt packet. Octet 4 in interrupt packets. The interrupt user data field can be 1 to 32 octets. If the emulation is in state p1 – Ready, p2 – Calling, or p5 – Collision, the emulation responds with a clear request packet. If the emulation is in state d1 – Data or d8 – Remote Busy and the interrupt user data field is greater than 32 octets in length, the emulation responds with a reset request packet.

RLCN (-- address)

Contains the combined logical group identifier and logical channel number of the received packet. Valid values are 0 through 4095. Bits 1 to 4 of the first packet octet and all bits of the second packet octet.

The emulation supports up to 255 logical channels at a time. These are defined on the LCN Setup Menu 1 as CH1 through CH255. Any changes to this should be made prior to running the emulation.

DCE Emulation If RLCN contains a value other than that defined on the LCN Setup Menu 1, the emulation ignores this received packet. If in a state waiting restart confirm or link up, it responds with a diagnostic packet.

DTE Emulation If RLCN contains a value other than that defined on the LCN Setup Menu 1, the emulation ignores this received packet regardless of the state.

SCAUSE (-- address)

Contains the cause field for transmitted clear request/indication, reset request/indication, and restart request/indication packets. Used in the automatic emulation and the S:CLEARR, S:RESETR, and S:RESTARTR commands. When the automatic emulation detects an error, SCAUSE contains the following values:

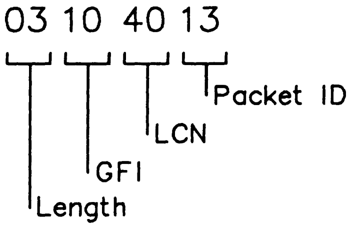
Packet Type	DCE Emulation Local Procedure Error	DTE Emulation DTE Originated
Clear	19	0
Reset	5	0
Restart	1	0

SDIAG (-- address)

Contains the diagnostic field for transmitted clear request/indication, reset request/indication, and restart request/indication packets. Used in the automatic emulation and the S:CLEARR, S:RESETR, S:RESTARTR, and S:DIAG commands. See the CCITT X.25 (1984) Recommendation, Annex E for defined values. After the packet is transmitted, SDIAG is reset to 0.

SDIAG-EXP (-- address)
Contains the diagnostic explanation field used in the S:DIAG command. The first byte contains the length of this field (up to 3 bytes). The remaining bytes contain the first 3 or less octets of the last received packet. To change this field in a transmitted packet, change the value in this variable just prior to transmission.

Example 1:
If a clear request packet is received on LCN 64, SDIAG-EXP contains the hex value:



Example 2:
Indicate that a short packet (2 bytes) was received on LCN 1.

```
0X02100100 SDIAG-EXP !
```

SENDM (-- address)
Contains the value of the M bit sent in the next data packet (default is 0.)

SIUD (-- address)
Contains the interrupt user data byte used when sending interrupt request packets. Octet 4 in interrupt request packets (default is 0). Maximum values are 32 octets for CCITT X.25 (1984); 1 octet for CCITT X.25 (1980).

STATE_L3 (-- address)
Contains a value which represents one of the layer 3 states in the layer emulation (see the 'Emulation State Machines' on page 19-25). Valid values are 1 through 4.

SET_INT_LEN (# --)
Sets the maximum length of interrupt user data of the received frame/packet. Maximum length is 32 octets for 1984, and octet for 1980.

SENDQB (-- address)
Contains the Q (qualifier) bit for transmitted packets (0 or 1). Bit 8 of the first packet octet. If this bit is set to 1 in a packet type other than a data packet during DTE emulation, the partner should respond with a diagnostic packet with a diagnostic code of 40, indicating an invalid GFI.

SENDDB (-- address)
Contains the D (delivery confirmation) bit of a transmitted packet (0 - default or 1). Bit 7 of the first packet octet. The emulation automatically sets it to 1 if a call request/incoming call packet is received with a D bit of 1. SENDDB is reset to 0 when the call accept/connect packet is transmitted. See RECD for expected response from the emulation partner.

SENDGFI (-- address)

Contains the GFI modulo indicator used for transmitting packets. Bits 5 and 6 of the first packet octet. The default value is hex 10 for packet modulo 8, and hex 20 for packet modulo 128.

RCALLED (-- address)

Contains a 16 byte string identifying the called address field of a received packet. It is used by the S:CALLR and S:CALLC commands. See the example under RCALLING; string contents and handling are similar.

RCALLING (-- address)

Contains a 16 byte string identifying the calling address field of a received packet. It is used by the S:CALLR and S:CALLC commands.

Example:
Check whether the CALLING number of the last received call request matches a pre-defined number (eg. 43042001). The ?MATCH command is used to determine if the calling address in a received call request packet matches the defined address.

```
TCLR

#IFNOTDEF MATCH-CALL
      0 VARIABLE MATCH-CALL 12 ALLOT
                           ( MATCH-CALL will contain the desired calling address )
#ENDIF

0 STATE_INIT{
      " 43042001"
      COUNT                 ( Obtain # of digits in calling address )
      15 MIN                ( Set maximum to 15 digits )
      DUP MATCH-CALL C!     ( Write # of digits to first byte of matching string )
      MATCH-CALL 1 + SWAP CMOVE     ( Write calling address in matching string )
  }STATE_INIT

0 STATE{
      R*CALLREQ 1 ?RX
      ACTION{
          RCALLING          ( Get this calling address )
          COUNT             ( Get # of digits in this calling address )
          MATCH-CALL        ( Get desired matching address )
          ?MATCH            ( Compare addresses )
          IF
              BEEP          ( Notify user )
              T." Address Match has occurred."  TCR
          ENDIF
      }ACTION
  }STATE
```

RCUD (-- address)

Contains a 128 byte string identifying the call user data of a received packet.

Example:
The tester receives a call request packet with a call user field that contains 11 characters, i.e. the hex characters C000000003010025800064.

Obtain the length of the call user data field (in this case 11).

```
RCUD C@
```

If the call user data field is present, its use and format are determined by bits 7 and 8 of the first octet. This octet can be obtained by RCUD 1 + C@. Refer to CCITT 1984 Recommendation X.244 for further information on call user data.

RFAC (-- address)

Contains a 256 byte string identifying the facility field of a received call request/incoming call, call accept/connect, clear request/clear indication, or clear confirmation packet.

NOTE
The maximum facility length is 109 octets. If the received length is longer than 109 octets, the X.25 Emulation transmits a clear request packet.

Example:
The tester receives a call request packet with a facility field that contains 8 characters, i.e. the hex characters 02AA420808430303.

Obtain the length of the facility field (8 in this case).

```
RFAC C@
```

Obtain the first octet of the first facility (hex 02 in this case). This indicates that the first facility is:

- a Class A facility, i.e. it is followed by a two octet parameter field; and
- throughput class negotiation.

```
RFAC 1 + C@
```

Obtain the throughput class octet (hex AA in this case). This indicates that the throughput class for the called DTE and calling DTE is 9600 bits.

```
RFAC 2 + C@
```

Obtain the first octet of the second facility (hex 42 in this case). This indicates that the second facility is:

- a Class B facility, i.e. it is followed by a two octet parameter field; and
- packet size.

```
RFAC 3 + C@
```

Obtain the packet size for the called DTE (hex 08 in this case). This indicates a packet size of 256.

```
RFAC 4 + C@
```

Obtain the packet size for the calling DTE (hex 08 in this case). This indicates a packet size of 256.

```
RFAC 5 + C@
```

Obtain the first octet of the third facility (hex 43 in this case). This indicates that the third facility is:

- a Class B facility, i.e. it is followed by a two octet parameter field; and
- window size.

```
RFAC 6 + C@
```

Obtain the window size of the called DTE (hex 03 in this case). This indicates a window size of 3.

```
RFAC 7 + C@
```

Obtain the window size of the calling DTE (hex 03 in this case). This indicates a window size of 3.

```
RFAC 8 + C@
```

NOTE
Refer to the CCITT X.25 (1984) Recommendation, Section 7 Formats for Facility Fields and Registration Fields for further information on decoding facilities.

SET_FAC_LENGTH (--)
Sets the maximum length of the facility field in received call/clear packets.

The X.25 layer 3 Emulation program supports simultaneous execution of 255 logical channels.

The logical channel commands access parameters from the currently selected logical channel (default is CH1). The current logical channel can be set using the following methods:

- Under the **X25_Send** topic, press the *Enter LCN* function key. If the entered value (0 through 4095) matches one of those defined on LCN Setup Menu 1, the value in the LCN variable will be set to that entered value.
- Use one of the CH1 to CH255 commands (see the 'LCN Setup' section on page 19–11).
- Use the =LCN command (see the 'LCN Setup' section on page 19–11).

LCN (-- address)
Contains a pointer to the value of the current logical channel and logical group. Valid values are 0 through 4095 (default is 1).

LCNCES (-- address)
Contains the value of link CES for the current channel (default is 0). Valid values are 0 through 7.

LCNSTATE (-- address)
Contains a pointer to the current LCN state with one of the following values:
1 – p1 Ready, 2 – p2 Calling, 3 – p5 Collision, 4 – d1 Data, 5 – d2 Reset, 6 – p6 Clearing, 8 – d8 Remote Busy (see the 'Emulation State Machines' section on page 19–25).

LCNWINDOW (-- address)
Contains a pointer to the window size for the current logical channel. Valid values are 1 through 7 for modulo 8, and 1 through 127 for modulo 128 (default is 2).

LCNSIZE (-- address)
Contains a pointer to the size of the data field used with the DATA command. Valid values are 0 through 4110 bytes (default is 128).

LCNDSIZE (-- address)
Contains a pointer to the maximum size of the data field in data packets for the current logical channel. This is negotiated in the facility field during call setup. The standard negotiated value is 128 octets; others are 16, 32, 64, 256, 512, 1024, 2048, and 4096 octets.

NVS (-- address)
Contains a pointer to the current LCN P(S) (send sequence number) used when a data packet is transmitted. It is set to 0 when the logical channel has just entered the flow control ready state – d1 and incremented by one every time a data packet is transmitted. Valid values are 0 through 7 for modulo 8, and 0 through 127 for modulo 128.

NVR (-- address)
Contains a pointer to the current LCN P(R) (receive sequence number). This is the next P(S) expected to be received. It is set to 0 when the logical channel has just entered the flow control ready state – d1. When a data packet is received with a valid P(S) and P(R), NVR is incremented by one. Valid values are 0 through 7 for modulo 8, and 0 through 127 for modulo 128. NVR is used when transmitting data, RR, RNR, and REJ packets.

NSU (-- address)
Contains a pointer to the LCN P(S) (sequence number) of the lowest unacknowledged data packet. It is set to 0 when the logical channel has just entered the flow control ready state – d1. When a data packet is received with a valid P(S) and P(R) or an RR, RNR, or REJ packet is received with a valid P(R), the current received P(R) is written in NSU. Valid values are 0 through 7 for modulo 8, and 0 through 127 for modulo 128.

19.3 Emulation Response

The X.25 layer 3 Emulation is implemented as a multi-layer, state-driven protocol emulation. There are separate program modules for each protocol layer. These modules communicate with each other to implement protocol response behavior.

The emulation has been set up to run as:

- an automatic simulation which operates precisely in accordance with the CCITT X.25 (1980/1984) Recommendations;
- a semi-automatic tester. The test manager is used to build and execute test scenarios to test responses and for generation of errors (see Section 20); and
- a manual tester. The test is controlled from the user's keyboard.

Emulation State Machines

To ensure correct protocol operation, state machines have been implemented. Based on input events (i.e. received frames or packets), transitions from one state to another are made in accordance with CCITT Recommendations.

NEW_L3_STATE (n --)

Sets the layer 3 state machine to a specific state. Valid values are 1 through 4. The state value is stored in the STATE_L3 variable.

Example:
Put the layer 3 state machine in the idle state.

```
1 NEW_L3_STATE
```

State Number	State Name	Description
1	Idle	Disconnected from layer 2
2	Waiting Operational	Waiting for link operational
3	Waiting Restart Confirm	Waiting for restart confirm
4	Link Up	Operational state

Table 19–2 Layer 3 States

Embedded in state 4 of the layer 3 state machine, is a state machine for each logical channel.

NEW_LCN_STATE (n --)

Sets the logical channel state of the currently selected LCN to a specific state. Valid values are 1, 2, 3, 4, 5, 6, and 8.

Example:
Put the logical channel state machine in state p1 – Ready.

```
1 NEW_LCN_STATE
```

NOTE

The layer 3 state machine should be in State 4 (i.e. link up) when using the NEW_LCN_STATE command.

State Number	State Name	Description
1	p1 – Ready	SVC LCN is ready to send or receive call
2	p2 – Calling	SVC LCN has sent call request, waiting for call connect
3	p5 – Collision	DTE and DCE simultaneously transmit a call request and incoming call on the same logical channel
4	d1 – Flow Control Ready	Flow control state: Ready for data
5	d2 – Reset	LCN has sent reset request, waiting for reset confirm
6	p6 – Clearing	SVC LCN has sent clear request, waiting for clear confirm
8	d8 – Remote Busy	Flow control ready with remote end busy

Table 19–3 Logical Channel States

Automatic Responses

The state machines normally handle the protocol automatically, i.e. there are automatic responses to received frames and packets.

The following commands activate and deactivate the frame and packet state machines.

X25_L3_OFF (--)
Deactivates the X.25 layer 3 state machine. No automatic responses to received packets are generated. This command is useful for layer 3+ simulation.

X25_L3_ON (--)
Activates the X.25 layer 3 state machine. Automatic responses to received packets are generated. This command is useful for layer 4+ simulation.

EMUL_ON (--)
Activates all state machines (default). Automatic responses to received frames and packets are generated.

EMUL_OFF (--)
Deactivates all state machines. No automatic responses to received frames and packets are generated.

State–Dependent Send Commands

Either function keys or commands are used to transmit frames or packets in conjunction with the automatic state machines. These commands or function keys force protocol state changes and the emulation thereby expects the correct response.

NOTE
When using these commands or function keys, the layer 2 and layer 3 protocol state machines must be activated. See Section 21 for examples.

The currently selected logical channel is:

- the last channel activated by the last CHn command;
- the value entered with the *Enter LCN* function key under the **X.25_Send** topic; or
- the last logical channel specific packet received.

CALL (--)

If the layer 3 and LCN state machines are in a state that allows a call packet to be sent, the emulation transmits a call request packet for a DTE emulation, or an incoming call packet for a DCE emulation. This packet is sent out on the currently selected LCN with the called and calling addresses as specified on the LCN Setup Menu.

The T21/T11 timer is started and the LCN state machine is set to state p2 – Calling. In response, the emulation expects a call connect packet if configured as DTE and a call accept if configured as DCE. If a correctly formatted call connect/accept packet is received, the LCN state machine goes to state d1 – Data and the T21/T11 is stopped. If the call connect/accept packet has an error in the facility field, a clear request packet is transmitted.

Example:

```
CALL          ( Send call request/incoming call on current LCN )
CH2  CALL     ( Sends call request/incoming call on channel 2 )
```

CLEAR (--)

If the layer 3 or LCN state machines are in a state that allows a clear packet to be sent, the emulation transmits a clear request packet for a DTE emulation, or a clear indication packet for a DCE emulation. This packet is sent out on the currently selected LCN.

The T23/T13 timer is started and the LCN state machine is set to state p6 – Clearing. In response, the emulation expects a clear confirm packet. If a correctly formatted clear confirm packet is received, the LCN state machine goes to state p1 – Ready and the T23/T13 is stopped.

Example:

```
CLEAR         ( Sends Clear request/indication on currently selected LCN )
CH3  CLEAR    ( Sends Clear request/indication on channel 3 )
```

DATA (--)

If the layer 3 or LCN state machines are in a state that allows a data packet to be sent and the packet layer window is open, the emulation transmits a data packet with the correct P(S) and P(R) with the maximum amount of data as specified on the Packet Layer Menu. This packet is sent out on the currently selected LCN. For an SVC (switched virtual circuit), a call must have been set up first.

The data field is filled with pre–defined text, and can be changed using the DEFINE_DATA command. A test program can determine if the window is open by using the WINDOW? command.

Example:

```
DATA           ( Sends Data packet on the currently selected LCN )
CH4  DATA      ( Sends Data packet on channel 4 )
```

DEFINE_DATA (filename --)

Defines the text within the data field of the data packet for the DATA command and the *DATA* function key. A file containing the desired text must first be created using the editor on the Home processor. DEFINE_DATA overwrites BUFFER 0 of the test manager (see the 'Using Buffers' section on page 20–16).

NOTE

If the file created by the user contains less than 1024 characters, the data field is padded out to 1024 characters.

Example:

Create a file with the name CUSTOM.F with the desired text.

- ❑ Press the **HOME** key.
- ❑ Move the topic bar to the **Files** topic.
- ❑ Insert a formatted floppy diskette in drive 0.
- ❑ Press the *Edit* function key.

The 'Edit script:' prompt is displayed.

- ❑ Type: DR0:CUSTOM.F.
- ❑ Press ↵ (RETURN).
- ❑ Enter desired text.
- ❑ Press the *Save* function key.
- ❑ Press the *Quit* function key.

Follow the instructions in the User Manual for loading the X.25 Emulation. Switch to the application processor which is running the program.

To use the previously created file:

- ❑ Press the **ESC** key to enter the command mode.
- ❑ Type: DR0 " CUSTOM.F" DEFINE_DATA
- ❑ Press the **ESC** key to leave the command mode.

Any data packets sent using the *DATA* function key under the **X.25_Send** topic will contain the text created by the user.

INTERRUPT (--)

If the layer 3 or LCN state machines are in a state that allows an interrupt packet to be sent, the emulation transmits an interrupt packet. This packet is sent out on the currently selected LCN provided a call has been set up.

Example:

```
INTERRUPT       ( Sends interrupt packet on currently selected LCN )
CH5  INTERRUPT  ( Sends interrupt packet on channel 5 )
```

RESET (--)

If the layer 3 or LCN state machines are in a state that allows a reset request packet to be sent, the emulation transmits a reset request packet for a DTE emulation or a reset indication packet for a DCE emulation. This packet is sent out on the currently selected LCN.

The T22/T12 timer is started and the LCN state machine is set to state d2 - Reset. In response, the emulation expects a reset confirm packet. If a correctly formatted reset confirm packet is received, the LCN state machine goes to state d1 - Data and T22/T12 is stopped.

Example:

```
RESET           ( Sends reset packet on currently selected LCN )
CH6  RESET      ( Sends reset packet on channel 6 )
```

RESTART (--)

If the layer 3 state machine is in a state that allows a restart request packet to be sent, the emulation transmits a restart request packet for a DTE emulation or a restart indication packet for a DCE emulation. This packet is sent out on logical channel 0.

The T20/T10 timer is started and the layer 3 state machine is set to the waiting restart confirm state. In response, the emulation expects a restart confirm packet. If a correctly formatted restart confirm packet is received, the layer 3 state machine goes to the Link Up state and the LCN state machine goes to state p1 - Ready for an SVC or state d1 - Data for a PVC. T20/T10 is stopped and CH1 is selected as the current LCN.

NOTE

RESTART, CALL, DATA, RESET, and CLEAR packets can also be transmitted by pressing the corresponding function key under the X.25_Send topic.

The following command transmits user-defined data (80 characters maximum).

SENDD (string --)

Transmits a user-defined data field in a data packet. The defined string is transmitted in a data packet containing the correct P(S) and P(R).

SENDD only transmits a data packet if the corresponding layer 3 window is open and sufficient acknowledgements have been received. The status of the layer 3 window is determined using the WINDOW? command.

If the layer 3 window is not open, the data is discarded as there is no queuing implemented at this level.

Example:

```
X" 10010B22303000000000" SENDP  ( Transmits a call request packet on LCN 1 )
" A quick brown fox jumped over the lazy dog" SENDD
          ( Transmits a data packet on current LCN with this text in data field )
```

State–Independent Send Commands

S:RESTARTR (--)

Transmits a restart request packet on logical channel 0 using values from the following variables:

- LCN – Logical group and channel value (0)
- SENDQB – Q bit value
- SENDDB – D bit value
- SENDGFI – GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)
- SCAUSE – Cause value
- SDIAG – Diagnostic value

S:RESTARTC (--)

Transmits a restart confirm packet on logical channel 0 using values from the following variables:

- LCN – Logical group and channel value (0)
- SENDQB – Q bit value
- SENDDB – D bit value
- SENDGFI – GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)

S:CALLR (--)

Transmits a call request/incoming call packet on the selected channel using values from the following variables:

- LCN – Logical group and channel value
- SENDQB – Q bit value
- SENDDB – D bit value
- SENDGFI – GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)
- LCNCALLED – Called address field with the first byte containing the length of address and followed by the address bytes in ASCII
- LCNCALLING – Calling address field with the first byte containing the length of address and followed by the address bytes in ASCII
- FACILITY-ACTIVE – Indication of type of facility negotiation desired
  0 = Facilities not wanted
  1 = Negotiate facilities for size, window, and throughput class
  2 = Send facilities defined with MAKE_FAC command.
- CUD-BUFFER – Call user data field buffer. The first byte is the length of the call user data field followed by the call user data

->CID_INFO_CHAN_SEL	Info. chan. sel., Octet 3
#NO_CHANNEL	*no channel*
#AS_INDICATED	*as indicated*
#B1_CHANNEL	*B1 channel*
#B2_CHANNEL	*B2 channel*
#ANY_CHANNEL	*any channel*
->CID_INT_ID	Interface ident., Octet 3.1 *
(hex characters)	*max. length 8 octets*
->CID_CODING_STANDARD	Coding standard, Octet 3.2
#CCITT	*CCITT*
#INTERNATIONAL	*other international standards*
#NATIONAL	*national standard*
#NETWORK_SPECIFIC	*standard defined for the network*
->CID_NUMBER/MAP	Number/Map, Octet 3.2
#NUMBER	*number*
#MAP	*map*
->CID_CHANNEL/MAP_TYPE	Chan./Map type, Octet 3.2
#B_CHANNEL_UNITS	*B−channel units*
#H0_CHANNEL_UNITS	*H0−channel units*
#H11_CHANNEL_UNITS	*H11−channel units*
#H12_CHANNEL_UNITS	*H12−channel units*
->CID_MAP	Slot map, Octet 3.3 *
(hex characters)	*max. length 4 octets*
->CID_NUMBER	Channel number, Octet 3.3
(numeric value)	*range 0 through 127*

Congestion Level IE (I#CONG_LEVEL)

->CL_CONGESTION_LEVEL	Congestion level
#RECEIVER_READY	*receiver ready*
#RECEIVER_NOT_READY	*receiver not ready*

Date/Time IE (I#DATE/TIME)

Possible octet inclusions/exclusions:

OCTET_3, OCTET_4, OCTET_5, OCTET_6, OCTET_7, OCTET_8

->DT_YEAR	Year, Octet 3
(numeric value)	*range 0 through 255*
->DT_MONTH	Month, Octet 4
(numeric value)	*range 0 through 255*
->DT_DAY	Day, Octet 5
(numeric value)	*range 0 through 255*
->DT_HOUR	Hour, Octet 6
(numeric value)	*range 0 through 255*

T_MINUTE	Minute, Octet 7
numeric value)	*range 0 through 255*
T_SECOND	Second, Octet 8
numeric value)	*range 0 through 255*

lay IE (I#DISPLAY)

ble octet inclusions/exclusions:

T_3

DISPLAY	Display information, Octet 3 *
IA5 characters)	*max. length 80 octets*

-to-End Transit Delay IE (I#END-END_DELAY)

ble octet inclusions/exclusions:

T_3, OCTET_3A, OCTET_3B, OCTET_4, OCTET_4A, OCTET_4B, OCTET_5, OCTET_5A,
T_5B

_CUMUL_DELAY	Cum. transit delay, Octet 3, 3a, & 3b
umeric value)	*range 0 through 64536*
_REQ_DELAY	Req. end-end delay, Octet 4, 4a, & 4b
umeric value)	*range 0 through 64536*
_MAX_DELAY	Max. end-end delay, Octet 5, 5a, & 5b
umeric value)	*range 0 through 64536*

oint Identifier IE (I#ENDPOINT_ID)

le octet inclusions/exclusions:

_3, OCTET_4

USID	User service id., Octet 3
umeric value)	*range 0 through 127*
INTERPRETER	Interpreter, Octet 4
ATCHES_USID+TID	*matches USID and TID*
ATCHES_USID	*matches USID and not TID*
TID	Terminal identifier, Octet 4
umeric value)	*range 0 through 63*

S:CALLC (--)

Transmits a call connected/accepted packet on selected channel using values from the following variables:

LCN – Logical group and channel value
SENDQB – Q bit value
SENDDB – D bit value
SENDGFI – GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)
RCALLED – Called address field with the first byte containing the length of address and followed by the address bytes in ASCII
RCALLING – Calling address field with the first byte containing the length of address and followed by the address bytes in ASCII
CAFAC-ACTIVE – Indication of the type of facility to use:
0 = Do not send facilities
1 = Echo received facilities from buffer RFAC
2 = Send facilities defined by MAKE_CAFAC command

S:CLEARR (--)

Transmits a clear request/indication packet on the selected channel using values from the following variables:

LCN – Logical group and channel value
SENDQB – Q bit value
SENDDB – D bit value
SENDGFI – GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)
SCAUSE – Cause value
SDIAG – Diagnostic value

When the fast select facility is active, the following are also included in clear request packets.

LCNCALLED – Called address field
LCNCALLING – Calling address field
FACILITY-ACTIVE – Indication of type of facility negotiation desired (see S:CALLR)
CUD-BUFFER – Call user data field buffer. The first byte is the length of the call user data field followed by the call user data

S:CLEARC (--)

Transmits a clear confirmation packet on the selected channel using values from the following variables:

LCN – Logical group and channel value
SENDQB – Q bit value
SENDDB – D bit value
SENDGFI – GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)

S:RESETR (--)

Transmits a reset request/indication packet on the selected channel using values from the following variables:

LCN – Logical group and channel value
SENDQB – Q bit value
SENDDB – D bit value
SENDGFI – GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)
SCAUSE – Cause value
SDIAG – Diagnostic value

S:RESETC (--)

Transmits a reset confirmation packet on the selected channel using values from the following variables:

LCN	- Logical group and channel value
SENDQB	- Q bit value
SENDDB	- D bit value
SENDGFI	- GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)

S:INTR (--)

Transmits an interrupt packet on the selected channel using values from the following variables:

LCN	- Logical group and channel value
SENDQB	- Q bit value
SENDDB	- D bit value
SENDGFI	- GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)
SIUD	- Interrupt user data byte

S:INTC (--)

Transmits an interrupt confirmation packet on the selected channel using values from the following variables:

LCN	- Logical group and channel value
SENDQB	- Q bit value
SENDDB	- D bit value
SENDGFI	- GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)

S:DATAP (--)

Transmits a data packet on the selected channel using values from the following variables:

LCN	- Logical group and channel value
SENDQB	- Q bit value
SENDDB	- D bit value
SENDGFI	- GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)
NVS	- P(S) value
NVR	- P(R) value
SENDM	- More bit value
DATA-BUF-ID	- Indication of which data buffer to use in user data field 10 = buffer created with SENDD command (maximum length is 80 characters) 11 = echo of received data packets Any other value - DATA-BUFFER which contains the default data field or data field created with DEFINE_DATA command (maximum 4100 characters)
LCNSIZE	- Length of the data field to send when DATA-BUFFER is used
MAX_LENGTH	- Maximum frame length

S:RRP (--)

Transmits an RR packet on the selected channel using values from the following variables:

LCN	- Logical group and channel value
SENDQB	- Q bit value
SENDDB	- D bit value
SENDGFI	- GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)
NVR	- P(R) value

S:RNRP (--)

Transmits an RNR packet on the selected channel using values from the following variables:

LCN	– Logical group and channel value
SENDQB	– Q bit value
SENDDB	– D bit value
SENDGFI	– GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)
NVR	– P(R) value

S:REJP (--)

Transmits an REJ packet on the selected channel using values from the following variables:

LCN	– Logical group and channel value
SENDQB	– Q bit value
SENDDB	– D bit value
SENDGFI	– GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)
NVR	– P(R) value

S:DIAG (--)

Transmits a diagnostic packet on the selected channel using values from the following variables:

LCN	– Logical group and channel value
SENDQB	– Q bit value
SENDDB	– D bit value
SENDGFI	– GFI modulo value (0x10 for modulo 8, and 0x20 for modulo 128)
SDIAG	– Diagnostic value
SDIAG–EXP	– Diagnostic explanation field. The first byte is the length of the field followed by up to three bytes for the explanation field to be sent.

20
TEST MANAGER

IDACOM has developed a comprehensive set of tools for the development of test scripts. These test scripts, written using the ITL language, control the operation of the ISDN Monitor/Emulation program.

For a complete explanation of the test manager and tools available, see the Programmer's Reference Manual.

This section reviews basic ITL components plus describes the protocol event and action commands specific to ISDN.

20.1 ITL Constructs

Following is a brief description of test manager constructs. For more details and examples, refer to the Programmer's Reference Manual.

TCLR (--)
Initializes the test manager. Any existing test suites already in memory are cleared. The current state is set to 0. All test scenarios should start with the TCLR command.

STATE_INIT{ }STATE_INIT (number --)
Brackets the execution sequence performed prior to entering a state. The initialization logic for a state is executed independently of how it was called.

This initialization procedure can be used for any state but is not compulsory. STATE_INIT{ must be preceded by the number of the state being initialized, eg. 0 STATE_INIT{.

The STATE_INIT{ }STATE_INIT clause is executed only once each time the state is entered from another state.

STATE{ }STATE (number --)
Brackets a state definition. STATE{ must be preceded by the number of the state. Valid values are 0 through 255. State 0 must be defined within an ITL program. If not, the test manager will not run the script. If multiple states are defined with the same number in the test script, the test manager uses the latest definition.

ACTION{ }ACTION (flag --)
Brackets the set of tasks, decisions, and outputs which execute once the expected event is received by the test manager. There must be at least one action defined for each expected event. The action is executed when the flag is true (non–zero).

NEW_STATE (n --)
Executes the initialization logic of the specified state (providing STAT_INIT{ }STAT_INIT is defined) and establishes the state to be executed for the next event. Any remaining action code for the current state is then executed. It must be preceded with a valid state number and be inside the ACTION{ }ACTION brackets. This command is not mandatory if no state change is desired.

TM_STOP (--)
Stops the execution of the test script. The test suite remains in memory and can be re-executed until another test script is loaded.

SEQ{ }SEQ (number --)
Brackets a definition of tasks and outputs which execute as part of the state machine action. SEQ{ expects a single integer which is the sequence number. Up to 256 sequences are supported. Valid values are 0 through 255. The SEQ{ }SEQ partners are extremely useful when more than one action sequence calls the same tasks and outputs. The SEQ{ }SEQ definition is defined outside the ACTION{ }ACTION definition and then called by the RUN_SEQ command.

This is an alternate mechanism to generate colon definitions. This mechanism causes the equivalent of a colon definition (now accessed via a numeric identifier) to be compiled into the test script dictionary rather than the user dictionary. Refer to the Programmer's Reference Manual.

RUN_SEQ (number --)
Executes a specified set of tasks defined in a SEQ{ }SEQ definition. It is called inside an ACTION{ }ACTION definition and must be preceded with a defined sequence number.

LOAD_RETURN_STATE (number --)
Permits the test script writer to program the equivalent of subroutine calls (used with RETURN_STATE). LOAD_RETURN_STATE sets the state to which control is to be returned. LOAD_RETURN_STATE must be within the action field; nesting is not permitted.

RETURN_STATE (--)
Returns control to the state specified by LOAD_RETURN_STATE from a state subroutine call.

NEW_TM (filename --)
Loads and compiles the specified file and then starts the test manager at state 0. It can be included as part of the action field to load and execute another scenario.

TM_INIT (--)
This DOER word is executed when a test script starts execution. It can be used to initialize variables for the script when using state 0 would not be appropriate (such as when using the Layer 3 Connection Multiplexor).

Example:

```
MAKE TM_INIT
    #BASIC SET_INTERFACE
    CLEAR_ALL_CNS
;
```

20.2 Control Commands

STATE_ON (--)
Displays trace statements for every protocol or test manager state change. This is useful for debugging test scripts.

STATE_OFF (--)
Trace statements for protocol or test manager state changes are not displayed.

?BRI (-- flag)
Returns true if the test script is running on a BRA application. This command is usually used with the compiler control commands (see the Programmer's Reference Manual).

Example:

```
#IF ?BRI #IS_TRUE
      #BASIC SET_INTERFACE
#ELSE
      #PRIMARY SET_INTERFACE
#ENDIF
```

?PRI (-- flag)
Returns true if the test script is running on a PRA application.

Example:

```
I#CHANNEL_ID ELEMENT>
      OCTET_3 INCLUDED

#IF ?PRI #IS_TRUE
      OCTET_3.2 INCLUDED
      OCTET_3.3 INCLUDED
      #NUMBER *COD ->CID_NUMBER/MAP !
      0 *COD ->CID_NUMBER !
#ENDIF
<ELEMENT
```

20.3 Event Recognition

During test script execution, any event received by the test manager is evaluated to determine if it matches the event-specifier of the first action within that state. If the evaluation does not return a true value, the following action clauses are evaluated in a sequential manner. Once an event evaluates true, the subsequent action clauses in that particular state are not examined.

Layer 1

?L1_EVENT (event ID -- flag)
Returns true if the specified layer 1 event has occurred. The layer 1 event identifiers are:

Basic Rate Access	**Primary Rate Access**
R#ACTIVATE	R#NORMAL
R#DEACTIVATE	R#OOFALM
R#RI2ERR	R#REDALM
R#LSTFRM	R#LSTSIGL
R#RECOVERY	R#YELALM
R#UNDEFINED	R#LSTPLOCK

Example:

```
R#ACTIVATE  ?L1_EVENT
ACTION{
      .
      code to be executed when S bus is activated
      .
}ACTION
```

Layer 2

?RX_FRAME (frame ID -- flag)
Returns true if the specified frame has been received. The frame identifiers are:

R#I
R#REJ
R#DISC
R#FRMR
R#INVCRC
R#RR
R#SABME
R#UA
R#UI
R#SHORTFRM
R#RNR
R#SABM
R#DM
R#INVFRM
R#XID

Example:

```
R#SABME  ?RX_FRAME
ACTION{
      .
      code to be executed when a SABME is received
      .
}ACTION
```

?COMMAND (-- flag)
Returns true if a command frame is received.

?RESPONSE (-- flag)
Returns true if a response frame is received.

?RX_MATCH (string -- flag)

Returns true if the user-defined string is found in the information field of the received information frame.

This is an *anchored* match, i.e. a byte-for-byte match starting at the first byte of the information field of the received information frame.

NOTE
To accommodate "don't care" character positions, the question mark character for ASCII or hex 3F character can be used.

The following examples assume the received information field is 'idacom electronics'.

Example 1:
Match a string containing the first four characters in the field; a true flag is returned.

```
" idac" ?RX_MATCH
```

Example 2:
Match a string containing the last characters in the field; a false flag is returned.

```
" electronics" ?RX_MATCH
```

?RX_SEARCH (string -- flag)

Returns true if the user-defined string is found in the information field of the received information frame.

This is an *unanchored* match, i.e. searches for an exact match anywhere in the information field of the received information frame, regardless of position.

The following examples assume the received information field is 'idacom electronics'.

Example 1:
Match a string containing the first four characters in the field; a true flag is returned.

```
" idac" ?RX_SEARCH
```

Example 2:
Match a string containing the last characters in the field; a true flag is returned.

```
" electronics" ?RX_SEARCH
```

?ABORT (-- flag)

Returns true if an abort frame is received.

?CRC_ERROR (-- flag)

Returns true if a frame with a CRC error is received.

?L2_SERVICE (service primitive -- flag)

Returns true if the specified service primitive has been received. The layer 2 services primitives are:

DL-EST#IND	data link established
DL-EST#CONF	data link establish confirmation
DL-REL#IND	data link release
DL-REL#CONF	data link release confirmation
DL-DATA#IND	data link sequenced data received
DL-DATA#CONF	data link confirm data transfer
DL-UDATA#IND	data link non-sequenced data received

Example:

```
DL-EST#IND  ?L2_SERVICE
ACTION[
       .
      action to be performed if an establish indication has been received
       .
}ACTION
```

?RX_DATA (-- flag)

Returns true if a layer 2 information or unnumbered information frame has been received with a SAPI = 0.

?FROM_NT (-- flag)

Returns true if a layer 2 frame was received from the network.

Layer 3

?L3_MSG (message identifier -- flag)

Returns true if the specified message has been received. Valid message identifiers are listed in each message set manual.

Example:

```
M#SETUP  ?L3_MSG
ACTION[
       .
      code to be executed if a setup message is received
       .
}ACTION
```

?L3_MATCH (string -- flag)

Returns true if the specified string is found in the target string of a layer 3 message.

This is an *anchored* match, i.e. a byte-for-byte match starting at the first byte of the received message.

?L3_SEARCH (string -- flag)
Returns true if the specified string is found in the target string of a layer 3 message.

This is an *unanchored* match, i.e. searches for an exact match anywhere in the received frame, regardless of position.

X.25 Layer 3

If the received frame is an information frame, the packet type is stored in the PACKET-TYPE variable. The identifiers used to match received packets are listed in Table 20-1.

Packet Identifiers	Description
R*DATAP	Data packet
R*RRP	Receive ready packet
R*RNRP	Receive not ready packet
R*REJP	Reject packet
R*CALLREQ	Call request or incoming call packet
R*CALLCON	Call connect or call accept packet
R*CLEARREQ	Clear request or clear indication packet
R*CLEARCONF	Clear confirm packet
R*INTREQ	Interrupt packet
R*INTCONF	Interrupt confirm packet
R*RESETREQ	Reset request or reset indication packet
R*RESETCONF	Reset confirm packet
R*RESTARTREQ	Restart request or restart indication packet
R*RESTARTCONF	Restart confirm packet
R*DIAGNOSTIC	Diagnostic packet
R*REGISTREQ	Registration request packet
R*REGISTCONF	Registration confirm packet
R*INVPKT	Invalid packet

Table 20–1 Packet Identifiers

NOTE
If the received frame does not contain a packet, the PACKET–TYPE variable contains 0.

For a more complete list of decoded communication variables, refer to Section 19.2.

?RX (packet id #1\...\packet id#n\n -- flag)
Returns true if one of the specified packets is received. See Table 20-1 for valid packet identifiers.

NOTE
In the emulation, layer 3 state machines are executed automatically.

Example:
Look for reception of invalid frames or packets using the monitor. The user receives an audible alarm and a notice.

```
3 STATE{
     R*INVFRM R*INVPKT  2  ?RX
     ACTION{
          BEEP
          " Invalid frame or packet received." W.NOTICE
     }ACTION
  }STATE
```

Example:
Look for the reception of a call request packet using the emulation. The automatic emulation provides the response and the test manager proceeds to state 6.

```
5 STATE{
     R*CALLREQ  1  ?RX
     ACTION{
          6  NEW_STATE                ( Layer 3 state machine provides response )
     }ACTION
  }STATE
```

?RX_PACKET (packet id#1\packet id#n\n -- flag)
Returns true if one of the specified packets is received. This command provides the same operation as the ?RX command. See ?RX for examples.

NOTE
The operation of this command is different than in the X.25 Emulation program. For ISDN LAPD, the layer 3 emulation state machine is executed for packet events. For X.25 LAPB, the layer 3 emulation state machine is not executed for packet events. When operation of the layer 3 emulation state machine is to be blocked, it can be turned off with the L3_OFF command.

?RX_X25_DATA (string -- flag)
Returns true if a user-defined character string is found in the data field of received packets.

This is an *anchored* match, i.e. a byte-for-byte match starting at the first byte of the data field of a received data packet.

NOTE
The ?RX_X25_DATA provides the same function as ?RX_DATA does in the X.25 LAPB Emulation.

NOTE
To accommodate "don't care" character positions, the question mark character for ASCII or hex 3F character can be used. The specified string is limited to 80 characters. The received data field can be longer than the specified string.

Example:
Search for the string 'IDACOM' starting at the second byte of a data packet. The first byte is a "don't care" and matches on any value.

```
" ?IDACOM"  ?RX_X25_DATA
```

or

```
X" 3F494441434F4D"  ?RX_X25_DATA
```

WINDOW? (-- flag)
Calculates the window for the selected logical channel. Returns 0 if the window is closed and 1 if the window is open.

Example:
Send a data packet while the window is open.

```
BEGIN
     WINDOW?                          ( Check LCN Data Window )
WHILE                                 ( While window is open )
     DATA                             ( Send a data packet )
REPEAT                                ( Repeat until window is closed )
```

Timeout Detection

There are 128 user programmable timers available. Timers 101 through 128 can be used in the test manager. Timer 4 is the test manager wakeup timer. The following timers are used within the application and should not be started or stopped in a test script.

TIMEOUT (-- flag)
Returns true if any timer has expired.

Example:
In State 8, look for the expiration of any timer. The action is to display a trace statement.

```
8 STATE{
      TIMEOUT        ( Check for timeout of any timer )
      ACTION{
          T." A Timer has expired." TCR
      }ACTION
  }STATE
```

?TIMER (timer # -- flag)
Returns true if the specified timer has expired. Valid input parameters are timers 101 through 128.

Example:
In State 8, look for the expiration of timer 101. The action is to display a trace statement.

```
8 STATE{
      101 ?TIMER           ( Check for timeout of timer 101 )
      ACTION{
          T." Timer 101 has expired." TCR
      }ACTION
  }STATE
```

?WAKEUP (-- flag)

Returns true if the wakeup timer has expired. The wakeup timer can be used to initiate action sequences immediately upon the test manager starting. Timer 4 is started for 100 milliseconds when the test manager is started after a WAKEUP_ON command has been issued. The default is WAKEUP_OFF.

Example:
In State 0, look for the expiration of the wakeup timer. The action is to prompt the user to press a function key, and then the test manager goes to State 1.

```
0 STATE{
      ?WAKEUP        ( Check for timeout of wakeup timer )
      ACTION{
          T." To start the test, press UF1." TCR
          1 NEW_STATE
      }ACTION
  }STATE
```

TIMER–NUMBER (-- address)

Contains the number of the expired timer. Valid values are 1 through 128.

?CN_TIMER (timer identifier -- flag)

Returns true when the layer 3 connection simulation timer has expired. Refer to the 'Connection Timer Management' section on page 18-8 for more information on connection timers.

LCNTIMER (-- address)

Contains the timer value for the selected LCN.

Example:
Detect a timeout on channel 50.

```
TIMEOUT
TIMER-NUMBER @ CH50 LCNTIMER @ =
AND
ACTION{
      ...
}ACTION
```

or

```
CH50  LCNTIMER  @  ?TIMER
ACTION{
      ...
}ACTION
```

NOTE
The two previous examples provide identical actions. The ?TIMER example is a more efficient method of coding.

Function Key Detection

Refer to the Programmer's Reference Manual.

Interprocessor Mail Events

Refer to the Programmer's Reference Manual.

Wildcard Events

OTHER_EVENT (-- true flag)
Returns true so that an ACTION{ }ACTION statement can check for events that have not been explicitly programmed into an event field.

The actual event is held in the EVENT-TYPE variable. Event identifiers are:

LAYER1#	L.1 event in L1-ID*
FRAME#	L.2 frame in FRAME-ID
TIME-OUT#	timer number in TIMER-NUMBER
FUNCTION-KEY#	function key in KEY-NUMBER
COMMAND_IND	mail has been received

NOTE
OTHER_EVENT should be the last item in a list of actions in a state definition.

Example:

```
OTHER_EVENT
ACTION{
          .
          default actions for this state
          .
       .
       .
}ACTION
```

20.4 ISDN Actions

All of the general actions explained in the Programmer's Reference Manual are supported in the ISDN Monitor and Emulation.

Layer 1 Actions

The following emulation commands turn control leads on and off (WAN only).

V.28/RS-232C Interface		
OFF to ON	**ON to OFF**	**Description**
RTS_ON	RTS_OFF	Request to send
CTS_ON	CTS_OFF	Clear to send
DSR_ON	DSR_OFF	Data set ready
CD_ON	CD_OFF	Carrier detect
DTR_ON	DTR_OFF	Data terminal ready
SQ_ON	SQ_OFF	Signal quality
RI_ON	RI_OFF	Ring indicate
DRS_ON	DRS_OFF	Data signal rate select

Table 20–2 V.28/RS–232C Interface Lead Transitions

V.35 Interface		
OFF to ON	**ON to OFF**	**Description**
RTS_ON	RTS_OFF	Request to send
CTS_ON	CTS_OFF	Clear to send
DSR_ON	DSR_OFF	Data set ready
CD_ON	CD_OFF	Carrier detect
DTR_ON	DTR_OFF	Data terminal ready
RI_ON	RI_OFF	Ring indicate

Table 20–3 V.35 Interface Lead Transitions

V.36/RS-449 Interface		
OFF to ON	ON to OFF	Description
RTS_ON	RTS_OFF	Request to send
CTS_ON	CTS_OFF	Clear to send
DSR_ON	DSR_OFF	Data set ready
DTR_ON	DTR_OFF	Data terminal ready
RI_ON	RI_OFF	Calling indicator
DRS_ON	DRS_OFF	Data signal rate select
CD_ON	CD_OFF	Data channel received line signal

Table 20–4 V.36/RS–449 Interface Lead Transitions

Lapse Timers

There are 256 lapse timers, numbered from 1 to 256, that can be started and read at any time.

START_LAPSE_TIMER (timer number --)
Starts the specified timer.

MINUTES_ELAPSED (timer number -- minutes)
Returns the number of minutes that have elapsed since the timer had started.

SECONDS_ELAPSED (timer number -- seconds)
Returns the number of seconds that have elapsed since the timer had started.

MILLISECONDS_ELAPSED (timer number -- milliseconds)
Returns the number of milliseconds that have elapsed since the timer had started.

Example:

```
1 START_LAPSE_TIMER        ( Starts lapse timer 1 )
1 MINUTES_ELAPSED          ( Returns # of minutes since timer was started )
1 SECONDS_ELAPSED          ( Returns # of seconds since timer was started )
```

Interval Timers

There are 28 interval timers, numbered from 101 to 128, that are available to the user.

START_TIMER (timer/interval --)
Starts the timer for the specified interval.

The timeout of the timer can be determined through the use of the ?TIMER command.

Example:

```
0 STATE_INIT{
     101 20 START_TIMER                ( Set timer for a 20 second time )
}STATE_INIT
0 STATE{
     101  ?TIMER
     ACTION{
         .
         action to be performed if timer 101 expires
         .
     }ACTION
}STATE
```

STOP_TIMER (timer --)
Stops the specified timer.

Using Buffers

IDACOM's test manager has 256 buffers available for creating customized frames. These buffers are numbered from 0 through 255 and can be created any size desired. However, the emulation can limit the number of bytes that can be transmitted.

A buffer consists of four bytes with values of 0, two bytes containing the length of the text, and the remaining bytes consisting of user-defined text.

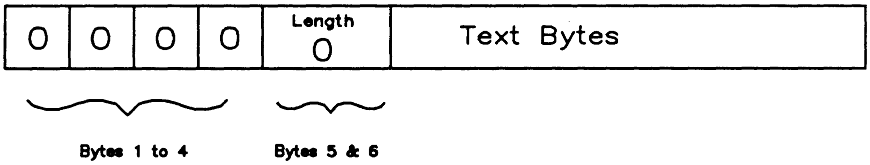


Figure 20-1 Buffer Structure

NOTE
All buffers are cleared when the TCLR command is issued. TCLR is usually the first command compiled when loading a test script.

There are three methods of moving text into a buffer.

Methods 1 and 2 automatically allocate memory for the specified text. Method 3 requires the user to allocate memory before moving text into the buffer. Use the TCLR command to clear all buffers.

Method 1

STRING->BUFFER (string\buffer number --)
Loads a quoted string into the specified buffer. The length is limited to 80 bytes if typing directly on the keyboard and 255 bytes if used within a test script. Either an ASCII or hex string can be specified. Valid buffer numbers are 0 through 255.

Example:

```
" IDACOM"  1  STRING->BUFFER          ( ASCII text moved to Buffer #1 )
X" 0100100100434445" 2 STRING->BUFFER ( Hex string of 8 bytes moved to Buffer #2 )
```

Method 2

FILE->BUFFER (filename\buffer number --)
Transfers a text file into the specified buffer (for text greater than 80 bytes). The file is created using the Edit function available on the Home processor. At this time, only ASCII text can be created. The last character to be transferred should be followed immediately by a CTRL 'p' character in the file. This special character is displayed as a pilcrow (¶) character. The file is transferred into the buffer until the ASCII control 'p' character is found or until the end of the file.

Example:
Create a file with the name CUSTOM.F and transfer to Buffer #3.

```
" CUSTOM.F"  3  FILE->BUFFER
```

Method 3

The following commands should not be used with FILE->BUFFER or STRING->BUFFER.

ALLOT_BUFFER (size \ buffer number -- flag)
Allocates memory for the specified buffer. ALLOT_BUFFER returns 0 if an error occurred, or 1 if correct.

NOTE
ALLOT_BUFFER should not be used repetitively with the same buffer number in the same test script.

FILL_BUFFER (data address \ size \ buffer number --)
Moves data, of a specified size, into a buffer. Previous contents are overwritten.

APPEND_TO_BUFFER (data address \ size \ buffer number --)
Appends data, of a specified size, into a buffer.

CLEAR_BUFFER (buffer number --)
Stores a size of 0 in the buffer. CLEAR_BUFFER has no effect on the allocated memory defined with ALLOT_BUFFER.

Example:

```
0 VARIABLE tempstring 6 ALLOT
" A TEST " tempstring $!              ( Initialize the string )
16 3 ALLOT_BUFFER                     ( Allocate 16 bytes of memory )
IF
      tempstring 4+ 5 3 FILL_BUFFER       ( Move 'TEST ' to buffer )
      " FAIL" COUNT 3 APPEND_TO_BUFFER    ( Append 'FAIL' to buffer )
ENDIF
```

BUFFER (buffer number -- address | 0)
Returns the address of the first byte of the specified buffer. The buffer must have been previously created by FILE->BUFFER, STRING->BUFFER, or ALLOT_BUFFER. A '0' is returned when the buffer is not created or an invalid buffer number is specified. Valid buffer numbers are 0 through 255.

20.5 X.25 PLP Actions

Packets can be transmitted utilizing any of the commands described in Section 19.3.

NOTE
The test manager can be run with the layer 2 and layer 3 state machines running automatically or turned off.

Before sending a buffer, the text must first be stored in the buffer using the STRING->BUFFER or FILE->BUFFER commands. Once the text is in place, the buffer can be transmitted repetitively.

The actual size of the frame or packet sent is defined by the frame and packet size set on the Emulation Configuration 2 Menu or by the value stored in the N201-TX* variable and the =SIZE command.

BUFFER_SENDP (buffer number --)
Transmits the specified buffer as the packet layer carried by an information frame. Valid buffer numbers are 0 through 255.

Example:
Create the text in the buffer and then transmit the buffer.

```
X" 10010043445"  3  STRING->BUFFER       ( Create text )
3  BUFFER_SENDP                          ( Send packet )
```

BUFFER_SENDD (buffer number --)
Transmits the specified buffer as the data field of a data packet. Valid buffer numbers are 0 through 255.

Example:
Create the text in the buffer and then transmit the buffer.

```
" IDACOM" 4  STRING->BUFFER                      ( Create text )
4  BUFFER_SENDD                                  ( Send data packet )
```

Example:
The text to be included is longer than 80 characters and is in a file named CUSTOM.F.

```
" CUSTOM.F" 5  FILE->BUFFER                      ( Put text in buffer )
5  BUFFER_SENDD                                  ( Send Data packet )
```

20.6 Layer 3 Connection Multiplexer

A connection multiplexer is available to support simulation of a number of simultaneous connections. The connection multiplexer maintains a separate test manager state for each connection.

When an event occurs, the connection for which it is destined is determined, on the basis of the call reference value of the received layer 3 message. This connection is made active, and the test manager state for this connection is loaded and becomes the current state for the test manager. When the test manager has finished executing, the test manager state is saved for that connection and is used the next time an event occurs for that connection. The test script should make use of the connection management commands which access or set data relevant to the active connection.

When an event occurs that is not associated with any connection, such as receiving a message with a new call reference value, the test manager is started in state 0. Thus, state 0 is used to initialize new connections.

When the layer 3 multiplexer is turned off, the test manager executes immediately in response to an event.

TM_MUX_ON (--)
Turns on the layer 3 connection multiplexer.

TM_MUX_OFF (--)
Turns off the layer 3 connection multiplexer.

=CN_TM_STATE (test manager state --)
Sets the test manager state for the currently selected connection.

WARNING
Use this command with caution so as not to corrupt the multiplexing behavior of the simulation.

?CN_TM_STATE (-- test manager state)
Returns the test manager state for the currently selected connection.

Use the following commands to determine the connection pertaining to a particular event, without using the layer 3 connection multiplexer. These commands also activate the indicated connection.

TIMER_TO_CN (-- CN | –1)
Returns the connection number corresponding to the last timer expiry, or –1 if the timer expiry does not correspond to any particular connection.

DETERMINE_CN (-- CN | –1)
Returns the number of the connection associated with the last layer 3 message decoded, or –1 if no connection is appropriate.

CR_TO_CN (CR value\CR flag\SAPI\CES -- CN | –1)
Determines the connection corresponding to the call reference value, flag, SAPI, and CES provided, or –1 if no connection is appropriate.

21
TEST SCRIPTS

This section contains sample test scripts which are also supplied on disk, and can be loaded and run as described in the Programmer's Reference Manual. These scripts illustrate ISDN functions using the following methods:

- Using hex strings to define transmit and expected receive values;
- Using message pools to define transmitted messages;
- Using the message builder to dynamically define transmitted messages;
- Defining new functions to use within the test script;
- Event recognition (both hex and special message/IE support functions).

Test scripts DSM_1 and DMS_2 are two versions of a single test script which illustrate the use of the Northern Telecom NT_S208-2 message set.

DMS_1 uses hex strings to send messages and search for IE's. Therefore, it is not necessary to select the NT message set.

NOTE
Using hex strings to search for IE's can be inaccurate and can result in an erroneous match.

DMS_2, however, uses the dynamic message builder to build/send messages, and standard commands to identify messages and search for IE's. The NT_S208-2 message set must be selected. This approach is more modular, easier to understand, and less prone to error.

The following table summarizes some of the methods used in the test scripts contained in this section.

	DMS_1	DMS_2	AT&T	1TR6	L3SIM
Hex Strings	YES				
Pool Messages			YES	YES	
Dynamic Msg Bldr		YES			YES
User Side	YES	YES	YES		
Network Side	YES	YES	YES	YES	YES
Message Set	NA	NT_S208-2	ATT_5E6	1TR6_NSA	CCITT_1988

21.1 DMS_1.F

This test script emulates both sides of a telephone call setup and teardown utilizing stimulus signalling procedures. The emulation answers a call from one terminal and then places a call to the other terminal. Once the call ahs been answered, the B-Channels are connected in a cross-looped manner. The originating telephone is expected to use B1, while the answering telephone is assigned B2.

The test script uses default TEI values of 1 and 2 for the two telephones. These can be modified by the use by changing the AREI commands in the initialization code for state 0.

```
( ------------------------------------------------------------------------- )
( File Title:  DMS_1.F                                                      )
(                                                                           )
(                Simulates a switch to let 2 stimulus mode terminals call  )
(             each other on the same S-bus.                                 )
( ------------------------------------------------------------------------- )


NTL_S1                         ( Select NT stimulus message set )
( Define words only if they have not already been defined. )
#IFNOTDEF ORIG-CES

( These words are used to manage the two links assigned to each terminal.   )
( When a call is originated, the current link is saved in the variable      )
( ORIG-CES.  Thus, we can set the current link to the calling terminal with )
( the CALLING_CES command and to the called terminal with the CALLED_CES    )
( command.  Note that links 0 and 1 are used for the two terminals.         )

0 VARIABLE ORIG-CES                ( Link # of the call originator )

: CALLING_CES   ( -- )             ( Set the link to the originating side )
   ORIG-CES @ SA
;

: CALLED_CES   ( -- )              ( Set the link to the answering side )
   ORIG-CES @
   DOCASE
       CASE 0 [ 1 SA ]
       CASE 1 [ 0 SA ]
   ENDCASE
;
```

```
( These words are used to collect digits from the Keypad IE.  KP is a        )
( buffer area that may contain 13 digits, plus the string length.  Digits    )
( are appended to the string with the +KP command.  It is used by the ?KP    )
( command, which scans the received layer 3 message for the Keypad IE,       )
( retrieves the digit character and saves it, and returns a logical flag to )
( indicate whether or not the digit was present. )

0 VARIABLE KP 10 ALLOT              ( buffer for 13 digits maximum )

: +KP    ( char -- )
    KP C@ 1+                        ( add 1 to string length )
    DUP KP C!                       ( store new string length )
    KP + C!                         ( store character at end of string )
;

: ?KP   ( -- flag )
    L3-POINTER @ L3-LENGTH @ X" 2C01" ?*SEARCH     ( scan for Keypad IE )
    IF
        C@ +KP YES                  ( fetch character and save in buffer )
    ELSE
        DROP NO                     ( drop the address and indicate failure )
    ENDIF
;

( These commands are defined simply for convenience. )

: ?ON_HOOK   ( -- flag )           ( true if On Hook received )
    M#INFO ?L3_MSG                 ( received INFO message )
    X" 380198" ?L3_SEARCH  AND     ( and Feature Activation 24 present? )
;

: ?CALL_REQ   ( -- flag )          ( true if Call Request received )
    M#INFO ?L3_MSG                 ( received INFO message )
    X" 380181" ?L3_SEARCH  AND     ( and Feature Activation 1 present? )
;

: SEND_CONF   ( -- )               ( confirmation reply to On Hook )
    X" 3A0101" ?L3_SEARCH          ( B Chan Control IE to release B2? )
    IF
        ( reply with CAD=space, PI=disconnect, FI=[1,0], BCC=disc B2 )
        X" 08007B0C0280201E02839696390281003A0101" DL_DATA
    ELSE
        ( reply with CAD=space, PI=disconnect, FI=[1,0], BCC=disc B1 )
        X" 08007B0C0280201E02839696390281003A0100" DL_DATA
    ENDIF
;
#ENDIF
```

```
TCLR                                   ( Initialize Test Manager )


0 STATE_INIT{
    0 SA 0 SAPI 1 ATEI                 ( Link 0:  SAPI 0 and TEI 1 )
    1 SA 0 SAPI 2 ATEI                 ( Link 1:  SAPI 0 and TEI 2 )
    PORT_BRID DRT_OFF DROUTING         ( Set routing of B Channels to "ignore" )
    DROP                               ( Ignore flag from DROUTING )
}STATE_INIT

0 STATE{
    ?ON_HOOK
    ACTION{
        SEND_CONF
        7 NEW_STATE
    }ACTION

    ?CALL_REQ
    ACTION{
        ( save origination Connection Endpoint Suffix )
        CES* @ ORIG-CES !

        ( reply with PI=dialing, SIG=dial tone, FI=[1,1], BCC=conn B1 )
        X" 08007B1E02829534010096390281013A0102" DL_DATA

        ( route the B1 channel to a dial tone )
        PORT_BRID DIAL TONE_TYPE
        PORT_BRID VOICE BCHAN1 BCHAN_SRC
        PORT_BRID DRT_SERIAL DROUTING DROP

        1 NEW_STATE
    }ACTION
}STATE


1 STATE_INIT{
    0 KP C!                            ( Initialize keypad string length to zero )
}STATE_INIT

1 STATE{
    ?ON_HOOK
    ACTION{
        SEND_CONF
        7 NEW_STATE
    }ACTION
    M#INFO ?L3_MSG
    ACTION{
        ?KP                         ( First keypad value collected? )
        IF
            ( send SIG=tones off )
            X" 08007B34013F" DL_DATA

            ( send PI=dialing, SIG=dial tone, FI=[1,1] )
            X" 08007B1E0282953401009639028101" DL_DATA

            ( turn off tones )
            PORT_BRID OFF TONE_TYPE

            2 NEW_STATE
        ENDIF
    }ACTION
}STATE

2 STATE{
    ?ON_HOOK
    ACTION{
        SEND_CONF
        7 NEW_STATE
    }ACTION

    M#INFO ?L3_MSG
    ACTION{
        ?KP                          ( Second keypad value collected? )
        IF
            ( send SIG=tones off )
            X" 08007B34013F" DL_DATA
            3 NEW_STATE
        ENDIF
    }ACTION
}STATE

3 STATE{
    ?ON_HOOK
    ACTION{
        SEND_CONF
        7 NEW_STATE
    }ACTION
    M#INFO ?L3_MSG
    ACTION{
        ?KP                         ( Additional keypad value collected? )
        IF
            KP C@ 7 =               ( 7 keypad values? )
            IF
                ( send PI=call proceeding )
                X" 08007B1E028292" DL_DATA

                ( change link to destination terminal )
                CALLED_CES

                ( send SIG=incoming call, OAD="4624545", FI=[1,3] )
                X" 08007B3401406C088034363234353435963902810З" DL_DATA

                ( simulate switching delay with 1s timeout )
                101 10 START_TIMER

                4 NEW_STATE
            ENDIF
        ENDIF
    }ACTION
}STATE

4 STATE{
    ?ON_HOOK
    ACTION{
        SEND_CONF
        7 NEW_STATE
    }ACTION

    101 ?TIMER
    ACTION{
        ( change link to origination terminal )
        CALLING_CES

        ( send PI=call alerting, SIG=audible ring )
        X" 08007B1E028293340101" DL_DATA

        ( change tone type to audible ring )
        PORT_BRID AUD_RING TONE_TYPE

        5 NEW_STATE
    }ACTION
}STATE
```

```
5 STATE{
    ?CALL_REQ
    ACTION{
        ( send CAD="4624545", PI=call connected, SIG=alerting off,
          FI=[1,1], BCC=connect B2 )
        X" 08007B0C0880343632343534351E02829434014F96390281013A0103" DL_DATA

        ( turn off tone )
        PORT_BRID OFF TONE_TYPE

        ( change link to origination terminal )
        CALLING_CES

        ( send CAD=last 4 digits of KP, SIG=tones off )
        X" 08007B0C0580303030303034013F"
        DUP KP 4 + SWAP 7 + 4 CMOVE
        DL_DATA

        ( send PI=call connected )
        X" 08007B1E028294" DL_DATA

        ( cross-loop B channels to connect call )
        PORT_BRID BCHAN1 BCHAN2 BCHAN_SRC
        PORT_BRID BCHAN2 BCHAN1 BCHAN_SRC

        6 NEW_STATE
    }ACTION

    ?ON_HOOK
    ACTION{
        SEND_CONF
        6 NEW_STATE
    }ACTION
}STATE


6 STATE{
    ?ON_HOOK
    ACTION{
        SEND_CONF
        7 NEW_STATE
    }ACTION
}STATE

7 STATE{
    ?ON_HOOK
    ACTION{
        SEND_CONF
        0 NEW_STATE
    }ACTION
}STATE
```

21.2 DMS_2

DMS_2a.F

```
( ------------------------------------------------------------------- )
( File Title:  DMS_2a.F                                               )
(                                                                     )
(                 Simulates a switch to let 2 stimulus mode terminals call  )
(              each other on the same S-bus.                          )
( ------------------------------------------------------------------- )


TCLR                                  ( Initialize Test Manager )
" NT_S208-2" LOAD_MESSAGE_SET         ( Select NT stimulus message set )
0 =CR_LENGTH


( Define words only if they have not already been defined. )
#IFNOTDEF ORIG-CES

( These words are used to manage the two links assigned to each terminal.   )
( When a call is originated, the current link is saved in the variable      )
( ORIG-CES.  Thus, we can set the current link to the calling terminal with )
( the CALLING_CES command and to the called terminal with the CALLED_CES    )
( command.  Note that links 0 and 1 are used for the two terminals.         )

0 VARIABLE ORIG-CES                   ( Link # of the call originator )

: CALLING_CES    ( -- )               ( Set the link to the originating side )
    ORIG-CES @ SA
;

: CALLED_CES    ( -- )                ( Set the link to the answering side )
    ORIG-CES @
    DOCASE
        CASE 0 { 1 SA }
        CASE 1 { 0 SA }
    ENDCASE
;
```

```
( These words are used to collect digits from the Keypad IE.  KP is a       )
( buffer area that may contain 13 digits, plus the string length.  Digits   )
( are appended to the string with the +KP command.  It is used by the ?KP   )
( command, which scans the received layer 3 message for the Keypad IE,      )
( retrieves the digit character and saves it, and returns a logical flag to )
( indicate whether or not the digit was present. )

0 VARIABLE KP 10 ALLOT               ( buffer for 13 digits maximum )

: +KP    ( char -- )
   KP C@ 1+                          ( add 1 to string length )
   DUP KP C!                         ( store new string length )
   KP + C!                           ( store character at end of string )
;

: ?KP    ( -- flag )
   I#KEYPAD 1 ?L3_IE
   IF
      *DEC ->KNTS_KEYPAD DUP C@ 1 =
      IF
        1 + C@ +KP YES ( fetch character and save in buffer )
      ELSE
        DROP NO
     THEN
   ELSE
       DROP NO                       ( drop the address and indicate failure )
   ENDIF
;


( These commands are defined simply for convenience. )

( number -- flag )
: ?FEATURE
     I#NTL_FEAT_ACT 1 ?L3_IE
     IF
        I#NTL_FEAT_ACT OCTET_3 ?L3_OCTET
        IF
          *DEC ->FA_VALUE @ =
        ELSE
          DROP
          0
        THEN
      ELSE
        DROP
        0
     THEN
;
```

```
: ?ON_HOOK   ( -- flag )              ( true if On Hook received )
    M#INFO ?L3_MSG                    ( received INFO message )
    IF
       24 ?FEATURE                    ( and Feature Activation 24 present? )
    ELSE
       0
    THEN
;

: ?CALL_REQ   ( -- flag )             ( true if Call Request received )
    M#INFO ?L3_MSG                    ( received INFO message )
    IF
       1 ?FEATURE                     ( and Feature Activation 1 present? )
    ELSE
       0
    THEN
;

: ?REL_B2                               ( B Chan Control IE to release B2? )
      I#B-CHAN_CONTR 1 ?L3_IE
      IF
         I#B-CHAN_CONTR OCTET_3 ?L3_OCTET
         IF
           *DEC ->BCC_PARAM @ #1 =
         ELSE
           0
         THEN
       ELSE
         0
      THEN
;

: SEND_CONF   ( -- )                  ( confirmation reply to On Hook )
    ?REL_B2
    IF
        ( reply with CAD=space, PI=disconnect, FI=[1,0], BCC=disc B2 )

      M#INFO MESSAGE>

       I#CONN_ADDR DUP ELEMENT>
            OCTET_3 INCLUDED
                 0                      *COD ->CA_ADDR_TYPE !
                 0                      *COD ->CA_NUMBER/ADDR !
            OCTET_4 INCLUDED
                 "  "                   *COD ->CA_ADDR_DIGIT !STRING
         <ELEMENT
```

```
     I#PROGRESS_IND DUP ELEMENT>
          OCTET_3 INCLUDED
              #CCITT                   *COD ->PI_CODING_STANDARD !
              #TRANSIT                 *COD ->PI_LOCATION !
          OCTET_4 INCLUDED
              #DISCONNECT              *COD ->PI_DESCRIPTION !
      <ELEMENT

      I#NTL_FEAT_IND DUP ELEMENT>
          OCTET_3 INCLUDED
              1                        *COD ->FI_VALUE !
          OCTET_4 INCLUDED
              0                        *COD ->FI_STATE_PARAM !
      <ELEMENT

      I#B-CHAN_CONTR DUP ELEMENT>
          OCTET_3 INCLUDED
              #1          *COD ->BCC_PARAM !
      <ELEMENT

  <SEND

ELSE
    ( reply with CAD=space, PI=disconnect, FI=[1,0], BCC=disc B1 )

    M#INFO MESSAGE>

     I#CONN_ADDR DUP ELEMENT>
          OCTET_3 INCLUDED
               0 *COD ->CA_ADDR_TYPE !
               0                        *COD ->CA_NUMBER/ADDR !
          OCTET_4 INCLUDED
               "  "                     *COD ->CA_ADDR_DIGIT !STRING
       <ELEMENT

       I#PROGRESS_IND DUP ELEMENT>
            OCTET_3 INCLUDED
                #CCITT                   *COD ->PI_CODING_STANDARD !
                #TRANSIT                 *COD ->PI_LOCATION !
            OCTET_4 INCLUDED
                #DISCONNECT              *COD ->PI_DESCRIPTION !
        <ELEMENT

        I#NTL_FEAT_IND DUP ELEMENT>
            OCTET_3 INCLUDED
                1                        *COD ->FI_VALUE !
            OCTET_4 INCLUDED
                0                        *COD ->FI_STATE_PARAM !
        <ELEMENT
```

```
            I#B-CHAN_CONTR DUP ELEMENT>
                OCTET_3 INCLUDED
                    #0                    *COD ->BCC_PARAM !
            <ELEMENT

        <SEND
    ENDIF
;
#ENDIF

" DMS_2b.F" EXECF
```

DMS_2b.F

```
( ------------------------------------------------------------------------ )
( File Title:  DMS_2b.F                                                    )
( Description:    Continuation of DMS2a.F test script                      )
( ------------------------------------------------------------------------ )

0 STATE_INIT{
    0 SA 0 SAPI 1 ATEI             ( Link 0:  SAPI 0 and TEI 1 )
    1 SA 0 SAPI 2 ATEI             ( Link 1:  SAPI 0 and TEI 2 )
    PORT_BRID DRT_OFF DROUTING     ( Set routing of B Channels to "ignore" )
    DROP                           ( Ignore flag from DROUTING )
}STATE_INIT

0 STATE{
    ?ON_HOOK
    ACTION{
        SEND_CONF
        7 NEW_STATE
    }ACTION

    ?CALL_REQ
    ACTION{
        ( save origination Connection Endpoint Suffix )
        CES* @ ORIG-CES !

        ( reply with PI=dialing, SIG=dial tone, FI=[1,1], BCC=conn B1 )
        M#INFO MESSAGE>

           I#PROGRESS_IND DUP ELEMENT>
                OCTET_3 INCLUDED
                    #CCITT               *COD ->PI_CODING_STANDARD !
                    #LOCAL_PUBLIC        *COD ->PI_LOCATION !
                OCTET_4 INCLUDED
                    #DIALING             *COD ->PI_DESCRIPTION !
            <ELEMENT

           I#SIGNAL DUP ELEMENT>
                OCTET_3 INCLUDED
                    #DIAL_ON             *COD ->SI_VALUE !
            <ELEMENT

            I#NTL_FEAT_IND DUP ELEMENT>
                OCTET_3 INCLUDED
                    1                    *COD ->FI_VALUE !
                OCTET_4 INCLUDED
                    #IDLE                *COD ->FI_STATE_PARAM !
            <ELEMENT
            I#B-CHAN_CONTR DUP ELEMENT>
                OCTET_3 INCLUDED
                    #2                   *COD ->BCC_PARAM !
            <ELEMENT

        <SEND

        ( route the B1 channel to a dial tone )
        PORT_BRID DIAL TONE_TYPE
        PORT_BRID VOICE BCHAN1 BCHAN_SRC
        PORT_BRID DRT_SERIAL DROUTING DROP

        1 NEW_STATE
    }ACTION
}STATE


1 STATE_INIT{
    0 KP C!                        ( Initialize keypad string length to zero )
}STATE_INIT

1 STATE{
    ?ON_HOOK
    ACTION{
        SEND_CONF
        7 NEW_STATE
    }ACTION

    M#INFO ?L3_MSG
    ACTION{
        ?KP                        ( First keypad value collected? )
        IF
            ( send SIG=tones off )
            M#INFO MESSAGE>

                I#SIGNAL DUP ELEMENT>
                   OCTET_3 INCLUDED
                      #TONES_OFF            *COD ->SI_VALUE !
                <ELEMENT

            <SEND

            ( send PI=dialing, SIG=dial tone, FI=[1,1] )

            M#INFO MESSAGE>

               I#PROGRESS_IND DUP ELEMENT>
                    OCTET_3 INCLUDED
                        #CCITT              *COD ->PI_CODING_STANDARD !
                        #LOCAL_PUBLIC       *COD ->PI_LOCATION !
                    OCTET_4 INCLUDED
                        #DIALING            *COD ->PI_DESCRIPTION !
                <ELEMENT
                I#SIGNAL DUP ELEMENT>
                     OCTET_3 INCLUDED
                         #DIAL_ON             *COD ->SI_VALUE !
                 <ELEMENT

                 I#NTL_FEAT_IND DUP ELEMENT>
                     OCTET_3 INCLUDED
                         1                    *COD ->FI_VALUE !
                     OCTET_4 INCLUDED
                         #IDLE                *COD ->FI_STATE_PARAM !
                 <ELEMENT

            <SEND

            ( turn off tones )
            PORT_BRID OFF TONE_TYPE

            2 NEW_STATE
        ENDIF
    }ACTION
}STATE

2 STATE{
    ?ON_HOOK
    ACTION{
        SEND_CONF
        7 NEW_STATE
    }ACTION

    M#INFO ?L3_MSG
    ACTION{
        ?KP                           ( Second keypad value collected? )
        IF
            ( send SIG=tones off )
            M#INFO MESSAGE>

                I#SIGNAL DUP ELEMENT>
                   OCTET_3 INCLUDED
                       #TONES_OFF             *COD ->SI_VALUE !
                <ELEMENT

            <SEND
            3 NEW_STATE
        ENDIF
    }ACTION
}STATE
```

```
3 STATE[
    ?ON_HOOK
    ACTION[
        SEND_CONF
        7 NEW_STATE
    ]ACTION

    M#INFO ?L3_MSG
    ACTION[
        ?KP                         ( Additional keypad value collected? )
        IF
            KP C@ 7 =               ( 7 keypad values? )
            IF
                ( send PI=call proceeding )
                M#INFO MESSAGE>

                   I#PROGRESS_IND DUP ELEMENT>
                        OCTET_3 INCLUDED
                            #CCITT               *COD ->PI_CODING_STANDARD !
                            #LOCAL_PUBLIC        *COD ->PI_LOCATION !
                        OCTET_4 INCLUDED
                            #CALL_PROCEEDING     *COD ->PI_DESCRIPTION !
                    <ELEMENT

                <SEND

                ( change link to destination terminal )
                CALLED_CES

                ( send SIG=incoming call, OAD="4624545", FI=[1,3] )
                M#INFO MESSAGE>

                    I#SIGNAL DUP ELEMENT>
                       OCTET_3 INCLUDED
                          #ALERTING_ON_0         *COD ->SI_VALUE !
                    <ELEMENT

                    I#ORIG_ADDR DUP ELEMENT>
                          OCTET_3 INCLUDED
                             0                   *COD ->OA_ADDR_TYPE !
                             0                   *COD ->OA_NUMBER/ADDR !
                          OCTET_4 INCLUDED
                             " 4624545"          *COD ->OA_ADDR_DIGIT !STRING
                    <ELEMENT

                    I#NTL_FEAT_IND DUP ELEMENT>
                        OCTET_3 INCLUDED
                            1                    *COD ->FI_VALUE !
                        OCTET_4 INCLUDED
                            #HELD                *COD ->FI_STATE_PARAM !
                    <ELEMENT
                <SEND

                ( simulate switching delay with 1s timeout )
                101 10 START_TIMER

                4 NEW_STATE
            ENDIF
        ENDIF
    }ACTION
}STATE

4 STATE{
    ?ON_HOOK
    ACTION{
        SEND_CONF
        7 NEW_STATE
    }ACTION

    101 ?TIMER
    ACTION{
        ( change link to origination terminal )
        CALLING_CES

        ( send PI=call alerting, SIG=audible ring )
        M#INFO MESSAGE>

           I#PROGRESS_IND DUP ELEMENT>
                OCTET_3 INCLUDED
                    #CCITT               *COD ->PI_CODING_STANDARD !
                    #LOCAL_PUBLIC        *COD ->PI_LOCATION !
                OCTET_4 INCLUDED
                    #ALERTING_DEST       *COD ->PI_DESCRIPTION !
            <ELEMENT

            I#SIGNAL DUP ELEMENT>
               OCTET_3 INCLUDED
                  #RING_BACK_ON          *COD ->SI_VALUE !
            <ELEMENT

        <SEND

        ( change tone type to audible ring )
        PORT_BRID AUD_RING TONE_TYPE

        5 NEW_STATE
    }ACTION
}STATE
```

```
5 STATE{
   ?CALL_REQ
   ACTION{
       ( send CAD="4624545", PI=call connected, SIG=alerting off,
         FI=[1,1], BCC=connect B2 )
       M#INFO MESSAGE>

           I#CONN_ADDR DUP ELEMENT>
                 OCTET_3 INCLUDED
                    0                    *COD ->CA_ADDR_TYPE !
                    0                    *COD ->CA_NUMBER/ADDR !
                 OCTET_4 INCLUDED
                    " 4624545"           *COD ->CA_ADDR_DIGIT !STRING
           <ELEMENT

          I#PROGRESS_IND DUP ELEMENT>
               OCTET_3 INCLUDED
                   #CCITT                *COD ->PI_CODING_STANDARD !
                   #LOCAL_PUBLIC         *COD ->PI_LOCATION !
               OCTET_4 INCLUDED
                   #DEST_CONNECTED       *COD ->PI_DESCRIPTION !
           <ELEMENT

           I#SIGNAL DUP ELEMENT>
              OCTET_3 INCLUDED
                 #ALERTING_OFF           *COD ->SI_VALUE !
           <ELEMENT

           I#NTL_FEAT_IND DUP ELEMENT>
               OCTET_3 INCLUDED
                   1                     *COD ->FI_VALUE !
               OCTET_4 INCLUDED
                   #IDLE                 *COD ->FI_STATE_PARAM !
           <ELEMENT

           I#B-CHAN_CONTR DUP ELEMENT>
               OCTET_3 INCLUDED
                   #3                     *COD ->BCC_PARAM !
           <ELEMENT

       <SEND

       ( turn off tone )
       PORT_BRID OFF TONE_TYPE

       ( change link to origination terminal )
       CALLING_CES

       ( send CAD=last 4 digits of KP, SIG=tones off )
       M#INFO MESSAGE>
```

```
            I#CONN_ADDR DUP ELEMENT>
                  OCTET_3 INCLUDED
                     0                     *COD ->CA_ADDR_TYPE !
                     0                     *COD ->CA_NUMBER/ADDR !
                  OCTET_4 INCLUDED
                     KP 4 + ( address of the last 4 digits )
                     *COD ->CA_ADDR_DIGIT DUP 4 SWAP C! ( store the length )
                     1 + 4 CMOVE ( copy the string )
            <ELEMENT

            I#SIGNAL DUP ELEMENT>
               OCTET_3 INCLUDED
                  #TONES_OFF                *COD ->SI_VALUE !
            <ELEMENT

        <SEND

        ( send PI=call connected )
        M#INFO MESSAGE>

           I#PROGRESS_IND DUP ELEMENT>
                OCTET_3 INCLUDED
                    #CCITT                 *COD ->PI_CODING_STANDARD !
                    #LOCAL_PUBLIC          *COD ->PI_LOCATION !
                OCTET_4 INCLUDED
                    #DEST_CONNECTED        *COD ->PI_DESCRIPTION !
            <ELEMENT
        <SEND

        ( cross-loop B channels to connect call )
        PORT_BRID BCHAN1 BCHAN2 BCHAN_SRC
        PORT_BRID BCHAN2 BCHAN1 BCHAN_SRC

        6 NEW_STATE
    }ACTION

    ?ON_HOOK
    ACTION{
        SEND_CONF
        6 NEW_STATE
    }ACTION
}STATE

6 STATE{
    ?ON_HOOK
    ACTION{
        SEND_CONF
        7 NEW_STATE
    }ACTION
}STATE
```

```
7 STATE{
    ?ON_HOOK
    ACTION{
        SEND_CONF
        0 NEW_STATE
    }ACTION
}STATE
```

21.3 ATT_NET.F

The ATT_NET.F test script simulates a network for handling calls made to a AT&T 7506 telephone. This phone also has a data link available for SAPI 16 communications. The network manages both links, but only handles call setup procedures on the SAPI 0 signalling link. The network initializes the telephone by powering the S/T Bus. When a call is established from the user, the network supplies a dial tone and an audible ring when the four digits have been collected. The voice connector on the testers connector module can be used for a handset. This script makes use of the message pool method to send messages. A pool file, ATT.P, is automatically loaded.

```
( -------------------------------------------------------------------- )
( File Title:  ATT_NET.F                                               )
(                                                                      )
(                   This script simulates a network for telephone call setup )
(              with a AT&T 7506 ISDN telephone.                        )
( -------------------------------------------------------------------- )


TCLR                                    ( initialize the Test Manager )
" ATT_5E6" LOAD_MESSAGE_SET             ( switch to AT&T message set )
" ATT.P" LOAD_MESSAGES                  ( load the message pool )

0 STATE_INIT{
   NTWK_EMUL                            ( reset protocol machine )
   0 SA 0 SAPI 3 ATEI                   ( set up for packet mode link )
   1 SA 0 SAPI                          ( set up for signalling link )
   1 RX-CALLREF !                       ( initialize call reference values )
   1 TX-CALLREF !
   PORT_BRID PS1_OFF SET_PS             ( turn power supply off )
   PORT_BRID VOICE BCHAN1 BCHAN_SRC     ( route voice to B1 channel )
   PORT_BRID DRT_OFF DROUTING DROP      ( disconnect B channel )
   CLEAR_KEYS                           ( clear key labels )
   " PS_On" 1 LABEL_KEY                 ( label first key )
   " TestKeys" SET_CURR_TOPIC           ( switch to TestKeys topic )
}STATE_INIT

0 STATE{
   UF1 ?KEY               ( user wishes to turn power supply on )
   ACTION{
       PORT_BRID PS1+ SET_PS            ( turn PS on )
       1 NEW_STATE                      ( wait for call origination )
   }ACTION
}STATE

1 STATE_INIT{
   PORT_BRID DRT_OFF DROUTING DROP      ( disconnect B channel )
   " MakeCall" 1 LABEL_KEY              ( relabel first key )
}STATE_INIT
```

```
1 STATE{
    M#SETUP ?L3_MSG        ( incoming call )
    ACTION{
        1 CLEAR_KEY                    ( clear "MakeCall" label )
        $MSG-CRVALUE @ RX-CALLREF !    ( use the same Call. Ref. value )
        DEST_SIDE                      ( indicate Call. Ref. flag is #DEST )
        " SETUP_ACK" POOL ALTER_CR SEND_I      ( acknowledge incoming SETUP )
        PORT_BRID DIAL TONE_TYPE               ( set codec to dial tone )
        PORT_BRID DRT_SERIAL DROUTING DROP     ( connect B channel )
        2 NEW_STATE                    ( wait for first keypad digit )
    }ACTION

    UF1 ?KEY               ( user wishes to initiate call )
    ACTION{
        1 CLEAR_KEY                    ( erase "MakeCall" label )
        ORIG_SIDE                      ( indicate Call. Ref. flag is #ORIG )
        1 SA                           ( ensure the signalling link is used )
        BROADCAST                              ( UI to be sent as TEI 127 )
        " SETUP" POOL ALTER_CR SEND_UI         ( send SETUP )
        PT_TO_PT                               ( restore UI send mode )
        6 NEW_STATE                    ( wait for TE to connect )
    }ACTION
}STATE

2 STATE{
    M#INFO ?L3_MSG         ( Keypad IE in INFO message received )
    I#KEYPAD 1 ?L3_IE AND
    ACTION{
        1 COUNTER1 !                           ( first key received )
        " TONES_OFF" POOL ALTER_CR SEND_I      ( send Tones Off signal )
        PORT_BRID OFF TONE_TYPE                ( turn tones off )
        3 NEW_STATE                            ( wait for next key )
    }ACTION
}STATE

3 STATE{
    M#INFO ?L3_MSG         ( Keypad IE in INFO message received )
    I#KEYPAD 1 ?L3_IE AND
    ACTION{
        1 COUNTER1 +!                  ( additional key received )
        COUNTER1 @ 4 =                 ( 4 digits received? )
        IF
            " CALL_PROC" POOL ALTER_CR SEND_I  ( send CALL PROCeeding )
            101 10 START_TIMER         ( timer simulates switching delay )
            4 NEW_STATE                ( wait for timer to expire )
        ENDIF
    }ACTION
}STATE
```

```
4 STATE{
    101 ?TIMER              ( "switching delay" timer expired )
    ACTION{
        1 SA                            ( ensure the signalling link is used )
        " ALERT" POOL ALTER_CR SEND_I   ( send ALERTing at Destination )
        101 30 START_TIMER              ( simulate delay for answer at far end )
        PORT_BRID AUD_RING TONE_TYPE    ( change tone to Audible Ring )
        5 NEW_STATE                     ( wait for timer to expire )
    }ACTION
}STATE

5 STATE{
    101 ?TIMER              ( "answer delay" timer expired )
    ACTION{
        1 SA                            ( ensure the signalling link is used )
        " CONN" POOL ALTER_CR SEND_I    ( send CONNected )
        PORT_BRID OFF TONE_TYPE         ( turn off tones )
        7 NEW_STATE                     ( wait for disconnect )
    }ACTION
}STATE

6 STATE{
    M#CONN ?L3_MSG          ( Connect from TE )
    ACTION{
        PORT_BRID DRT_SERIAL DROUTING DROP      ( connect B channel )
        " CONN_ACK" POOL ALTER_CR SEND_I        ( send CONNection ACKnowledge )
        7 NEW_STATE                             ( wait for disconnect )
    }ACTION
}STATE

7 STATE_INIT{
    " HangUp" 1 LABEL_KEY               ( label first key )
}STATE_INIT

7 STATE{
    M#DISC ?L3_MSG          ( TE goes On Hook and disconnects )
    ACTION{
        " REL" POOL ALTER_CR SEND_I     ( send RELease )
        1 NEW_STATE                     ( wait for origination of next call )
    }ACTION

    UF1 ?KEY                ( user wishes to Disconnect call )
    ACTION{
        1 CLEAR_KEY                     ( erase "HangUp" label )
        1 SA                            ( ensure the signalling link is used )
        " DISC" POOL ALTER_CR SEND_I    ( send DISConnect )
        8 NEW_STATE                     ( wait for TE to release )
    }ACTION
}STATE
```

```
8 STATE{
    M#REL ?L3_MSG           ( Release from TE )
    ACTION{
        " REL_COM" POOL ALTER_CR SEND_I         ( send RELease COMplete )
        1 NEW_STATE                     ( wait for origination of next call )
    }ACTION
}STATE
```

Message Pool Descriptions

There are ten pool entries in the ATT.P message pool file, as described in the following list. Each pool entry is shown in hexadecimal and complete formats.

1. **SETUP_ACK**

```
08 01 81 0D
                  18 01 89
                  34 01 00
                  96


PD = Q.931  CR = 0X01       Dest  SETUP ACKnowledge       Var. = ATT_5E6
     1    00011000  INFORMATION ELEMENT : CHANNEL IDentification
     2    00000001  IE length           : 1 octets
     3    1-------  Extension bit       : not continued
          -0------  Interface ident.    : Interface implicitly identified
          --0-----  Interface type      : Basic Rate Interface
          ---0----  Spare               :
          ----1---  Preferred/Exclusive : exclusive; only this ch. acceptable
          -----0--  D-channel indicator : The channel is not the D-channel
          ------01  Info. chan. sel.    : B1-channel
     1    00110100  INFORMATION ELEMENT : SIGNAL
     2    00000001  IE length           : 1 octets
     3    00000000  Signal value        : Dial tone on
     1    1001----  INFORMATION ELEMENT : SHIFT
          ----0---  Shift type          : locking
          -----110  New codeset ident.  : local service network specific IEs
     1    00111100  INFORMATION ELEMENT : DISPLAY FIELD
     2    00000100  IE length           : 4 octets
     3    0001----  Display Mode        : Normal
          ----0001  Submode             : Direct
     4    000-----  Spare               :
          ---00001  Display Field Type  : Call Appearance ID
     5    ********  Display information : [ 1]
```

2. TONES_OFF

```
08 01 01 7B
                 34 01 3F

PD = Q.931  CR = 0X01        Orig  INFOrmation                Var. = ATT_5E6
     1    00110100  INFORMATION ELEMENT : SIGNAL
     2    00000001  IE length           : 1 octets
     3    00111111  Signal value        : Tones off
```

3. CALL_PROC

```
08 01 81 02

PD = Q.931  CR = 0X01        Dest  CALL PROCeeding            Var. = ATT_5E6
```

4. ALERT

```
08 01 81 01

PD = Q.931  CR = 0X01        Dest  ALERTing                   Var. = ATT_5E6
```

5. REL

```
08 01 81 4D
                 08 02 82 90
                 34 01 4F
                 96
                 22 01 01

PD = Q.931  CR = 0X01        Dest  RELease                    Var. = ATT_5E6
     1    00001000  INFORMATION ELEMENT : CAUSE
     2    00000010  IE length           : 2 octets
     3    1-------  Extension bit       : not continued
          -00-----  Coding standard     : CCITT standardized in Q.931
          ---0----  Spare               :
          ----0010  Location            : Public Network Serving Local User
     4    1-------  Extension bit       : not continued
          -001----  Class               : Normal event
          ----0000  Cause value         : 16 Normal, Clearing
     1    00110100  INFORMATION ELEMENT : SIGNAL
     2    00000001  IE length           : 1 octets
     3    01001111  Signal value        : Alerting off
     1    1001----  INFORMATION ELEMENT : SHIFT
          ----0---  Shift type          : locking
          -----110  New codeset ident.  : local service network specific IEs
     1    00100010  INFORMATION ELEMENT : SELected CALL APPearance
     2    00000001  IE length           : 1 octets
     3    00000001  Button Nr/Call App  : 1
```

6. SETUP

```
08 01 01 05
                  04 03 80 90 A2
                  18 01 89
                  34 01 40
                  96
                  22 01 01
                  25 01 01

PD = Q.931  CR = 0X01       Orig  SETUP                   Var. = ATT_5E6
     1    00000100  INFORMATION ELEMENT : BEARER CAPability
     2    00000011  IE length           : 3 octets
     3    1-------  Extension bit       : not continued
          -00-----  Coding standard     : CCITT standardized in Q.931
          ---00000  Info. trans. cap.   : speech
     4    1-------  Extension bit       : not continued
          -00-----  Transfer mode       : circuit mode
          ---10000  Info. transfer rate : 64 kbit/s
     5    1-------  Extension bit       : not continued
          -01-----  Layer ident.        : User information layer 1 protocol
          ---00010  Layer 1 protocol    : VALUE NOT SPECIFIED BY AT&T
     1    00011000  INFORMATION ELEMENT : CHANNEL IDentification
     2    00000001  IE length           : 1 octets
     3    1-------  Extension bit       : not continued
          -0------  Interface ident.    : Interface implicitly identified
          --0-----  Interface type      : Basic Rate Interface
          ---0----  Spare               :
          ----1---  Preferred/Exclusive : exclusive; only this ch. acceptable
          -----0--  D-channel indicator : The channel is not the D-channel
          ------01  Info. chan. sel.    : B1-channel
     1    00110100  INFORMATION ELEMENT : SIGNAL
     2    00000001  IE length           : 1 octets
     3    01000000  Signal value        : Normal alerting
     1    1001----  INFORMATION ELEMENT : SHIFT
          ----0---  Shift type          : locking
          -----110  New codeset ident.  : local service network specific IEs
     1    00100010  INFORMATION ELEMENT : SELected CALL APPearance
     2    00000001  IE length           : 1 octets
     3    00000001  Button Nr/Call App  : 1
     1    00100101  INFORMATION ELEMENT : DESTination CALL APPearance
     2    00000001  IE length           : 1 octets
     3    00000001  Dest. call app.     : 1
```

7. CONN_ACK

```
08 01 5A 0F
                 18 01 89
                 34 01 4F

PD = Q.931  CR = 0X5A        Orig  CONNect ACKnowl          Var. = ATT_5E6
     1    00011000  INFORMATION ELEMENT : CHANNEL IDentification
     2    00000001  IE length           : 1 octets
     3    1-------  Extension bit       : not continued
          -0------  Interface ident.    : Interface implicitly identified
          --0-----  Interface type      : Basic Rate Interface
          ---0----  Spare               :
          ----1---  Preferred/Exclusive : exclusive; only this ch. acceptable
          -----0--  D-channel indicator : The channel is not the D-channel
          ------01  Info. chan. sel.    : B1-channel
     1    00110100  INFORMATION ELEMENT : SIGNAL
     2    00000001  IE length           : 1 octets
     3    01001111  Signal value        : Alerting off
```

8. DISC

```
08 01 5A 45
                 08 02 80 90

PD = Q.931  CR = 0X5A        Orig  DISConnect               Var. = ATT_5E6
     1    00001000  INFORMATION ELEMENT : CAUSE
     2    00000010  IE length           : 2 octets
     3    1-------  Extension bit       : not continued
          -00-----  Coding standard     : CCITT standardized in Q.931
          ---0----  Spare               :
          ----0000  Location            : User
     4    1-------  Extension bit       : not continued
          -001----  Class               : Normal event
          ----0000  Cause value         : 16 Normal, Clearing
```

9. REL_COM

```
08 01 5A 5A
                 08 02 82 90
                 96
                 22 01 00

PD = Q.931  CR = 0X5A       Orig  RELease COMplete        Var. = ATT_5E6
     1   00001000  INFORMATION ELEMENT : CAUSE
     2   00000010  IE length           : 2 octets
     3   1-------  Extension bit       : not continued
         -00-----  Coding standard     : CCITT standardized in Q.931
         ---0----  Spare               :
         ----0010  Location            : Public Network Serving Local User
     4   1-------  Extension bit       : not continued
         -001----  Class               : Normal event
         ----0000  Cause value         : 16 Normal, Clearing
     1   1001----  INFORMATION ELEMENT : SHIFT
         ----0---  Shift type          : locking
         -----110  New codeset ident.  : local service network specific IEs
     1   00100010  INFORMATION ELEMENT : SELected CALL APPearance
     2   00000001  IE length           : 1 octets
     3   00000000  Button Nr/Call App  : 0
```

10. CONN

```
08 01 81 07

PD = Q.931  CR = 0X01       Dest  CONNect                 Var. = ATT_5E6
```

21.4 1TR6 Primary Rate Test Scripts

These scripts simulate the user, and network sides for call setup and teardown using the 1TR6 message set over a Primary Rate link.

S2M_N.F

The S2M_N.F test script simulates the user side of a telephone call setup and teardown procedure. Functional signalling procedures are utilized and overlap sending is employed.

```
( ---------------------------------------------------------------------)
( File Title:   S2M_N.F                                                )
(                                                                      )
(               Simulates the network side of an ISDN PCM-30 link according  )
(               to overlap sending procedures as defined in the Deutsche     )
(               Bundespost Recommendation 1TR6.                        )
( -------------------------------------------------------------------- )

" 1TR6_NSA" LOAD_MESSAGE_SET                ( Select 1TR6 message set )

( Variables and buffers are defined if they have not already been. )
#IFNOTDEF CURR-BCHAN
 X" 0" VARIABLE CURR-BCHAN           ( Contains active B Channel )
 1 VARIABLE GBZ                    ( Contains Charging information units )
60 VARIABLE GBZ-TIME               ( Charging informations unit timer value )
 0 VARIABLE DATE-BUF 14 ALLOT      ( Buffer for formatted Date information )
 0 VARIABLE KP-BUF 20 ALLOT        ( Buffer to contain KeyPad values )


( initialize CLS IE )
I#CLS ELEMENT>
     OCTET_3 INCLUDED
        #KEINE_ANGABE   *COD ->SDT_STATUS !
<ELEMENT

( initialize CAUse IE )
I#CAU ELEMENT>
    OCTET_3 INCLUDED
       #REMOTE_INITIATED  *COD ->CAU_VALUE !
    OCTET_4 INCLUDED
       #NATIONAL          *COD ->C_CODING_STANDARD !
       #PRIVATE_NETWORK   *COD ->C_LOCATION !
<ELEMENT
```

```
( initialize Service INdicator IE )
I#SIN ELEMENT>
   OCTET_3 INCLUDED
       #FERNSPRECHEN   *COD ->SIN_SERVICE !
   OCTET_4 INCLUDED
       #ANALOG         *COD ->SIN_ADD_INFO !
<ELEMENT

: APPEND   ( source string \ length \ dest string address -- )
    DUP C@ >R                    ( save current length of string )
    OVER R + OVER C!             ( add lengths for new string length )
    R> + 1+                      ( compute address to move source string )
    SWAP CMOVE                   ( copy source string after dest string )
;

( STR+CH is used to append a  single character to the end of a string. )

: STR+CH   ( char \ string -- )
    DUP >R                       ( save copy of string address )
    COUNT + C!                   ( store character at end of string )
    1 R> C+!                     ( increment string length )
;

( The following words are defined to build 1TR6 Information Elements as there )
( is no Message Builder support for this message set yet. )

: BLD_CIF    ( -- )    ( Builds Charging Information IE )
  I#CIF ELEMENT>
     OCTET_3 INCLUDED
         #ANZAHL_EINHEITEN   *COD ->CIF_GEA !
     OCTET_4 INCLUDED
         GBZ @ <# #S #>    *COD ->CIF_ANZAHL
         2DUP C!            ( store the string length )
         1+ SWAP CMOVE      ( copy the string )
   <ELEMENT
;
```

```
: BLD_DTE    ( -- )    ( Builds Date IE )
    GET_TIME                     ( read real time clock: ss mm hh dd mm yy )
    ROT <# # # #>                ( format day: "dd" )
    DATE-BUF 2DUP C! 1+ SWAP CMOVE  ( copy it into the date string )
    SWAP <# # # 0X2E HOLD #>     ( format month: ".mm" )
    DATE-BUF APPEND              ( append to date string )
    <# # # 0X2E HOLD #>          ( format year: ".yy" )
    DATE-BUF APPEND              ( append to date string )
    <# # # 0X2D HOLD #>          ( format hour: "-hh" )
    DATE-BUF APPEND              ( append to date string )
    <# # # 0X3A HOLD #>          ( format minute: ":mm" )
    DATE-BUF APPEND              ( append to date string )
    DROP                         ( drop seconds )
    I#DTE ELEMENT>
    OCTET_3 INCLUDED
            DATE-BUF   *COD ->DTE_DATA !STRING
    <ELEMENT
;

: BLD_CHI    ( P/E -- )  ( Builds Channel Identification IE )
    I#CHI ELEMENT>
        ALL_EXCLUDED
        OCTET_3 INCLUDED
            #IMPLICIT          *COD ->CID_INT_PRESENT !
            ?PRI               *COD ->CHI_PAT1 !
          ( P/E from stack )   *COD ->CHI_P/E !
            #NOT_D_CHANNEL     *COD ->CHI_PAT2 !
            #SEE_CHAN_NO       *COD ->CHI_ICS !
        OCTET_4 INCLUDED
            #NATIONAL          *COD ->CID_CODING_STANDARD !
            #NUMBER            *COD ->CID_NUMBER/MAP !
            #B_CHANNEL_UNITS   *COD ->CID_CHANNEL/MAP_TYPE !
        OCTET_5 INCLUDED
            CURR-BCHAN @       *COD ->CHI_CHANNEL !STRING
    <ELEMENT

;

: BLD_DAD    ( -- )    ( Builds Destination Address IE )
    I#DAD  ELEMENT>
        OCTET_3 INCLUDED
          #UNKNOWN        *COD ->DAD_ADDR_TYPE !
          #ISDN_PLAN      *COD ->DAD_ADDR_PLAN !
        OCTET_4 INCLUDED
          1 COUNTER2 +!                ( increment digit counter )
          *COD ->DAD_ADDR 1 OVER C! ( length )
          KP-BUF COUNTER2 @ + C@ SWAP 1+ C! ( digit )
    <ELEMENT
;
```

```
( The following words are defined to aid in sending messages.  These words )
( use the dynamic message building method to create each message. )

: SEND_ALERT    ( -- )
   M#ALERT MESSAGE>  I#CLS  <SEND
;

: SEND_CIF      ( -- )
   BLD_CIF
   M#INFO MESSAGE>  I#CIF  <SEND
;

: SEND_CONN     ( -- )
   BLD_DTE
   M#CONN MESSAGE>  I#DTE  <SEND
;

: SEND_CONN_ACK ( -- )
   BLD_DTE
   M#CONN_ACK MESSAGE>  I#DTE  <SEND
;

: SEND_DIGIT    ( -- )
   BLD_DAD
   M#INFO MESSAGE>  I#DAD  <SEND
;

: SEND_DISC     ( -- )
   BLD_CIF BLD_DTE
   M#DISC MESSAGE>  I#CAU I#CIF I#DTE  <SEND
;

: SEND_REL      ( -- )
   BLD_CIF BLD_DTE
   M#REL MESSAGE>  I#CIF I#DTE  <SEND
;

: SEND_REL_ACK  ( -- )
   M#REL_ACK MESSAGE>  <SEND
;

: SEND_SETUP    ( -- )
   #PREFERRED BLD_CHI
   M#SETUP MESSAGE>  I#CHI I#SIN  <SEND
;

: SEND_SETUP_ACK   ( -- )
   #EXCLUSIVE BLD_CHI
   M#SETUP_ACK MESSAGE>  I#CHI  <SEND
;
#ENDIF
```

```
TCLR                                    ( Clear test manager )
TM_MUX_OFF                              ( Turn test manager multiplexer off )
1 =CR_LENGTH                            ( Set call reference length )
0X41 =CN_INT_PD                         ( Set N1 protocol discriminator )


0 STATE_INIT{
    CLEAR_KEYS                          ( Set up TestKeys topic labels )
    " Anruf" 1 LABEL_KEY
    " TestKeys" SET_CURR_TOPIC
}STATE_INIT

0 STATE{
    UF1 ?KEY                ( Initiate call )
    ACTION{
        10 NEW_STATE                    ( Originate call )
    }ACTION

    M#SETUP ?L3_MSG         ( Incoming call )
    ACTION{
        I#CHI 1 ?L3_IE                  ( Extract B Channel # from CHI IE )
        IF
            *DEC ->CHI_CHANNEL @ CURR-BCHAN !
        ENDIF
        #DEST =CN_CR_FLAG               ( Set call reference flag )
        $MSG-CRVALUE @ =CN_CR_VALUE     ( Use user's call reference )
        SEND_SETUP_ACK                  ( Send SETUP ACKnowledge )
        1 NEW_STATE
    }ACTION
}STATE

1 STATE_INIT{
    1 CLEAR_KEY                         ( Erase "Anruf" label )
    " " KP-BUF !STRING                  ( Initialize keypad string )
}STATE_INIT

1 STATE{
    M#INFO ?L3_MSG          ( Collecting keypad digits )
    ACTION{
        I#DAD 1 ?L3_IE                  ( Extract digit from DAD IE )
        IF
            *DEC ->DAD_ADDR 1+ C@ KP-BUF STR+CH
            KP-BUF C@ 4 =               ( 4 digits received? )
            IF
                SEND_ALERT              ( Send ALERTing )
                101 30 START_TIMER      ( Simulate switching delay )
                2 NEW_STATE
            ENDIF
        ENDIF
    }ACTION
}STATE
```

```
2 STATE{
    101 ?TIMER             ( "Switching delay" timer expired )
    ACTION{
        SEND_CONN                      ( Send CONNected )
        3 NEW_STATE
    }ACTION
}STATE

3 STATE_INIT{
    " Ausloesen" 1 LABEL_KEY
    101 GBZ-TIME @ START_TIMER         ( Start Charging Information timer )
    0 GBZ !                            ( Initialize Charging Info. units )
}STATE_INIT

3 STATE{
    UF1 ?KEY               ( Hangup )
    ACTION{
        SEND_DISC                      ( Send DISConnected )
        4 NEW_STATE
    }ACTION

    M#DISC ?L3_MSG         ( User goes on-hook )
    ACTION{
        SEND_REL                       ( Send RELease )
        5 NEW_STATE
    }ACTION

    101 ?TIMER             ( CIF timer expired )
    ACTION{
        101 GBZ-TIME @ START_TIMER     ( Restart CIF timer )
        1 GBZ +!                       ( Increment charging units )
        SEND_CIF                       ( Send INFO message with CIF IE )
    }ACTION
}STATE

4 STATE{
    M#REL ?L3_MSG          ( RELease received )
    ACTION{
        SEND_REL_ACK                   ( Send RELease ACKnowledge )
        0 NEW_STATE
    }ACTION
}STATE

5 STATE{
    M#REL_ACK ?L3_MSG      ( RELease ACKnowledge received )
    ACTION{
        0 NEW_STATE
    }ACTION
}STATE
```

```
10 STATE_INIT{
    PROMPT" Bitte gewuenschte Rufnummer eingeben (3 Ziffern) "
    prompt DUP C@ 3 =                   ( 3 digits entered? )
    IF
        KP-BUF !STRING                  ( Save Tel. No. in KP-BUF )
        0 SA  DL_ESTABLISH              ( Establish data link )
    ELSE
        DROP " Invalid Entry" W.ERROR
        10 NEW_STATE                    ( Re-issue prompt )
    ENDIF
    END_PROMPT
    3 COUNTER1 !                        ( # of digits to send )
    0 COUNTER2 !                        ( # of digits sent )
    1 CLEAR_KEY                         ( Clear "Anruf" label )
}STATE_INIT

10 STATE{
    DL-EST#CONF ?L2_SERVICE             ( Data link establishment confirmation )
    ACTION{
        #ORIG =CN_CR_FLAG               ( Set call reference flag )
        SEND_SETUP                      ( Send SETUP )
        11 NEW_STATE
    }ACTION
}STATE

11 STATE{
    M#SETUP_ACK ?L3_MSG     ( SETUP ACKnowledge received )
    ACTION{
        SEND_DIGIT                      ( Send first digit )
        12 NEW_STATE
    }ACTION
}STATE

12 STATE{
    R#RR ?RX_FRAME          ( INFO frame acknowledged )
    ACTION{
        COUNTER2 @ COUNTER1 @ =         ( All digits sent? )
        IF
            13 NEW_STATE
        ELSE
            SEND_DIGIT                  ( Send next digit )
        ENDIF
    }ACTION
}STATE

13 STATE{
    M#ALERT ?L3_MSG         ( ALERTing received )
    ACTION{
        14 NEW_STATE
    }ACTION
}STATE
```

```
14 STATE{
    M#CONN ?L3_MSG          ( CONNected received )
    ACTION{
        SEND_CONN_ACK                   ( Send CONNect ACKnowledge )
        3 NEW_STATE
    }ACTION
}STATE
```

S2M_U.F

The S2M_U.F test scripts simulates the user side of a telephone call setup and teardown procedure utilizing functional signalling procedures – overlap sending. A message pool, S2M_U.P, is automatically loaded.

```
( ------------------------------------------------------------------------ )
( File Title:   S2M_U.F                                                    )
(                                                                          )
(               Simulates the user side of and ISDN PCM-30 link according  )
(               to overlap sending procedures as defined in the Deutsche   )
(               Bundespost Recommendation 1TR6                             )
( ------------------------------------------------------------------------ )

" 1TR6_NSA" LOAD_MESSAGE_SET                 ( Select 1TR6 message set )

( Variables and buffers are defined if they have not already been. )
#IFNOTDEF CURR-BCHAN
 0 VARIABLE CURR-BCHAN          ( Contains active B Channel )
 0 VARIABLE KP_BUF 20 ALLOT     ( Buffer to contain KeyPad values )


( These words each retrieve a predefined message from the message pool and )
( modify any internal fields before sending the message. )

: SETUP_U       ( -- )        ( Send SETUP message )
   " SETUP-U" POOL
   OVER 8+ CURR-BCHAN @ SWAP C!
   ALTER_CR SEND_I
;

: SETUP_ACK_U   ( -- )        ( Send SETUP ACK message )
   " SETUPACK-U" POOL
   OVER 8+ CURR-BCHAN @ SWAP C!
   ALTER_CR SEND_I
;

: ALERT_U       ( -- )        ( Send ALERTing message )
   " ALERT-U" POOL
   OVER 7 + KP_BUF 1+ SWAP 3 CMOVE
   ALTER_CR SEND_I
;
```

```
: CONN_U         ( -- )        ( Send CONNect message )
    " CONN-U" POOL
    OVER 7 + KP_BUF 1+ SWAP 3 CMOVE
    ALTER_CR SEND_I
;

( COUNTER2 is offset in KP_BUF of next char to send. )
( COUNTER1 is number of digits entered )

: DIAL_OUT       ( -- )        ( Send INFO message containing KeyPad digit )
    " DIAL-U" POOL
    OVER 7 + KP_BUF 1+ COUNTER2 @ + C@ SWAP C!
    1 COUNTER2 +!
    ALTER_CR SEND_I
;

: +KP   ( char -- )            ( Append the next digit to the keypad string )
    KP_BUF C@ 1+                         ( string length + 1 )
    DUP KP_BUF C!                        ( save new length )
    KP_BUF + C!                          ( store char at end of string )
;
#ENDIF


TCLR                                     ( Clear test manager )
" S2M_U.P" LOAD_MESSAGES                 ( Load message pool )
TM_MUX_OFF                               ( Turn test manager multiplexer off )
1 =CR_LENGTH                             ( Set call reference length )


0 STATE_INIT{
    CLEAR_KEYS                           ( Set up TestKeys topic )
    " Anruf" 1 LABEL_KEY
    " TestKeys" SET_CURR_TOPIC
}STATE_INIT
```

```
0 STATE{
    UF1 ?KEY               ( Originate call )
    ACTION{
        10 NEW_STATE
    }ACTION

    M#SETUP ?L3_MSG        ( Call initiated from far end )
    ACTION{
        I#CHI 1 ?L3_IE                 ( Extract B Channel # from CHI IE )
        IF
            *DEC ->CHI_CHANNEL @ CURR-BCHAN !
        ENDIF
        DEST_SIDE                      ( Set CR flag for ALTER_CR )
        $MSG-CRVALUE @ RX-CALLREF !    ( Copy CR value for ALTER_CR )
        SETUP_ACK_U                    ( Send SETUP ACKnowledge )
        1 NEW_STATE
    }ACTION
}STATE

1 STATE_INIT{
    1 CLEAR_KEY                        ( Erase "Anruf" label )
    " " KP_BUF !STRING                 ( Initialize keypad string )
}STATE_INIT

1 STATE{
    M#INFO ?L3_MSG         ( Keypad digit received? )
    ACTION{
        I#DAD 1 ?L3_IE                 ( Extract digit from DAD IE )
        IF
            *DEC ->DAD_ADDR 1+ C@  +KP
            KP_BUF C@ 3 =              ( 3 digits received? )
            IF
                ALERT_U                ( Send ALERTing )
                101 30 START_TIMER     ( Simulate switching delay )
                3 NEW_STATE
            ENDIF
        ENDIF
    }ACTION
}STATE

3 STATE{
    101 ?TIMER             ( "Switching delay" timer expired )
    ACTION{
        CONN_U                         ( Send CONNected )
        4 NEW_STATE
    }ACTION
}STATE
```

```
4 STATE{
    M#CONN_ACK ?L3_MSG      ( CONNect ACKnowledge received )
    ACTION{
        5 NEW_STATE
    }ACTION
}STATE

5 STATE_INIT{
    " Ausloesen" 1 LABEL_KEY
}STATE_INIT

5 STATE{
    UF1 ?KEY                ( Hang up )
    ACTION{
        " DISC-U" POOL ALTER_CR SEND_I      ( Send DISConnect )
        6 NEW_STATE
    }ACTION

    M#DISC ?L3_MSG          ( Far end disconnects )
    ACTION{
        " REL-U" POOL ALTER_CR SEND_I       ( Send RELease )
        7 NEW_STATE
    }ACTION
}STATE

6 STATE{
    M#REL ?L3_MSG           ( RELease received )
    ACTION{
        " REL_ACK" POOL ALTER_CR SEND_I     ( Send RELease ACKnowledge )
        0 NEW_STATE
    }ACTION
}STATE

7 STATE{
    M#REL_ACK ?L3_MSG       ( RELease ACKnowledge received )
    ACTION{
        0 NEW_STATE
    }ACTION
}STATE
```

```
10 STATE_INIT{
    PROMPT" Bitte gewuenschte Rufnummer eingeben (4 Ziffern) "
    prompt DUP C@ 4 =                   ( 4 digits entered? )
    IF
        KP_BUF !STRING                  ( Save Tel. No. in KP_BUF )
        0 SA  DL_ESTABLISH              ( Establish data link )
    ELSE
        DROP " Invalid Entry" W.ERROR
        10 NEW_STATE                    ( Re-issue prompt )
    ENDIF
    END_PROMPT
    4 COUNTER1 !                        ( # of digits to send )
    0 COUNTER2 !                        ( # of digits sent )
    1 CLEAR_KEY                         ( Erase "Anruf" label )
}STATE_INIT

10 STATE{
    DL-EST#CONF ?L2_SERVICE             ( Data link establishment confirmation )
    ACTION{
        ORIG_SIDE                       ( Set the call reference flag )
        SETUP_U                         ( Send SETUP )
        11 NEW_STATE
    }ACTION
}STATE

11 STATE{
    M#SETUP_ACK ?L3_MSG     ( SETUP ACKnowledgement received )
    ACTION{
        DIAL_OUT                        ( Send the first digit )
        12 NEW_STATE
    }ACTION
}STATE

12 STATE{
    R#RR ?RX_FRAME          ( INFO frame acknowledgement received? )
    ACTION{
        COUNTER2 @ COUNTER1 @ =         ( All digits sent? )
        IF
            13 NEW_STATE
        ELSE
            DIAL_OUT                    ( Send the next digit )
        ENDIF
    }ACTION
}STATE

13 STATE{
    M#ALERT ?L3_MSG         ( ALERTing received )
    ACTION{
        14 NEW_STATE
    }ACTION
}STATE
```

```
14 STATE[
    M#CONN ?L3_MSG          ( CONNected received )
    ACTION[
        5 NEW_STATE                     ( Wait for hang up )
    ]ACTION
]STATE
```

Message Pool Descriptions

There are eight pool entries in the S2M_U.P message pool file as described in the following list. Each pool entry is shown in hexadecimal and complete formats.

1. SETUP-U

```
41 01 00 05
                 18 03 A9 C3 0D
                 28 08 1B 01 49 44 41 43 4F 4D
                 6C 04 80 32 30 32
                 9E
                 01 02 01 01
                 9F
                 01 03 A5 00 90
                 9F
                 03 0C 30 00 00 80 0E 00 00 80 01 00 00 8D

PD = N1     CR = 0X00        Orig  SETUP                     Var. = 1TR6_NSA
     1    00011000  INFORMATION ELEMENT : CHannel Identification
     2    00000011  IE length           : 3 octets
     3    1-------  Extension bit       : not continued
          -0------  Interface ident.    : implicitly identified
          --1-----  Interface type      : primary interface
          ---0----  Spare               :
          ----1---  P/E                 : vorgeschriebener Kanal
          -----0--  D-Channel Indicator : not D-channel
          ------01  ICS                 : siehe Channel Number
     4    1-------  Extension bit       : not continued
          -10-----  Coding standard     : national standard
          ---0----  Number/Map          : number
          ----0011  Chan./Map type      : B-channel units
     5    ********  Channel number      : 0D
     1    00101000  INFORMATION ELEMENT : DiSPlay
     2    00001000  IE length           : 8 octets
     3    ********  Displayinhalt       : [<00><00>IDACOM]
     1    01101100  INFORMATION ELEMENT : Origination ADdress
     2    00000100  IE length           : 4 octets
     3    1-------  Extension bit       : not continued
          -000----  Type of address     : unknown
          ----0000  Numbering plan      : unknown
     4    ********  Address digits      : [202]
     1    1001----  INFORMATION ELEMENT : SHIft
```

```
          ----1---  Shift type          : Codeumschaltung ohne Feststellung
          -----111  Codeset ident.      : Codesatz 7
     1    00000001  INFORMATION ELEMENT : Set(07)/Code(01)
     2    00000011  IE length           : 3 octets
     3    ********  IE contents         : A5 00 90
     1    1001----  INFORMATION ELEMENT : SHIft
          ----1---  Shift type          : Codeumschaltung ohne Feststellung
          -----111  Codeset ident.      : Codesatz 7
     1    00000001  INFORMATION ELEMENT : Set(07)/Code(01)
     2    00000011  IE length           : 3 octets
     3    ********  IE contents         : A5 00 90
     1    1001----  INFORMATION ELEMENT : SHIft
          ----1---  Shift type          : Codeumschaltung ohne Feststellung
          -----111  Codeset ident.      : Codesatz 7
     1    00000011  INFORMATION ELEMENT : Set(07)/Code(03)
     2    00001100  IE length           : 12 octets
     3    ********  IE contents         : 30 00 00 80 0E 00 00 80 01 00 00 8D
```

2. DIAL-U

```
41 01 00 6D
                 70 02 80 31

PD = N1     CR = 0X00        Orig  INFOrmation              Var. = 1TR6_NSA
     1    01110000  INFORMATION ELEMENT : Destination ADdress
     2    00000010  IE length           : 2 octets
     3    1-------  Extension bit       : not continued
          -000----  Type of address     : unknown
          ----0000  Numbering plan      : unknown
     4    ********  Address digits      : [1]
```

3. REL-U

```
41 01 00 4D
                 9E
                 03 00

PD = N1     CR = 0X00        Orig  RELease                  Var. = 1TR6_NSA
     1    1001----  INFORMATION ELEMENT : SHIft
          ----1---  Shift type          : Codeumschaltung ohne Feststellung
          -----110  Codeset ident.      : Codesatz 6
     1    00000011  INFORMATION ELEMENT : DaTE
     2    00000000  IE length           : 0 octets
```

4. REL_ACK

```
41 01 80 5A


PD = N1     CR = 0X00        Dest  RELease ACKnowledge      Var. = 1TR6_NSA
```

5. DISC-U

```
41 01 00 45
                 9E
                 03 00
                 9F
                 01 01 81
                 9F
                 03 0C 00 00 00 80 00 00 00 80 00 00 00 80
```

```
PD = N1      CR = 0X00        Orig  DISConnect              Var. = 1TR6_NSA
     1    1001----  INFORMATION ELEMENT : SHIft
          ----1---  Shift type          : Codeumschaltung ohne Feststellung
          -----110  Codeset ident.      : Codesatz 6
     1    00000011  INFORMATION ELEMENT : DaTE
     2    00000000  IE length           : 0 octets
     1    1001----  INFORMATION ELEMENT : SHIft
          ----1---  Shift type          : Codeumschaltung ohne Feststellung
          -----111  Codeset ident.      : Codesatz 7
     1    00000001  INFORMATION ELEMENT : Set(07)/Code(01)
     2    00000001  IE length           : 1 octets
     3    ********  IE contents         : 81
     1    1001----  INFORMATION ELEMENT : SHIft
          ----1---  Shift type          : Codeumschaltung ohne Feststellung
          -----111  Codeset ident.      : Codesatz 7
     1    00000011  INFORMATION ELEMENT : Set(07)/Code(03)
     2    00001100  IE length           : 12 octets
     3    ********  IE contents         : 00 00 00 80 00 00 00 80 00 00 00 80
```

6. SETUPACK-U

```
PD = N1      CR = 0X01        Dest  SETUP ACKnowledge       Var. = 1TR6_NSA
     1    00011000  INFORMATION ELEMENT : CHannel Identification
     2    00000011  IE length           : 3 octets
     3    1-------  Extension bit       : not continued
          -0------  Interface ident.    : implicitly identified
          --1-----  Interface type      : primary interface
          ---0----  Spare               :
          ----0---  P/E                 : bevorzugter Kanal
          -----0--  D-Channel Indicator : not D-channel
          ------01  ICS                 : siehe Channel Number
     4    1-------  Extension bit       : not continued
          -10-----  Coding standard     : national standard
          ---0----  Number/Map          : number
          ----0011  Chan./Map type      : B-channel units
     5    ********  Channel number      : 1E
```

7. ALERT–U

```
41 01 81 01
                0C 04 81 32 30 32
                28 08 1B 01 49 44 41 43 4F 4D
                9E
                07 00
                9F
                01 03 A5 10 90
                9F
                03 0C 30 00 00 80 0E 00 00 80 00 00 00 8D

PD = N1    CR = 0X01      Dest  ALERTing                Var. = 1TR6_NSA
    1    00001100  INFORMATION ELEMENT : Connected ADdress
    2    00000100  IE length           : 4 octets
    3    1-------  Extension bit       : not continued
         -000----  Type of address     : unknown
         ----0001  Numbering plan      : ISDN numbering plan Rec. E.164
    4    ********  Address digits      : [202]
    1    00101000  INFORMATION ELEMENT : DiSPlay
    2    00001000  IE length           : 8 octets
    3    ********  Displayinhalt       : [<00><00>IDACOM]
    1    1001----  INFORMATION ELEMENT : SHIft
         ----1---  Shift type          : Codeumschaltung ohne Feststellung
         -----110  Codeset ident.      : Codesatz 6
    1    00000111  INFORMATION ELEMENT : Status des geruf Tln
    2    00000000  IE length           : 0 octets
    1    1001----  INFORMATION ELEMENT : SHIft
         ----1---  Shift type          : Codeumschaltung ohne Feststellung
         -----111  Codeset ident.      : Codesatz 7
    1    00000001  INFORMATION ELEMENT : Set(07)/Code(01)
    2    00000011  IE length           : 3 octets
    3    ********  IE contents         : A5 10 90
    1    1001----  INFORMATION ELEMENT : SHIft
         ----1---  Shift type          : Codeumschaltung ohne Feststellung
         -----111  Codeset ident.      : Codesatz 7
    1    00000011  INFORMATION ELEMENT : Set(07)/Code(03)
    2    00001100  IE length           : 12 octets
    3    ********  IE contents         : 30 00 00 80 0E 00 00 80 00 00 00 8D
```

8. CONN-U

```
41 01 81 07
                0C 04 81 32 30 32
                28 08 1B 01 49 44 41 43 4F 4D
                9E
                03 00
                9F
                01 03 A5 10 90
                9F
                03 0C 30 00 00 80 0E 00 00 80 00 00 00 8D

PD = N1      CR = 0X01        Dest  CONNect                Var. = 1TR6_NSA
     1     00001100  INFORMATION ELEMENT : Connected ADdress
     2     00000100  IE length           : 4 octets
     3     1-------  Extension bit       : not continued
           -000----  Type of address     : unknown
           ----0001  Numbering plan      : ISDN numbering plan Rec. E.164
     4     ********  Address digits      : [202]
     1     00101000  INFORMATION ELEMENT : DiSPlay
     2     00001000  IE length           : 8 octets
     3     ********  Displayinhalt       : [<00><00>IDACOM]
     1     1001----  INFORMATION ELEMENT : SHIft
           ----1---  Shift type          : Codeumschaltung ohne Feststellung
           -----110  Codeset ident.      : Codesatz 6
     1     00000011  INFORMATION ELEMENT : DaTE
     2     00000000  IE length           : 0 octets
     1     1001----  INFORMATION ELEMENT : SHIft
           ----1---  Shift type          : Codeumschaltung ohne Feststellung
           -----111  Codeset ident.      : Codesatz 7
     1     00000001  INFORMATION ELEMENT : Set(07)/Code(01)
     2     00000011  IE length           : 3 octets
     3     ********  IE contents         : A5 10 90
     1     1001----  INFORMATION ELEMENT : SHIft
           ----1---  Shift type          : Codeumschaltung ohne Feststellung
           -----111  Codeset ident.      : Codesatz 7
     1     00000011  INFORMATION ELEMENT : Set(07)/Code(03)
     2     00001100  IE length           : 12 octets
     3     ********  IE contents         : 30 00 00 80 0E 00 00 80 00 00 00 8D
```

21.5 Layer 3 Simulation

This test script is composed of three files. The file L3SIM.F is loaded first. When L3SIM.F has finished loading, it automatically loads L3S_USER.F or L3S_NTWK.F, depending on whether the application has been configured for user or network emulation.

L3SIM.F

```
" CCITT_1988" LOAD_MESSAGE_SET ( make sure that ccitt message set is loaded )
L3_OFF                         ( Turn off L3 Emulation )
TM_MUX_ON                      ( Turn Test Manager Multiplexer on )

( Define these words only if they have not already been defined. )
#IFNOTDEF BEEP-ALTER

( These words are used to simulate a phone ring via the PT´s speaker. )

0 VARIABLE BEEP-ALTER

: RING_ON
    BEEP-ALTER @                    ( Beep on? )
    IF
        #USER1 10 =CN_TIMER_DUR     ( Timer duration = 1s )
        OFF BEEP-ALTER !            ( Indicate beep is off )
    ELSE
        #USER1 20 =CN_TIMER_DUR     ( Timer duration = 2s )
        ON BEEP-ALTER !             ( Indicate beep is on )
    ENDIF
    #USER1 CN_START_TIMER           ( Start beep timer )
    220 BEEP_TONE !
    4 BEEP_DUR !
    BEEP BEEP
;

: RING_OFF
    #USER1 CN_STOP_TIMER            ( Stop beep timer )
    OFF BEEP-ALTER !
    82 BEEP_TONE !
    2 BEEP_DUR !
;
```

```
( The following words are used to dynamically build Information Elements )
( used in this simulation.  Most of the parameters are given default values; )
( some are passed via the stack. )

: SETUP_BEARER_CAP   ( transfer mode -- )
    I#BEARER_CAP ELEMENT>
        ALL_EXCLUDED
        OCTET_3 INCLUDED
            #CCITT               *COD ->BC_CODING_STANDARD    !
            #UNRESTRICTED        *COD ->BC_TRANSFER_CAP       !
        OCTET_4 INCLUDED
            ( transfer mode )    *COD ->BC_TRANSFER_MODE      !
            #64KBIT/S            *COD ->BC_TRANSFER_RATE      !
        OCTET_4A INCLUDED
            #DEFAULT             *COD ->BC_STRUCTURE          !
            #POINT_TO_POINT      *COD ->BC_CONFIGURATION      !
            #DEMAND              *COD ->BC_ESTABLISHMENT      !
        OCTET_4B INCLUDED
            #BIDIRECT_SYMMETRIC  *COD ->BC_SYMMETRY           !
            #64KBIT/S            *COD ->BC_TRANSFER_RATE_4B   !
    <ELEMENT
;

: SETUP_CALLED_NUM   ( number -- )
    I#CALLED_NUM ELEMENT>
        ALL_INCLUDED
            #LOCAL_DIRECTORY     *COD ->CLDN_NUMBER_TYPE      !
            #NATIONAL_PLAN      *COD ->CLDN_NUMBERING_PLAN   !
            ( number )           *COD ->CLDN_NUMBER           !STRING
    <ELEMENT
;

: SETUP_CALL_STATE   ( state -- )
    I#CALL_STATE ELEMENT>
        ALL_INCLUDED
            #CCITT               *COD ->CS_CODING_STANDARD    !
            ( state )            *COD ->CS_CALL_STATE         !
    <ELEMENT
;
```

```
: SETUP_CAUSE   ( value -- )
    I#CAUSE ELEMENT>
        ALL_EXCLUDED
        OCTET_3 INCLUDED
            #CCITT               *COD ->C_CODING_STANDARD    !
            USR*NET @ TE =
            IF
                #USER            *COD ->C_LOCATION           !
            ELSE
                #LOCAL_PUBLIC    *COD ->C_LOCATION           !
            ENDIF
        OCTET_4 INCLUDED
            ( value )            *COD ->C_CAUSE_VALUE        !
    <ELEMENT
;

: SETUP_CHANNEL_ID   ( channel \ preferred -- )
    I#CHANNEL_ID ELEMENT>
        ALL_INCLUDED
        OCTET_3.1 EXCLUDED
            #IMPLICIT            *COD ->CID_INT_PRESENT      !
            #OTHER_INTERFACE     *COD ->CID_INT_TYPE         !
            ( preferred )        *COD ->CID_PREF/EXCL        !
            #NOT_D_CHANNEL       *COD ->CID_DCHANNEL         !
            #AS_INDICATED        *COD ->CID_INFO_CHAN_SEL    !
            #CCITT               *COD ->CID_CODING_STANDARD  !
            #NUMBER              *COD ->CID_NUMBER/MAP       !
            #B_CHANNEL_UNITS     *COD ->CID_CHANNEL/MAP_TYPE !
            ( channel )          *COD ->CID_NUMBER           !
    <ELEMENT
;

: SETUP_SIGNAL   ( signal value -- )
    I#SIGNAL ELEMENT>
        ALL_INCLUDED
            ( signal value )     *COD ->SI_VALUE
    <ELEMENT
;


( These words are defined to simplify construction of the test script: )

( This word returns true if a valid L.3 message was received and the call )
( reference field applies to this connection. )
: ?VALID_MSG    ( Msg-id --- boolean )
    ?L3_VALID_MSG DUP             ( Valid Layer 3 Signalling message ? )
    IF
        $MSG-CRLEN   @ ?CR_LENGTH      = AND   ( Call Reference matched ? )
        $MSG-CRVALUE @ ?CN_CR_VALUE    = AND
        $MSG-CRFLAG  @ 0= ?CN_CR_FLAG  = AND
    ENDIF
```

```
( This word attempts to find an unused B Channel for use by the call.  The )
( preferred channel is attempted first. )
: NEGOTIATE_CHANNEL   ( --- Channel # \ YES  or  NO )
    *DEC ->CID_INT_TYPE @ #OTHER_INTERFACE   =       ( Not Basic interface? )
    *DEC ->BC_TRANSFER_MODE @ #CIRCUIT_MODE  = AND   ( Circuit mode? )
    *DEC ->CID_DCHANNEL @ #NOT_D_CHANNEL     = AND   ( B Channel wanted? )
    *DEC ->CID_INFO_CHAN_SEL @ #AS_INDICATED = AND   ( Indicated in CID IE? )
    *DEC ->CID_NUMBER/MAP @ #NUMBER          = AND   ( Number used? )
    *DEC ->CID_CHANNEL/MAP_TYPE @ #B_CHANNEL_UNITS = AND
    IF
        *DEC ->CID_NUMBER @
        DUP ?BC_ALLOC 0=        ( Is selected B Channel available? )
        IF
            YES
        ELSE
            DROP
            *DEC ->CID_PREF/EXCL @ #EXCLUSIVE =      ( only use indicated? )
            IF
                NO              ( The selected channel is not available )
            ELSE
                ?BC_SELECT      ( Any B Channels available? )
                ?DUP            ( Flag is true if channel non-zero )
            ENDIF
        ENDIF
    ELSE
        NO
    ENDIF
;
```

```
( This word is used to indicate, via the CAUSE IE, a message error. )
: L3_ERROR  ( --- )
    $MSG-ERROR @                        ( Decoding error? )
    IF
        #INVALID_MESSAGE_UNSPEC
    ELSE
        M#UNDEF ?L3_MSG                 ( Undefined message? )
        IF
            #MESSAGE_TYPE_UNIMPL
        ELSE
            $MSG-ID @ ?L3_MAND_IE 0=    ( Mandatory IEs missing? )
            IF
                #MAND_IE_MISSING
            ELSE
                $MSG-ID @ ?L3_UNEXP_IE  ( Unexpected IE present )
                ?L3_IE_ORDER 0= OR      ( or IEs are not in order? )
                IF
                    #INVALID_MESSAGE_UNSPEC
                ELSE
                    #MESSAGE_UNDEFINED
                ENDIF
            ENDIF
        ENDIF
    ENDIF
    SETUP_CAUSE
;


( This word reports the status using trace statements. )
: REPORT_PEER_STATUS
    T." ***** Received STATUS message ***** " TCR
    T."     Peer entity state : " *DEC ->CS_CALL_STATE @ T. TCR
    T."     Cause class       : " *DEC ->C_CAUSE_VALUE @ T. TCR
;
#ENDIF


( Load the approriate Test Manager state machine: )

#IF  USR*NET @ NT =  #IS_TRUE
" L3S_NTWK.F" EXEC
#ELSE
" L3S_USER.F" EXEC
#ENDIF
```

L3S_NTWK.F

A reliable data link must be first established. The interface structure is basic access en-bloc sending and circuit switching TE: Type 1 terminal, i.e. one connection per data link.

```
( ------------------------------------------------------------------ )
( File Title:   L3S_NTWK.F                                           )
(                                                                    )
(               This script simulates the network in a point to multi- )
(               point configuration                                  )
( ------------------------------------------------------------------ )


( Two counter variables are used in this script: )
(    COUNTER1 : retransmission counter for T303 )
(    COUNTER2 : Release Complete received before T303 expiry )

TCLR        ( Initialize test manager )

MAKE TM_INIT CLEAR_ALL_CNS ;

0 STATE_INIT{
    0 COUNTER1 !            ( Initialize retransmission counter )
    NO COUNTER2 !      ( No RELEASE COMPLETE received yet )
    CLEAR_KEYS
    " MAKE CALL" 1 LABEL_KEY
    " TestKeys" SET_CURR_TOPIC
}STATE_INIT
```

```
0 STATE[
    UF1 ?KEY
    ACTION[             ( Incoming call to user )
        DL_ESTABLISH    ( Establish the Link )
        ?CN_ALLOC       ( Connection control available )
        IF
            =CN                     ( Set the current connection controller )
            #ORIG 0 CN_INIT         ( Initialize CN )
            ?BC_SELECT ?DUP         ( Allocate an idle B-Channel )
            IF
                DUP =CN_CHANNEL_NUM     ( Set the channel id )
                BC_ALLOC                ( Reserve the channel )
                SELECT_CR =CN_CR_VALUE  ( Select Call reference value )
                0 CES* @ =CN_CEI    ( Set Connection Endpoint Identifier )
                #CIRCUIT_MODE               SETUP_BEARER_CAP
                ?CN_CHANNEL_NUM #EXCLUSIVE  SETUP_CHANNEL_ID
                " 5416320"                  SETUP_CALLED_NUM
                #ALERTING_ON_0              SETUP_SIGNAL
                T." ----> Send SETUP message " TCR
                M#SETUP MESSAGE>
                    I#BEARER_CAP I#CHANNEL_ID I#SIGNAL I#CALLED_NUM
                <SEND
                #T303 #T303_DUR =CN_TIMER_DUR
                #T303 CN_START_TIMER ( Start timer T303 )
                6 NEW_STATE
            ELSE                ( No channel available )
                CN_DEALLOC
                ( Clear connection controller )
                " NO CHANNEL AVAILABLE "  W.ERROR
            ENDIF
        ELSE                    ( Network busy )
            " NO CONNECTION MODULE AVAILABLE " W.ERROR
        ENDIF
    }ACTION

    M#SETUP ?L3_VALID_MSG
    ACTION[
        I#CHANNEL_ID ?L3_IECOUNT 0 >
        I#CALLED_NUM ?L3_IECOUNT 0 > AND    ( All required info existed ? )
        IF
            ?CN_ALLOC               ( Allocate connection controller )
            IF
                =CN                 ( Set current connection controller )
                #DEST 0 CN_INIT     ( Initialize the controller )
                NEGOTIATE_CHANNEL
                IF
                    MSAPI* @ CES* @ =CN_CEI
                    DUP =CN_CHANNEL_NUM         ( Save the channel id )
                    BC_ALLOC                    ( Reserve the channel )
                    ?CN_CHANNEL_NUM #EXCLUSIVE SETUP_CHANNEL_ID
                    T." ----> Send CALL PROCEEDING message " TCR
                    M#CALL_PROC MESSAGE>
                        I#CHANNEL_ID
                    <SEND
                    3 NEW_STATE
                ELSE                ( No B-Channel available )
                    #NO_CHANNEL_AVAIL SETUP_CAUSE
                    T." ----> Send RELEASE COMPLETE message " TCR
                    M#REL_COM MESSAGE>
                        I#CAUSE
                    <SEND
                    CN_DEALLOC
                    ( Clear connection controller )
                ENDIF
            ELSE                    ( No connection controller )
                #SWITCH_CONGESTION SETUP_CAUSE
                T." ----> Send RELEASE COMPLETE message " TCR
                M#REL_COM MESSAGE>
                    I#CAUSE
                <SEND
            ENDIF
        ELSE    ( Insufficient Information, Overlap Sending not supported )
            #SERVICE_UNIMPL_UNSPEC SETUP_CAUSE
            T." ----> Send RELEASE COMPLETE message " TCR
            M#REL_COM MESSAGE>
                I#CAUSE
            <SEND
        ENDIF
    }ACTION

    M#STATUS ?L3_VALID_MSG
    ACTION{
        REPORT_PEER_STATUS
    }ACTION
}STATE

3 STATE_INIT{
    CLEAR_KEYS
    " CONNECT" 2 LABEL_KEY
    " REJECT"  3 LABEL_KEY
}STATE_INIT
```

```
3 STATE{          ( OUTGOING CALL PROCEEDING )
    UF2 ?KEY                  ( Call is accepted and connected )
    ACTION{
        ?CN_CEI SA DROP
        ?CN_CHANNEL_NUM BC_CONN         ( Connected to the B channel )
        T." ----> Send CONNECT message " TCR
        M#CONN MESSAGE>
        <SEND
        10 NEW_STATE
    }ACTION

    M#STATUS ?L3_VALID_MSG   ( Received STATUS message or              )
    UF3 ?KEY  OR             ( Call is rejected -> initiate clearing     )
    ACTION{
        #USER_BUSY SETUP_CAUSE
        T." ----> Send DISCONNECT message " TCR
        M#DISC MESSAGE>
            I#CAUSE
        <SEND
        #T305 #T305_DUR =CN_TIMER_DUR
        #T305 CN_START_TIMER  ( Start timer T305 )
        12 NEW_STATE
    }ACTION

    M#DISC ?L3_VALID_MSG        ( Calling user releases the call )
    ACTION{
        #USER_BUSY SETUP_CAUSE
        T." ----> Send RELEASE message " TCR
        M#REL MESSAGE>
            I#CAUSE
        <SEND
        #T308 #T308_DUR =CN_TIMER_DUR
        #T308 CN_START_TIMER    ( Start timer T308      )
        19 NEW_STATE
    }ACTION
}STATE

6 STATE{          ( CALL PRESENT )
    M#CONN ?L3_VALID_MSG               ( Received a CONNECT message )
    ACTION{
        #T303 CN_STOP_TIMER         ( Stop timer T303 )
        0 COUNTER1 !                  ( Reset retransimission counter )
        8 NEW_STATE
    }ACTION

    M#REL_COM ?L3_VALID_MSG
    ACTION{                         ( Received RELEASE COMPLETE message )
        YES COUNTER2 !                   ( Received REL COM      )
    }ACTION
    M#STATUS ?L3_VALID_MSG
    ACTION{
        REPORT_PEER_STATUS
        ?CN_CHANNEL_NUM BC_FREE ( Release B channel )
        CLEAR_CR
        ( Clear call reference & connection module )
        0 NEW_STATE
    }ACTION

    #T303 ?CN_TIMER                 ( Timer T303 expired )
    ACTION{
        COUNTER1 @ 0= COUNTER2 @ NO = AND
        IF
            1 COUNTER1 +!             ( Increment the counter )
            T." ----> Re-send SETUP message " TCR
            M#SETUP MESSAGE>
                I#BEARER_CAP I#CHANNEL_ID I#SIGNAL I#CALLED_NUM
            <SEND  ( Retransmit the SETUP message )
            #T303 #T303_DUR =CN_TIMER_DUR
            #T303 CN_START_TIMER    ( Start timer T303 )
        ELSE
            ?CN_CHANNEL_NUM BC_FREE ( Release B channel )
            CLEAR_CR
            ( Clear call reference & connection module )
            0 NEW_STATE
        ENDIF
    }ACTION

    ?RX_DATA            ( Check received message error )
    ACTION{
        L3_ERROR          ( Check error )
        T." ----> Send DISCONNECT message " TCR
        M#DISC MESSAGE>
            I#CAUSE
        <SEND
        #T305 #T305_DUR =CN_TIMER_DUR
        #T305 CN_START_TIMER
        12 NEW_STATE
    }ACTION
}STATE

8 STATE_INIT{
    CLEAR_KEYS
    " CONNECT"    2 LABEL_KEY
    " DISCONNECT" 3 LABEL_KEY
}STATE_INIT
```

```
8 STATE{          ( NETWORK CONNECT )
    UF2 ?KEY ACTION{                  ( Accept the call )
        #ALERTING_OFF SETUP_SIGNAL
        T." ----> Send CONNECT ACKNOWLEDGE message " TCR
        M#CONN_ACK MESSAGE>
            I#SIGNAL
        <SEND
        ?CN_CHANNEL_NUM BC_CONN     ( Connect B channel )
        10 NEW_STATE
    }ACTION

    UF3 ?KEY ACTION{                  ( Reject the call )
        #NORMAL_CLEARING SETUP_CAUSE
        T." ----> Send DISCONNECT message " TCR
        M#DISC MESSAGE>
            I#CAUSE
        <SEND
        #T305 #T305_DUR =CN_TIMER_DUR
        #T305 CN_START_TIMER         ( Start timer T305 )
        12 NEW_STATE
    }ACTION

    M#DISC ?L3_VALID_MSG
    ACTION{
        #NORMAL_CLEARING SETUP_CAUSE
        T." ----> Send RELEASE message " TCR
        M#REL MESSAGE>
            I#CAUSE
        <SEND
        19 NEW_STATE
    }ACTION
}STATE

10 STATE_INIT{
    CLEAR_KEYS
    " DISCONNECT" 2 LABEL_KEY
}STATE_INIT

10 STATE{                ( ACTIVE )
    UF2 ?KEY             ( Network initiates the release )
    ACTION{
        ?CN_CHANNEL_NUM  BC_DISC        ( Disconnect channel-in-use )
        #NORMAL_CLEARING SETUP_CAUSE
        T." ----> Send DISCONNECT message " TCR
        M#DISC MESSAGE>
            I#CAUSE
        <SEND
        #T305 #T305_DUR =CN_TIMER_DUR
        #T305 CN_START_TIMER        ( Start timer T305 )
        12 NEW_STATE
    }ACTION
    M#DISC ?L3_VALID_MSG
    ACTION{                         ( User wants to release the call )
        ?CN_CHANNEL_NUM BC_DISC     ( Disconnect the channel )
        *DEC ->C_CAUSE_VALUE @ SETUP_CAUSE
        T." ----> Send RELEASE message " TCR
        M#REL MESSAGE>
            I#CAUSE
        <SEND
        #T308 #T308_DUR =CN_TIMER_DUR
        #T308 CN_START_TIMER        ( Start timer T308 )
        19 NEW_STATE
    }ACTION
}STATE

12 STATE_INIT{
    CLEAR_KEYS
}STATE_INIT

12 STATE{               ( DISCONNECT IND )
    M#REL ?L3_VALID_MSG
    ACTION{
        ?CN_CHANNEL_NUM BC_FREE     ( Free the channel )
        *DEC ->C_CAUSE_VALUE @ SETUP_CAUSE
        T." ----> Send RELEASE COMPLETE message " TCR
        M#REL_COM MESSAGE>
            I#CAUSE
        <SEND
        CLEAR_CR                    ( Clear Call reference )
        0 NEW_STATE
    }ACTION

    #T305 ?CN_TIMER                  ( Timer T305 expired )
    ACTION{
        #NORMAL_CLEARING SETUP_CAUSE
        T." ----> Send RELEASE message " TCR
        M#REL MESSAGE>
            I#CAUSE
        <SEND
        #T308 #T308_DUR =CN_TIMER_DUR
        #T308 CN_START_TIMER        ( Start timer T308 )
        19 NEW_STATE
    }ACTION
}STATE

19 STATE_INIT{
    CLEAR_KEYS
}STATE_INIT
```

```
19 STATE{
    M#REL_COM ?L3_VALID_MSG            ( Received RELEASE COMPLETE message )
    ACTION{
        ?CN_CHANNEL_NUM BC_FREE     ( Release B Channel )
        CLEAR_CR                    ( Release call reference )
        0 NEW_STATE
    }ACTION

    #T308 ?CN_TIMER                 ( Timer T308 expired )
    ACTION{
        COUNTER1 @ 2 <
        IF
            1 COUNTER1 +!             ( Increment counter )
            #NORMAL_CLEARING SETUP_CAUSE
            T." ----> Re-send RELEASE message " TCR
            M#REL MESSAGE>
                I#CAUSE
            <SEND
            #T308 #T308_DUR =CN_TIMER_DUR
            #T308 CN_START_TIMER    ( Restart timer T308 )
        ELSE
            ?CN_CHANNEL_NUM BC_FREE     ( Release B Channel )
            CLEAR_CR                    ( Release call reference )
            0 NEW_STATE
        ENDIF
    }ACTION
}STATE
```

L3S_USER.F

A reliable data link must first be established. The interface structure is basic access en-bloc sending and circuit switching TE: Type 1 terminal, i.e. one connection per data link.

```
( -------------------------------------------------------------------- )
( File Title:   L3S_USER.F                                              )
(                                                                       )
(               This script simulates the user side in a point to point )
(               configuration                                           )
( -------------------------------------------------------------------- )

TCLR        ( Initialize test manager )

MAKE TM_INIT CLEAR_ALL_CNS ;

( Three counter variables are used as flags that may be changed to alter the )
( operation of the simulation: )

YES COUNTER1 !          ( true if the terminal is compatible )
YES COUNTER2 !          ( true if the terminal accepts incoming calls )
YES COUNTER3 !          ( true if the terminal sends CONNect ACKnowledge in )
                        ( response to CONNect messages )


0 STATE_INIT{
    CLEAR_KEYS                          ( Erase TestKeys function key labels )
    " MAKE CALL" 1 LABEL_KEY            ( Label FK #1 )
    " TestKeys" SET_CURR_TOPIC          ( Switch to the TestKeys topic )
}STATE_INIT
```

```
0 STATE{                ( Initial State )
    UF1 ?KEY                    ( User initiates call )
    ACTION{
        DL_ESTABLISH                    ( Establish the link )
        ?CN_ALLOC                       ( Allocate connection control module )
        IF
            =CN                         ( Set the current CN )
            #ORIG 0 CN_INIT             ( Initialize CN )
            SELECT_CR =CN_CR_VALUE      ( Select Call reference value )
            0 CES* @ =CN_CEI            ( Set Connection Endpoint Identifier )
            #CIRCUIT_MODE           SETUP_BEARER_CAP
            #B1_CHANNEL #PREFERRED SETUP_CHANNEL_ID
            " 5416320"              SETUP_CALLED_NUM
            T." ----> Send SETUP message " TCR
            M#SETUP MESSAGE>
                I#BEARER_CAP I#CHANNEL_ID I#CALLED_NUM
            <SEND
            1 NEW_STATE
        ELSE
            " NO CONNECTION MODULE AVAILABLE " W.ERROR
        ENDIF
    }ACTION

    M#SETUP ?L3_VALID_MSG       ( Incoming Call )
    ACTION{
        I#CALLED_NUM ?L3_IECOUNT 0 >    ( Called num IE present ? )
        IF
            COUNTER1 @                  ( Compatible terminal ? )
            IF
                ?CN_ALLOC               ( Allocate connection control module )
                IF
                    =CN                 ( Set the current connection handler )
                    #DEST 0 CN_INIT     ( Initialize the connection )
                    NEGOTIATE_CHANNEL   ( Channel available ? )
                    IF
                        DUP =CN_CHANNEL_NUM     ( Set the allocate channel )
                        BC_ALLOC        ( Reserved the channel )
                        COUNTER2 @
                        IF
                            I#SIGNAL ?L3_IECOUNT        ( Signal IE present ? )
                            IF
                                RING_ON                 ( Turn ring on )
                            ENDIF       ( Turn ring on )
                            MSAPI* @ CES* @ =CN_CEI     ( Save CEI value   )
                            T." ----> Send CONNECT message " TCR
                            M#CONN MESSAGE> <SEND       ( Send CONNECT message )
                            8 NEW_STATE
                        ELSE
                            #NORMAL_CLEARING SETUP_CAUSE
                            T." ----> Send RELEASE COMPLETE message " TCR
                            M#REL_COM MESSAGE> I#CAUSE <SEND
                            ?CN_CHANNEL_NUM BC_FREE ( Free reserved B channel )
                            CN_DEALLOC              ( Reset connection handler )
                        ENDIF
                    ELSE                            ( Channel not available )
                        #NO_CHANNEL_AVAIL SETUP_CAUSE
                        T." ----> Send RELEASE COMPLETE message " TCR
                        M#REL_COM MESSAGE> I#CAUSE <SEND
                        CN_DEALLOC                  ( Reset connection handler )
                    ENDIF
                ELSE                                ( User busy )
                    1 ( #NORMAL1 ) #USER_BUSY SYS_Q931_CAUSE
                    T." ----> Send RELEASE COMPLETE message " TCR
                    M#REL_COM SM_MSG
                ENDIF
            ELSE                                    ( Incompatible terminal )
                #CALL_REJECTED SETUP_CAUSE
                T." ----> Send RELEASE COMPLETE message " TCR
                M#REL_COM MESSAGE> I#CAUSE <SEND
            ENDIF
        ELSE                            ( Overlap sending not supported )
            #SERVICE_UNIMPL_UNSPEC SETUP_CAUSE
            T." ----> Send RELEASE COMPLETE message " TCR
            M#REL_COM MESSAGE> I#CAUSE <SEND
        ENDIF
    }ACTION

    M#STATUS ?L3_VALID_MSG      ( Network requests status )
    ACTION{
        REPORT_PEER_STATUS
    }ACTION

}STATE

1 STATE_INIT{
    " DISCONNECT"  2 LABEL_KEY
}STATE_INIT

1 STATE{                ( Call Initialization )
    UF2 ?KEY                            ( Clear the call )
    ACTION{
        #NORMAL_CLEARING SETUP_CAUSE
        T." ----> Send DISCONNECT message " TCR
        M#DISC MESSAGE> I#CAUSE <SEND
        11 NEW_STATE
    }ACTION
    M#CALL_PROC ?VALID_MSG             ( Received a CALL PROC message )
    ACTION[
        *DEC ->CID_NUMBER @ DUP        ( Selected Channel )
        ?BC_ALLOC 0=                   ( Channel available ? )
        IF
            DUP =CN_CHANNEL_NUM        ( Save the channel number )
            BC_ALLOC                   ( Allocate the reserved channel )
            3 NEW_STATE
        ELSE                           ( Channel not available )
            DROP                       ( Discard the negotiated channel )
            #NO_CHANNEL_AVAIL SETUP_CAUSE
            T." ----> Send DISCONNECT message " TCR
            M#DISC MESSAGE> I#CAUSE <SEND
            11 NEW_STATE
        ENDIF
    ]ACTION

    M#REL_COM ?L3_VALID_MSG    ( Received a RELEASE COMPLETE message )
    ACTION[
        CLEAR_CR
        0 NEW_STATE
    ]ACTION

    M#STATUS ?L3_VALID_MSG     ( Status Request, treat as RELEASE COMPLETE )
    ACTION[
        REPORT_PEER_STATUS
        CLEAR_CR
        0 NEW_STATE
    ]ACTION

    ?RX_DATA                   ( Check received messge error )
    ACTION[
        L3_ERROR                       ( Check error )
        #CALL_INIT SETUP_CALL_STATE
        T." ----> Send STATUS message " TCR
        M#STATUS SM_MSG
        CLEAR_CR ( Clear call reference & connection handler )
        0 NEW_STATE
    ]ACTION
]STATE

3 STATE_INIT[
    CLEAR_KEYS
]STATE_INIT
```

```
3 STATE{                ( Outgoing call proceeding )
    M#ALERT ?L3_VALID_MSG       ( Calling user has been alerted )
    ACTION{
        4 NEW_STATE
    }ACTION

    M#CONN ?L3_VALID_MSG        ( Call is connected )
    ACTION{
        ?CN_CHANNEL_NUM BC_CONN         ( Channel is connected )
        COUNTER3 @                      ( Option to send CONNECT ACK )
        IF
            T." ----> Send CONNECT ACKNOWLEDGE message " TCR
            M#CONN_ACK MESSAGE> <SEND
        ENDIF
        10 NEW_STATE
    }ACTION

    M#DISC ?L3_VALID_MSG        ( Call is rejected )
    ACTION{
        ?CN_CHANNEL_NUM ?DUP
        IF
            BC_FREE                     ( Release the B-channel )
        ENDIF
        #NORMAL_CLEARING SETUP_CAUSE
        T." ----> Send RELEASE message " TCR
        M#REL MESSAGE> I#CAUSE <SEND    ( Send RELEASE message )
        19 NEW_STATE
    }ACTION

    M#REL ?L3_VALID_MSG         ( Network releases call )
    ACTION{
        ?CN_CHANNEL_NUM BC_FREE         ( Release B channel & Call Reference )
        *DEC ->C_CAUSE_VALUE @ SETUP_CAUSE
        T." ----> Send RELEASE COMPLETE message " TCR
        M#REL_COM MESSAGE> I#CAUSE <SEND
        CLEAR_CR                        ( Clear call reference )
        0 NEW_STATE
    }ACTION
}STATE

4 STATE_INIT{
    2 CLEAR_KEY
}STATE_INIT
```

```
4 STATE{                ( Call delivered )
    M#CONN ?L3_VALID_MSG        ( Call is connected )
    ACTION{
        ?CN_CHANNEL_NUM BC_CONN         ( Channel is connected )
        COUNTER3 @                      ( Option to send CONNECT ACK )
        IF
            T." ----> Send CONNECT ACKNOWLEDGE message " TCR
            M#CONN_ACK MESSAGE> <SEND   ( Send a CONNECT ACK message )
        ENDIF
        10 NEW_STATE
    }ACTION

    M#DISC ?L3_VALID_MSG        ( Call is rejected )
    ACTION{
        ?CN_CHANNEL_NUM BC_FREE         ( Release the B-channel )
        #NORMAL_CLEARING SETUP_CAUSE
        T." ----> Send RELEASE message " TCR
        M#REL MESSAGE> I#CAUSE <SEND    ( Send RELEASE message )
        19 NEW_STATE
    }ACTION

    M#REL ?L3_VALID_MSG         ( Network releases call )
    ACTION{
        ?CN_CHANNEL_NUM BC_FREE         ( Release B channel & Call Reference )
        *DEC ->C_CAUSE_VALUE @ SETUP_CAUSE
        T." ----> Send RELEASE COMPLETE message " TCR
        M#REL_COM MESSAGE> I#CAUSE <SEND
        CLEAR_CR ( Clear call reference & connection handler )
        0 NEW_STATE
    }ACTION
}STATE

8 STATE_INIT{
    CLEAR_KEYS
    " DISCONNECT" 2 LABEL_KEY
}STATE_INIT

8 STATE{                ( Connect Request )
    UF2 ?KEY                    ( Initiate call release )
    ACTION{
        #NORMAL_CLEARING SETUP_CAUSE
        T." ----> Send DISCONNECT message " TCR
        M#DISC MESSAGE> I#CAUSE <SEND   ( Send DISCONNECT message )
        RING_OFF                        ( Turn the ring off )
        11 NEW_STATE
    }ACTION

    M#CONN_ACK ?L3_VALID_MSG    ( Received a CONNECT ACK message )
    ACTION{
        ?CN_CHANNEL_NUM BC_CONN         ( Connect the B channel )
        RING_OFF                        ( Turn the ring off )
        10 NEW_STATE
    }ACTION
    M#DISC ?L3_VALID_MSG        ( Network initiates call release )
    ACTION{
        ?CN_CHANNEL_NUM BC_FREE         ( Release B channel )
        #NORMAL_CLEARING SETUP_CAUSE
        T." ----> Send RELEASE message " TCR
        M#REL MESSAGE> I#CAUSE <SEND    ( Send RELEASE message )
        RING_OFF                        ( Turn the ring off )
        19 NEW_STATE
    }ACTION

    M#REL ?L3_VALID_MSG         ( Network releases call )
    ACTION{
        ?CN_CHANNEL_NUM BC_FREE         ( Release B channel )
        *DEC ->C_CAUSE_VALUE @ SETUP_CAUSE
        T." ----> Send RELEASE message " TCR
        M#REL_COM MESSAGE> I#CAUSE <SEND    ( Send RELEASE message )
        RING_OFF                        ( Turn the ring off )
        0 NEW_STATE
    }ACTION

    #USER1 ?CN_TIMER            ( Ringing timer is set )
    ACTION{
        RING_ON
    }ACTION
}STATE

10 STATE_INIT{
    " DISCONNECT" 2 LABEL_KEY
}STATE_INIT

10 STATE{               ( Active )
    UF2 ?KEY                    ( User initiates call release )
    ACTION{
        #NORMAL_CLEARING SETUP_CAUSE
        T." ----> Send DISCONNECT message " TCR
        M#DISC MESSAGE> I#CAUSE <SEND   ( Send a DISCONNECT message )
        11 NEW_STATE
    }ACTION

    M#DISC ?L3_VALID_MSG        ( Remote party releases the call )
    ACTION{
        ?CN_CHANNEL_NUM BC_FREE         ( Release B channel )
        #NORMAL_CLEARING SETUP_CAUSE
        T." ----> Send RELEASE message " TCR
        M#REL MESSAGE> I#CAUSE <SEND    ( Send RELEASE message )
        19 NEW_STATE
    }ACTION
    M#REL ?L3_VALID_MSG         ( Remote party releases the call )
    ACTION{
        ?CN_CHANNEL_NUM BC_FREE         ( Release B channel )
        *DEC ->C_CAUSE_VALUE @ SETUP_CAUSE
        T." ----> Send RELEASE COMPLETE message " TCR
        M#REL_COM MESSAGE> I#CAUSE <SEND    ( Send RELEASE COMPLETE message )
        CLEAR_CR ( Clear call reference & connection handler )
        0 NEW_STATE
    }ACTION
}STATE

11 STATE_INIT{
    2 CLEAR_KEY
}STATE_INIT

11 STATE{               ( Disconnect Request )
    M#REL ?L3_VALID_MSG         ( Network releases call )
    ACTION{
        ?CN_CHANNEL_NUM ?DUP            ( Release allocated channel )
        IF
            BC_FREE
        ENDIF
        *DEC ->C_CAUSE_VALUE @ SETUP_CAUSE
        T." ----> Send RELEASE COMPLETE message " TCR
        M#REL_COM MESSAGE> I#CAUSE <SEND    ( Send RELEASE COMPLETE message )
        CLEAR_CR ( Clear call reference & connection handler )
        0 NEW_STATE
    }ACTION
}STATE

19 STATE_INIT{
    2 CLEAR_KEY
}STATE_INIT

19 STATE{               ( Release Request )
    M#REL_COM ?L3_VALID_MSG     ( Release complete from network )
    ACTION{
        CLEAR_CR                ( Clear call reference & connection handler )
        CN_DEALLOC              ( deallocate connection )
        0 NEW_STATE
    }ACTION
}STATE
```

21.6 X.25 PLP Monitor/Emulation

The TEST1_X25.F and TEST2_X25.F test scripts run on the ISDN Basic Rate D-Channel with layer 3 X.25 PLP Emulation. The X25P_STAT.F test script runs on the ISDN Basic Rate D-Channel Monitor.

TEST1_X25.F

This test script generates call/clears for 100 seconds. Enter function key f1 to start the test. The COUNTER variable contains the number of calls done.

```
( ---------------------------------------------------- )
( Script File   : TEST1_X25.F                          )
( Date Modified : September 21, 1989                   )
( ---------------------------------------------------- )


TCLR    ( Initialize test script dictionary )

( STATE_INIT 0 is executed when the Test Script execution is started .   )
( It is used to label function key f1 and move to the TestKeys topic.    )
( Configure Layer 2 LAP D link 0 to use SAPI 16 for X.25 packet traffic. )
( Configure X.25 logical channels CH1 to CH8.                            )

0 STATE_INIT{  " START TEST" 1 LABEL_KEY   ( Label f1 key )
               2 CLEAR_KEY   3 CLEAR_KEY  4 CLEAR_KEY
               5 CLEAR_KEY   6 CLEAR_KEY  7 CLEAR_KEY   8 CLEAR_KEY
               DROP_TEST              ( Do not show Test Script Window  )
               " TestKeys"  SET_CURR_TOPIC   ( Move to TestKeys topic )
               0 SA                    ( Use Link 0 )
               16 SAPI                 ( SAPI 16 used )
               CH1  SVC   1 =LCN     0 =LCNCES    ( CH1 LCN parameters )
               CH2  SVC   2 =LCN     0 =LCNCES    ( CH2 LCN parameters )
               CH3  SVC   3 =LCN     0 =LCNCES    ( CH3 LCN parameters )
               CH4  SVC   4 =LCN     0 =LCNCES    ( CH4 LCN parameters )
               CH5  SVC   5 =LCN     0 =LCNCES    ( CH5 LCN parameters )
               CH6  SVC   6 =LCN     0 =LCNCES    ( CH6 LCN parameters )
               CH7  SVC   7 =LCN     0 =LCNCES    ( CH7 LCN parameters )
               CH8  SVC   8 =LCN     0 =LCNCES    ( CH8 LCN parameters )
               }STATE_INIT

( STATE 0 is used to wait for the f1 function key to be entered.        )
( Then the link connection will be established and a SABME transmitted. )
```

```
0 STATE[ UF1 ?KEY
            ACTION[ T." TEST STARTING"   TCR
           " Test Starting.  Sending Calls/Clears for 100 Seconds" W.NOTICE
               1 CLEAR_KEY                    ( Clear f1 key )
               DL_ESTABLISH                   ( Establish link connection )
               1 NEW_STATE ]ACTION
   }STATE

( STATE 1 will wait for the UA response indicating that the link connection )
( is established and that layer 3 traffic can commence.                     )
( Then a Restart Packet will be transmitted.                                )

1 STATE[ R#UA  ?RX_FRAME                      ( Wait until UA received )
            ACTION[ RESTART                   ( Send Restart packet )
                    2 NEW_STATE }ACTION
   }STATE

( STATE 2 will wait for the Restart confirm packet, then will generate call  )
( request packets on Channels 1 to 8.  The COUNTER variable is used to count )
( the number of calls done will be initialized to a value of 8.              )
( Timer 101 is started  with a duration of 100 seconds.                      )
( The test will go to state 3 for the next events.                           )

2 STATE[ R*RESTARTCONF 1 ?RX                  ( Start generating calls )
            ACTION[ CH1 CALL  CH2 CALL  CH3 CALL  CH4 CALL
                    CH5 CALL  CH6 CALL  CH7 CALL  CH8 CALL
                    8 COUNTER !       ( Start count of calls established )
                    101 1000 START_TIMER       ( Start 100 sec timer )
                    3 NEW_STATE }ACTION
   }STATE

( STATE 3 continues to generate calls and clears until timer 101 expires. )
( Then a Restart request is generated and the test goes to state 4.       )

3 STATE[ R*CALLCON 1 ?RX           ( After each call connected, clear LCN )
            ACTION[ CLEAR ]ACTION

         R*CLEARCONF 1 ?RX         ( After each LCN cleared, make new call )
            ACTION[ CALL
                    1 COUNTER +! }ACTION

         101  ?TIMER               ( Keep making calls for 100 seconds )
            ACTION[ RESTART        ( Send Restart after 100 Seconds )
                    4 NEW_STATE }ACTION
  }STATE

( State 4 will wait for the Restart confirm packet, then disconnect the )
( layer 2 connection.   The test will then go to state 5.               )

4 STATE[ R*RESTARTCONF  1 ?RX      ( Wait for Restart confirm packet )
            ACTION[ DL_RELEASE     ( Disconnect Layer 2 )
                    5 NEW_STATE }ACTION
  }STATE
```

```
( State 5 will wait for the layer 2 UA response, then generate results  )
( for the test.  The total number of calls and calls per second will be )
( displayed in the Test Script Window.   The test manager then will be  )
( turned off and the TestScript Topic will become the current topic.    )

5 STATE{ R#UA  ?RX_FRAME           ( Wait for UA, Layer 2 disconnected )
           ACTION{ T." Test Finished. " TCR
               "  " W.NOTICE       ( Clear Notice line on screen )
               SHOW_TEST  CR       ( Show Script window on screen )
               OPEN_TEST           ( Display output in Script window )
               WHI_FG   SET_ATTR  ( Display using White characters )
               COUNTER @  .   ." Calls in 100 seconds.        "
               COUNTER @  100 U/
               .   WHERE  1 - THERE   ." ."      .
               ." Calls per second."   CR
               " UF1" 1 LABEL_KEY
               " TestScript"  SET_CURR_TOPIC ( Move to TestScript Topic )
                   TM_STOP         ( Stop Test manager )
                   }ACTION
  }STATE
```

TEST2_X25.F

Enter function key f1 to start the test; function key f2 to stop the test.

```
( ------------------------------------------------------- )
( Script File   : TEST2_X25.F                             )
( Date Modified : September 21, 1989                      )
( ------------------------------------------------------- )

TCLR    ( Initialize test script dictionary )

( ==================================================================== )
( Sequence 0 will generate data packets on the current logical channel )
( until the window is closed.                                          )

0 SEQ{  BEGIN
             DATA          ( send data packets )
        WINDOW? 0=  UNTIL  ( until window is closed )
        }SEQ

( ====================================================================== )
( STATE_INIT 0 is executed when the Test Script execution is started .   )
( It is used to label function key f1,f2 and move to the TestKeys topic. )
( Configure Layer 2 LAP D link 0 to use SAPI 16 for X.25 packet traffic. )
( Configure X.25 logical channels CH1 to CH8.                            )

0 STATE_INIT{  " Start Test" 1 LABEL_KEY   ( Label f1 key )
               2 CLEAR_KEY   3 CLEAR_KEY  4 CLEAR_KEY
               5 CLEAR_KEY   6 CLEAR_KEY  7 CLEAR_KEY   8 CLEAR_KEY
               DROP_TEST            ( Do not show Test Script Window  )
               " TestKeys"  SET_CURR_TOPIC   ( Move to TestKeys topic )
               0 SA                   ( Use Link 0 )
               16 SAPI                ( SAPI 16 used )
               CH1  SVC   1 =LCN    0 =LCNCES    ( CH1 LCN parameters )
               CH2  SVC   2 =LCN    0 =LCNCES    ( CH2 LCN parameters )
               CH3  SVC   3 =LCN    0 =LCNCES    ( CH3 LCN parameters )
               CH4  SVC   4 =LCN    0 =LCNCES    ( CH4 LCN parameters )
               CH5  SVC   5 =LCN    0 =LCNCES    ( CH5 LCN parameters )
               CH6  SVC   6 =LCN    0 =LCNCES    ( CH6 LCN parameters )
               CH7  SVC   7 =LCN    0 =LCNCES    ( CH7 LCN parameters )
               CH8  SVC   8 =LCN    0 =LCNCES    ( CH8 LCN parameters )
               }STATE_INIT
```

```
( ===================================================================== )
( STATE 0 is used to wait for the f1 function key to be entered.       )
( Then the link connection will be established and a SABME transmitted. )

0 STATE{ UF1 ?KEY
            ACTION{ T." TEST STARTING"   TCR
           " Test Starting.  Sending Calls on LCN 1 to 8" W.NOTICE
               1 CLEAR_KEY                     ( Clear f1 key )
               DL_ESTABLISH                    ( Establish link connection )
               1 NEW_STATE }ACTION
   }STATE

( ========================================================================= )
( STATE 1 will wait for the UA response indicating that the link connection )
( is established and that layer 3 traffic can commence.                     )
( Then a Restart Packet will be transmitted.                                )

1 STATE{ R#UA  ?RX_FRAME                       ( Wait until UA received )
            ACTION{ RESTART                    ( Send Restart packet )
                    2 NEW_STATE }ACTION
   }STATE

( ========================================================================== )
( STATE 2 will wait for the Restart confirm packet, then will generate call  )
( request packets on Channels 1 to 8.  The COUNTER variable is used to count )
( the number of cycles through making calls, sending data, and clearing.     )
( The test will go to state 3 for the next events.                           )

2 STATE{ R*RESTARTCONF 1 ?RX                   ( Start generating calls )
            ACTION{ CH1 CALL  CH2 CALL  CH3 CALL  CH4 CALL
                    CH5 CALL  CH6 CALL  CH7 CALL  CH8 CALL
                    0 COUNTER !                ( Clear count of calls )
                    3 NEW_STATE }ACTION
   }STATE

( ====================================================================== )
( State 3 will wait for all 8 Call connected packets, then generate data )
( packets on all 8 channels.                                             )

3 STATE{ R*CALLCON 1 ?RX   ( Wait for call connected packet. )
            ACTION{ 1 COUNTER +! COUNTER @ 8 =
                    IF   ( Check for 8 call connected packets )
                         ( Then generate data packets on all 8 channels )
                         " Sending Data on LCN 1 to 8" W.NOTICE
                         CH1  0 RUN_SEQ    ( send data packets on CH1 )
                         CH2  0 RUN_SEQ    ( send data packets on CH2 )
                         CH3  0 RUN_SEQ    ( send data packets on CH3 )
                         CH4  0 RUN_SEQ    ( send data packets on CH4 )
                         CH5  0 RUN_SEQ    ( send data packets on CH5 )
                         CH6  0 RUN_SEQ    ( send data packets on CH6 )
                         CH7  0 RUN_SEQ    ( send data packets on CH7 )
                         CH8  0 RUN_SEQ    ( send data packets on CH8 )

                        " Stop Test"  2  LABEL_KEY
                        4 NEW_STATE
                    ENDIF
                    }ACTION
  }STATE

( ===================================================================== )
( State 4 will generate more data packets every time a RR packet is       )
( received.  If the f2 function key is entered, the test will be stopped. )

4 STATE{ R*RRP R*DATAP 2 ?RX   ( RR or Data packet received on this channel )
         ACTION{   0 RUN_SEQ   ( send data packets until window is closed. )
                  }ACTION

         UF2 ?KEY          ( f2 function key entered to stop test. )
            ACTION{ RESTART   ( Send restart request packet. )
                    2  CLEAR_KEY
                    5 NEW_STATE
                    }ACTION
  }STATE

( ===================================================================== )
( State 5 will wait for the Restart confirm packet, then disconnect the  )
( layer 2 connection.   The test will then go to state 6.                )

5 STATE{ R*RESTARTCONF  1 ?RX      ( Wait for Restart confirm packet )
            ACTION{ DL_RELEASE     ( Disconnect Layer 2 )
                    6 NEW_STATE }ACTION
  }STATE

( ===================================================================== )
( State 6 will wait for the layer 2 UA response.   The test manager      )
( then will be turned off and the TestScript Topic will become the       )
( current topic.    )
```

```
6 STATE{ R#UA  ?RX_FRAME
           ACTION{ T." Test Finished" TCR   TM_STOP
               " TestScript"  SET_CURR_TOPIC ( Move to TestScript Topic )
               }ACTION
  }STATE
```

X25P_STAT.F

```
( ----------------------------------------------------------)
( X25P_STAT.F : X.25  ANALYZER  Test Manager Scenario       )
(              Collect and display X.25 Packet statistics   )
(              COUNTER1 to COUNTER30 collect counts.        )
(       f1 = Display Statistics.                            )
(       f2 = Display Data.                                  )
(       f3 = Clear Statistic counts.                        )
( ----------------------------------------------------------)

TCLR         ( CLEAR Test manager dictionary )
WAKEUP_ON    ( Wakeup the test manager to display statistics on startup )


0 STATE_INIT[  " Show Stat" 1 LABEL_KEY
               " Show Data" 2 LABEL_KEY
               " Clear"     3 LABEL_KEY
               " Stop Test" 4 LABEL_KEY   ]STATE_INIT

0 STATE[   ( Define state 0 to collect statistics and ck events )


    R*CALLREQ     1 ?RX ACTION[          ( Call request received        )
        OPEN_USER                        ( Open user display window     )
        1 COUNTER10 +!                   ( Update Call request counter  )
        2 48 THERE COUNTER10  @ W.       ( Display Call request count   )
        CLOSE_WINDOW    ]ACTION          ( Close display window         )

    R*CALLCON     1 ?RX ACTION[          ( Call connect received        )
        OPEN_USER                        ( Open user display window     )
        1 COUNTER11 +!                   ( Update Call connect counter  )
        3 48 THERE COUNTER11  @ W.       ( Display Call connect count   )
        CLOSE_WINDOW    ]ACTION          ( Close display window         )

    R*CLEARREQ    1 ?RX ACTION[          ( Clear request received       )
        OPEN_USER                        ( Open user display window     )
        1 COUNTER12 +!                   ( Update Clear request counter )
        4 48 THERE COUNTER12  @ W.       ( Display Clear request count  )
        CLOSE_WINDOW    ]ACTION          ( Close display window         )

    R*CLEARCONF   1 ?RX ACTION[          ( Clear confirm received       )
        OPEN_USER                        ( Open user display window     )
        1 COUNTER13 +!                   ( Update Clear confirm counter )
        5 48 THERE COUNTER13 @ W.        ( Display Clear confirm count  )
        CLOSE_WINDOW    ]ACTION          ( Close display window         )
```

```
R*RESTARTREQ  1 ?RX ACTION{          ( Restart request received       )
    OPEN_USER                        ( Open user display window       )
    1 COUNTER14 +!                   ( Update Restart request count   )
    6 48 THERE COUNTER14 @ W.        ( Display Restart request count )
    CLOSE_WINDOW    }ACTION          ( Close display window           )

R*RESTARTCONF 1 ?RX ACTION{          ( Restart confirm received       )
    OPEN_USER                        ( Open user display window       )
    1 COUNTER15 +!                   ( Update restart confirm count   )
    7 48 THERE COUNTER15 @ W.        ( Display Restart confirm count )
    CLOSE_WINDOW    }ACTION          ( Close display window           )

R*RESETREQ    1 ?RX ACTION{          ( Reset request received         )
    OPEN_USER                        ( Open user display window       )
    1 COUNTER16 +!                   ( Update Reset request count     )
    8 48 THERE COUNTER16 @ W.        ( Display Reset request count    )
    CLOSE_WINDOW    }ACTION          ( Close display window           )

R*RESETCONF   1 ?RX ACTION{          ( Reset confirm received         )
    OPEN_USER                        ( Open user display window       )
    1 COUNTER17 +!                   ( Update Reset confirm count     )
    9 48 THERE COUNTER17 @ W.        ( Display Reset confirm count    )
    CLOSE_WINDOW    }ACTION          ( Close display window           )

R*DATAP       1 ?RX ACTION{          ( Data packet received           )
    OPEN_USER                        ( Open user display window       )
    1 COUNTER18 +!                   ( Update Data packet count       )
    10 48 THERE COUNTER18 @ W.        ( Display Data packet count      )
    CLOSE_WINDOW    }ACTION          ( Close display window           )

R*RRP         1 ?RX ACTION{          ( RR packet received             )
    OPEN_USER                        ( Open user display window       )
    1 COUNTER19 +!                   ( Update RR packet count         )
    11 48 THERE COUNTER19 @ W.       ( Display RR packet count        )
    CLOSE_WINDOW    }ACTION          ( Close display window           )
```

```
   UF1 ?KEY  ?WAKEUP OR           ( f1 key or  TM_RUN wakeup  events )
   CF1 ?KEY  OR
   ACTION[                        ( Open and show user display window )
       POP_USER                   ( Open user display window          )
       CLEAR_TEXT  WHI_FG PAINT   ( Clear screen text and color       )
       " X.25 Packet Statistics"  WHI_FG  15 70 0 5 CYA_FG  HEADLINE
       13 10 THERE  W." f1 = Show Statistics , "
                   W." f2 = Show Data , "
                   W." f3 = Clear Statistics "
       2 30 THERE  W." CALL REQUEST    = "   COUNTER10  @ W.
       3 30 THERE  W." CALL CONNECT    = "   COUNTER11  @ W.
       4 30 THERE  W." CLEAR REQUEST   = "   COUNTER12  @ W.
       5 30 THERE  W." CLEAR CONFIRM   = "   COUNTER13  @ W.
       6 30 THERE  W." RESTART REQUEST = "   COUNTER14  @ W.
       7 30 THERE  W." RESTART CONFIRM = "   COUNTER15  @ W.
       8 30 THERE  W." RESET REQUEST   = "   COUNTER16  @ W.
       9 30 THERE  W." RESET CONFIRM   = "   COUNTER17  @ W.
      10 30 THERE  W." DATA PACKET     = "   COUNTER18  @ W.
      11 30 THERE  W." RR PACKET       = "   COUNTER19  @ W.
   CLOSE_WINDOW
   ]ACTION


   UF2 ?KEY   CF2 ?KEY  OR
       ACTION[ SHOW_DATA ]ACTION   ( Show data window )

   UF3 ?KEY   CF3 ?KEY OR    ACTION[    ( Clear statistic counters )
       0 COUNTER1  ! 0 COUNTER2  ! 0 COUNTER3  ! 0 COUNTER4  ! 0 COUNTER5  !
       0 COUNTER6  ! 0 COUNTER7  ! 0 COUNTER8  ! 0 COUNTER9  ! 0 COUNTER10 !
       0 COUNTER11 ! 0 COUNTER12 ! 0 COUNTER13 ! 0 COUNTER14 ! 0 COUNTER15 !
       0 COUNTER16 ! 0 COUNTER17 ! 0 COUNTER18 ! 0 COUNTER19 ! 0 COUNTER30 !
           ]ACTION

  UF4 ?KEY   CF4  ?KEY  OR  ACTION[
      TM_STOP  CLEAR_TEXT WHI_FG PAINT
      " UF1" 1 LABEL_KEY
      " UF2" 2 LABEL_KEY
      " UF3" 3 LABEL_KEY
      " UF4" 4 LABEL_KEY
     ]ACTION
 ]STATE    ( End of state 0 )
```

A
INTRODUCTION TO ISDN

This appendix contains a brief introduction to the ISDN interface structure at the S/T reference points. For further information, please consult the latest CCITT ISDN Recommendations, Blue Book Volume 3, Fascicle III.9, 1988, and Digital Subscriber Signalling System No. 1 (DSS 1) Data Link Layer, Blue Book Volume 4, Fascicle VI.10, 1988.

A.1 The Origins of ISDN

Traditionally, voice communication was the only service supported by the telecommunication companies. The advent of data communications required the provisioning of dedicated data lines along with a plethora of interface types and speeds. Other services, such as facsimile and switched data have become more and more important to both the subscriber and the telephone company. In the future, new services, such as switched video and high speed data, will become telecommunication company offerings.

In order to accommodate the vast number of services that will be offered to the consumer, the telecommunications companies realized that their services must be integrated so as to provide a standard access to the telecommunications network, in much the same way that the power company provides a standard wall plug for power access. The ISDN (Integrated Services Digital Network) will be the structure to provide these different types of telecommunications services over a common physical user interface.

ISDN was laid down by the International Telegraph and Telephone Consultative Committee (CCITT) in order to provide the elements of a universal telecommunications network, namely the ISDN.

A.2 ISDN Access

There are two different types of ISDN access. The first is BRA (Basic Rate Access) consisting of two 64 kbit/s channels known as B–Channels, and a 16 kbit/s signalling channel known as the D–Channel (see Figure A–1). The B–Channels can carry voice, data, or image information.

The D–Channel carries the signalling information for the B–Channels and can carry low speed packetized information. This configuration is known as 2B+D. The bit rate over a Basic Rate access is 64 kbit/s + 64 kbit/s + 16 kbit/s = 144 kbit/s. The addition of framing bits and other support bits brings the line speed up to 192 kbit/s on the S/T interface or 160 kbit/s on the U interface (see Section A.3 for a description of the S/T and U interfaces).

The second type of access is PRA (Primary Rate Access). Primary Rate access in North America consists of 23 64 kbit/s B-Channels and a 64 kbit/s D-Channel. The configuration is known as 23B+D (see Figure A-2). The bit rate over the Primary Rate Access is 24 * 64 kbit/s = 1.536 Mbit/s. The addition of framing bits brings the line speed up to 1.544 Mbit/s. In Europe, Primary Rate access consists of 30 B-Channels and a D-Channel (and a framing channel of 64 kbit/s). This configuration is known as 30B+D. The line speed in this configuration is 2.048 Mbps.

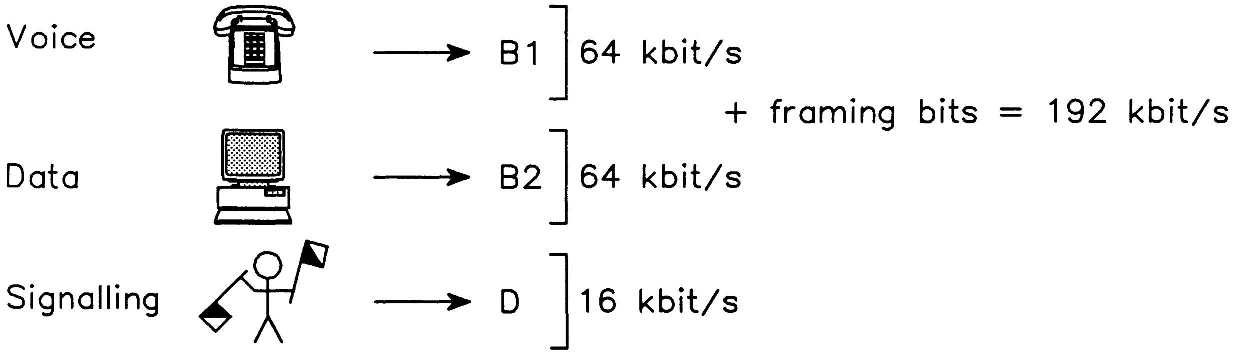


Figure A-1 Basic Rate Configuration

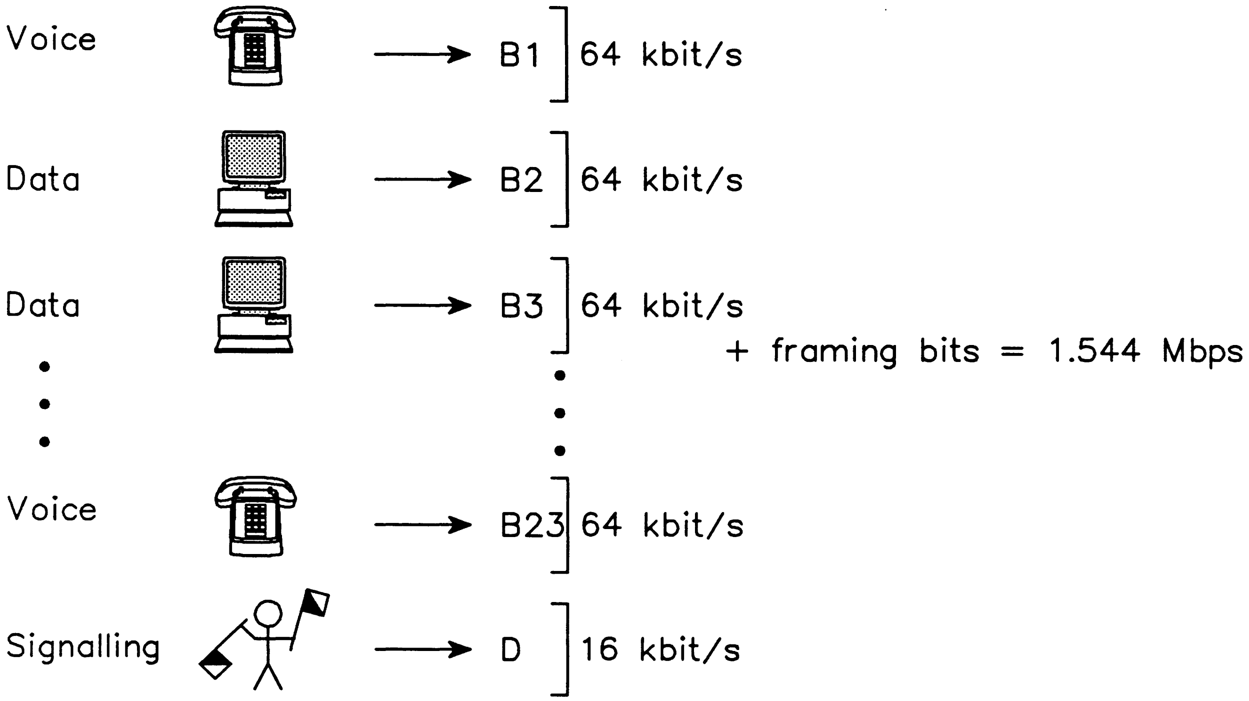


Figure A-2 Primary Rate Configuration

A.3 The ISDN Network

An example of an ISDN network is shown in Figure A-3. At the user 1 side there are a number of pieces of equipment connected to a Basic Rate access line. This equipment is connected to a PABX, which is in turn connected to an ISDN switch via a Primary Rate facility.

A TE1 (terminal equipment 1) is an ISDN terminal and can have both data and voice capabilities. A TE2 is a non-ISDN terminal such as a telephone or a computer terminal. The TE2 is connected to the S reference point (the S/T Bus) through a TA (terminal adapter). The S/T Bus can support up to eight devices. The S/T Bus is connected to an NT2. The NT2 (network termination 2) provides interface termination, layer 2 and 3 protocol handling, multiplexing, switching and concentration. A typical example of an NT2 is a PABX.

The NT2 is connected to an NT1 (network termination 1) through the T interface. The NT1 terminates the signal from the network and provides layer 1 maintenance capabilities such as loopback and line buildout. The line from the subscriber is terminated at the telephone office by an LT (line termination).

At the switch, signalling information, controlling the routing of calls between switches, is sent via the common channel signalling number 7 system (CCS7) while data is sent via separate carriers. Signalling information is gathered or transmitted at switches and is transferred at signalling transfer points (STP). Signalling information can also be transferred directly between switches.

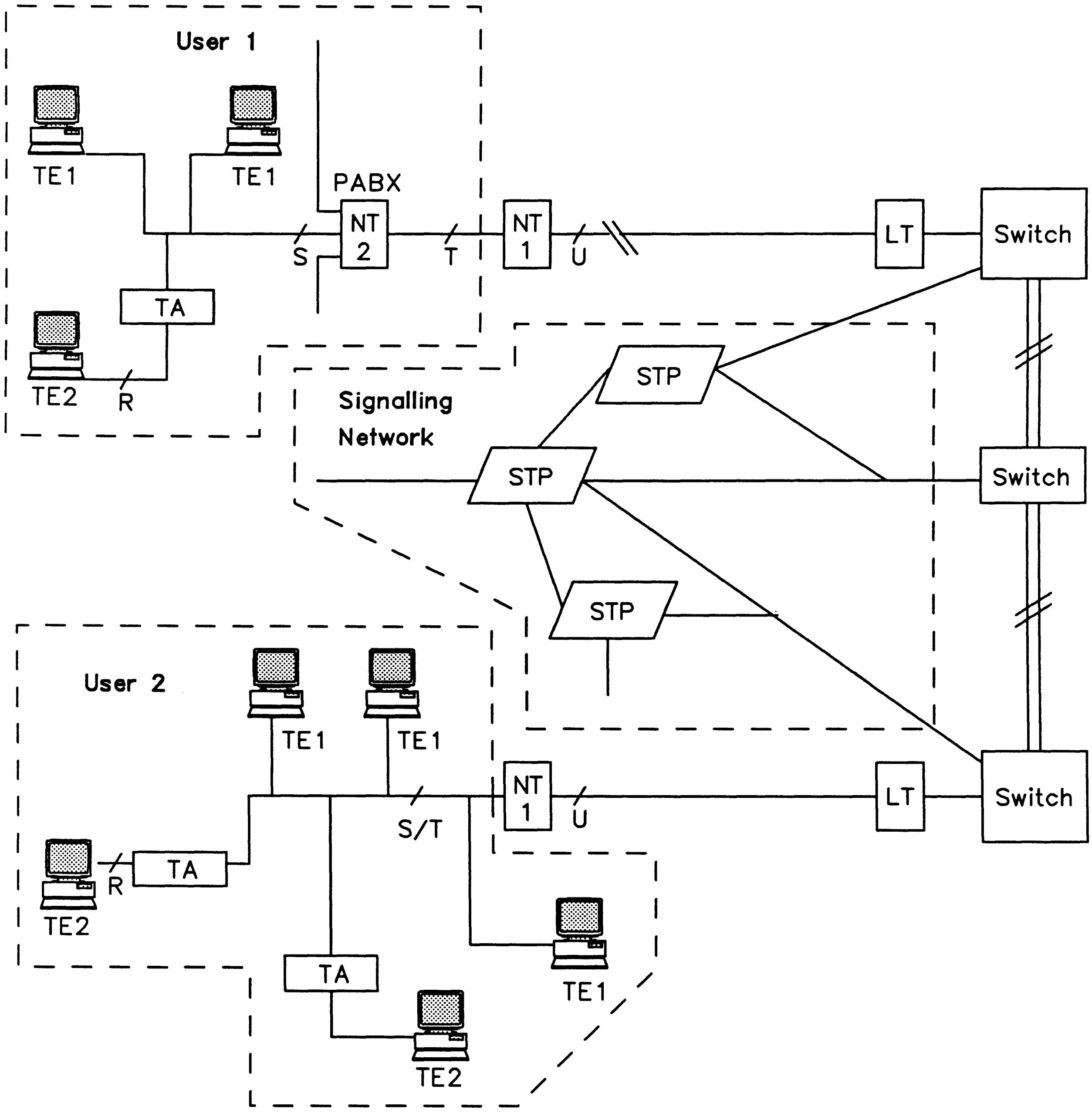


Figure A-3 ISDN Network

A.4 Channel Structure

The D-Channel is layered according to the OSI (open systems interconnection) model of data communications layering (see Figure A-4).

Layer 1 provides the physical, mechanical, and electrical conditions for transmission of the Basic Rate or Primary Rate signal.

Layer 2, or the data link layer, contained in the D-Channel, provides end-to-end connection and information transfer.

Layer 3 carries the signalling information for the B-Channels as well as user-user information over the D-Channel.

Each layer has a management entity which manages the flow of communication and the transfer of data at its layer, along with communication between adjacent layers (see Figure A-5).

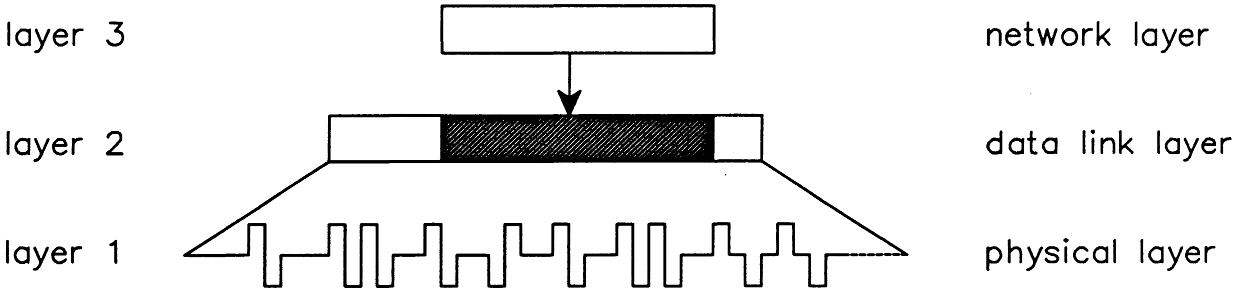


Figure A-4 OSI Model of the D-Channel

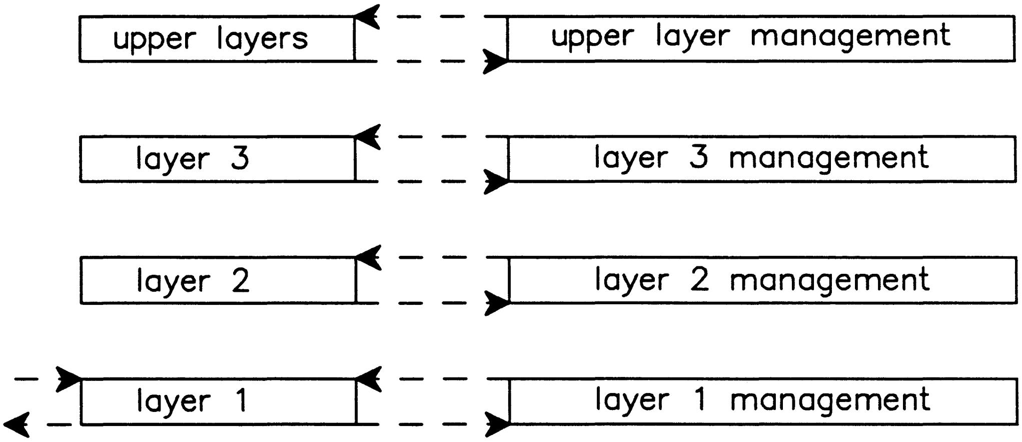


Figure A-5 Management Layers

A.5 Communication Between Layers in the D-Channel

The OSI model for communication between layers requires that primitives form the basis of communication between adjacent layers inside equipment. Primitives strictly define the interface between layers and detail the actions that can occur between layers.

Consequently, the ISDN protocol provides communication primitives between the physical layer and the data link layer, and between the data link layer and the network layer.

There are four different types of primitives between layers:

- Request
- Indication
- Response
- Confirm

The primitives can contain additional information and parameters.

The primitives between layer 1 and layer 2 are:

PH-DATA	data transfer (request, indication)
PH-ACTIVATE	establish a layer 1 connection (request, indication)
PH-DEACTIVATE	release a layer 1 connection (request, indication)

The primitives between layer 1 and its management layer are:

MPH-ACTIVATE	layer 1 is activated (indication)
MPH-DEACTIVATE	layer 1 is deactivated (indication)
MPH-INFORMATION	provides information indicating whether there is sufficient power, and whether the terminal is connected (indication)
MPH-ERROR	error in layer 1 (indication, response)

For example, to initiate a layer 1 connection, the layer 2 sends a PH-ACTIVATE request to layer 1. If the activation is successful, the layer 1 sends a PH-ACTIVATE indication to layer 2.

The primitives between layer 2 and 3 are:

DL-ESTABLISH	establish a link (request, indication, confirmation)
DL-RELEASE	release a link (request, indication, confirmation)
DL-UNIT-DATA	data transfer (request, indication)
DL-DATA	data transfer, acknowledged operation (request, indication)

For example, in order for layer 3 to establish a connection, send a message, and release the connection, it must send a DL-ESTABLISH request to layer 2. After servicing the request, layer 2 in turn responds with a DL-ESTABLISH confirmation. Layer 3 sends data using either a DL-UNIT-DATA request, for unacknowledged information transfer, or DL-DATA, for acknowledged information transfer. At the end of the session, layer 3 indicates to layer 2 to release the connection by issuing a DL-RELEASE request. Layer 2 responds with a DL-RELEASE confirmation.

A number of primitives are also used between layer 2 and its management entity. These are:

MDL-ASSIGN	assign a TEI terminal endpoint identifier to the link (request, indication)
MDL-REMOVE	remove the association between a link and a TEI (request)
MDL-UNIT-DATA	send management control information (request, indication)
MDL-ERROR	error diagnostics (indication, response)

If a TEI has not been assigned, layer 2 passes an MDL-ASSIGN indication to the layer 2 management entity upon receipt of a DL-ESTABLISH request. If a TEI is required, the management entity gives an MDL-ASSIGN request to layer 2. Layer 2 will proceed to request a TEI from the network.

A.6 Layer 2 – Data Link Layer (LAPD)

The data link layer implements the link access protocol on the D-Channel (LAPD) and allows the interchange of frames between terminals and the NT2, between the NT2 and the exchange, or between the terminal and the exchange.

The data link layer provides the following services:

- Multiplexing of several channels on the same D-Channel
- Detection of transmission, formatting and operating errors on the data link
- Retransmission of faulty frames
- Flow control

Addressing

A layer 3 communication entity is identified by two elements which comprise the CEI (connection endpoint identifier). The first of these is the SAPI (service access point identifier). The second is the CES (connection endpoint suffix).

The SAPI identifies a point through which data link services are provided to the layer 3 entity. There are three commonly used types of data link services. The first of these are the management procedures. These procedures have a SAPI of 63. These procedures are used for TEI assignment and control, and other management procedures.

The second type of data link services are the call control procedures. These procedures are identified by a SAPI of 0. These procedures control calls placed over the B-Channels.

The third type of service is the packet communication service which is identified by a SAPI of 16. This service sends data over the D-Channel. For example, the excess capacity in a D-Channel can be used for data communication between low speed terminals (up to 9600 bps).

The CES identifies the layer 3 entity connected to a particular service. For example, in Figure A-6, terminal A is connected to the packet communication service. Since there is more than one terminal connected to this service, terminal A is identified by a number – the CES. The CEI is thus the SAPI (16 in this case) plus the CES (2 in this case).

The layer 3 entity uses the CEI to identify or address its connection to layer 2. The layer 2 in turn identifies this connection by the DLCI (data link connection identifier). The DLCI is contained within the layer 2 frame. The DLCI is composed of two parts: the SAPI and the TEI (terminal endpoint identifier).

The TEI uniquely identifies the terminal within a service access point. For example, in Figure A-6, terminal A is identified by a TEI of 64.

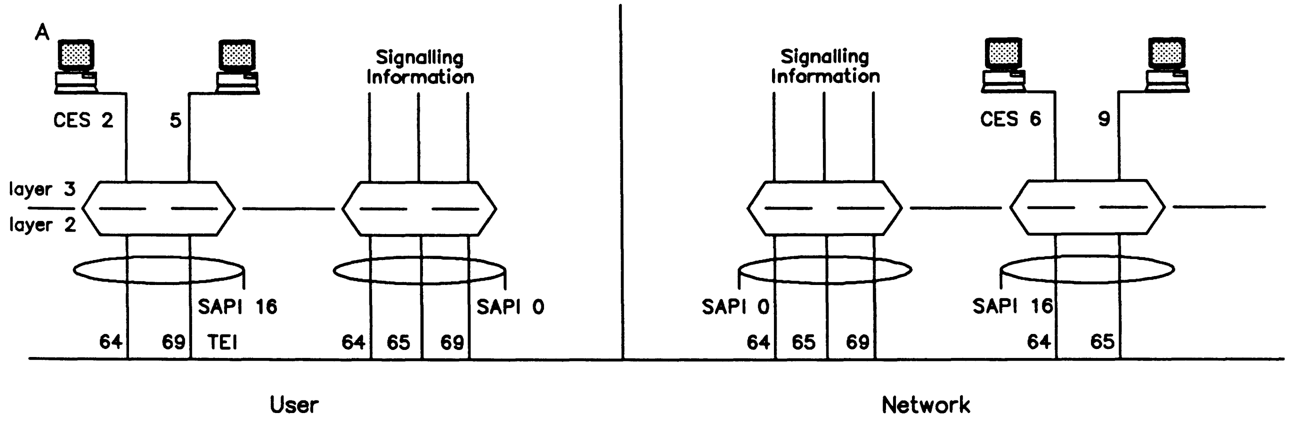


Figure A-6 TEI/SAPI Relationship

Establishing a Layer 2 Link

Figure A-7 shows the data flow in a layer link establishment. The S/T Bus has already been activated. The first action the user equipment performs is to request a TEI. The network responds with a TEI assignment to be used in future messages.

The user then sends a SABME (set asynchronous balanced mode extended). This command prepares both sides for information transfer using numbered frames that cycle through the values 0 through 127. The network responds with a UA (unnumbered acknowledge) frame.

Information frames are then exchanged and are acknowledged using RR (receiver ready) frames. At the end of information transfer, the user issues a DISC (disconnect) message to the network. The network responds with a UA frame.

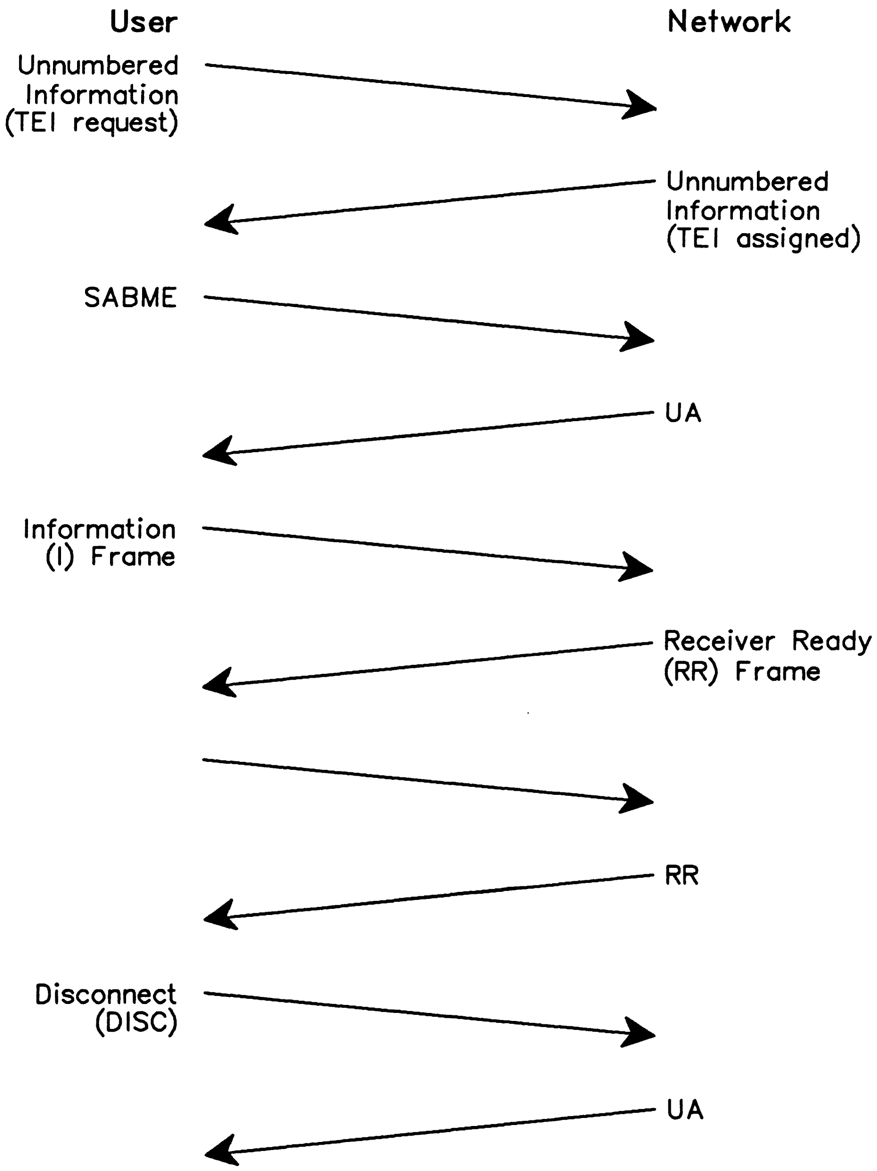

User
Network
Unnumbered Information (TEI request)
Unnumbered Information (TEI assigned)
SABME
UA
Information (I) Frame
Receiver Ready (RR) Frame
RR
Disconnect (DISC)
UA

Figure A–7 Data Flow in a Link Establishment

LAPD Frames

There are three different types of LAPD frames:

- Information
- Supervisory
- Unnumbered information

Information frames carry information between the ends of the communication. They contain sequence numbers and thus require an acknowledgement from the other end.

Unnumbered frames carry additional data link control functions. They do not carry sequence numbers and thus do not require acknowledgement of transmission. Unnumbered frames are used for several functions. First, they set the modulus mode. Second, they carry frame reject, frame acknowledge, disconnect, and other data link control functions. Third, they are used by layer 2 to carry DL-UNIT-DATA information from the layer 3. Unnumbered information frames are also used by the layer 2 management entity to carry TEI request and assign frames as a result of MDL-ASSIGN procedures from the management entity.

The supervisory frames perform supervisory control functions such as information frame acknowledgement, retransmission requests, and temporary suspension of transmission.

Information and supervisory frames are sequenced using either a modulo 8 (normal) or modulo 128 (extended) scheme. The sequencing ensures that frames are sent in the proper order. If retransmission of a frame is required, specifying the sequence number identifies the frame to be retransmitted. Note that modulo 8 operation is not supported by the 1988 Blue Book.

See Table A-1 for a list of the LAPD frames for modulo 8 operation, and Table A-2 for a list of the frames for modulo 128 operation.

Format	Commands	Responses	Encoding								Octet
			8	7	6	5	4	3	2	1	
Information Transfer	I (information)		N(R)			P	N(S)			0	4
Supervisory	RR (receive ready)	RR (receive ready)	N(R)			P/F	0	0	0	1	4
	RNR (receive not ready)	RNR (receive not ready)	N(R)			P/F	0	1	0	1	4
	REJ (reject)	REJ (reject)	N(R)			P/F	1	0	0	1	4
Unnumbered	SABM (set asynchronous balance mode)		0	0	1	P	1	1	1	1	4
		DM (disconnect mode)	0	0	0	F	1	1	1	1	4
	UI (unnumbered information)		0	0	0	P	0	0	1	1	4
	DISC (disconnect)		0	1	0	P	0	0	1	1	4
		UA (unnumbered acknowledge)	0	1	1	F	0	0	1	1	4
		FRMR (frame reject)	1	0	0	F	0	1	1	1	4
	XID (exchange identification)	XID (exchange identification)	1	0	1	P/F	1	1	1	1	4

Table A–1 Frames for Modulo 8 Operation

Format	Commands	Responses	Encoding								Octet
			8	7	6	5	4	3	2	1	
Information Transfer	I (information)		N(S)							0	4
			N(R)							P	5
Supervisory	RR (receive ready)	RR (receive ready)	0	0	0	0	0	0	0	1	4
			N(R)							P/F	5
	RNR (receive not ready)	RNR (receive not ready)	0	0	0	0	0	1	0	1	4
			N(R)							P/F	5
	REJ (reject)	REJ (reject)	0	0	0	0	1	0	0	1	4
			N(R)							P/F	5
Unnumbered	SABME (set asynchronous balance mode extended)		0	1	1	P	1	1	1	1	4
		DM (disconnect mode)	0	0	0	F	1	1	1	1	4
	UI (unnumbered information)		0	0	0	P	0	0	1	1	4
	DISC (disconnect)		0	1	0	P	0	0	1	1	4
		UA (unnumbered acknowledge)	0	1	1	F	0	0	1	1	4
		FRMR (frame reject)	1	0	0	F	0	1	1	1	4
	XID (exchange identification)	XID (exchange identification)	1	0	1	P/F	1	1	1	1	4

Table A–2 Frames for Modulo 128 Operation

LAPD Frame Structure

The structure of the LAPD frame is shown in Figure A-8. The frame starts with a hex 7E flag.

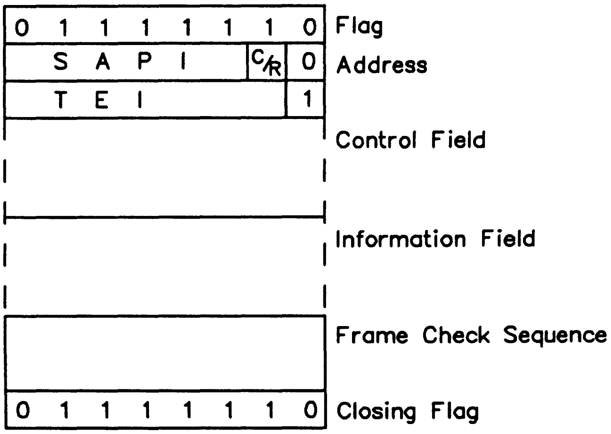


Figure A–8 LAPD Frame Structure

The next two bytes are the address. The first byte contains the SAPI and the C/R bit (command/response bit) which indicates whether the frame is a command or a response. The TEI is contained in the second byte.

The next one or two bytes is the control field which identify the type of the frame. When applicable, the control field contains sequence numbers. The control field structure is also shown in Tables A-1 and A-2.

Next, is the information field which can be of variable length up to a maximum of 260 bytes. The information field is not present if the frame carries only data link control commands.

Finally, is a frame check sequence and a closing flag.

A.7 Layer 3 – Network Layer

The network layer provides the services to establish, maintain, and terminate calls across an ISDN between communicating entities.

Operation of the Network Layer

Figure A-9 shows a simple ISDN call for voice communication. When the call is commenced by the user picking up a phone and dialing a number, the terminal sends a SETUP message to the network over an already established data link. The SETUP message contains a unique value identifying the call, known as the call reference value, and is used in all communication regarding this call.

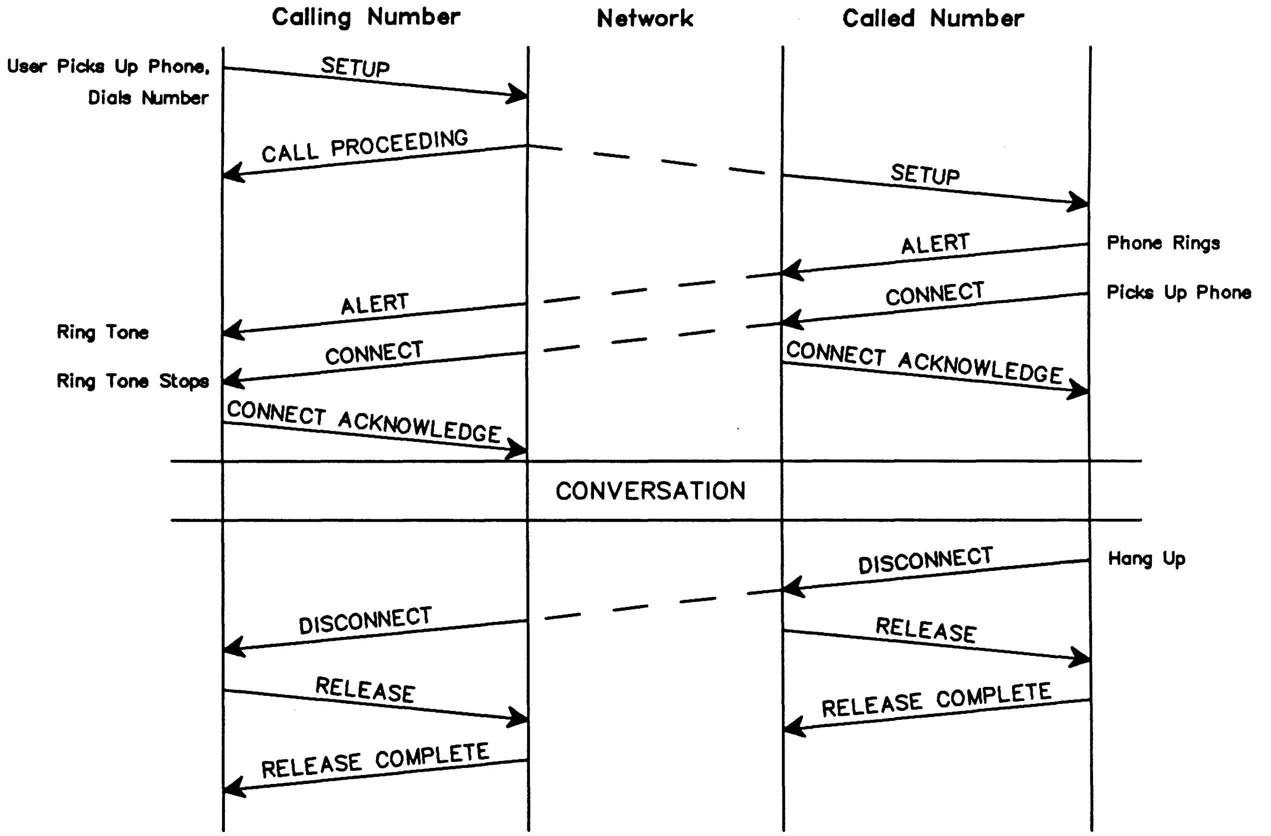


Figure A–9 ISDN Voice Communication

In addition to the call reference value, the SETUP message also contains information such as the called number, the type of service to be used (voice, data, etc.), the channel to be used (B1, B2, or any channel), and the capabilities of the terminal.

When the network receives the called number, it sends a CALL PROCEEDING message back to the user and tries to connect to the called terminal. The network sends a SETUP message to the called terminal. If the called terminal is able to accept the call, it returns an ALERT message to the network. This message indicates to the network that it is accepting the call and is ringing. The network sends an ALERT message to the calling terminal to indicate that the far end is ringing.

When the called party picks up the phone, the terminal sends a CONNECT message to the network. The network in turn sends a CONNECT ACKNOWLEDGE message back to the called party. The network also sends a CONNECT message to the calling party to indicate a connection has been made. The calling party's terminal sends a CONNECT ACKNOWLEDGE back to the network.

At this point, the two parties can talk to each other.

When the called party hangs up, the terminal sends a DISCONNECT message to the network. The network sends a DISCONNECT message to the calling party and sends a RELEASE message to the called party. The called party's terminal sends a RELEASE COMPLETE message to confirm disconnection of the call. The calling party's terminal sends a RELEASE Message to the network. The network responds by sending a RELEASE COMPLETE message.

Structure of the Network Layer

The network layer information is carried in layer 2 information frames as shown in Figure A-10. The network layer packet is formatted as shown in Figure A-11.

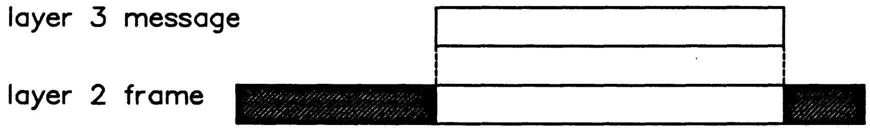


Figure A–10 Layer 2 Information Frames

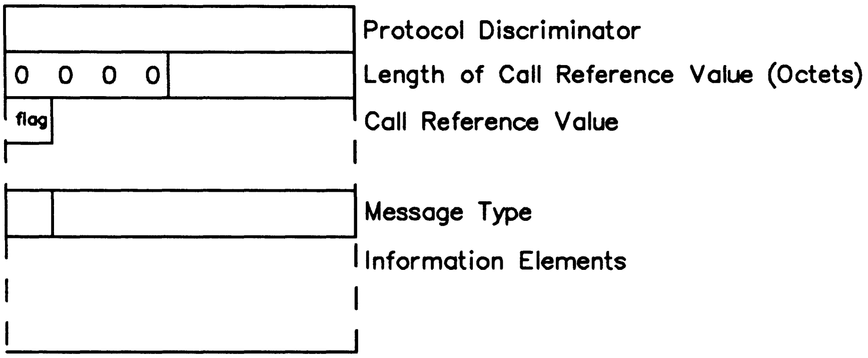


Figure A–11 Network Layer Packet

The first byte, the protocol discriminator, distinguishes between messages which are coded according to CCITT standards from other national message sets.

The second byte contains the length of the call reference value in bytes. The call reference value is contained in the third and successive bytes, and uniquely identifies the call at the User/Network interface. The first bit is the call reference flag. The call reference flag identifies the layer 3 message as coming from the side originating the call, or the destination side.

The next byte, after the call reference value, is the message type identifier. The message type is a general type command such as Setup, Alert or Call Proceeding.

Successive bytes are allocated to information elements, of which there can be zero, one, or more in a message. The information elements carry information relevant to the message. For example, a SETUP message might contain the terminal capabilities in one information element and the called number in another information element.

Information elements can be encoded in two different formats. Figure A–12 shows the single octet information element format. This format is used when one octet can hold the required information. Figure A–13 shows the variable length information element. In this case, the first octet is the information element identifier. The second octet is the length of the information element in octets. The third and successive octets carry the information of the information elements. To code this part of the information element, consult the CCITT Blue Book.

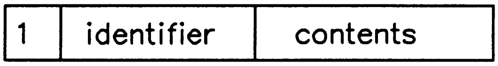


Figure A–12 Single Octet Information Element

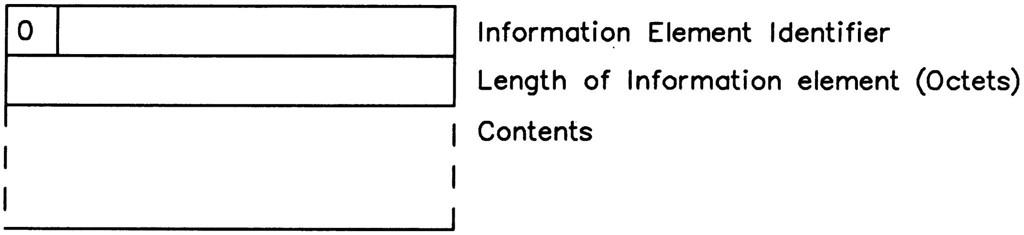

0
Information Element Identifier
Length of Information element (Octets)
Contents

Figure A–13 Variable Length Information Element

B
INTRODUCTION TO CCITT X.25 LAYER 3

This appendix contains a brief introduction to X.25. For further information, the reader is advised to consult the CCITT X.25 (1984) Recommendation, Red Book VIII.3, Malaga–Torremolinos.

B.1 Purpose of the Recommendation

This recommendation was established to produce standards to facilitate international networking between various countries which have established public data networks providing packet switched data transmission services.

B.2 Types of X.25 Services

PVC (permanent virtual circuit) is the establishment of a permanent relationship between two users.

SVC (switched virtual circuit) is a relationship that is established only for the duration of a call. SVC requires a call setup phase, the delivery of data in sequences, and a call clearing phase to terminate the call.

B.3 Layer 3 – Network Level

The network layer performs basic multiplexing of data and allows many different virtual circuits to be operated over a single link layer. It is at this level that call setup and clearing occurs, as well as access to network provided facilities. Data transfer is accomplished with a mechanism that ensures that information is transferred in the correct sequence.

The network layer information is contained in packets which are carried in information frames. The packet information commences in the first byte following the control field of an I frame. This byte is commonly called octet one when referring to packet formats.

The packet structure discussed here is for layer 3 modulo 8, only as described in the 1984 Recommendation. The user should consult the Recommendation for modulo 128 structures.

Each packet contains a packet control header consisting of three octets. Table B-1 shows the format for the packet control header with the size of each field in bits.

	Bits							
Octets	8	7	6	5	4	3	2	1
1	General format identifier				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							

Table B–1 Packet Header

GFI (General Format Identifier)

This field identifies the general format identifier of the data packet sequencing scheme, i.e. modulo 8 or modulo 128. Packet sequence numbers cycle between 0 and 7 In modulo 8, and 0 and 127 for modulo 128. The modulo is determined by examining bits 5 and 6 of the first octet of the packet.

Data packets contain a Q bit within the GFI. This is the eighth bit of octet 1 in the data packet header. When the Q (qualifier) bit is set to 1, the data packet being sent is not user data.

Data packets and call setup packets contain a D bit. This is the seventh bit of octet 1 in the packet header. When the D (delivery confirmation) bit is set, an acknowledgement from a distant subscriber is required.

Logical Channel Group Number and Logical Channel Number

These fields show information regarding the destination of a packet over a logical virtual channel in the network.

Packet Identifier

Each packet is identified in octet 3 according to Table B-2. A bit which is marked as X in this table can be set to a 0 or 1.

Packet Type		Octet 3 Bits							
From DCE to DTE	**From DTE to DCE**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
Call setup and clearing									
Incoming call	Call request	0	0	0	0	1	0	1	1
Call connected	Call accepted	0	0	0	0	1	1	1	1
Clear indication	Clear request	0	0	0	1	0	0	1	1
DCE clear confirmation	DTE clear confirmation	0	0	0	1	0	1	1	1
Data and interrupt									
DCE data	DTE data	X	X	X	X	X	X	X	0
DCE interrupt	DTE interrupt	0	0	1	0	0	0	1	1
DCE interrupt confirmation	DTE interrupt confirmation	0	0	1	0	0	1	1	1
Flow control and reset									
DCE RR (modulo 8)	DTE RR (modulo 8)	X	X	X	0	0	0	0	1
DCE RR (modulo 128)	DTE RR (modulo 128)	0	0	0	0	0	0	0	1
DCE RNR (modulo 8)	DTE RNR (modulo 8)	X	X	X	0	0	1	0	1
DCE RNR (modulo 128)	DTE RNR (modulo 128)	0	0	0	0	0	1	0	1
	DTE REJ (modulo 8)	X	X	X	0	1	0	0	1
	DTE REJ (modulo 128)	0	0	0	0	1	0	0	1
Reset indication	Reset request	0	0	0	1	1	0	1	1
DCE reset confirmation	DTE reset confirmation	0	0	0	1	1	1	1	1
Restart									
Restart indication	Restart request	1	1	1	1	1	0	1	1
DCE restart confirmation	DTE restart confirmation	1	1	1	1	1	1	1	1
Diagnostic									
Diagnostic		1	1	1	1	0	0	0	1
Registration									
	Registration request	1	1	1	1	0	0	1	1
Registration confirmation		1	1	1	1	0	1	1	1

Table B–2 Packet Type Identifier

NOTE
For Modulo 8, bits 6, 7, and 8 in RR, RNR, REJ, or data packets contain the packet receive sequence number P(R). Bits 2, 3, and 4 in data packets contain the packet send sequence number P(S). Bit 5 in data packets contains the M (more) bit. If this bit is set to 1, more data is to follow.

B.4 Example of Call Setup, Data Transfer, and Call Clear

Figure B-1 is an example of the commands and expected responses for call setup, data transfer, and call clear for an SVC.

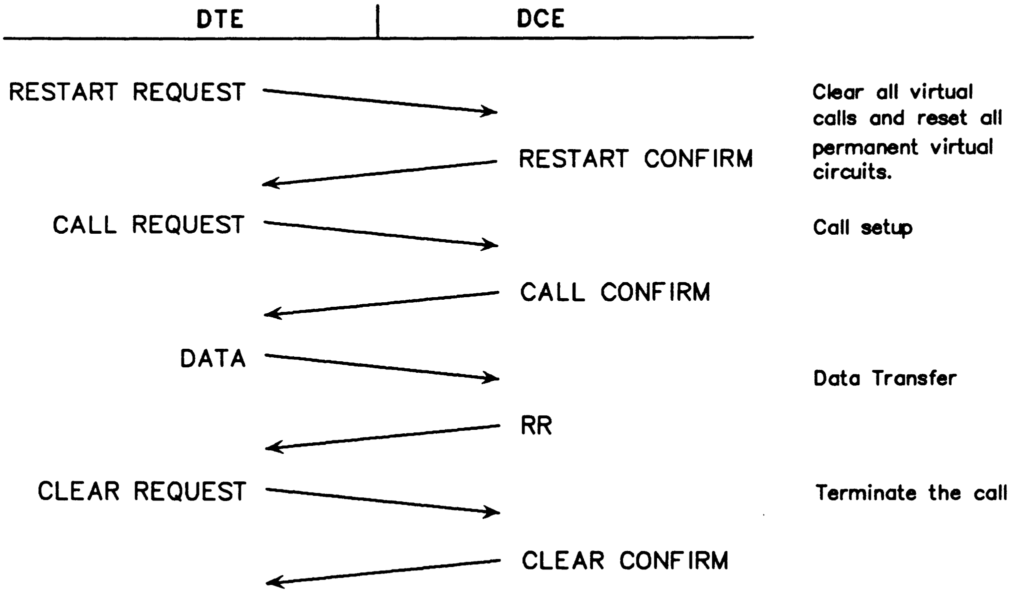


Figure B-1 Call Setup, Data Transfer, and Call Clearing

C
XID PROCEDURES

The XID procedures are implemented in accordance with CCITT Recommendation Q.921 (COM XI–R 12–E, DEC 1985), APPENDIX IV. However, there are some shortcomings in this description:

There is no description of the 'negotiation' aspect of the procedure – i.e. what does a layer 2 do with the XID parameters that it receives in an XID frame? The approach used in this implementation is:

- If an XID command is received, the layer 2 compares the received values with its internal preferred values. For N201–TX, N201–RX, and K, it adopts the lower values for its subsequent user: and for T200 it adopts the higher value for its subsequent user.
- The resulting XID response frame that it sends contains the new layer 2 values – i.e. the values just adopted.
- If an XID response is received, the layer 2 adopts the values exactly as received (except for the K value) for its subsequent use, since the side that sent the response (as a result of having received an XID command) has already adopted values that are compatible with both sides.

There is no provision for both sides of the data link to negotiate different window sizes (only K–TX is allowed in the XID message). The approach used in this implementation is to allow both sides to have their own unique K values:

- The layer 2 really wants the peer layer 2 to adopt a K that will keep the peer from sending too many I frames (which may overflow the receive buffer causing this layer 2 to lose some frames). The objective is to reduce, or prevent reject situations. To achieve this, the value placed in the K–TX parameter field in the outgoing XID frame is actually what it wishes the peer side to use for its K value – in this case, the K–RX variable which reflects the size of the receive buffer. Note that the K value that this side wants to use is not sent.
- When a frame is received, the layer 2 adopts the lower of the received K value and its own K value.

The definition of what constitutes an XID frame with a 'zero I field' can be interpreted 2 ways: there are either 3 bytes (the frame header only) or there are 7 bytes (frame header plus GI, plus FI, plus a 2 byte length field – which equals 0). The approach used in this implementation is:

- Either type of 'short' frame will be accepted. If it is a command, a full length XID response frame (21 bytes) is returned.
- When an XID command is sent via the state machine, a full length frame is always sent.
- Short XID frames of either type, both responses and commands, can be sent outside of the state machine.

No options are described for how many of the 4 parameters must be present in the XID frame. Hence, any XID frame that is not 3, 7, or 21 bytes long is considered to be an incorrect length.

The procedure is not described if an XID frame has 1 or more incorrect control codes. Hence, the frame is considered to be totally invalid if any incorrect code is detected.

The procedure is not described if an XID frame is received with either P or F=1. This implementation treats it as an error condition by notifying the ML or ASP, via the MDL-ERROR-INDICATION primitive (ERROR CODE=8), and then discards it.

The procedure is not described if an unsolicited XID response frame (F=0) is received, i.e. when this side has *not* sent an XID command (P=0) earlier. This implementation simply ignores (discards) it.

The procedure concerning how the network changes it's T201 duration when different T200 value are acquired for the various data links on one basic access is not described. In this network emulation implementation, T201 is only used when the network initiates a 'link audit', i.e. by sending out the ID CHECK REQUEST message (Ai= 127). Hence, only one value of T201 is used to time the responses to this request. To accommodate the slowest terminal (as indicated by the duration of it's T200), T201 is made equal to the longest T200 duration of any of the terminals that have TEI's assigned to them. Thus, part of the XID procedure includes comparing the T200 just negotiated with the current T201 value, and making T201 equal to the longer of these durations. (Although this is also done on the user emulation as well, T201 is not used, so it's value is irrelevant.)

The procedures concerning how a terminal changes it's T202 duration are not described. In this user implementation, T202 is made equal to twice the value of the T200 duration just negotiated. In actual fact, this has no real impact because T202 is only used by the user emulation while the TEI is being acquired – i.e. before the XID procedure is executed, and a possibly different value of T200 acquired. Hence, during the time that T202 is used, the default value (2 seconds) would actually be used. (Although this is also done for the network emulation as well, T202 is not used, so it's value is irrelevant). If, however, the user is caused to request a new TEI without the user emulation being re-initialized, the new request would be governed by the T202 duration negotiated in the previous session.

D
CODING CONVENTIONS

This section outlines some coding and style conventions recommended by IDACOM. Although you can develop your own style, it is suggested to stay close to these standards to enhance readability.

D.1 Stack Comments

A stack comment is surrounded by parentheses, and shows two stack pictures. The first picture shows any items or 'input parameters' that are consumed by the command; the second picture shows any items or 'output parameters' returned by the command.

Example:
The '=' command has the following stack comment.

(n_1\\n_2 -- flag)

In this example, n_1 and n_2 are numbers and the flag is either 0 for a false result, or 1 for a true result. This same example could also be written as follows.

(n_1\\n_2 -- 0|1)

The '\' character separates parameters when there is more than one. The parameters are listed from left to right with the leftmost item representing the bottom of the stack and the rightmost item representing the top of the stack.

The '|' character indicates that there is more than one possible output. The above example indicates that either a 0 (false result) or a 1 (true result) is returned on the stack after the '=' operation.

D.2 Stack Comment Abbreviations

Following is a list of commonly used abbreviations. In most cases, the stack comments shown in this manual have been written in full rather than abbreviated.

Symbol	Description
a	Memory address
b	8 bit byte
c	7 bit ASCII character
n	16 bit signed integer
d	32 bit signed integer
u	32 bit unsigned integer
f	Boolean flag (0=false, non-zero=true)
ff	Boolean false flag (zero)
tf	Boolean true flag (non-zero)
s	String (actual address of a character string which is stored in a count prefixed manner)

Table D-1 ITL Symbols

D.3 Program Comments

Program comments appear in source code surrounded by parentheses. These describe the intent or purpose of the definition or line of code.

There must be at least one space on each side of the parentheses.

Example:

```
:  HELLO  ( -- )                          ( Display text Hello in Notice Window )
     " HELLO"                             ( Create string )
     W.NOTICE                             ( Output to Notice Window )
;
```

The program comment should be kept to a minimum and yet contain enough information that another programmer can tell the intent at a glance.

D.4 Test Manager Constructs

Coding conventions for user test scripts should generally follow the style presented throughout this manual.

Indenting nested program structures should be done using the tab key in the editor. The use of many meaningful comments is highly recommended to enhance the continued maintainability of the program.

Example:
(State definition purpose comment)

```
0 STATE{
      EVENT Recognition Commands        ( Comment )
      ACTION{
          Action Commands               ( Comment )
          IF
              ...                       ( Comment )
              ...                       ( Comment )
          ENDIF
      }ACTION
  }STATE
```

D.5 Spacing and Indentation Guidelines

The following list outlines the general guidelines for spacing and indentations:

- One space between colon and name in colon definitions.
- One space between opening parenthesis and text in comments.
- One space between numbers and words within a definition.
- One space between initial " in strings (i.e. with " string", W." string", T." string", P." string", X" hex characters", etc...)
- One or more spaces at the end of each line unless defining a string which requires additional characters.
- Tab for nested constructs.
- Carriage return after colon definition and stack comment.
- Carriage return after last line of code in colon definition and semi-colon.

See the examples in Appendices A.6 and A.4.

D.6 Colon Definitions

The colon definition should be preceded by a short comment and should start at the first column of a line. All codes underneath the definition name should be preceded by one tab. Each element within the colon definition should be well defined.

Example:
(Description of command)

```
:  COMMANDNAME                          ( Stack description )
      .....                             ( Comment for first line of code )
      IF
          ....                          ( Comment )
          DOCASE
              CASE  X  [ ... ]          ( Comment )
              CASE  Y  [ ... ]          ( Comment )
              CASE  DUP  [ ... ]        ( Comment )
          ENDCASE
      ELSE
          BEGIN
              .....                     ( Comment )
              .....                     ( Comment )
          UNTIL
      ENDIF
;
```

E
ASCII/EBCDIC/HEX CONVERSION TABLE

HEX	DEC	OCT	ASCII	EBCDIC	HEX	DEC	OCT	ASCII	EBCDIC
00	0	00	NUL	NUL	30	48	60	0	
01	1	01	SOH	SOH	31	49	61	1	
02	2	02	STX	STX	32	50	62	2	SYN
03	3	03	ETX	ETX	33	51	63	3	IR
04	4	04	EOT	PF	34	52	64	4	PP
05	5	05	ENQ	HT	35	53	65	5	TRN
06	6	06	ACK	LC	36	54	66	6	NBS
07	7	07	BEL	DEL	37	55	67	7	EOT
08	8	10	BS	GE	38	56	70	8	SBS
09	9	11	HT	SPS	39	57	71	9	IT
0A	10	12	LF	RPT	3A	58	72	:	RFF
0B	11	13	VT	VT	3B	59	73	;	CU3
0C	12	14	FF	FF	3C	60	74	<	DC4
0D	13	15	CR	CR	3D	61	75	=	NAK
0E	14	16	SO	SO	3E	62	76	>	
0F	15	17	SI	SI	3F	63	77	?	SUB
10	16	20	DLE	DLE	40	64	100	@	SP
11	17	21	DC1	DC1	41	65	101	A	
12	18	22	DC2	DC2	42	66	102	B	
13	19	23	DC3	DC3	43	67	103	C	
14	20	24	DC4	RES	44	68	104	D	
15	21	25	NAK	NL	45	69	105	E	
16	22	26	SYN	BS	46	70	106	F	
17	23	27	ETB	POC	47	71	107	G	
18	24	30	CAN	CAN	48	72	110	H	
19	25	31	EM	EM	49	73	111	I	
1A	26	32	SUB	UBS	4A	74	112	J	cent
1B	27	33	ESC	CUI	4B	75	113	K	.
1C	28	34	FS	IFS	4C	76	114	L	<
1D	29	35	GS	IGS	4D	77	115	M	(
1E	30	36	RS	IRS	4E	78	116	N	+
1F	31	37	US	IUS	4F	79	117	O	|
20	32	40	SP	DS	50	80	120	P	&
21	33	41	!	SOS	51	81	121	Q	
22	34	42	″	FS	52	82	122	R	
23	35	43	#	WUS	53	83	123	S	
24	36	44	$	BYP	54	84	124	T	
25	37	45	%	LF	55	85	125	U	
26	38	46	&	ETB	56	86	126	V	
27	39	47	′	ESC	57	87	127	W	
28	40	50	(	SA	58	88	130	X	
29	41	51	)	SFE	59	89	131	Y	
2A	42	52	*	SM/SW	5A	90	132	Z	!
2B	43	53	+	CSP	5B	91	133	[	$
2C	44	54	,	MFA	5C	92	134	\	
2D	45	55	−	ENQ	5D	93	135	]	)
2E	46	56	.	ACK	5E	94	136	ˆ	;
2F	47	57	/	BEL	5F	95	137	_	¬

HEX	DEC	OCT	ASCII	EBCDIC	HEX	DEC	OCT	ASCII	EBCDIC
60	96	140	`	–	90	144	220		
61	97	141	a	/	91	145	221		j
62	98	142	b		92	146	222		k
63	99	143	c		93	147	223		l
64	100	144	d		94	148	224		m
65	101	145	e		95	149	225		n
66	102	146	f		96	150	226		o
67	103	147	g		97	151	227		p
68	104	150	h		98	152	230		q
69	105	151	i		99	153	231		r
6A	106	152	j	|	9A	154	232		
6B	107	153	k	,	9B	155	233		}
6C	108	154	l	%	9C	156	234		□
6D	109	155	m	_	9D	157	235		)
6E	110	156	n	>	9E	158	236		±
6F	111	157	o	?	9F	159	237		■
70	112	160	p		A0	160	240		–
71	113	161	q	^	A1	161	241		o
72	114	162	r		A2	162	242		s
73	115	163	s		A3	163	243		t
74	116	164	t		A4	164	244		u
75	117	165	u		A5	165	245		v
76	118	166	v		A6	166	246		w
77	119	167	w		A7	167	247		x
78	120	170	x		A8	168	250		y
79	121	171	y	\	A9	169	251		z
7A	122	172	z	:	AA	170	252		
7B	123	173	{	#	AB	171	253		└
7C	124	174	|	@	AC	172	254		┌
7D	125	175	}	'	AD	173	255		[
7E	126	176	~	=	AE	174	256		≥
7F	127	177	DEL	"	AF	175	257		●
80	128	200			B0	176	260		0
81	129	201		a	B1	177	261		1
82	130	202		b	B2	178	262		2
83	131	203		c	B3	179	263		3
84	132	204		d	B4	180	264		4
85	133	205		e	B5	181	265		5
86	134	206		f	B6	182	266		6
87	135	207		g	B7	183	267		7
88	136	210		h	B8	184	270		8
89	137	211		i	B9	185	271		9
8A	138	212			BA	186	272		
8B	139	213		{	BB	187	273		┘
8C	140	214		≤	BC	188	274		┐
8D	141	215		(	BD	189	275		]
8E	142	216		+	BE	190	276		≠
8F	143	217		†	BF	191	277		–

HEX	DEC	OCT	ASCII	EBCDIC
C0	192	300		{
C1	193	301		A
C2	194	302		B
C3	195	303		C
C4	196	304		D
C5	197	305		E
C6	198	306		F
C7	199	307		G
C8	200	310		H
C9	201	311		I
CA	202	312		
CB	203	313		
CC	204	314		
CD	205	315		
CE	206	316		
CF	207	317		
D0	208	320		}
D1	209	321		J
D2	210	322		K
D3	211	323		L
D4	212	324		M
D5	213	325		N
D6	214	326		O
D7	215	327		P
D8	216	330		Q
D9	217	331		R
DA	218	332		
DB	219	333		
DC	220	334		
DD	221	335		
DE	222	336		
DF	223	337		
E0	224	340		\
E1	225	341		
E2	226	342		S
E3	227	343		T
E4	228	344		U
E5	229	345		V
E6	230	346		W
E7	231	347		X
E8	232	350		Y
E9	233	351		Z
EA	234	352		
EB	235	353		
EC	236	354		
ED	237	355		
EE	238	356		
EF	239	357		
F0	240	360		0
F1	241	361		1
F2	242	362		2
F4	244	364		4
F3	243	363		3
F5	245	365		5
F6	246	366		6
F7	247	367		7
F8	248	370		8
F9	249	371		9
FA	250	372		
FB	251	373		
FC	252	374		
FD	253	375		
FE	254	376		
FF	255	377		

F
COMMAND CROSS REFERENCE LIST

This appendix cross references old commands, not appearing in this manual, with new replacement commands.

Old Command	New Command
#INCOMING	#DEST
#OUTGOING	#ORIG
$MSG-CALLREF	$MSG-CRVALUE
$MSG-SOURCE	$MSG-CRFLAG
$MSG_ERROR	$MSG-ERROR
=CN_CALLED_NUM	*COD ->CLDN_NUMBER !STRING
=CN_CALLED_SAD	*COD ->CLDS_ADDRESS !STRING
=CN_CALLING_NUM	*COD ->CLGN_NUMBER !STRING
=CN_CALLING_SAD	*COD ->CLGS_ADDRESS !STRING
?CN_CALLED_NUM	*COD ->CLDN_NUMBER
?CN_CALLED_SAD	*COD ->CLDS_ADDRESS
?CN_CALLING_NUM	*COD ->CLGN_NUMBER
?CN_CALLING_SAD	*COD ->CLGS_ADDRESS
?RX_MSG	?L3_MSG
ADDR1*	MADDR1*
ADDR2*	MADDR2*
CMND/RESP*	MC/R-BIT*
CONTROL1*	MCONTROL1*
CONTROL2*	MCONTROL2*
DATA-STATUS	STATUS_ERR?
DL_DATA_MSG	MESG SEND_I
DL_DATA_POOL	POOL SEND_I
DL_DATA_RAW	RAW SEND_I
DL_DATA_REQ	SEND_I
DL_UDATA_MSG	MESG SEND_UI
DL_UDATA_POOL	POOL SEND_UI
DL_UDATA_RAW	RAW SEND_UI
DL_UNIT_DATA	DL_UDATA
DL_UNIT_DATA_REQ	SEND_UI
K-XID*	XID-K*
MDL_UDATA_MSG	MESG SEND_MUI
MDL_UDATA_POOL	POOL SEND_MUI
MDL_UDATA_RAW	RAW SEND_MUI
MDL_UNIT_DATA	MDL_UDATA

Old Command	New Command
M_ADDR1	MADDR1*
M_ADDR2	MADDR2*
M_CMND/RESP	MC/R-BIT*
M_CONTROL1	MCONTROL1*
M_CONTROL2	MCONTROL2*
M_L2-LENGTH	L2-LENGTH
M_L2-POINTER	L2-POINTER
M_L3-LENGTH	L3-LENGTH
M_L3-POINTER	L3-POINTER
M_NR	MNR*
M_NS	MNS*
M_P/F*RCVD	MP/F-BIT*
M_SAPI	MSAPI*
N201-RX-XID*	XID-RX-N201*
N201-TX-XID*	XID-TX-N201*
NO_IE_ERROR#	NO-IE-ERROR#
NR*	MNR*
NS*	MNS*
P/F*RCVD	MP/F-BIT*
PARAM_WRONG_LEN#	PARAM-WRONG-LEN#
R-XIDC#	R#XIDC
R-XID#	R#XID
REC-LENGTH*	L2-LENGTH
REC-POINTER*	L2-POINTER
S:I_MSG	MESG S:I
S:I_POOL	POOL S:I
S:I_RAW	RAW S:I
S:MSG	MESG SEND_I
S:MUI_MSG	MESG S:MUI
S:MUI_POOL	POOL S:MUI
S:MUI_RAW	RAW S:MUI
S:UI_MSG	MESG S:UI
S:UI_POOL	POOL S:UI
S:UI_RAW	RAW S:UI
SENDP	DL_DATA
SEND_I_MSG	MESG SEND_I
SEND_I_POOL	POOL SEND_I
SEND_I_RAW	RAW SEND_I
SEND_MESSAGE	POOL SEND_I
SEND_MESSAGE/CR	POOL SEND_I
SEND_MUI_MSG	MESG SEND_MUI
SEND_MUI_POOL	POOL SEND_MUI

[continued]

Old Command	New Command
SEND_MUI_RAW	RAW SEND_MUI
SEND_UI_MSG	MESG SEND_UI
SEND_UI_POOL	POOL SEND_UI
SEND_UI_RAW	RAW SEND_UI
SEND_UNIT_MESSAGE	POOL SEND_I
SET_LONG n	n LONG-INTERVAL !
SET_SHORT n	n SHORT-INTERVAL !
SET_SPEED n	n INTERFACE_SPEED !
SU:MSG	MESG SEND_UI
S_DISC	S:DISC
S_DM	S:DM
S_FRMR	S:FRMR
S_I	S:DATA
S_REJ	S:REJ
S_REJC	S:REJC
S_RNR	S:RNR
S_RNRC	S:RNRC
S_RR	S:RR
S_RRC	S:RRC
S_SABM	S:SABM
S_SABME	S:SABME
S_UA	S:UA
S_UI	S:UDATA
S_XID	S:XID
S_XID0	S:XID0
S_XID4	S:XID4
S_XIDC	S:XIDC
S_XIDC0	S:XIDC0
S_XIDC4	S:XIDC4
UI_3	DL_UDATA
UI_M	MDL_UDATA
VSAPI*	MSAPI*

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