



# **DTX-360**

## **DIGITAL CIRCUIT MULTIPLICATION EQUIPMENT**

### **GENERAL DESCRIPTION**

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- a) Directive 73/23/EEC - Council Directive of 19/02/1973 on the harmonization of the laws of Member States relating to electrical equipment designed for use within certain voltage limits.
- b) Directive 89/336/EEC - Council Directive of 3/05/1989 on the approximation of laws of the Member States relating to Electro-Magnetic Compatibility (EMC).



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# DTX-360

## General Description

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Figure 1-1. DTX-360 Terminal

# INTRODUCTION

## 1.1 General

The DTX-360 Digital Circuit Multiplication Equipment is the latest addition to ECI Telecom's family of telecommunication products.

The DTX-360 is designed to provide global solutions to present and future DCME requirements.

Figure 1-1 shows a DTX-360 terminal.

Utilizing DSI (Digital Speech Interpolation), ADPCM (Adaptive Differential PCM) or LD-CELP (Low Delay - Code Excited Linear Prediction), VBR (Variable Bit Rate), and Fax Demodulation/Modulation techniques, the DTX-360 enables a maximum effective compression of transmission facilities in digital operating environments, together with a very high level of signal quality and system reliability.

Each DTX-360 terminal accepts up to 360 trunk channels, carrying 64 kbit/s signals of speech, voice-band data (fax and non-fax), and inter-exchange signaling types. These signals are transmitted to their destination terminal(s) over a single bitstream (Bearer) at a rate of 2.048 Mbit/s or 1.544 Mbit/s.

The DTX-360 system provides a high compression ratio of up to 10:1 for speech signals and a fax compression ratio of more than 6:1 for ITU Group 3 fax calls.

Figure 1-2 shows the network components of a DTX-360 DCME.

In addition, the DTX-360 supports the following network operating modes:

- ☐ **Point-to-Point**
- ☐ **Multi-Destination**
- ☐ **Multi-Clique**
- ☐ **Inter-operation**

Figure 1-3, Figure 1-4, and Figure 1-5 illustrate the Point-to-Point, Multi-Destination, and Multi-Clique modes, respectively.

**Note:** Multi-Clique mode enables use of up to 4 cliques.

The DTX-360 can be operated in one of the following DCME modes:

- ☐ LD-CELP mode
- ☐ ITU G.763-G.766 mode. (Intelsat IESS-501, REV.3)
- ☐ ITU G.763 mode (Intelsat IESS-501, REV.2)

The Fax Demodulation technique improves transmission performance of fax calls by significantly reducing link impairments.

In addition, it is possible to apply error protection techniques to the fax demodulated signals. This results in substantial improvements in the overall bit error rate performance for fax communications - an important feature when operating on links with poor bit error rate performance.



A complete set of system configuration modes equips the DTX-360 with powerful operational characteristics that assure top performance in almost any environment.

The system supports various transmitted services, including Nx64 kbit/s service and non-interpolated traffic.

The DTX-360 provides an optional DCME-ISC data communication link, using T.S. 16 of the trunk bit streams, in full compliance with ITU Rec. Q.50. This data link enables information exchange between the DTX-360 and associated switching nodes, for various ISDN bearer services involving 64 kbit/s unrestricted traffic, DLC (Dynamic Load Control), alarms, and other purposes. In addition, the system will support any user-customized protocol.

ECI Telecom has also developed the DTX-360C - a compact version of the DTX-360. The DTX-360C is a single-shelf, optimized system, especially suited for IESS-501 applications.

## 1.2 Main Features

The DTX-360 offers the following main features:

- ❑ Standard E1 (2.048 Mbit/s) and T1 (1.544 Mbit/s) for Trunk and Bearer Interfaces
- ❑ Compression ratio of up to 10:1 for speech signals
- ❑ Easy upgrading from G.763 version (ADPCM) to LD-CELP version (10:1 gain) by insertion of plug-and-play LD-CELP and related cards and replacing terminal software (No modifications of shelf hardware are required)
- ❑ Compression ratio of more than 6:1 for ITU Group 3 fax calls
- ❑ Compression ratio of 3:1 for half duplex non-fax Voice Band Data calls of up to and including 19.2 kbit/s (1.6:1 for full duplex), using a unique LD-CELP-based algorithm
- ❑ Transmission of 64 kbit/s dynamically assigned Clear Channels
- ❑ Transmission of pre-assigned channels at 64 kbit/s, 40 kbit/s, 32 kbit/s, and 16 kbit/s
- ❑ Low Rate Encoding, using ADPCM or LD-CELP techniques
- ❑ Transmission of up to 360 voice trunks during distributed peak traffic hours
- ❑ Transmission of more than 300 voice trunks during non-distributed peak traffic hours
- ❑ ITU Group 3 fax calls are demodulated by means of Waveform Analysis technique (ITU G.766)
- ❑ Supports ITU Group 3 V.17, V.27, and V.29 fax calls
- ❑ Support for standard and non-standard protocols (ITU T.30)
- ❑ Simultaneous transmission of up to 180 ITU Group 3 fax calls
- ❑ Efficient Inter-Exchange Signaling support
- ❑ Support for ITU Signaling Systems #5, #6, #7, R1 and R2D
- ❑ DTX-360 - ISC data link interface in compliance with ITU Rec. Q.50
- ❑ Optional DTX-360-ISC customized interfaces
- ❑ Plesiochronous buffering and optional Doppler buffer
- ❑ Multi-Destination Mode with up to four destinations
- ❑ Multi-Clique Mode with up to four pools (LD-CELP) and up to two pools (ADPCM)
- ❑ Inter-operability of Single-Destination and Multi-Clique versus Multi-Destination
- ❑ High level of noise immunity, even for high bit error rate bearers
- ❑ Excellent speech call quality
- ❑ Adaptive Threshold Setting and Adaptive Noise Injection - enhancing speech quality on trunk circuits with a high noise level
- ❑ Forward Error Correction - enhancing fax call quality when operating on bearers with degraded BER (Bit Error Rate)
- ❑ High single-terminal and overall system reliability
- ❑ High level of system protection provided by a comprehensive Built-In-Test feature
- ❑ Redundant traffic-affecting subsystems, ensuring Service Continuity Protection
- ❑ Up to 8+1 terminals (8 operational and 1 backup) in cluster configuration

- ❑ Cluster configuration with distributed Change-Over Matrix
- ❑ Reliable change-over process, independent of the Operator Station (OPS-360)
- ❑ Fast restoration of service following an alarm condition requiring change-over switching
- ❑ Reduced cluster installation cost and improved maintainability
- ❑ High level of modularity that assures immediate system expansion in response to changes in traffic profile and volume
- ❑ Powerful Operator Station (OPS-360) incorporating advanced user interface technologies
- ❑ Attractive graphic user interface for the Operator Station (OPS-360)
- ❑ Concurrent operation, maintenance, and commissioning of multiple terminals, supported by a single Operator Station (OPS-360)
- ❑ Safe and easy data entry through the OPS-360
- ❑ Comprehensive system control and traffic monitoring reports

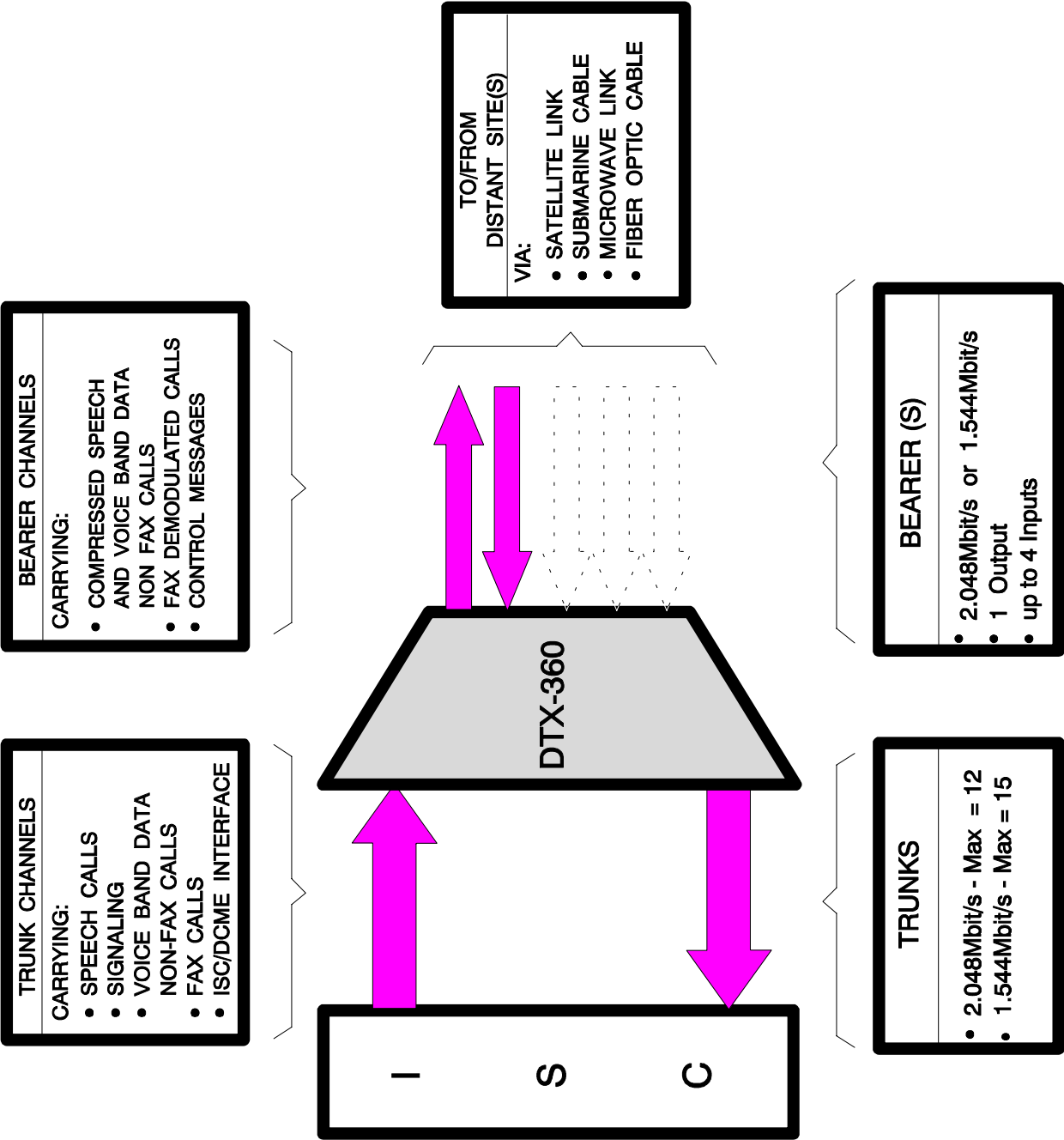


Figure 1-2. Network Components of a DTX-360 DCME System

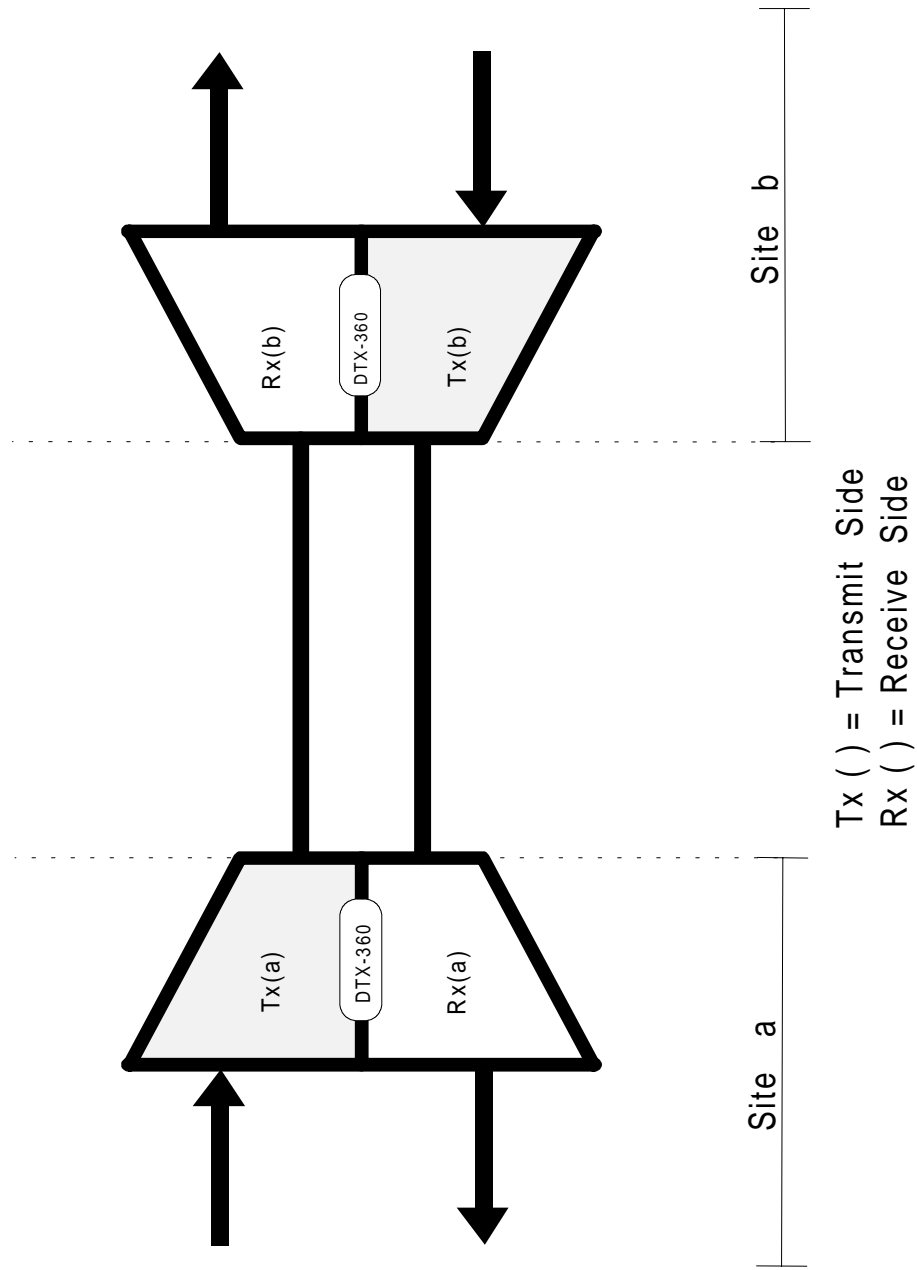


Figure 1-3. DTX-360 Point-to-Point Mode

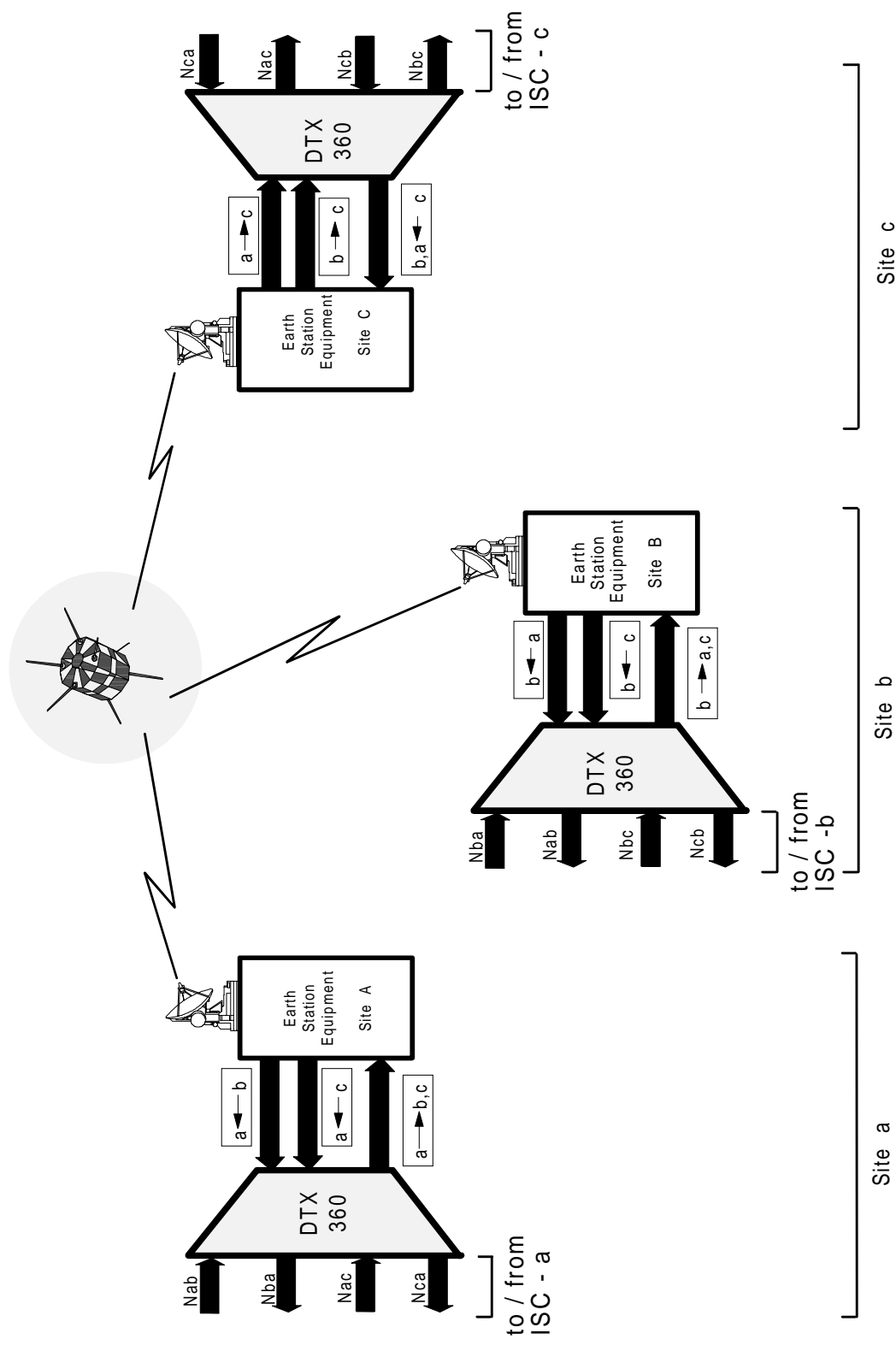


Figure 1-4. DTX-360 Multi-Destination Mode

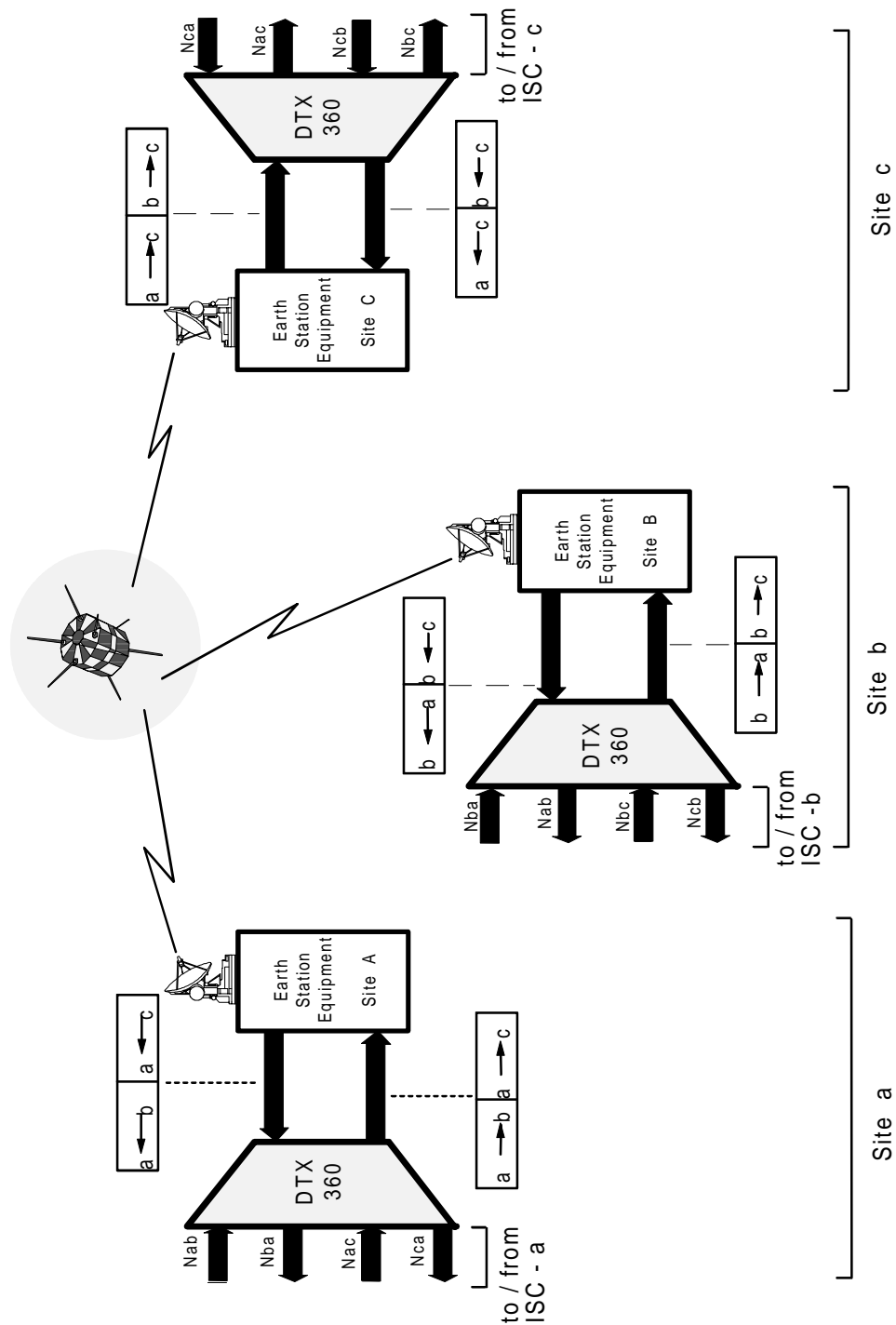


Figure 1-5. DTX-360 Multi-Clique Mode - 2 Cliques out of 4 Possible (in LD-CELP)

# BASIC DESIGN

## 2.1 Functional Blocks

A DTX-360 system is implemented with several interconnected DTX-360 terminals. The type of interconnection and number of terminals depends on the network operational selected mode (Point-to-Point, Multi-Clique or Multi-Destination).

A basic functional diagram of a DTX-360 terminal is shown in Figure 2-1. The diagram illustrates different signal compression procedures in the transmit direction (from trunk channels to bearer), corresponding to the possible results of the incoming signal analysis process.

The same diagram also serves to illustrate signal processing in the receive direction. In this case, the signal flow is in the opposite direction and decompression procedures are applied.

There are ten basic functional stages:

- ☐ TR-DLI - Trunk Digital Line Interface
- ☐ TSI&SA - Timeslot Interchange & Signal Analysis
- ☐ DSI - Digital Speech Interpolation
- ☐ S-LRE - Speech Low Rate Encoding / Decoding
- ☐ VBR - Variable Bit Rate
- ☐ VBD-LRE - Voice Band Data-Low Rate Encoding/Decoding

- ☐ FAX - DEM/MOD - Fax Demodulation / Remodulation
- ☐ BM - Bit Mapping
- ☐ FEC - Forward Error Correction
- ☐ BR-DLI - Bearer Digital Line Interface

These stages are described briefly below.

## 2.2 TR-DLI - Trunk Digital Line Interface

The TR-DLI stage provides interfacing between standard 1.544 Mbit/s or 2.048 Mbit/s external trunks and the DTX-360 internal NRZ signals. The interface provides synchronization, plesiochronous buffering, and optional format conversion and/or Doppler buffer.

## 2.3 TSI & SA - Timeslot Interchange & Signal Analysis

### 2.3.1 TSI - Timeslot Interchange

The TSI stage provides time-slot mapping between the Trunk Channels and the Intermediate Trunks. For example, a terminal equipped with 1.544 Mbit/s trunks enables a regrouping of up to fifteen 24-channel bit streams into twelve 30-channel bit streams. The stage is implemented using VLSI Time-Space PCM switches.

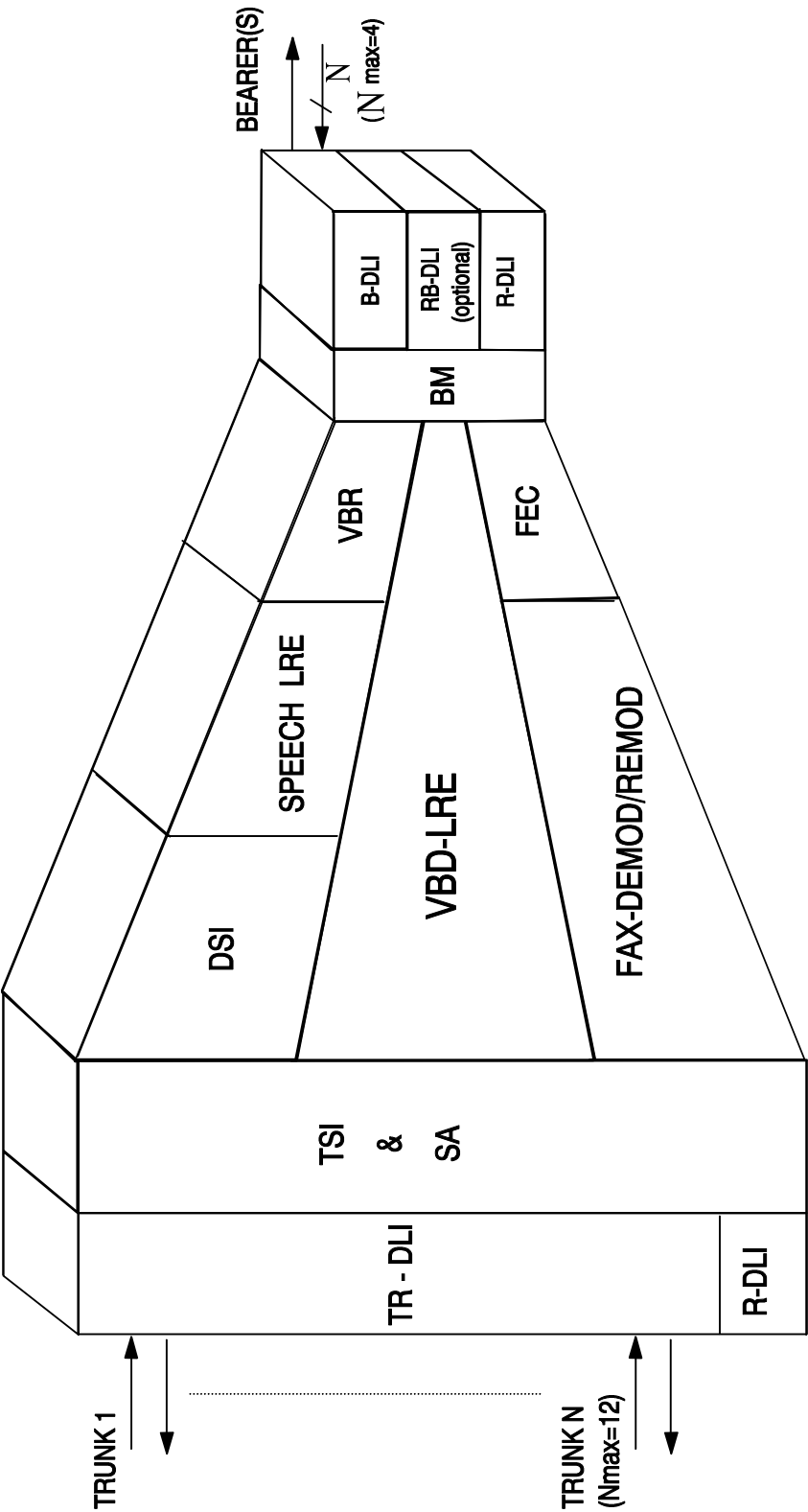


Figure 2-1. DTX-360 Terminal Functional Block Diagram



### 2.3.2 Signal Analysis

This stage checks the incoming Intermediate Trunks on a per-time-slot basis. Detection of signal activity triggers a signal classification process in order to determine the type of signal: speech, voice band data, fax or non-fax or signaling. When the signal is classified, the system assigns it internal paths and resources needed to perform the corresponding signal processes (compression).

## 2.4 DSI - Digital Speech Interpolation

The DSI stage performs voice compression using the Digital Speech Interpolation technique.

A typical system configuration consists of up to 300 trunk circuits compressed into 31 bearer timeslots. The number of compressed voice channels can be increased by the VBR stage.

## 2.5 S-LRE - Speech Low Rate Encoding

### 2.5.1 LD-CELP Low Delay Code Excited Linear Prediction

This stage performs Low Rate Encoding of speech signals using the LD-CELP encoding algorithm.

The LD-CELP algorithm provides a further 4:1 speech compression capability, beyond the nominal 2.5:1 compression obtained in the DSI stage.

Under normal traffic conditions, speech signals are coded with 2 bits per sample (16 kbit/s). In order to cope with traffic overload conditions, the LD-CELP device can be automatically instructed to use 12.8 kbit/s or 9.6 kbit/s coding instead of the standard 16 kbit/s coding.

### 2.5.2 ADPCM - Adaptive Differential PCM

The ADPCM stage performs ADPCM encoding of speech signals in compliance with ITU G.726.

The ADPCM algorithm provides a further 2:1 speech compression capability beyond the nominal 2.5:1 compression obtained in the DSI stage.

Under normal traffic conditions, speech signals are coded with 4 bits per sample (32 kbit/s). Under overload conditions, the ADPCM is instructed to use 24 kbit/s or 16 kbit/s coding.

## 2.6 VBR - Variable Bit Rate

The VBR stage creates additional speech bearer channels to cope with periods of traffic overload.

The LRE mode, ADPCM or LD-CELP provides the following alternatives:

### 2.6.1 VBR and LD-CELP

During normal operation, LD-CELP codecs process speech, using 2 bit per sample encoding. Under overload conditions, additional speech channels are created using fewer bits per sample. This is achieved by performing 12.8 kbit/s or 9.6 kbit/s coding.

This process distributes the less than 2 bit per sample encoding among all the active speech channels, using a randomizing algorithm (G.728). This ensures equal speech quality for all users.

### 2.6.2 VBR and ADPCM

During normal operation, ADPCM codecs process speech using 4 bit per sample encoding. Under overload conditions, additional speech channels are created by the VBR process.

This is achieved by dynamic allocation of 3 instead of 4 bits per sample (or 2 instead of 3) for a number of ADPCM speech channels.

A random process distributes the 3 (or 2) bit samples evenly among all active speech channels to ensure equal speech quality for all users.

## 2.7 VBD-LRE - Voice Band Data Low Rate Encoding

This stage compresses incoming voice-band data signals of up to and including 19.2 kbit/s from eight (8) bits per sample into five (5) bits per sample.

The LD-CELP codecs provide reliable encoding and transmission of VBD of up to and including 19.2 kbit/s data rate. The ADPCM VBD codecs (ITU G.726) provide encoding and transmission of non-fax data of up to and including 12.0 kbit/s data rate.

The VBD calls are protected against bit reduction and clipping.

## 2.8 FAX - Group 3 Facsimile

### 2.8.1 FAX Process: (Demodulation / Remodulation)

In the transmit direction, the Fax Dem/Mod block of the fax stage demodulates all fax data (ITU-Group 3 type) of up to and including 14.4 kbit/s, and sends the information over the bearer in dedicated bearer channels (Fax Banks). The fax data bits are managed within the Fax Banks in compliance with ITU G.766.

In the receive direction, the Fax Dem/Mod block of the fax stage performs the reverse process. Fax data contained in the received bearer is modulated back and transformed into the original 64 kbit/s fax data.

### FEC - Forward Error Correction

The FEC stage enables the system to transmit demodulated fax data using two operator-selected modes:

- ☐ Without FEC - When dealing with good error-performance bearers (e.g.,  $BER \leq 10^{-6}$ ). In this mode, the system achieves more than 6:1 compression ratio.
- ☐ With FEC - For poor bit error performance bearers (e.g.,  $BER > 10^{-5}$ ), a significant enhancement in fax transmitted calls is possible using Forward Error Correction (FEC Enabled). In this mode, the system achieves up to 4:1 compression ratio.

## 2.9 BM - Bit Mapping

This stage allocates bits belonging to compressed speech and voice band data signals, transparent channels, fax demodulated calls, and signaling into their corresponding bearer channel positions.

## 2.10 BR-DLI - Bearer Digital Line Interface (PCM)

The BR-DLI stage provides the interface between the internal NRZ signals of the DTX-360 and the standard 1.544 or 2.048 Mbit/s bearers. It performs the same tasks as the TR-DLI.

# TRAFFIC HANDLING FEATURES

## 3.1 Performance

The DTX-360 system handles traffic consisting of Speech, Voice-Band Data, Fax and Non-Fax, High-Speed Data, and Inter-Exchange Signaling information.

The DTX-360 system provides both the highest Digital Circuit Multiplication figures and the best transmission quality.

Speech signals are low-rate encoded using ADPCM (Adaptive Differential PCM) or LD-CELP (Low Delay - Code Excited Linear Prediction) algorithms.

Using the ADPCM algorithm, speech signals are transmitted at a nominal total compression ratio of 5:1.

Using the LD-CELP algorithm, speech signals are transmitted at a nominal total compression ratio of 10:1.

When the LD-CELP algorithm is used, the performance of the LD-CELP encoder at 16 kbit/s closely resembles the performance of the standard ADPCM at 32 kbit/s. The inclusion of the VBR process enables operation at any rate between 9.6 kbit/s and 16 kbit/s.

In addition, ITU Group 3 fax calls using standard or non-standard protocols, in accordance with ITU-REC.T.30, can be detected and demodulated with the aid of the fax compression unit.

The Fax Demodulation process is implemented using Waveform Analysis techniques.

The Fax mode of operation permits two user-selected features: Fax Demodulation without or with Forward Error Correction (FEC disabled and FEC enabled, respectively).

When FEC is enabled, the DTX-360 can operate successfully over routes with poor Bit Error Rate performance (e.g., BER between  $10^{-3}$  and  $10^{-5}$ ).

Fax calls of the ITU Group 3 type are transmitted with a compression ratio of more than 6:1 when the DTX-360 operates with FEC disabled, and with a compression ratio of more than 4:1 when FEC is enabled.

A maximum of 180 simultaneous fax calls of ITU V.17, V.29, and V.27 types, or 96 simultaneous fax calls of ITU V.17 type can be recognized and demodulated by the DTX-360.

The DTX-360 system operating in LD-CELP mode provides higher traffic load capacity than in the ITU G.763 and G.766 modes.

Figure 3-1 and Figure 3-2 show the overall traffic capacity of the DTX-360 with LD-CELP and ITU G.763 and G.766 modes. The figures show different traffic load conditions - with Forward Error Correction disabled and enabled for fax demodulated calls (Computations are based on a full bearer.)

## 3.2 Bearer Assignment

The DTX-360 transmits digital signals which are dynamically assigned or pre-assigned in the bearer bit stream.

Intermediate Trunks carrying non-pre-assigned signals are constantly scanned by the DTX-360 on a per time slot basis.

When signal energy is detected, a classification process takes place to determine the appropriate processes. See Table 3-1.

**Table 3-1 Signal Processing Alternatives**

SIGNAL TYPE	PROCESS
Voice	Digital Speech Interpolation plus Low Rate Encoding plus Variable Bit Rate
Voice Band Data Non-Fax	Low Rate Encoding
ITU-Group 3 Fax	FAX Demodulation plus FEC (optional)

Finally, the signals are compressed into a single bitstream (Bearer) where each signal occupies a bearer facility (Bearer Channel) assigned by the system.

In addition, pre-assigned signals are included in the bearer in previously system-defined bearer facilities.

### 3.2.1 Dynamic Assignment

The following types of Dynamic Assignment are available:

- ❑ **Speech Traffic:** Speech traffic is compressed using Digital Speech Interpolation (DSI) and Low Rate Encoding (LRE), LD-CELP or ADPCM.

When the LD-CELP mode is used, speech-type calls are encoded by the LD-CELP algorithm and transmitted through the bearer via bearer channels at bit rates of 16, 12.8 or 9.6 kbit/s, depending on the traffic load characteristics.

If the ITU G.763 - G.766 mode is used, speech calls are encoded by the ADPCM algorithm according to ITU G.726 and are

transmitted through the bearer via bearer channels at bit rates of 16, 24 or 32 kbit/s, depending on traffic load.

- ❑ **Voice-Band Data Traffic:** Non-Fax VBD traffic is subjected to Low Rate Encoding Techniques using LD-CELP (up to 19.2 kbit/s) and/or ADPCM (up to 12.0 kbit/s), and transmitted via the bearer bit stream at 40 kbit/s.
- ❑ **Fax Traffic:** ITU Group 3 (standard and non-standard protocol) fax calls are recognized and demodulated by the fax compression unit which supports ITU V.17, V.27, and V.29.

An optional Forward Error Correction feature enables the DTX-360 to operate successfully over any route with poor bit error performance (i.e. BER between  $10^{-3}$  and  $10^{-5}$ ).

Fax demodulated calls are dynamically assigned to 32 kbit/s bearer channels, called Fax Banks. The assignment is performed in accordance with ITU G.766.

- ❑ **64 kbit/s Traffic:** 64 kbit/s unrestricted traffic may be connected on demand from the ISC, to bearer channels. This is done transparently (not subjected to DSI and LRE), if a DCME-to-ISC interface (i.e., ITU Q.50) is provided to identify the relevant trunk channel.

### 3.2.2 Pre-Assignment

- ❑ **Nx64 kbit/s:** The DTX-360 supports pre-assignment of Nx64 kbit/s channels.
- ❑ **64 kbit/s, 40 kbit/s, 32 kbit/s and 16 kbit/s Traffic Pre-Assignment:** 64 kbit/s, 40 kbit/s, 32 kbit/s and 16 kbit/s channels may be pre-assigned for leased line services which would not be subjected to DSI or VBR processes.

When ADPCM (G.726) encoding is used, pre-assigned channels are transmitted at a fixed rate of 40 or 32 kbit/s.

If LD-CELP encoding is used, pre-assigned channels are transmitted at a fixed rate of 40 or 16 kbit/s.

### 3.2.3 Inter-Exchange Signaling

- ❑ **ITU Signaling System No. 5: ITU #5** signals will be passed transparently through the DTX-360 using dynamically assigned channels.
- ❑ **ITU R1 and R2D Signaling Systems:** Signals corresponding to Signaling Systems ITU R1 and R2D can be transmitted within the control channel when the optional signaling module is included.
- ❑ **ITU Signaling Systems No. 6 and 7:** ITU #6 and ITU#7 signals can be accommodated through 64 kbit/s pre-assigned channels.

## 3.3 Network Operating Modes

The DTX-360 supports the following modes of operation (ITU Rec. G.763).

- ❑ Point-to-Point (Single-Destination Mode)
- ❑ Multi-Clique Mode (MC)
- ❑ Multi-Destination Mode (MD)
- ❑ Interoperation

The different multiple destination capabilities of the DTX-360 for the above mentioned modes are summarized in Table 3-2(a) and Table 3-2(b).

**Table 3-2. DCME Multiple Destination Capability for Multi-Clique and Multi-Destination Modes**

#### a. Transmit

	TOTAL NO. OF DESTINATIONS	POOLS IN THE BEARER	NO. OF DESTINATIONS IN THE POOL
Multi-Clique	1-4	ADPCM - 1,2 LDCELP - 1-4	1
Multi-Destination	4 Max.	1 2	1 to 4

#### b. Receive

	TOTAL NO. OF ORIGINS	NO. OF RECEIVED BEARERS	NO. OF POOLS IN EACH BEARER
Multi-Clique	4 Max. (in LDCELP)	1	1 - 4
Multi-Destination	4 Max.	4 Max.	1

### 3.3.1 Multi-Clique (MC) Mode

In the Multi-Clique (MC) mode, one DTX-360 or DTX-360C terminal can be interconnected to up to four distant terminals (LD-CELP) or up to two distant terminals (ADPCM), using the same bearer link but different bearer channels for each destination. The bearer channels are subdivided into four (4) independent pools (LD-CELP) or two (2) independent pools (ADPCM).

Each pool has a fixed capacity and corresponds to a defined route.

The allocation of trunk channels over a specific clique has no effect on the allocation of bearer capacity over the other clique.

### 3.3.2 Multi-Destination (MD) Mode

In the Multi-Destination Mode (MD), one DTX-360 terminal can be interconnected with up to four (4) distant terminals using the same bearer link and sharing bearer channels.

Using Multi-Destination, the input Intermediate Trunk signals for all destinations are compressed and interpolated over the same group of bearer channels.

### 3.3.3 Interoperation

In the Interoperation Mode, the Bearer Pool of a DTX-360 may be divided so it can connect to up to three Multi-Destination terminals and one single destination terminal.

## 3.4 Traffic Overload Handling

The DTX-360 system employs a Variable Bit Rate (VBR) encoding technique to reduce adverse effects on speech quality during traffic overload periods.

Moreover, at a specified traffic threshold, the system employs a Dynamic Load Control (DLC) process. As a result, the ISC is informed by the DLC activation signal in the DTX-360 that a high traffic level has been encountered. The ISC responds by temporarily blocking any additional incoming calls for as long as the DLC signal remains active. While all new incoming calls remain blocked, the traffic load handled by the system will gradually decrease. Thus, the DLC process combined with the VBR technique, enables the DTX-360 to operate with minimum speech quality degradation.

The DLC activation and deactivation thresholds are user programmable. The DTX-360 sends

DLC activation and deactivation signals to the ISC through the corresponding ISC - DTX-360 interface using:

- ☐ ITU Q.50 protocol via trunks T.S 16
- ☐ ISC/DCME customized interface
- ☐ DLC relays (per destination)

In addition, the local terminal DLC-status is signaled to the remote terminal(s) through the control channel.

A selective DLC facility can be enabled by the operator, allowing the DLC activation/deactivation information transfer on a per-destination basis.

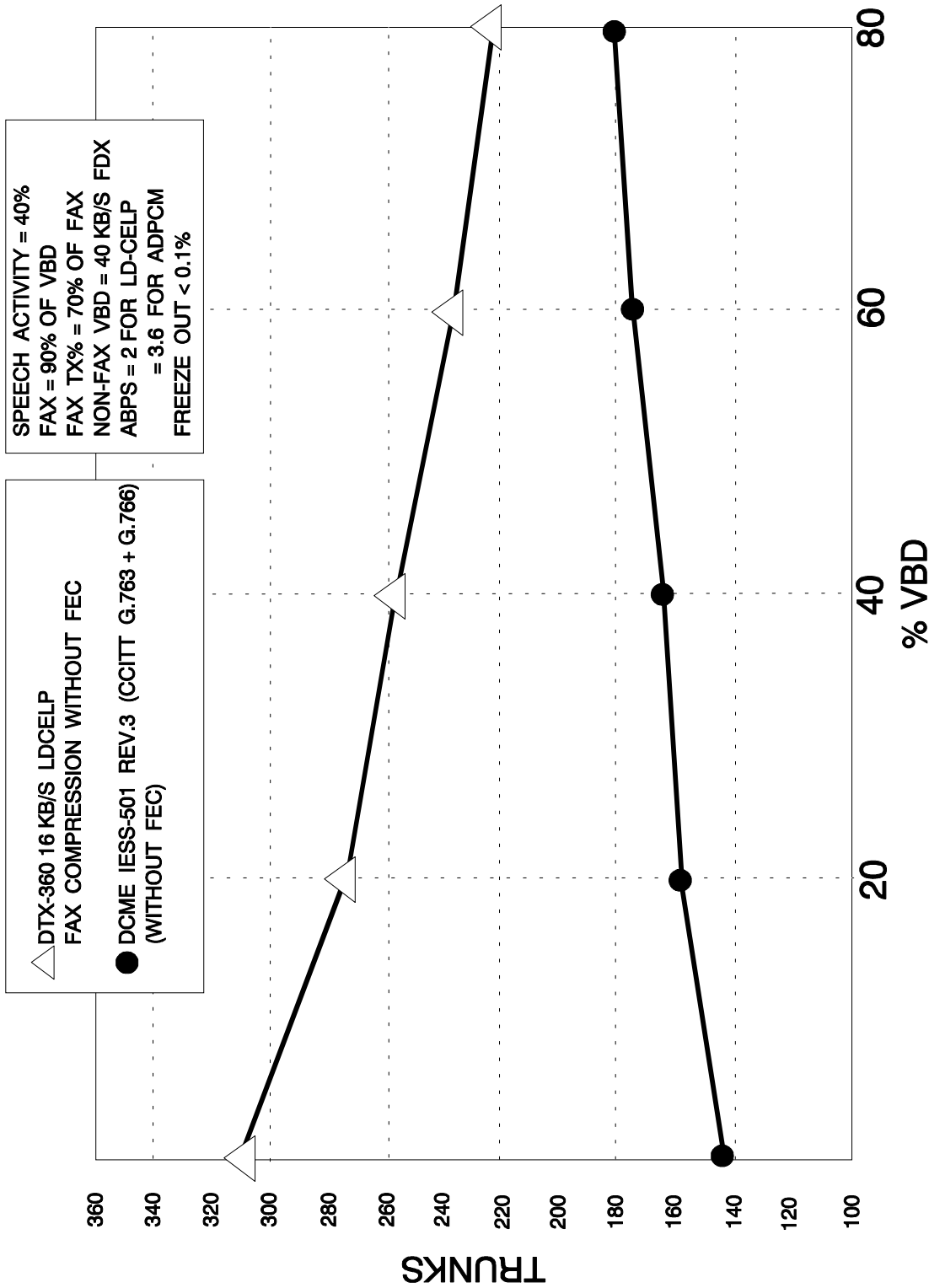


Figure 3-1. DTX-360 Traffic Capacity - FEC Disabled

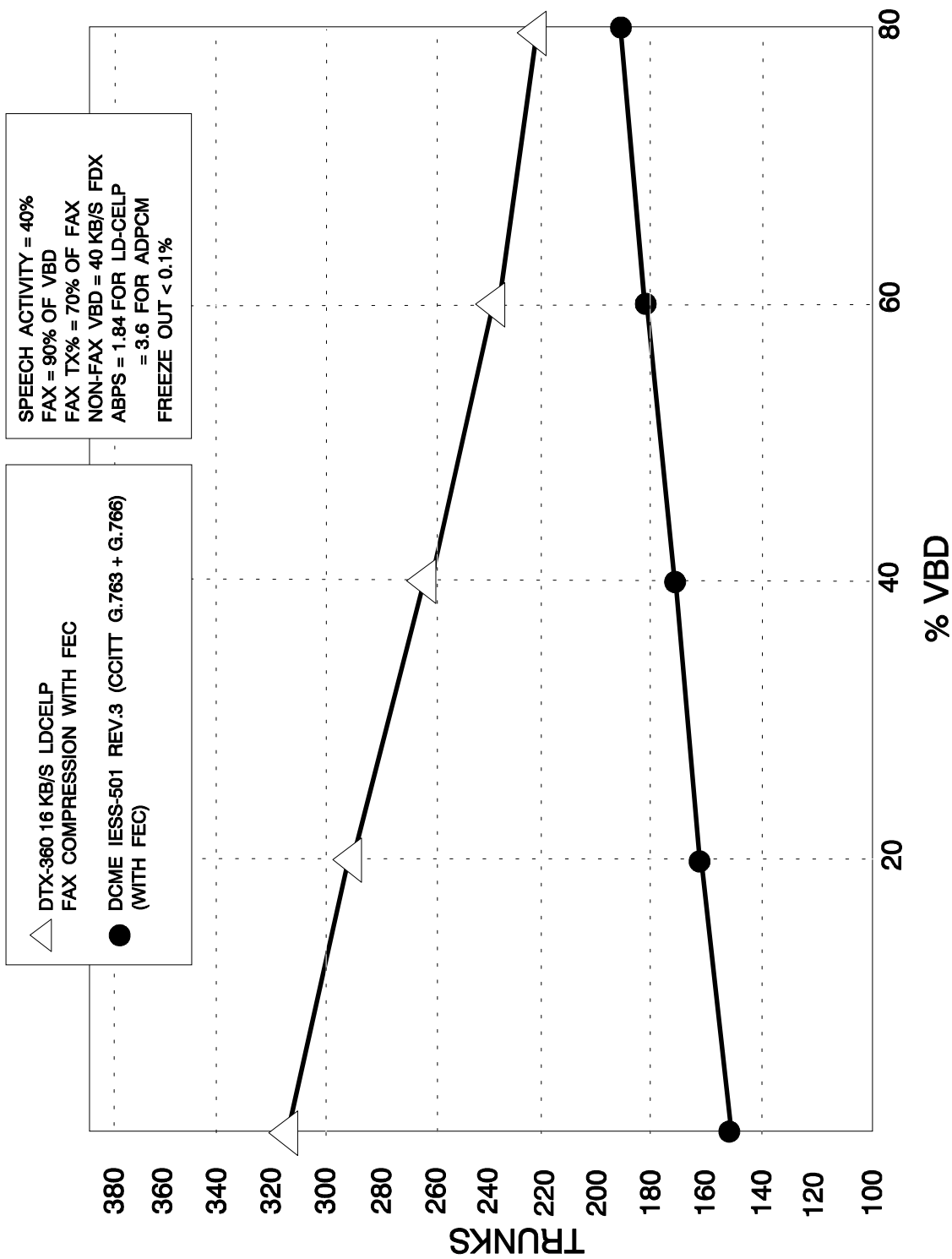


Figure 3-2. DTX-360 Traffic Capacity - FEC Enabled



# CLUSTER CONFIGURATION

## 4.1 General

Cluster Mode configuration is provided for the DTX-360 in order to achieve the highest value of system reliability.

The system's modularity allows the installation of exactly the required equipment and assures easy growth as traffic conditions change.

A complete DTX-360 cluster consists of up to five (5) cabinets. One cabinet contains the standby terminal and the Central COM (CCOM) unit providing terminal back-up protection. Each of the other four (4) cabinets contain two DTX-360 terminals and a Local COM unit (LCOM).

When operating DTX-360C terminals, up to three (3) terminals can be installed in the same cabinet. A complete DTX-360C cluster consists of three (3) cabinets. Two (2) of the cabinets contain three (3) DTX-360C terminals and a Local COM (LCOM) unit each: One (1) cabinet contains two (2) DTX-360C operating terminals, one (1) stand-by terminal, one (1) Local COM (LCOM) unit, and one (1) Central COM (CCOM) unit.

The Micro-Cluster is the smallest available cluster configuration comprising two (2) terminals [one (1) for regular service and one (1) standby] and a Local Change Over Matrix (LCOM). The Micro Cluster can be installed in a single cabinet.

A 2+1 compact configuration (two (2) operational DTX-360C terminals and one (1) DTX-360C standby terminal) can also be implemented in a single cabinet.

If one of the operating terminals fails and the fault gives rise to a change-over alarm condition, all the trunks, bearers, and DLC signals of the faulty terminal are switched to and handled by the standby terminal.

The distributed Change Over Matrix (COM) performs a two-level link transfer process with the Local COM (LCOM) performing the first level and the Central COM (CCOM) performing the second level.

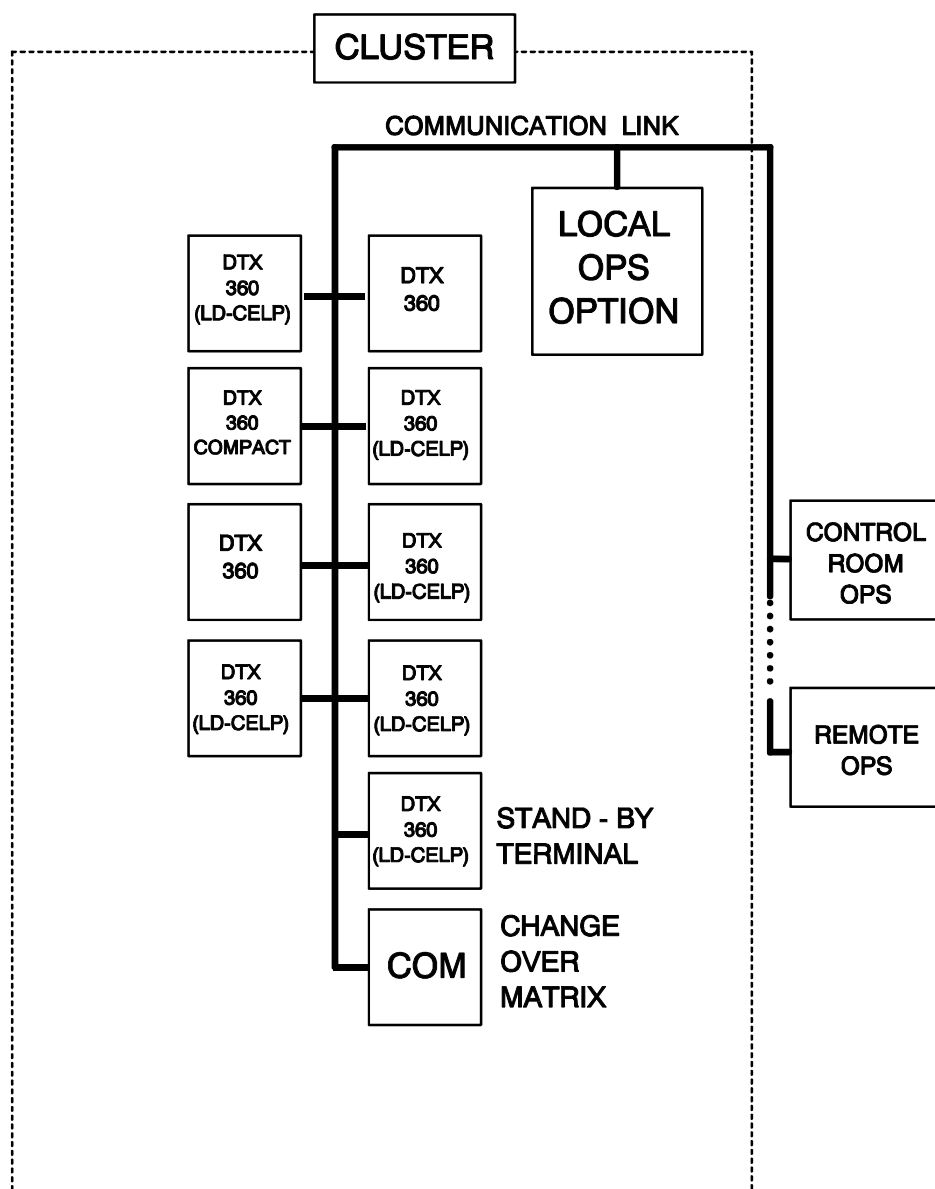
The change-over process is controlled by the Distributed Change Over Matrix (DCOM). The DCOM is implemented as a distributed structure and can be expanded gradually according to cluster size.

Each Local COM handles critical alarm events within its cabinet. The Central COM controls the cluster's Local COMs.

When a fault occurs in any of the DTX-360 terminals in a cluster, the Central COM re-assigns the selected bit streams and DLC wires from the selected Local COM unit to the standby terminal.

In the event of a malfunctioning terminal, a complete switch-over process and restoration of the system to full service is completed within several seconds.

Figure 4-1 shows a DTX-360 cluster layout including DTX-360 operating and standby terminals, Distributed Change Over Matrix, Operator Station(s) and Order Wire switch.



36708-01

Figure 4-1. DTX-360 Mixed Cluster Layout

## 4.2 DCOM - Distributed Change Over Matrix

The DTX-360 Distributed Change Over Matrix (DCOM) provides a cost-effective solution to the problem of cluster cabling.

The DCOM consists of two subsystems: Central COM (CCOM) and Local COM (LCOM).

Figure 4-2 shows the block diagram of a Distributed Change Over Matrix (DCOM), including Local and Central COM subsystems, service and back-up terminals, signal (trunks, bearers and DLC), and control links.

### 4.2.1 LCOM - Local Change Over Matrix

There are up to four LCOMs in a DTX-360 cluster. Each LCOM shares the same cabinet with up to two DTX-360 terminals (except for DTX-360 Compact - up to 3 terminals).

The signal cabling (trunk, bearers, and DLC) for each terminal-pair in a cabinet is located in the cabinet's Local COM.

Two types of cards are installed in a LCOM:

- ☐ LRMX - Local Relay Matrix
- ☐ LODP - Local Operate & Display Panel

The LRMX cards handle switching of the digital bit stream, trunks, and bearers and the DLC connection of the ISC-DTX-360 interface.

The LCOM comprises up to five (5) switching cards (LRMX); each card handles four (4) bit streams per terminal.

For example, a configuration of eight (8) trunks and one (1) bearer requires two (2) LRMX cards for the trunks and one (1) LRMX card for the bearer.

The LODP card sends control signals to the LRMX cards according to signals received from the CCOM.

When a terminal has a critical alarm condition, the Central COM sends the appropriate commands to the corresponding LCOM. The LCOM then re-routes the trunks, bearers, and DLC signals of the faulty terminal towards the CCOM (First level switching).

### 4.2.2 CCOM - Central Change Over Matrix

The Central COM is installed in the same cabinet as the standby Terminal. It controls up to four (4) LCOMs.

The CCOM contains the following cards types:

- ☐ CRMX - Central Relay Matrix
- ☐ CRIO - Central Relay Input Output Interface
- ☐ COCP - Change Over Central Processor

Normally, the CCOM comprises two (2) control cards (COCP and CRIO) and up to five (5) switching cards (CRMX); each CRMX card handles four (4) bit streams.

For example, a configuration including terminals with up to eight (8) trunks and one (1) bearer, requires two (2) CRMX cards for the trunk bit streams and one (1) CRMX card for the bearer bit stream.

The CRMX card receives the rerouted bit-streams of the LRMX cards installed in the LCOMs.

The CRIO card serves as an interface between the COCP card and CRMX relay cards. It also serves as an interface for the remote signals to the LCOMs.

The COCP detects a Critical Alarm condition in any operating DTX-360 terminal, sends the appropriate Redundancy Control signals to the corresponding LCOM, CRMXs via the CRIO card in order to initiate an immediate change-over process to the standby DTX-360 terminal.

The signals (trunks, bearers, and DLC) switched by the LCOM towards the CCOM are re-routed by the CRMX of the CCOM towards the standby terminal (second level switching).

### 4.2.3 SCOM - Single Cabinet Change Over Matrix

The basic 1+1 and 2+1 configurations require only one cabinet.

In these configurations, the DCOM is implemented as a Single Cabinet COM (SCOM). The SCOM detects a Critical Alarm condition of the in-service terminal and re-routes the appropriate signals (trunks bearers and DLC) toward the standby terminal.

In this case, COM hardware is identical to the LCOM with CRIO and COCP cards installed as a replacement for the LODP card.

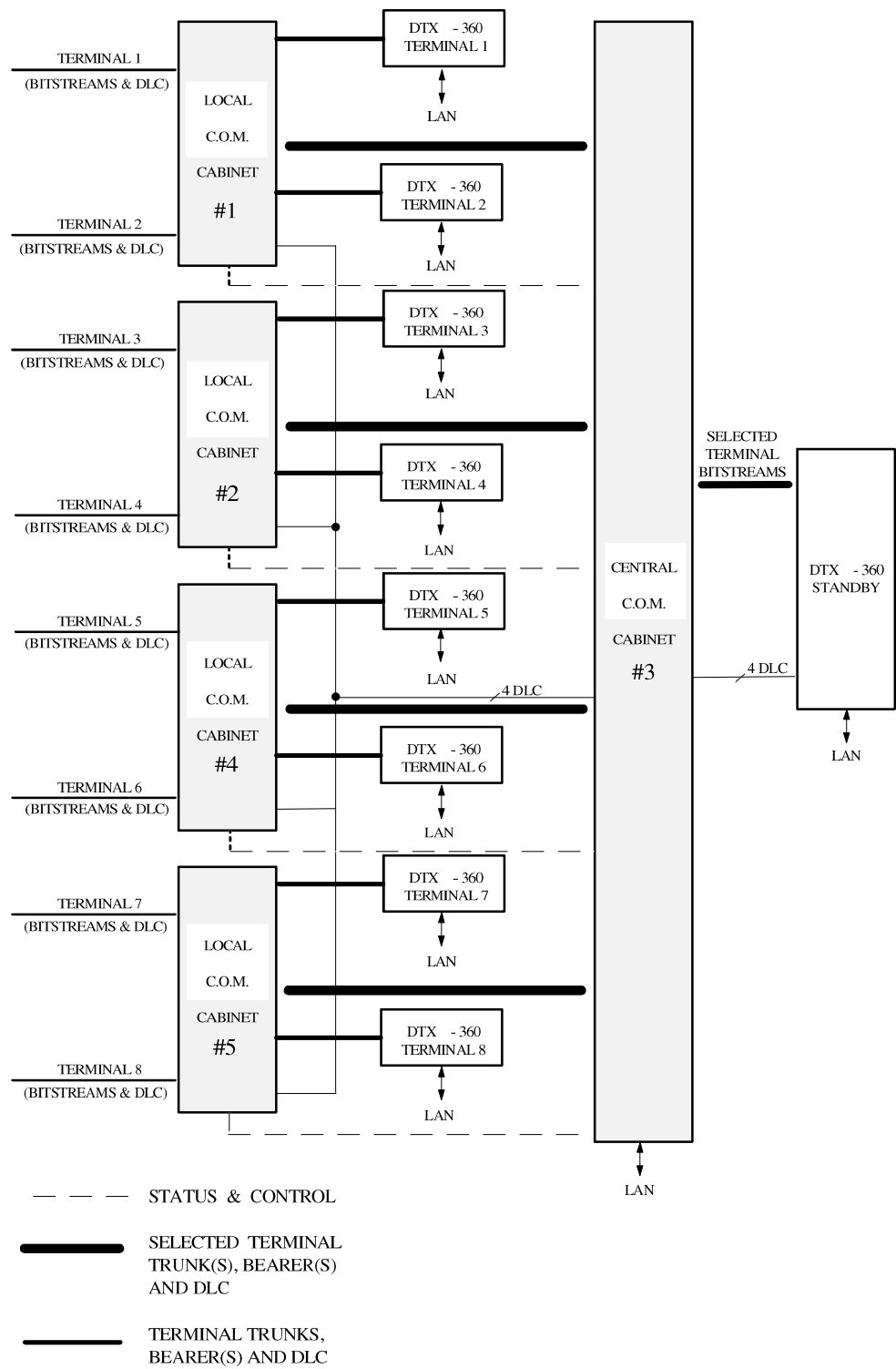


Figure 4-2. DCOM - Block Diagram

### 4.3 DTX-360 OPS

The OPS-360 is the operation and maintenance station of the DTX-360 system.

The OPS-360 provides a powerful tool for traffic and service monitoring, system maintenance, and terminal operation control.

A single OPS-360 controls up to eight (8) full DTX-360 clusters consisting of 64 operating terminals, eight (8) standby terminals, eight Distributed Change Over Matrices (DCOM), and eight optional Order Wire Switches (OWS).

The OPS-360 controls the DTX-360 cluster(s) via an Ethernet Local Area Network (LAN) data link, thereby allowing (with proper interfaces) local and/or remote site system management and control of concurrent multiple operators.

The OPS-360 is based on a Sun SPARC Work Station, a UNIX operating system, a high resolution color monitor, X-Windows and Motif graphic users interface.

The OPS-360 follows the Graphic User Interface (GUI) principles concerning Object-Oriented operations and Context Sensitivity. It is implemented using active graphic elements, main menu bar, pop-up menus, push-buttons, and dialogue boxes.

The Graphic User Interface (GUI) of the OPS-360 allows easy inspection of any controlled subsystem and offers the operator an intuitive navigation access to DTX-360 systems and subsystems.

High-level status information is readily available in graphic format at all times and routine operations can be carried out without interfering with the system's tasks.

The OPS-360 main functions are:

- ☐ Monitoring the operations of all DTX-360 terminals and other units in the controlled cluster(s)
- ☐ Displaying real-time status of controlled cluster(s), terminals and other units
- ☐ Enabling the operator to issue system commands
- ☐ Editing and downloading mapping configuration
- ☐ Maintaining logs and real time reports of alarms, operator's activities, vital statistics, non-alarm events, channel-check reports and Mapping data on the station's hard disk
- ☐ Storing and downloading terminal software

The OPS-360 can display the following periodical and on-demand reports:

- ☐ Status Reports
- ☐ Event Log
- ☐ Alarm Reports
- ☐ Statistic Time Interval Report
- ☐ Fax Statistic Time Interval Report
- ☐ Error Performance Report
- ☐ Busiest Period Report
- ☐ Fax Report
- ☐ Channel Check Report

# PHYSICAL DESCRIPTION

## 5.1 Dimensions

The DTX-360 Digital Circuit Multiplication Equipment has been designed to comply with CCITT Rec. G.231 and with additional guidelines set by major administrations.

The system is housed in a standard 23 inch wide rack and its units are installed in cabinets of the following dimensions:

### DTX-360 Cabinet

<b>WIDTH</b>	655 mm (25.75 inches)
<b>HEIGHT</b>	2134mm (84 inches) or 2600mm (102 inches)
<b>DEPTH</b>	450 mm (17.75 inches)

Figure 5-1 shows a DTX-360 Cabinet Assembly with its external dimensions.

The following shelf dimensions are used, depending on the type of equipment installed:

### DTX-360 Terminal

<b>WIDTH</b>	584 mm (23 inches)
<b>HEIGHT</b>	533 mm (21 inches)
<b>DEPTH</b>	375 mm (15 inches)

### DTX-360C Terminal

<b>WIDTH</b>	584 mm (23 inches)
<b>HEIGHT</b>	533 mm (21 inches)
<b>DEPTH</b>	375 mm (15 inches)

### LCOM and CCOM

<b>WIDTH</b>	584 mm (23 inches)
<b>HEIGHT</b>	266 mm (10.5 inches)
<b>DEPTH</b>	330 mm (13.2 inches)

## 5.2 Card Shelf Description

### 5.2.1 DTX-360 Terminal

The cards of a DTX-360 terminal are installed in two card shelves: TX and IF/RX.

Table 5-1 and Table 5-2 contain the names and designations of DTX-360 terminal cards corresponding to TX and IF/RX shelves, respectively.

**Table 5-1. DTX-360 Cards - TX Shelf**

NAME	DESIGNATION
SDSP <sup>2</sup>	Signal Analysis DSP
SCPU <sup>1</sup>	Signal Analysis CPU
TCPU <sup>1</sup>	Transmit CPU
DSIT	Digital Speech Interpolation - Transmit
ADPC	Adaptive Differential PCM Encoder
TDSP <sup>2</sup>	Transmit Demodulator (Fax)
LDCT LDCH	Low Delay - Code Excited Linear Prediction Encoder - TX
BMCT	Bit Map CPU - Transmit
AUXC	Auxiliary Card

**Table 5-2. DTX-360 Cards - IF/RX Shelf**

NAME	DESIGNATION
RDSW	Redundancy Switch
QDLI	Quad Digital Line Interface
CKSL	Clock Select
TSDF	Time Slot Interchange and DCME Frame Alignment
SIGN	Signaling CPU
OMCP	Operation and Maintenance CPU
RCPU <sup>1</sup>	Receive CPU
DSIR	Digital Speech Interpolation - Receive
ADPX	Adaptive Differential PCM - Decoder
RDSP <sup>2</sup>	Receive Remodulator (Fax)
LDCH	Low Delay - Code Excited Linear Prediction Decoder - RX
BMCR	Bit Map CPU - Receive

Figure 5-2 and Figure 5-3 show typical DTX-360 cluster configurations corresponding to upper and lower cabling installation, respectively.

Figure 5-4 and Figure 5-5 show the card slot designation of DTX-360 terminals, with or without LD-CELP mode option, respectively.

Figure 5-6 shows the card slot designation of a DTX-360C terminal.

### 5.2.2 Change-Over Matrix (COM)

The Change-Over Matrix is implemented using a distributed structure. Local COM (LCOM) functions are distributed to the terminal and are controlled by a Central COM (CCOM).

A complete Change-Over Matrix consists of one Central Change-Over Matrix and up to four Local Change-Over Matrices.

The CCOM shares the same cabinet with the DTX-360 Redundant Terminal, while the LCOMs are situated in the cabinets of the Cluster's operating terminals.

Table 5-3 contains the names and designations of the DTX-360 COM cards. The L/C column indicates whether the card belongs to a Local or Central COM.

**Table 5-3. DTX-360 COM Cards**

NAME	DESIGNATION	L/C
CRMX	Central Relay Matrix	C
CRIO	Central Relay Input-Output Interface	C
COCP	Change Over Central Processor	C
LRMX	Local Relay Matrix	L
LODP	Local Operator Display Panel	L

**Note:** When the LCOM functions in a 1+1 configuration, the LODP card is replaced by the CRIO card and a COCP card is added.

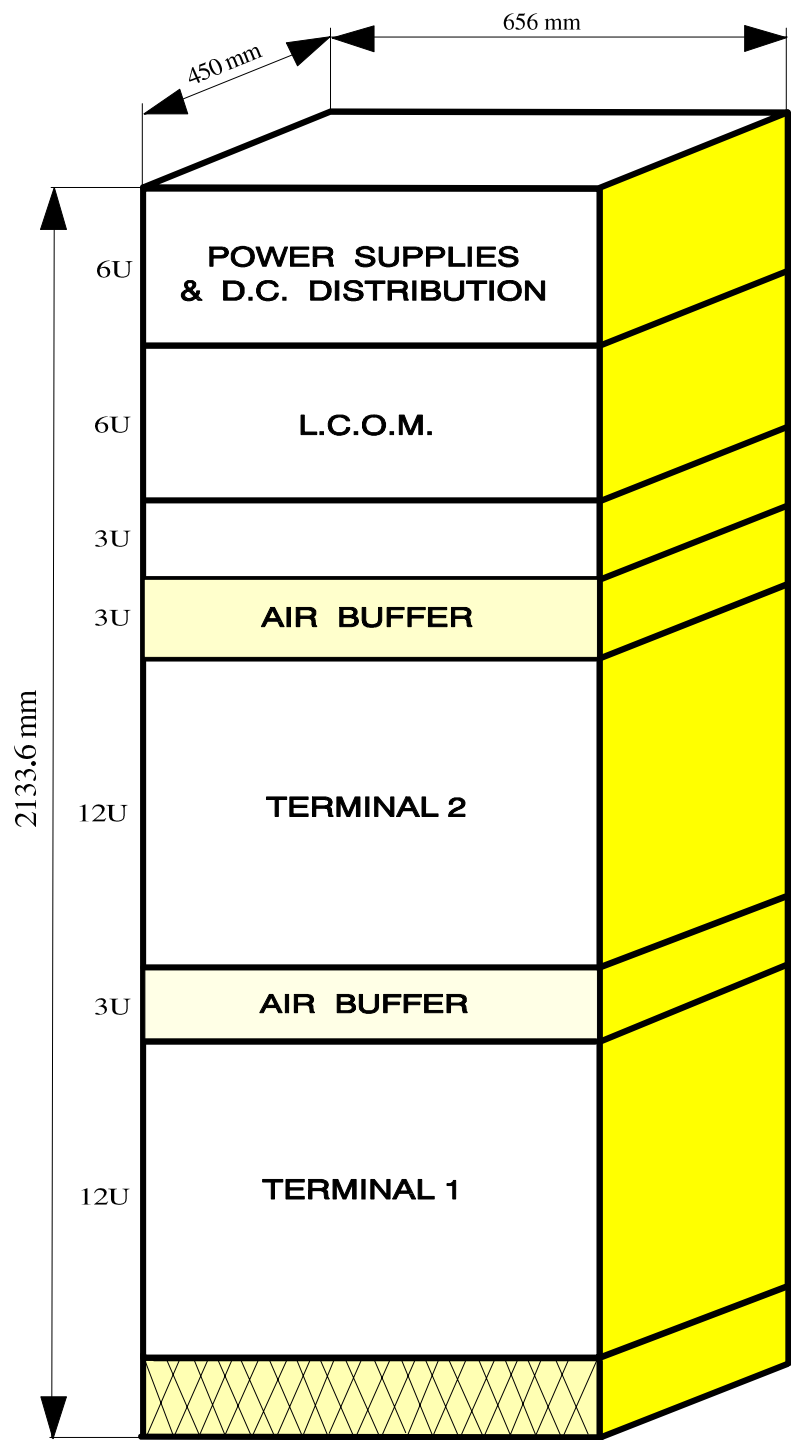
Figure 5-7 and Figure 5-8 show the slot designation CCOM and LCOM cards, respectively.

## 5.3 Power Supply

Each DTX-360 cabinet receives power from up to six (6) power supplies. The Power Supplies for the terminals are installed in the same cabinet as the terminals they serve. Power distribution is done through a protection circuit breaker panel, installed in the same shelf.

<sup>1</sup> These cards are implemented with the same hardware (-CPU). Their physical location defines their task.

<sup>2</sup> These cards are implemented with the same hardware (-DSP). Their physical location defines their task.



**1U = 1.75 INCHES = 4.445 CENTIMETERS**

Figure 5-1. DTX-360 Cabinet Assembly



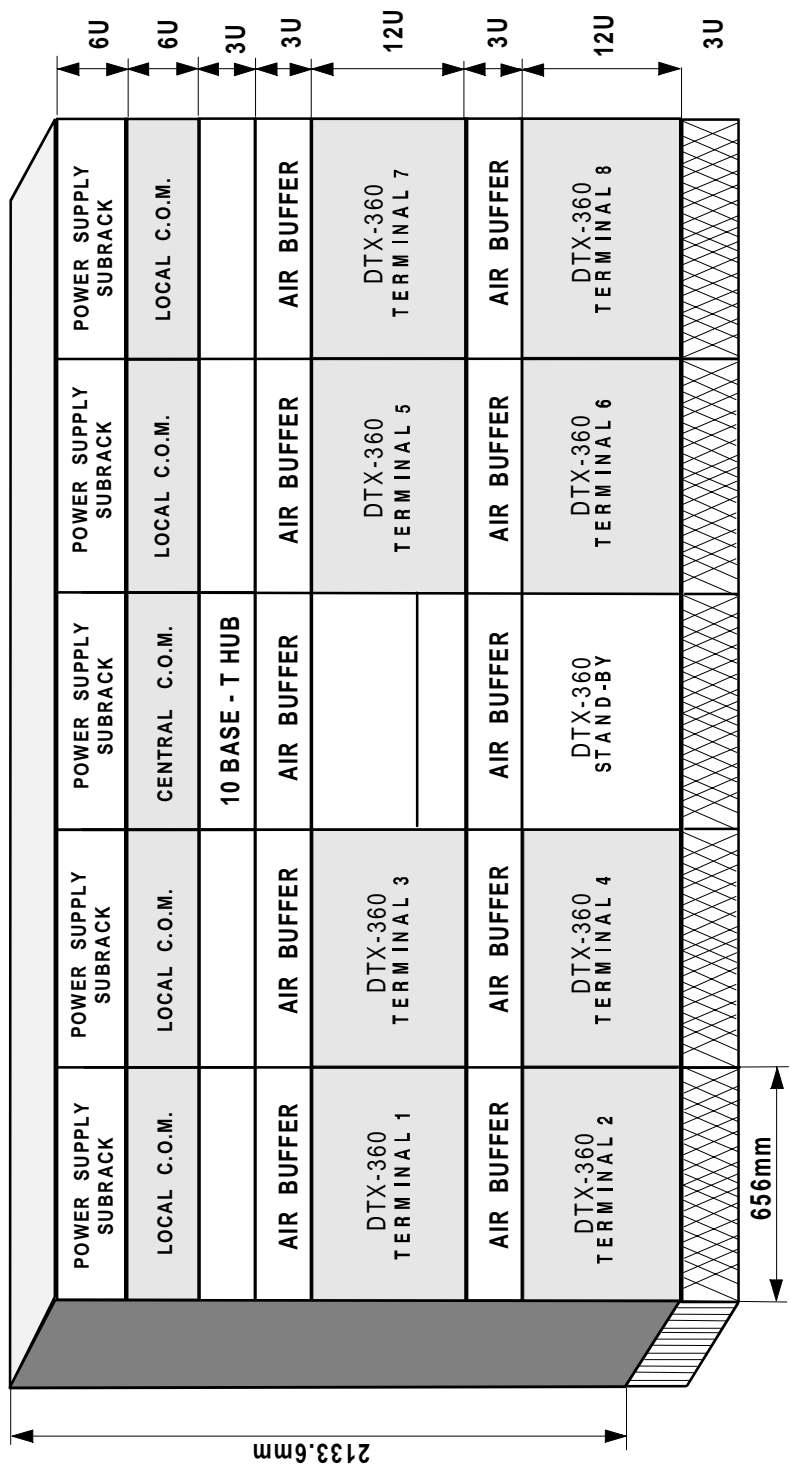


Figure 5-2. Typical DTX-360 Cluster Configuration - Upper Cabling Installation

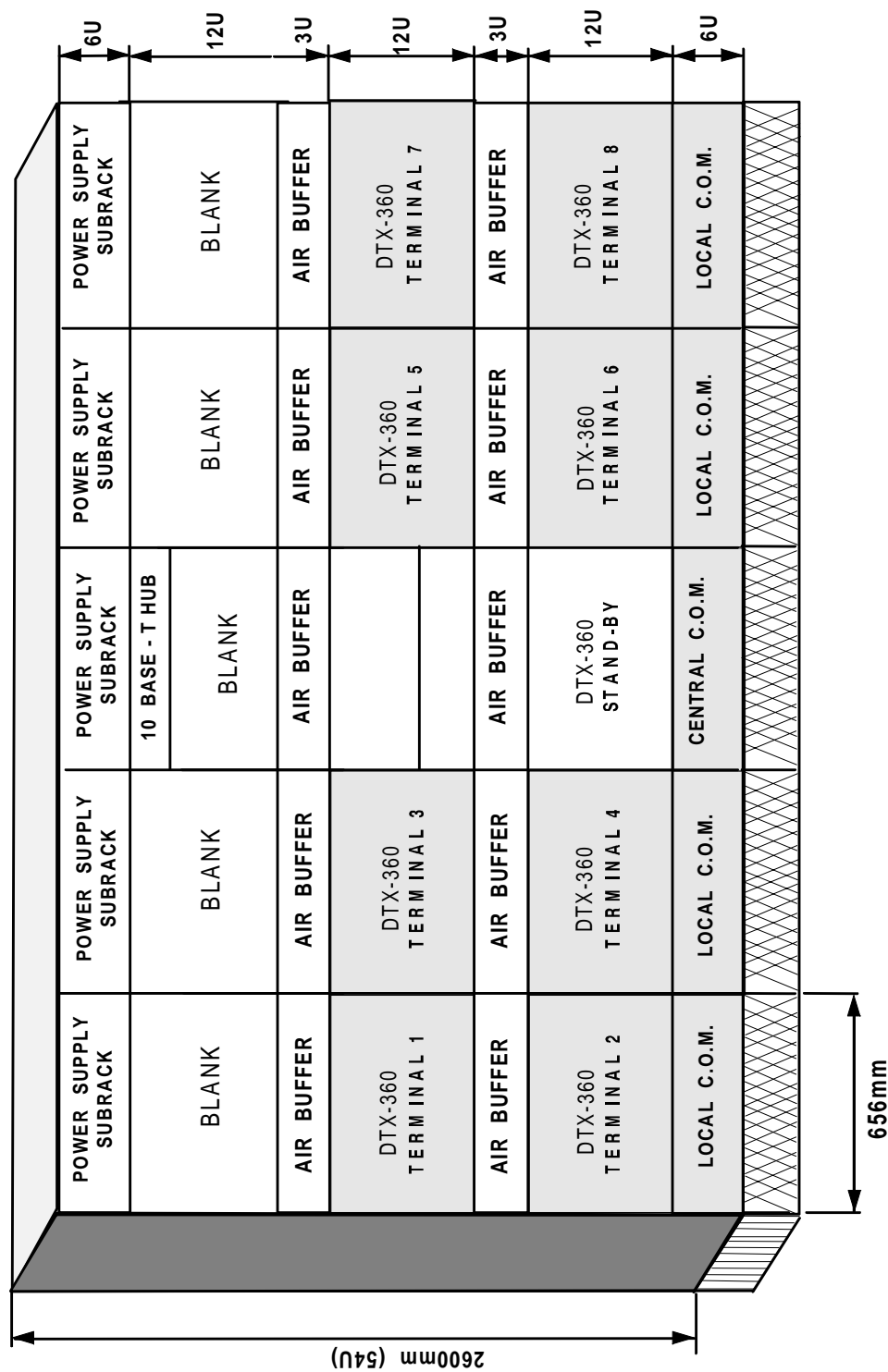


Figure 5-3. Typical DTX-360 Cluster Configuration - Lower Cabling Installation



Figure 5-5. DTX-360 - CCITT G.763 & G.766 Configuration Card Slot Designation

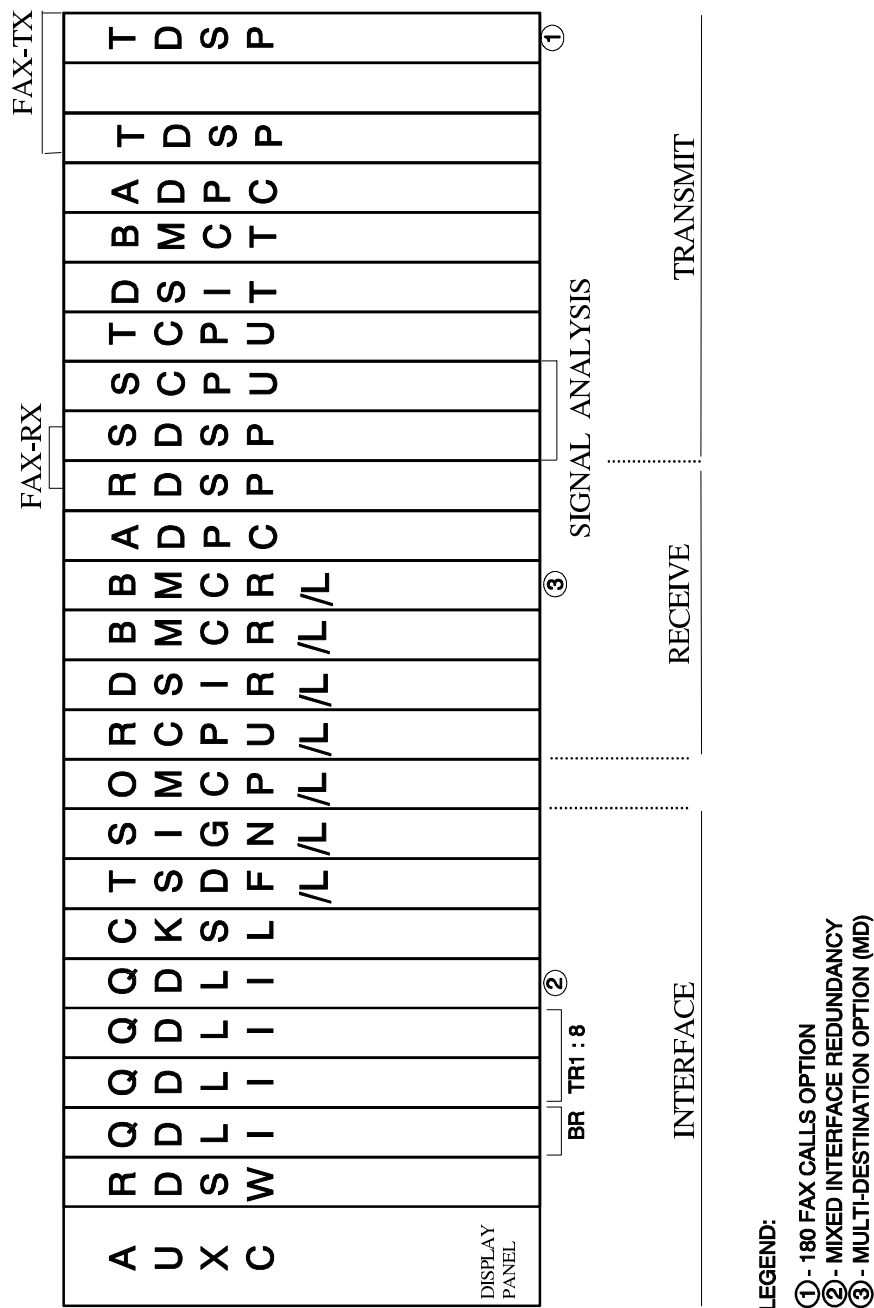


Figure 5-6. DTX-360C - Card Slot Designation

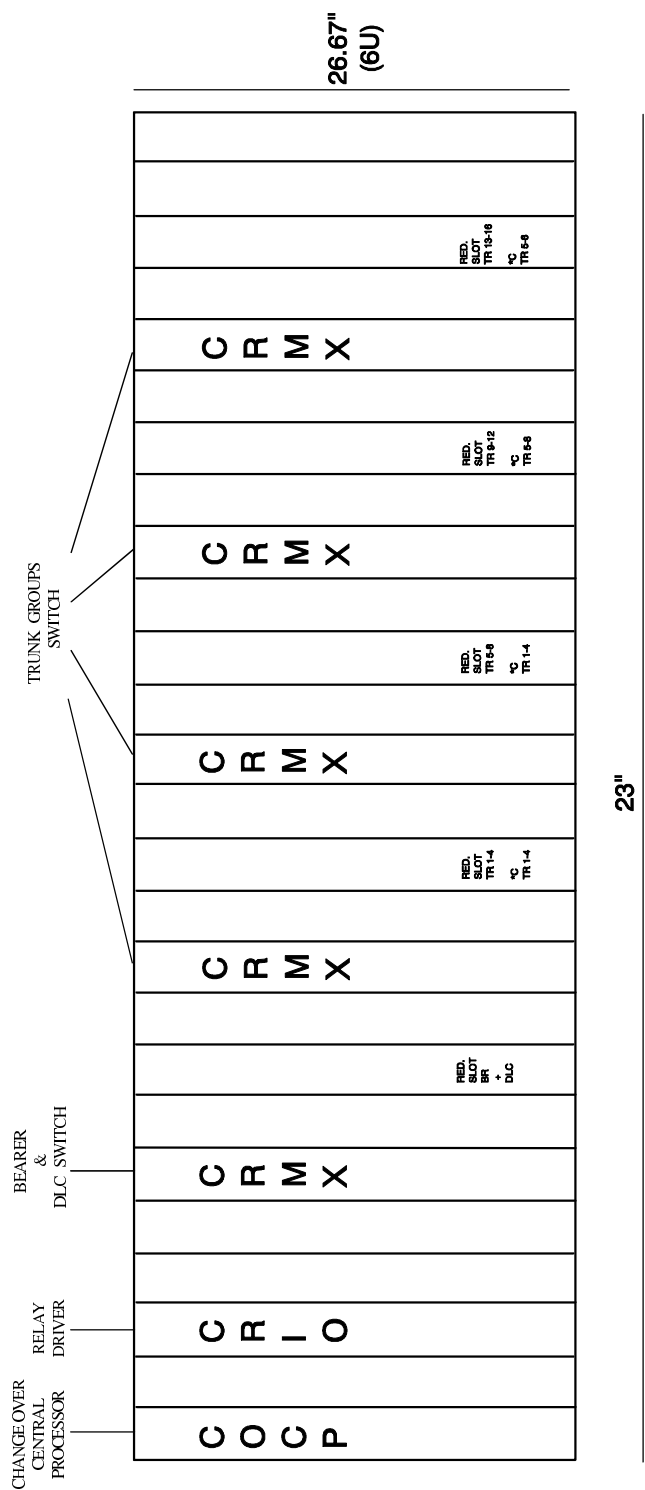


Figure 5-7. Central COM - Card Slot Designation



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# TERMINAL CARDS

## FUNCTIONAL DESCRIPTION

### 6.1 Functional Subsystems

The DTX-360 terminal internal processes are divided into three functional subsystems:

- ☐ Interface Subsystem
- ☐ Transmit Subsystem
- ☐ Receive Subsystem

The following section provides the functional description of the DTX-360 terminal cards.

### 6.2 Interface Subsystems

The Interface Subsystem provides signal interface and redundancy functions between external and internal bitstreams.

#### 6.2.1 RDSW - Redundancy Switch

The RDSW cards provide redundancy switching facilities for the Trunk and Bearer QDLI (Quad Digital Line Interface - see item 6.2.2) cards on the QDLI external side.

A Redundant QDLI (R-QDLI) backs up the operating Trunk QDLI (TR-QDLI) and Bearer QDLI (B-QDLI) cards. An optional Redundant Bearer QDLI (RB-QDLI) can also be installed, providing exclusive B-QDLI backup functions.

If an operating QDLI fails, the OMCP (Operation & Maintenance CPU) card sends appropriate commands to the RDSW card in order to switch

the corresponding bit streams (trunks or bearers) to the redundant QDLI.

A single RDSW card supports up to eight (8) trunks and four (4) bearers. For additional trunks, a second RDSW is required.

In addition, the RDSW provides a Bypass connection from trunk to bearer facilities. Test connectors on the front panel provide high impedance monitoring facilities for trunk and bearer primary groups.

#### 6.2.2 QDLI - Quad Digital Line Interface

One (1) QDLI card supports four (4) Digital Line Interfaces (DLIs) of the E1 (2.048 Mbit/s) or T1 (1.544 Mbit/s) type.

Each Digital Line Interface performs the following tasks:

- ☐ Timing recovery from an input bit stream
- ☐ Detection of alarm status on each of the incoming bit streams
- ☐ Displaying of incoming alarm status (AIS, FR & RAI)
- ☐ Timing coordination between bit stream clocks and system clocks
- ☐ Generation of framing and alarm signals in the outgoing bit streams



- ☐ Error Performance parameter calculation
- ☐ Transmission of Error Performance reports to the OMCP
- ☐ Communication with the Operation & Maintenance CPU (OMCP)
- ☐ Selection of current system clock
- ☐ Injection of signaling data in the outgoing digital trunks
- ☐ Digital Line termination and protection (75 Ohm-E1, 120 Ohm-E1 & 100 Ohm-T1)
- ☐ Signal conversion (from bipolar into NRZ for incoming bit streams and from NRZ to bipolar for outgoing bit streams)
- ☐ Line Code conversion (HDB3, B8ZS)
- ☐ Built-In-Test
- ☐ Bit Rate conversion when dealing with T1 standard bit streams

A DTX-360 DCME contains up to three TR-QDLIs (T1 up to 4), one B-QDLI, one R-QDLI and one optional RB-QDLI. An R-QDLI provides backup protection for both types, TR-QDLI and B-QDLI. When the optional RB-QDLI is included, it provides exclusive redundancy for the B-QDLI card.

#### 6.2.2.1 Near-End Error Performance

Each DLI calculates Near End Error Performance and sends messages with the following information:

- ☐ Bit Stream Number
- ☐ Measurement Time
- ☐ Available Time
- ☐ Errored Seconds
- ☐ Severe Errored Seconds
- ☐ Alarmed Seconds
- ☐ Slip-In Seconds
- ☐ Slip Rx Seconds

#### 6.2.2.2 Far-End Error Performance

When the DTX-360 operates in Single Destination Mode it is possible to calculate the Tx bearer link performance. The far-end block errors of the CRC-4 procedure are used to calculate the Tx bearer error performance.

The DLI sends messages with the following parameters:

- ☐ DLI Bit Stream
- ☐ Measurement Time
- ☐ Unavailable Time
- ☐ Errored Seconds
- ☐ Severely Errored Seconds
- ☐ Alarmed Seconds (seconds with Remote Alarm Indication - RAI)

#### 6.2.3 TSDF - Time Slot Interchange and DCME Frame Alignment

The TSDF card provides mapping and QDLI redundancy switching functions.

Additionally, a Time Slot Interchange block provides mapping functions between system external trunk channels and internal (Intermediate Trunks) 64 kbit/s timeslots.

The Transmit Time Slot Interchange (TTSI) switch receives up to twelve 2.048 Mbit/s bit streams carrying traffic signals, plus one bit stream carrying Order Wire and Test signals. These bit streams are mapped into six 4.096 Mbit/s bit streams at the output of the TTSI.

The Receive Time Slot Interchange (RTSI) switch performs the inverse process for signals arriving from the Receive Subsystem.

When a QDLI fails and its function is provided by a redundant QDLI, the TSDF card routes the digital bit streams supported by the R-QDLI or BR-QDLI into the correct internal bit stream.

The switching functions are performed upon receipt of commands from the OMCP card.

In addition, the TSDF card provides facilities related with Control Channel synchronization and DCME Frame Alignment, when operating in Multi-Clique or Multi-Destination modes.

#### 6.2.4 CKSL - Clock Select Card

The CKSL card provides system timing signals.

The card generates the various system clocks of a DTX-360 terminal:

- ☐ Tx - Transmit Clock
- ☐ TRO - Trunk Output Clock
- ☐ Rx - Receive Clock

Each clock source is selected from the following group:

- ☐ Incoming Trunks
- ☐ Incoming Bearer(s)
- ☐ External Clock
- ☐ Internal Clock

The source selection is implemented by a set of multiplexers controlled by the OMCP.

For each system clock, a main source and a reserve source are defined. If both main and reserve sources fail, an emergency fallback clock is selected.

The CKSL card includes monitoring circuits for the above mentioned clocks. The results of the verifications are reported to the OMCP card. In case of a clock fail condition, the OMCP generates a new selection process of the appropriate current clock.

### 6.3 Transmit Subsystem

The Transmit Subsystem receives traffic signals (carried by the transmitting trunk bit streams) from the Interface Subsystem. The Transmit Subsystem performs signal detection and classification, accomplishes the appropriate compression procedures, builds up the outgoing bearer signal, and sends it to the Interface Subsystem.

#### 6.3.1 DSIT - Digital Speech Interpolation - Transmit

The DSIT card provides timing and switching functions in the transmit direction.

The card has two main sections:

- ☐ TDELAY: Transmit Delay
- ☐ TDSI: Transmit Digital Speech Interpolation Switch

The information received from the TSDF card is delayed by the TDELAY section to compensate for the delay in signal analysis timing requirements.

In addition, the bitstreams outgoing from the TTSI block in the TSDF card are switched into bitstreams routed to the SDSP card. This task is performed under control of the SCPU card.

The TDSI section implements the Digital Speech Interpolation Technique for voice band traffic signals. Voice band signals contained in 4.096 Mbit/s bitstreams, arriving either directly or through the TDELAY, are compressed into a few timeslots by the elimination of the corresponding silence intervals.

The compressed digital samples are then transmitted to the TDSP, ADPC or LD-CELP cards.

#### 6.3.2 SDSP - Signal Analysis DSP SCPU - Signal Analysis CPU

The SDSP and SCPU cards perform the following main tasks:

- ☐ Signal Activity Detection
- ☐ Incoming Signal Classification
- ☐ Background Noise Measurement

The SDSP card works under control of the SCPU card

The transmit channel inputs received from the DSIT card are monitored on a time slot basis. Upon detection of time slot activity a T.S. Activity Status Table is updated and a classification process is initiated.

Incoming signal samples are classified according to Speech, signaling, Non-Fax Voice Band Data, and Fax calls.

Fax Calls are further analyzed in order to establish their type of modulation and speed. This is performed in the FDSP card.

The Hangover Time parameter for the Activity Detectors is also defined on a per time slot basis, and depends on the results of the signal classification stage. In addition, the background noise of non-active time slots is measured and the corresponding values are sent to the TCPU card.

### 6.3.3 TCPU - Transmit CPU

The TCPU card handles the transmit side of the DTX-360 terminal. The card manages the encoders and bearer resources and assigns active channels to the appropriate encoder and bearer channel.

The TCPU card receives information related to Intermediate Trunk signal activity state transitions from the SCPU card. The card generates assignment messages that are sent to the far-end DCME terminal.

The messages contain all the information required by the Receive Subsystem of the far-end terminal (IT number, BC number and BC type) in order to perform the appropriate connections and complete the channel path.

The assignment messages are constructed according to the Control Channel message format specified in the ITU G.763 Recommendation (Rev. 3).

A local encoder is selected from the available pool of FDSP, ADPC or LD-CELP cards to perform the required processing on the transmitted signal, according to its classified type.

Signaling messages received from the optional SIGN card are also handled by means of special assignment messages.

The information sent by the Control Channel includes background noise values per each IT, channel-check code, alarms, and DLC status.

The connection maps of currently active ITs and their corresponding BCs, as well as the channel type and the attached encoder, are locally handled in the TCPU card. The card responds to transitions according to the bearer status at the time of the transition, and according to a pre-defined priority order derived from the activity type and required service type.

The TCPU card also handles the "Refresh" process of all the connections during "No Transition" periods, in order to protect the assignment tables in the DCMEs on both sides of the DCME. Furthermore, the TCPU is responsible for the transmit side of the DCME Control Channel. Apart from the above mentioned assignment messages, this task includes the transmission of the Synchronous Word and the Asynchronous Word of the control channel.

The TCPU supports the Multi-Clique and Multi-Destination operation modes and can handle several separate bearer sections, each with its own Control Channel assignment mechanism.

Fax Control Channel message handling as well as the Transmit side of the BIT (Built-In-Test) are also performed by the TCPU card.

### 6.3.4 LDCH (T) - Low Delay-Code Excited Linear Prediction - Encoder

The LDCH card performs digital voice band signal compression by means of the Low Delay-Code Excited Linear Prediction algorithm.

The LDCH card encodes 64 kbit/s PCM speech signals into 16, 12.8, or 9.6 kbit/s LD-CELP channels.

64 kbit/s Voice Band Data calls can also be encoded by LDCT into 40 kbit/s.

### 6.3.5 ADPC - Adaptive Differential PCM - Encoder

When the DTX-360 system works in ITU G.763 and G.766 Mode, Speech and Non-Fax Voice Band Data signals are encoded using an ADPCM (Adaptive Differential PCM) algorithm.

The ADPCM encoding process is performed by the ADPC card in compliance with ITU G.726, where data signals of up to 12.0 kbit/s are encoded into five (5) bits per sample and speech signals are encoded into 4, 3, or 2 bits per sample.

During Normal traffic conditions, the ADPC codecs process speech calls at four (4) bits per sample (32 kbit/s). Under overload conditions, additional speech channels are created by invoking the ADPCM-VBR process in which pseudo-randomly selected speech channels are encoded with 3 or 2 bits per sample (24 kbit/s or 16 kbit/s), respectively.

### 6.3.6 TDSP - Transmit Demodulator (FAX)

The TDSP Demodulator card demodulates fax calls of the type ITU Group 3 (standard and non-standard protocols) in accordance with ITU Rec. T.30.

Fax calls of up to and including 14.4 kbit/s are demodulated and the original digital data bits are allocated in dedicated bearer channels (Fax Banks).

The complete process complies with ITU G.766.

One (1) TDSP Demodulator card supports up to 96 fax calls of up to and including 14.4 kbit/s. Depending on the fax traffic load and profile, up to two (2) TDSP Demodulator cards can be installed in a DTX-360 terminal supporting a maximum of 180 ITU V.27, V.17, and V.29 fax calls.

An optional Forward Error Correction (FEC) feature enables the DTX-360 to operate successfully over any route with poor bit error performance.

When the FEC feature is disabled, a Fax Compression ratio of greater than 6:1 is achieved for Fax calls; when FEC is enabled the compression ratio is greater than 4:1.

### 6.3.7 BMCT - Bit Map CPU - Transmit

The BMCT card performs the final construction of the Bearer Bit Stream in the transmit direction. This task is executed in two different sections:

- ☐ Speech/Data/Clear Channel (CC) Bit Map
- ☐ Fax Bit Map

The Speech/Data/CC Bit Map section handles the Bearer's assembly process for Voice, Non-Fax Voice Band Data, and Clear Channel signals.

When handling system overload conditions, the BMCT computes and determines which regular Voice Bearer Channels are going to be transmitted with fewer bits per sample. These channels are designated "Overload Voice Bearer Channels". Also, the BMCT arranges the fifth bit of Non-Fax Voice Band Data samples into Bit Banks.

The Fax Bit Map section handles the Fax Bank assembly and insertion process into the Bearer of Fax demodulated data.

Both sections work in accordance with the control messages received from the TCPU card. These messages are used to encode the data that occurs three DCME frames later.

In addition, the BMCT card inserts the bits of the Golay error correction code (BCH in LD-CELP) into the Control Channel message that is received from the TCPU card. The BCMT adds a synchronization pattern and locates the message on the bearer.

For Fax Control Channel messages received from the TCPU, the BMCT card inserts the bits of BCH error correction code and assigns it to a Fax Bank on the Bearer.

The BMCT card has the ability to handle Multi-Clique and Multi-Destination modes. In this case the BMCT has several pools, one for each part of the bearer and performs the VBR, FAX, Control Channel, and Fax Control Channel processes for each pool separately.

## 6.4 Receive Subsystem

The Receive Subsystem receives the Bearer information signals (carried by the incoming Bearer(s)) from the Interface Subsystem, performs the appropriate decompression procedures, builds up the outgoing trunks and sends them back to the Interface Subsystem.

### 6.4.1 BMCR - Bearer Map CPU - Receive

The BMCR card performs disassembling and processing of information contained in the incoming bearer(s).

Speech, Clear Channel and Non-Fax Voice Band Data calls are separated from Fax calls in order to make the information readable by the corresponding decoder or modulator. Overload Voice channels created by the VBR process are reconstructed. Non-Fax Voice Band Data signals are re-assembled by taking the fifth bit from the suitable location in the bit bank and Fax Banks are sent to the RDSP card.

The Control Channel and the Fax Control Channel messages are used to decode the Bearer(s) traffic that occurs three DCME frames later.

The BMCR card also removes the synchronization pattern bits from the Control Channel message, performs error code detection and correction of Control Channel and Fax Control messages decoding before transferring them to the RCPU card.

Depending on the number of errors that are corrected in CC messages and on the information received from the TSDF card, the BMCR card generates  $10^{-3}$  to  $10^{-5}$  Bit Error Rate alarm and informs the OMCP.

A DTX-360 terminal includes one (1) or two (2) BMCR cards.

When working in Point-to-Point mode, a single BMCR card is required.

During Multi-Destination mode operation, one (1) BMCR card handles two destinations.

When the DTX-360 terminal operates in Multi-Clique mode, each BMCR card handles up to two (2) cliques.

#### **6.4.2 DSIR - Digital Speech Interpolation - Receive**

The DSIR card provides timing and switching functions in the receive direction.

The card has two main sections:

- ☐ RDSI: Receive Digital Speech Interpolation
- ☐ MDSW: Multi-Destination Switch

The Multi-Destination Switch receives the Bearer information from the BMCR card(s) and performs bearer channel to intermediate trunk switching. Its outputs are received by the RDSP, ADPC or LD-CELP decoder cards in order to produce the decoded data that corresponds to each call.

In addition, the RDSI section performs a speech channel decompression process that assigns an individual time slot to each call and regenerates the original speech silences.

The outputs of the RDSI section are sent to the RTSI section of the TSDF card which executes an Internal Trunk-to-Trunk Channel switching (demapping) process.

The AIS signal and Noise are also injected in the RTSI section into the corresponding outgoing trunk channels.

All of the above mentioned processes are controlled by the RCPU card.

#### **6.4.3 ADPX - Adaptive Differential PCM - Decoder**

When the DTX-360 system works in ITU G.763 and G.766 Modes, Speech and Non-Fax Voice Band Data signals are ADPCM encoded in the transmit terminal and are ADPCM decoded in the receive terminal by the ADPCM Decoder card.

Under normal traffic load conditions, ADPCM-encoded speech calls are decoded from four (4) bits per sample into eight (8) bits per sample signals (32 kbit/s to 64 kbit/s decoding).

When traffic overload conditions are encountered, the VBR process is invoked and speech channels are selected pseudo-randomly in the transmit terminal for 4, 3, or 2 bits per sample encoding. They are identified and decoded in the receive terminal to the original 64 kbit/s signal.

In addition, ADPCM-encoded Non-Fax Voice Band Data calls at five (5) bits per sample are decoded in the receive terminal by the ADPCM decoder card into the original 64 kbit/s rate.

#### **6.4.4 LDCR - Low Delay-Code Excited Linear Prediction - Decoder**

The LDCR card performs the LDCR decoding algorithm in order to regenerate the original speech samples at 64 kbit/s.

Under normal traffic load conditions, LDCR encoded speech calls are decoded from two (2) bits per sample into eight (8) bits per sample signals (16 kbit/s to 64 kbit/s decoding).

When the system experiences traffic overload conditions, the VBR process is invoked and speech channels, pseudo-randomly selected in the transmit terminal for less than two (2) bits per sample encoding, are identified and decoded in the receive terminal to the original 64 kbit/s signal.

Additionally, LDCR Non-Fax Voice Band Data calls are decoded on the receive terminal into the original 64 kbit/s rate.

#### **6.4.5 RDSP - Receive Re-Modulator (Fax)**

The RDSP Re-Modulator card remodulates fax calls whose original data bits are demodulated in the transmit terminal and received in Fax Banks in the bearer.

The complete demodulation/remodulation process of ITU Group 3 Fax Calls, up to and including 14.4 kbit/s data rate, is performed in compliance with ITU G.766.

When Forward Error Correction (FEC) is enabled for fax demodulated calls, the RDSP ReModulator card performs the corresponding error detection and correction.

One (1) RDSP ReModulator card supports up to 180 fax calls of up to and including 14.4 kbit/s.

#### 6.4.6 RCPU - Receive CPU

The RCPU card provides the connections between the bearer channels, the ADPCM or LD-CELP decoders and the intermediate trunks for clear channel, Speech and Non-Fax Voice Band Data calls. The card also performs the fax assignment for fax calls.

The assignment messages received from the far-end DCME are decoded in order to obtain the information required for dynamic assignments of non-preassigned bearer channels and intermediate trunks and the ADPCM or LD-CELP decoders. The actual connection is implemented at the beginning of the DCME frame which occurs three (3) DCME frames after the start of the DCME frame containing the applicable assignment message.

In addition, the RCPU handles the noise insertion process for outgoing trunks on a time slot basis.

The card communicates with one or two BMCR cards and handles the end-to-end Control Channel check on the receive side.

### 6.5 OMCP - Operation & Maintenance CPU

The OMCP card performs the following tasks:

- ❑ System Clocks Selection: Selects the clock system, main reserve and current clock, according to the configuration parameters. The selected clock information is sent to the QDLI CPUs. The OMCP also sends commands to the CKSL to select the current clock source.

- ❑ QDLI Redundancy Switching Control: When an operating QDLI fails, the OMCP card requests the switch over to the redundant QDLI and controls the execution of the process
- ❑ Communication With Other CPUs: The OMCP communicates with the RCPU, TCPU, SCPU, SIGN, QDLI CPUs and AUXC unit by means of serial communication channels (HDLC links)
- ❑ Collection System, Alarm Collection and Handling: The OMCP card queries the above mentioned CPUs and itself, too - to collect BIT results
- ❑ Statistics and Error Performance: Using the error performance parameters and alarm information received from the QDLI CPUs, the OMCP card calculates statistics and Error Performance results
- ❑ Reports Editing and Delivery to the OPS.
- ❑ Communication with DOM

### 6.6 SIGN - Signaling CPU

The SIGN card supports the DCME-ISC Communication protocol according to ITU Rec. Q.50.

The card also supports inter-exchange line signaling, for example, ITU R1 and ITU R2D, according to ITU Rec. G.763.

In addition, simplified DTX-360-ISC protocols can be supported according to the special needs of the administrators.

# SYNCHRONIZATION

## 7.1 Synchronization Modes

The specific network application of the DTX-360 system determines the synchronization mode to be selected.

The DTX-360 timing can operate in different synchronization modes:

- ☐ **Mode A:** Independent
- ☐ **Mode B:** Master/Slave 1
- ☐ **Mode C:** Master/Slave 2
- ☐ **Mode D:** Transparent

Figure 7-1 shows the DTX-360 inter-terminal synchronization configuration.

All synchronization modes ensure that both the LRE (ADPCM or LD-CELP) encoder and the decoder, in the same direction, are driven by the same clock sources.

In modes A and B, controlled slips may occur in the DTX-360 due to frequency differences between C1 and C2. The slips will occur on the trunk side input (mode B only) and on the trunk side output (modes A and B).

In mode C and D, no controlled slips will occur in the DTX-360 during normal operation of the system.

## 7.2 Plesiochronous Operation

The DTX-360 operates with plesiochronous or synchronous networks. All trunk side interfaces are provided with elastic buffers, enabling plesiochronous buffering and wander filtering. The elastic buffering provides slip control for the system. The elastic buffer capacity is two PCM frames.

Optional Doppler buffers can be included with a buffer size of 6 msec.

## 7.3 Wander and Jitter

The use of elastic buffers at the trunk side interfaces enables the expected quantities of wander and jitter to be absorbed on incoming digital links without introducing controlled or uncontrolled slips. In addition, internal clock circuits ensure high tolerable input jitter, low intrinsic output jitter, and high transfer jitter attenuation.

## 7.4 Slips

A slip event will not cause the loss of frame alignment by downstream digital terminals. Prior to overflow or emptying, the elastic buffer will shift to the initial position maintaining frame alignment.

## 7.5 Clocking

Each DTX-360 terminal may be driven from three main clocking signals (see Figure 7-2):

- ❑ **TRUNK OUTPUT CLOCK:** can be derived from any selected clock source, depending on the synchronization mode and the preprogramming of the terminal.
- ❑ **TRANSMIT CLOCK:** can be derived from any selected clock source, depending on the synchronization mode and the preprogramming of the terminal.
- ❑ **RECEIVE CLOCK:** can be derived, during normal operation, from the bearer input recovered clock. A fallback clock (internal) will be switched on automatically under specified alarm conditions.

Any of the following clocks can be selected as a source for the TRANSMIT CLOCK and TRUNK OUTPUT CLOCK:

- ❑ Any of the clocks recovered from the trunk bit streams
- ❑ External clock
- ❑ The clock recovered from one of up to four incoming bearer bit streams
- ❑ Internal clock

The RECEIVE CLOCK may use as its source the clock recovered from one of the bearers or the internal clock.



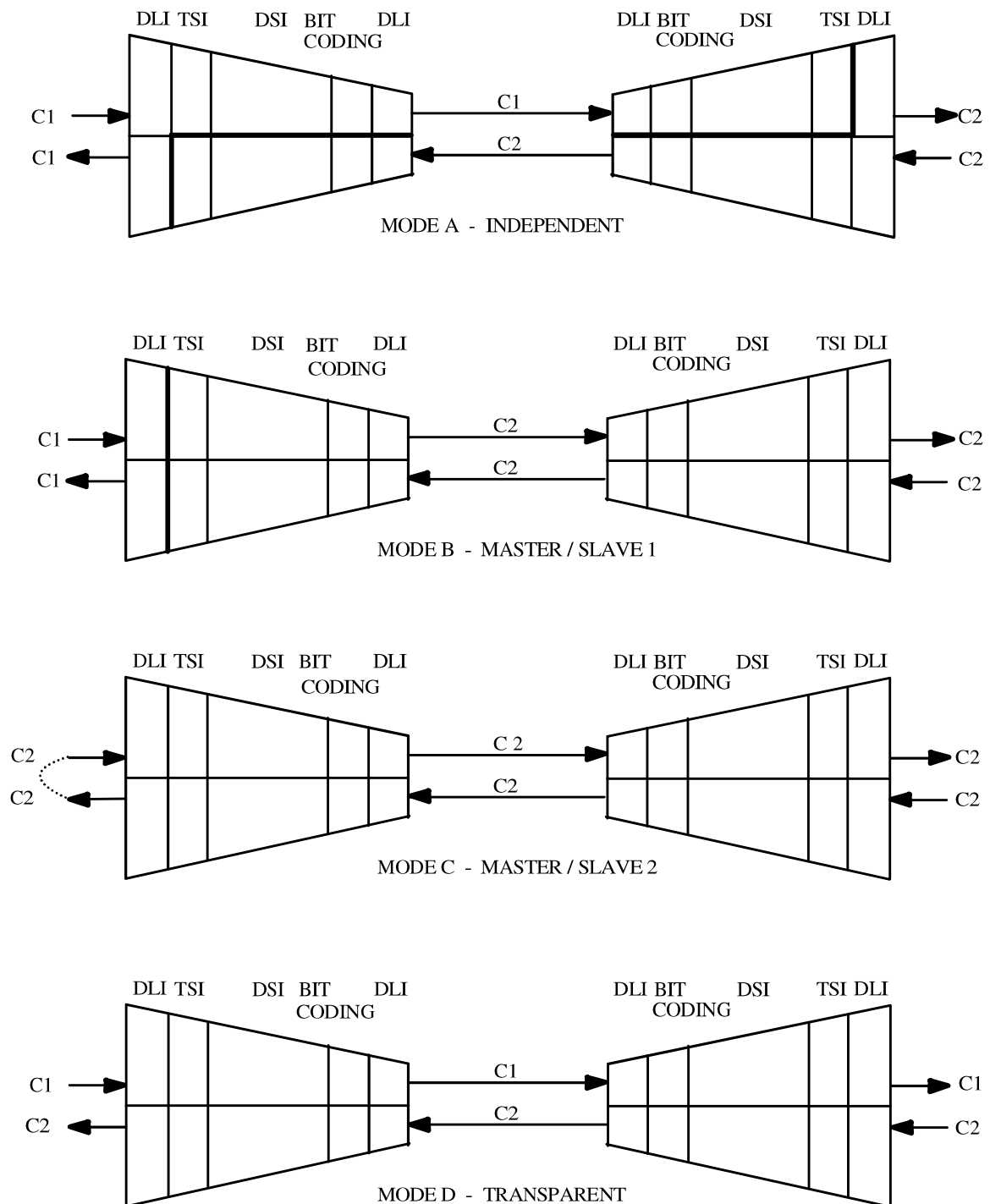


Figure 7-1. DTX-360 Synchronization Modes

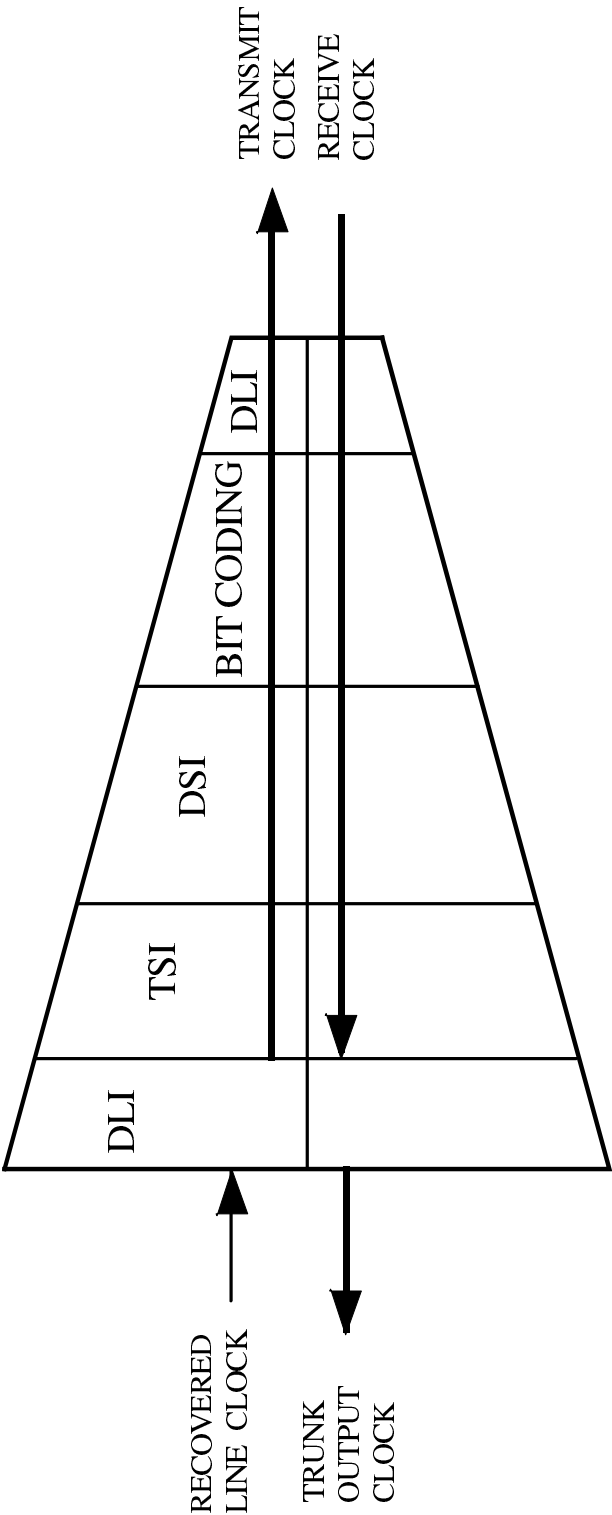


Figure 7-2. DTX-360 - System Clocks

# MAINTENANCE FACILITIES

## 8.1 Functions

The DTX-360 provides a complete package of in-service functions in support of maintenance tasks to assure uninterrupted service.

The following in-service functions are available:

- ☐ Local Built-In-Test
- ☐ Terminal Internal Redundancy
- ☐ System Clock Monitoring
- ☐ Control Channel BER Monitoring
- ☐ Trunk and Bearer Error Performance
- ☐ System Statistics
- ☐ System Anomaly Reports
- ☐ Terminals Alarm Condition Indications (Acoustic and Visual)
- ☐ Terminal Alarm Condition Outputs
- ☐ End-to-End Tests
- ☐ Communication Link Monitoring
- ☐ Standby Terminal for Cluster Mode

System reports in the DTX-360 can be generated both locally and remotely. In both cases, the reports are based on events that have been logged in the DTX-360 terminals as well as the Operator Station and can be generated automatically or on demand.

The system continuously chronicles, compiles, and stores information required to generate reports and provide the following services:

- ☐ Assist maintenance personnel in diagnosing and locating faults or abnormal conditions.
- ☐ Provide status, traffic and performance information related to facilities and equipment, aimed at monitoring terminal and overall system performance.

Each DTX-360 terminal generates reports when:

- ☐ An operator requests a report
- ☐ An operator's predefined time-interval has elapsed
- ☐ A pre-defined system time interval, such as daily automatic period (once every 24 hours) has elapsed

All automatic reports can be enabled or disabled by the operator. These reports provide the following general information:

- ☐ Report designation
- ☐ Report cause (operator's request, time-interval, etc.)
- ☐ System identification
- ☐ System configuration
- ☐ Date and time

## 8.2 Built-In-Test

The DTX-360 terminal subsystems and functions are self-checked by an internal Built-In-Test packet.

The self-check procedures include tests on hardware and software facilities during normal operations, without interference or impact on traffic carrying capacity.

Any fault detection is reported to the OMCP to initiate corrective and protective measures.

## 8.3 Terminal Alarms

The DTX-360 terminal alarms fall into four (4) categories:

- ☐ **Critical:** Critical alarms are a subgroup of the prompt alarms. They are used by the redundancy control unit to initiate automatic switch over to a redundant terminal. Critical alarms are issued when a traffic-affecting, internal equipment failure occurs.
- ☐ **Prompt:** A prompt alarm condition is raised following the detection of a fault requiring immediate maintenance attention.
- ☐ **Deferred:** A deferred alarm condition is raised following the detection of a fault which does not require immediate maintenance attention.
- ☐ **Service:** A service alarm condition is raised when the terminal is informed of the occurrence of an external fault.

## 8.4 DTX-360 Display Panel (AUX Card Panel)

The DTX-360 AUX card enables the following man-machine functions:

- ☐ Indication of Terminal Alarms
- ☐ System Status Display
- ☐ Alarm Cut-Off
- ☐ Order Wire Communication

### 8.4.1 Terminal Alarm Indications

Terminal alarm conditions, prompt, deferred, or service, are visually indicated by corresponding red LEDs on the front panel of the AUX card.

### 8.4.2 Alphanumeric Display

The Alphanumeric display provides visual information related to the following conditions:

- ☐ System Status (i.e., on-line normal, on-line faulty, off-line normal, off-line faulty, maintenance, etc.)
- ☐ Terminal Built-In-Test Alarm

### 8.4.3 Order Wire Call Indicators

Four (4) LEDs are provided to indicate an incoming voice order wire call (one LED per destination).

### 8.4.4 Order Wire Buzzer

While an unattended call is waiting, it is possible to activate an acoustic buzzer.

### 8.4.5 Handset

A 4-wire handset with touch-tone facility is used to enable voice order wire communication.

### 8.4.6 Test Port (Drop & Insert)

This port provides the capability of connecting any internal intermediate trunk (IT) to an analog test generator/receiver.

Assignments to this test port are possible only through the configuration map.

### 8.4.7 Power On/Off Switch

Access to this switch is protected to prevent accidental activation. The switch is equipped with a LED indicator to provide visual display of ON/OFF condition.

## 8.5 System Reset

A protected-access system reset pushbutton is provided on the front panel of the OMCP card.

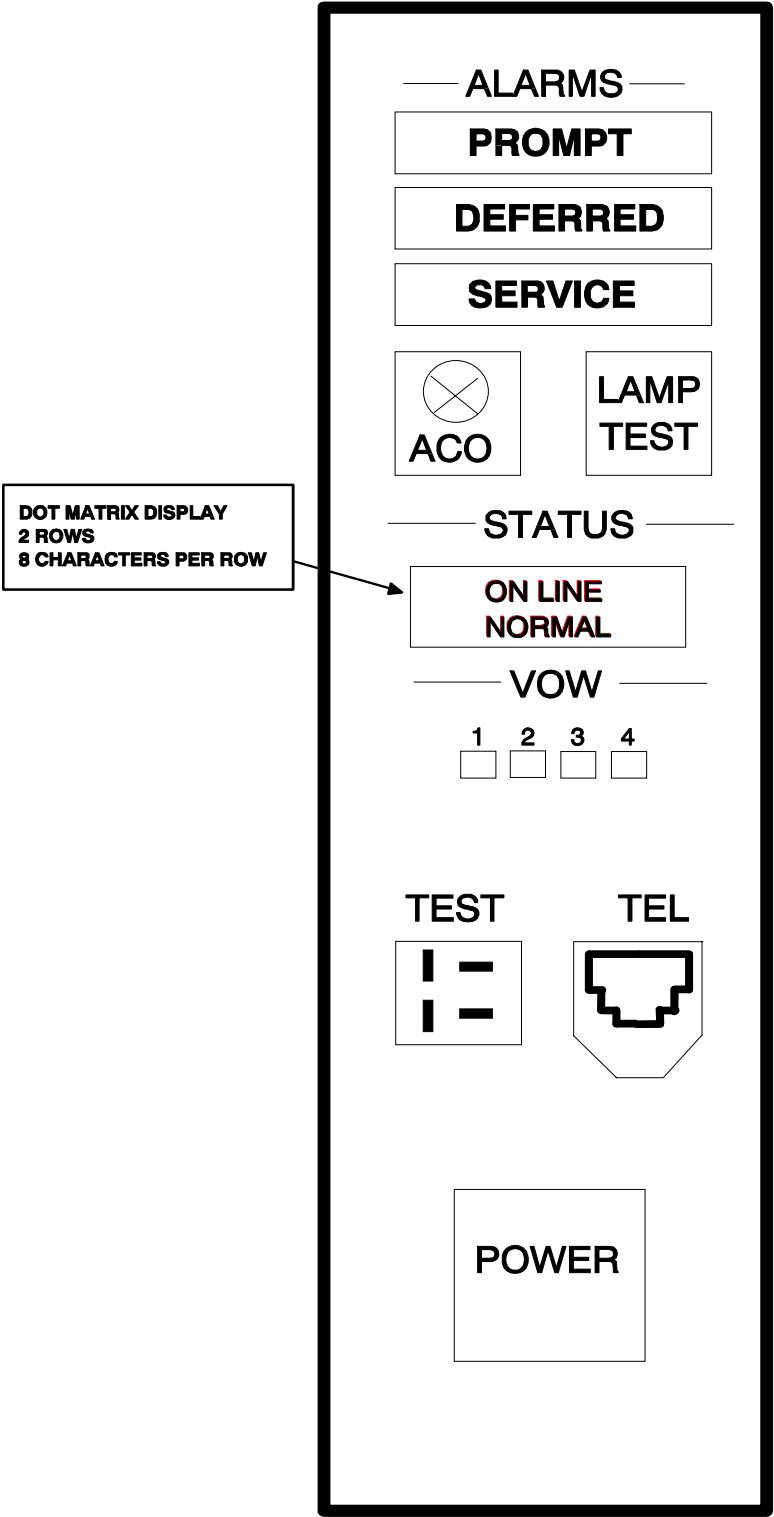


Figure 8-1. DTX-360 AUX Card

# TECHNICAL SPECIFICATIONS

## 9.1 General

### CE MARKING

The DTX-360 product is certified for CE.

The product was tested according to RC5000N specification, referring to EN55022 CLASS A limits.

### WARNING

This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

**Note:** A DOMESTIC ENVIRONMENT is an environment where the use of broadcast radio and television receivers may be expected within a distance of 10 meters of the product.

The following table contains a summary of the DTX-360 technical specifications.

FUNCTION	SPECIFICATIONS
<b>DCME MODES</b>	- IESS-501 REV.3, ITU REC. G.763 - G.766 - IESS-501 REV.2 - LD-CELP
<b>NETWORK MODES</b>	- Single-Destination (SD) - Multi - Destination (MD) - Multi-Clique (MC) - Interoperation (Mixed MC and MD)
<b>COMPRESSION RATIO</b>	- * 5:1 Typical for 150 trunks (40% FAX) - ** 8:1 Typical for 240 trunks (40% FAX)
<b>CHANNEL CAPACITY</b>	- Trunk Channels: Max. 360 - Intermediate Trunks (Processed Trunks): * MAX. 216 ** MAX. 360 - Bearer Channels: * Max. 122 (61 Normal + 61 Overload) ** Max. 200 (120 Normal + 80 Overload)
<b>NOTE:</b> * For DTX - 360 in ITU G.763 and G.766 Configuration (IESS - 501, REV 3 Mode) ** For DTX - 360 in LD-CELP Configuration	

FUNCTION	SPECIFICATIONS
<b>DIGITAL GROUP INTERFACE</b>	<ul style="list-style-type: none"> <li>- Trunk Side Interface: DTX-360: Up to 12 CEPT (2.048 Mbit/s) or 12 T1 (1.544 Mbit/s) interfaces DTX-360 (Compact): Up to 8 CEPT (2.048 Mbit/s) or 18 T1(1.544 Mbit/s) interfaces</li> <li>- Bearer Side Interface: DTX-360: One Tx bearer and up to 4 Rx bearers (CEPT or T1) DTX-360 (Compact): One Tx bearer and up to 4 Rx bearers (CEPT or T1)</li> <li>- CEPT Interface: ITU G.703, 120 or 75 Ω. Framing complies with G.704-G.706</li> <li>- T1 Interface: ITU G.703, 100 Ω. Framing complies with G.704</li> </ul>
<b>EXTERNAL CLOCK INTERFACE</b>	- 2.048 kbit/s According to ITU G.703
<b>PLESIOCHRONOUS BUFFER</b>	<ul style="list-style-type: none"> <li>- Trunk side Tx = 2 PCM frames</li> <li>- Trunk side Rx = 2 PCM frames</li> <li>- Bearer side Rx = 2 PCM frames</li> </ul>
<b>BEARER SERVICES</b>	<ul style="list-style-type: none"> <li>- Voice: 1) Dynamically Assigned Channel <ul style="list-style-type: none"> <li>* ADPCM (ITU G.726) at 32/24/16 kbit/s</li> <li>** LD-CELP at 16/12.8/9.6 kbit/s</li> </ul> </li> <li>2) Pre-Assigned Channel <ul style="list-style-type: none"> <li>* ADPCM at 32 kbit/s</li> <li>** LD-CELP at 16/12.8/9.6 kbit/s</li> </ul> </li> <li>- VBD (NON-FAX): 1) Dynamically Assigned Channel <ul style="list-style-type: none"> <li>* ADPCM (ITU G.726) at 40 kbit/s; V.32, V.34 - up to 14.4 kbit/s</li> <li>** LD-CELP at 40 kbit/s ; V.32, V.34 - up to 19.2 kbit/s</li> </ul> </li> <li>2) Pre-Assigned Channel (fixed rate) <ul style="list-style-type: none"> <li>* ADPCM at 40/32 kbit/s</li> <li>** LDCELP at 40/16 kbit/s</li> </ul> </li> <li>- VBD (Group 3 FAX): 32 kbit/s Transparent Fax Banks according to ITU G.766 (Forward Error Correction selectable)</li> <li>- 64 kbit/s: 1) Dynamically Assigned Channel (Q.50 protocol required)</li> <li>2) Pre-Assigned Channel at 64 kbit/s rate</li> <li>- N*64kbit/s: N Pre-Assigned Channels at 64 kbit/s rate</li> </ul>
<b>SPEECH DETECTOR</b>	- Adaptive Threshold (-30 to -40 dBm0)
<b>NOISE INJECTION</b>	- Matched to far end (ITU G.763)
<b>FACSIMILE CALL PROCESSING</b>	<ul style="list-style-type: none"> <li>- FAX Demodulation by waveform analysis (ITU G.766)</li> <li>- Group 3 Facsimile, standard and non-standard protocols are demodulated: Up to 180 V.29/V.27/V.17 fax calls</li> </ul>
<b>DCME-ISC LINK</b>	<ul style="list-style-type: none"> <li>- ITU Q.50 protocol via T.S.16 <ul style="list-style-type: none"> <li>1) Q.50 type 1</li> <li>2) Q.50 type 2, Annex A</li> <li>3) Q.50 type 2, Annex B</li> </ul> </li> <li>- DLC dry contacts (per destination)</li> </ul>
<b>INTER-EXCHANGE SIGNALING</b>	<ul style="list-style-type: none"> <li>- ITU Sign. System No. 5, via dynamically assigned channel</li> <li>- ITU Sign. System No. 6 or 7, via pre-assigned 64 kbit/s channel</li> <li>- DPNSS signaling supported on TS 16 as well as other time slots</li> <li>- ITU R2 D, via R2 D User Signaling Module</li> <li>- ITU R1 via optional User Signaling Module</li> </ul>
<b>NOTE:</b> * For DTX - 360 in ITU G.763 and G.766 Configuration (IESS - 501, REV 3 Mode) ** For DTX - 360 in LD-CELP Configuration	

FUNCTION	SPECIFICATIONS
<b>ALARM INTERFACE</b>	- Relay closures for visual and audio alarms - Alarm classification: Prompt, Deferred, Service
<b>DIGITAL OFFICE MONITOR (DOM) INTERFACE OPTION</b>	- RS-485
<b>VOICE ORDER WIRE (VOW) INTERFACE</b>	- 4 -Wire 600 $\Omega$ interface (per destination) - VOW is accessible via handset on DTX-360 front panel
<b>DTX-360 TERMINAL PROTECTION</b>	- N+1 (N=1-8) cluster protection switching by means of Change Over Matrix
<b>DTX-360 TERMINAL OPERATION &amp; MAINTENANCE</b>	- Sun (or Sun-compatible) Operator Station (OPS) - OPS may operate 1-8 DTX-360 clusters
<b>CLUSTER COMMUNICATION LINK (OPS, DTX-360, CCOM)</b>	- Ethernet 10 Base-2 or Ethernet 10 Base-T
<b>POWER REQUIREMENTS</b>	1) Input power: -48V DC or -60V DC Station Power (input voltage range = -40.5 to -72 Volts DC) 2) Power consumption: * DTX-360 ADPCM = 240W DTX-360 LD-CELP = 350W Local COM (LCOM) = 58W Central COM (CCOM) = 63W
<b>DIMENSIONS</b>	Cabinet dimensions: Width: 655mm (25.75 inches) Height: 2134mm (84 inches) or 2600mm (102 inches) Depth: 450mm (17.75 inches) Cabinet Weight: 45U - 66Kg 54U - 77Kg Shelf dimensions: Width: DTX-360: 584mm (23 inches) DTX-360C: 584mm (23 inches) Local COM: 584mm (23 inches) Central COM: 584mm (23 inches) Height: DTX-360: 533mm (21 inches) DTX-360C: 266mm (10.5 inches) Local COM: 266mm (10.5 inches) Central COM: 266mm (10.5 inches) Depth: DTX-360: 375mm (15 inches) DTX-360C: 375mm (15 inches) Local COM: 330mm (13.2 inches) Central COM: 330mm (13.2 inches) Shelf Weights: DTX-360 (12U) - 26Kg LCOM, CCOM - 10Kg (each) DTX-360C - 18Kg
<b>ENVIRONMENTAL CONDITIONS</b>	- Operation: 1) Ambient temperature: 0°C to +40°C 2) Humidity: up to 90% at 30°C without condensation - Storage: 1) Ambient temperature: -40°C to +70°C 2) Humidity: From 5% to 95% R.H
<b>ELECTROMAGNETIC COMPATABILITY</b>	- Complies with: RC5000N Part 1 (British Telecom) VDE 0878 Part 1, Class B
<b>ESD</b>	- Complies with: RC5000N Part 1 (British Telecom) FTZ 12 TR1 Part 40 (German Telecom)
<b>NOTE:</b> * For DTX - 360 in ITU G.763 and G.766 Configuration (IESS - 501, REV 3 Mode) ** For DTX - 360 in LD-CELP Configuration	





## GLOSSARY OF TERMS

- ❑ ADPCM - Adaptive Differential Pulse Code Modulation
- ❑ ADPC - Adaptive Differential PCM Encoder/Decoder
- ❑ ACO - Alarm Cut-Off
- ❑ AIS - Alarm Indicator Signal
- ❑ AMI - Alternate Mark Inversion
- ❑ AUXL - Auxiliary Card
- ❑ BC - Bearer Channel
- ❑ BER Bit Error Rate
- ❑ BR - Bearer
- ❑ BIT - Built-in Test
- ❑ BMCT - Bit Map CPU - Transmit
- ❑ BMCR - Bit Map CPU - Receive
- ❑ CCOM - Central Change Over Matrix
- ❑ CC - Clear Channel (Transparent Channel)
- ❑ CKSL - Clock Select
- ❑ COCP - Change Over Central Processor
- ❑ CRMX - Central Relay Matrix
- ❑ CRIO - Central Relay Input-Output Interface
- ❑ DCME- Digital Circuit Multiplication Equipment
- ❑ DCMS - Digital Circuit Multiplication System
- ❑ DCOM - Distributed Change Over Matrix
- ❑ DSIT - Digital Speech Interpolation - Transmit
- ❑ DSIR - Digital Speech Interpolation - Receive
- ❑ DLC - Dynamic Load Control
- ❑ DLI - Digital Line Interface
- ❑ DSI - Digital Speech Interpolation
- ❑ FAX - Facsimile
- ❑ FEC - Forward Error Correction
- ❑ FDSP - Fax Demodulator
- ❑ IDR - Intermediate Data Rate
- ❑ ISC - International Switching Center
- ❑ ISL - Incoming Signal Loss
- ❑ IT - Intermediate Trunk
- ❑ LCOM - Local Change Over Matrix
- ❑ LD-CELP - Low Delay - Code Excited Linear Prediction
- ❑ LDCH (T) - Low Delay - Code Excited Linear Prediction card - Encoder (Transmit)
- ❑ LDCH (R) - Low Delay - Code Excited Linear Prediction card - Decoder (Receive)
- ❑ LODP - Local Operator Display Panel
- ❑ LRE - Low Rate Encoding
- ❑ LRMX - Local Relay Matrix
- ❑ MC - Multi Clique

- ☐ MD - Multi Destination
- ☐ MTBF - Mean Time Between Failures
- ☐ MTTR - Mean Time To Repair
- ☐ NRZ - Non-Return to Zero
- ☐ OPS - Operator Station
- ☐ OMCP - Operation and Maintenance CPU
- ☐ OW - Order Wire
- ☐ PCM - Pulse Code Modulation
- ☐ PSU - Power Supply Unit
- ☐ QDLI - Quad Digital Line Interface
- ☐ RAI - Remote Alarm Indication
- ☐ RCPU - Receive CPU
- ☐ RDSP - Receive Remodulator (Fax)
- ☐ RDSW - Redundancy Switch
- ☐ RX - Receive
- ☐ SCOM - Single Cabinet Change Over Matrix
- ☐ SCPU - Signal Analysis CPU
- ☐ SDSP - Signal Analysis DSP
- ☐ SIGN - Signaling CPU
- ☐ TCPU - Transmit CPU
- ☐ TC - Trunk Channel
- ☐ TDMA - Time Division Multiple Access
- ☐ TSDF - Time Slot Interchange and DCME Frame Alignment
- ☐ TDSP - Transmit Demodulator (Fax) DSP
- ☐ TX - Transmit
- ☐ TSI - Time Slot Interchange
- ☐ TR - Trunk
- ☐ VBR - Variable Bit Rate
- ☐ VBD - Voice-Band Data
- ☐ VOW - Voice Order Wire
- ☐ ZCS - Zero Code Suppression