Public Carrier Networks

Meridian Business Services Network Access

Interface Specification

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Note 1: Issues rated “Draft” or “Preliminary” are identified alphabetically, in sequence; issues rated “Standard” are identified numerically, in sequence. The issue and date appear on each page of this document.

Note 2: Significant changes and additions are marked with vertical bars in the outer page margins beside the changed or added information.

NOTICE

This Interface Specification is specifically intended as a guide for the developers, designers, and users of customer provided terminal equipment which is to be directly electrically connected to a Nortel DMS-100 Family Digital Multiplex System that provides Meridian Business Services.

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1. Introduction

1.1 General

This document is intended as a disclosure document that defines the performance and compatibility requirements for terminal equipment that will be directly connected to the network interface for Enhanced Business Service.

The document describes the physical, electrical and network protocol aspects of the Meridian Business Service. It is intended for the use of both customers and manufactures. It is specifically intended for the developers, designers and users of customer provided in terminal equipment.

The scope of the document should be sufficient to allow CPE manufacturers to design and build terminal sets that will satisfactorily function with the service. Actual implementations of the required functionality are generally not covered, but rather are left to the ingenuity of the designer. Specific implementations are occasionally suggested, but only where they serve to clarify the meaning.

In addition to meeting the performance and compatibility requirements given in this document, any terminal requirement that is to be connected to this network interface shall be in compliance with the network protection requirements that apply.

Manufacturers should note that connection specifications dictate a terminating impedance that is the same in both on-hook and off-hook states. This is quite different from the norm for telephone instruments.

The Meridian Business Service terminal will also be regulated under radio frequency interference regulations that are applicable. Terminal equipment must comply with rules established for class B computing equipment.

1.2 Service

The Meridian Business Service is designed to provide access to DMS-100 features through a key telephone-like user interface. Capability inherent in the system encourages the development of relatively unsophisticated CPE that will allow access to most features via direct, i.e., single button, selection.

The service is implemented through the establishment of a supervisory data link between the customer provided terminal equipment and the DMS. This link conveys control and destination information from the CPE to the DMS, and alerting and status information from the DMS to the CPE. Control information to the switch includes such things as requests for service or the activation of a feature. Information passed back to the CPE includes verification that the DMS has responded to a user input, and alerting of feature status in both on-hook and off-hook conditions.

The supervisory data link is established as a secondary channel over the same facility that accommodates voice communication. It is assigned a portion of the frequency spectrum well above the band normally audible in telecommunications. Supervisory data is conveyed on a modulated carrier between the CPE and DMS Switch. It is maintained as a half duplex link with carrier being present only during the transmission of information or acknowledgment.

Use of the secondary channel is controlled by a low level link protocol. This protocol prescribes that all transmissions will be formatted into a link message envelope. It includes rules on format, header content intermessage timing, acknowledgments and retransmission, and collision handling and priority. It operates under a contention scheme that anticipates occasional collisions and provides a method to clear them.

Switch control and status information is carried by the secondary channel embedded within the link message envelope. All information consists of single byte commands, the definitions and application rules for which comprise a higher level command protocol.

2. Network Interface Overview

2.1 General

The Network Interface (NI) to any telecommunications service is the point of connection between the facilities of the service provider and facilities and equipment provided by the customer. The NI is located on the customer's premises as illustrated for Meridian Business Service in Figure 2-1.

The NI to Meridian Business Service, provides a balanced, two wire termination allowing access to two spectrum separated channels.

The first is a voice grade channel of a nominal 3000 Hz bandwidth that is available for voice and voice grade data communications and is also utilized for conveying call progress and alerting signals to the CPE. The second is a secondary channel centered at 8000 Hz used to pass supervisory and signalling information across the interface. The two channels are specified independently. Table 2-1 summarizes the main interface characteristics.

2.2 Voice Transmission

The channel provided for voice has transmission characteristics similar to those of an exchange access line to the public Switched Network. These characteristics are adequately described in Chapter 6 of Bell Communications Research PUB 61100, Description of the Analog Voiceband Interface between the Bell System Local Exchange Lines and Terminal Equipment, January 1983. For Meridian Business Service, however, it is appropriate to substitute 900 ohms for the given 600 ohms, wherever impedance is mentioned.

Terminal equipment connecting to Meridian Business Service should have voice transmission characteristics complementary to those of the Network as described in the above mentioned reference. Additional considerations unique to Meridian Business Service are covered in Section 3.2.3 .

2.3 Secondary Channel Transmission

The secondary channel used in Meridian Business Service is a half duplex channel implemented by amplitude shift keying (ASK) an 8000 hz sinusoidal carrier. Keying takes place

only during the transmission of supervisory or signaling information or in response to such transmissions.

Complete electrical specifications are provided in Section 3.2.4 .

2.4 Direct Current Considerations

A DC loop shall be maintained through the NI with the Meridian Business Service. This current is utilized by the DMS to verify that CPE is attached and to maintain loop continuity. It is maintained at all times - even in the on-hook condition.

The DC current is not used for supervision (with the above exception). That function is provided by the supervisory and signalling commands conveyed over the secondary channel.

Complete details of required DC voltage, current, and resistance characteristics are provided in Section 3.2.5 .

2.5 Supervision And Signaling

Supervision and signalling information is passed back and forth across the interface on the secondary channel. The channel operates under a low level link protocol that governs message exchange. A higher level command protocol governs supervisory and status message content and response.

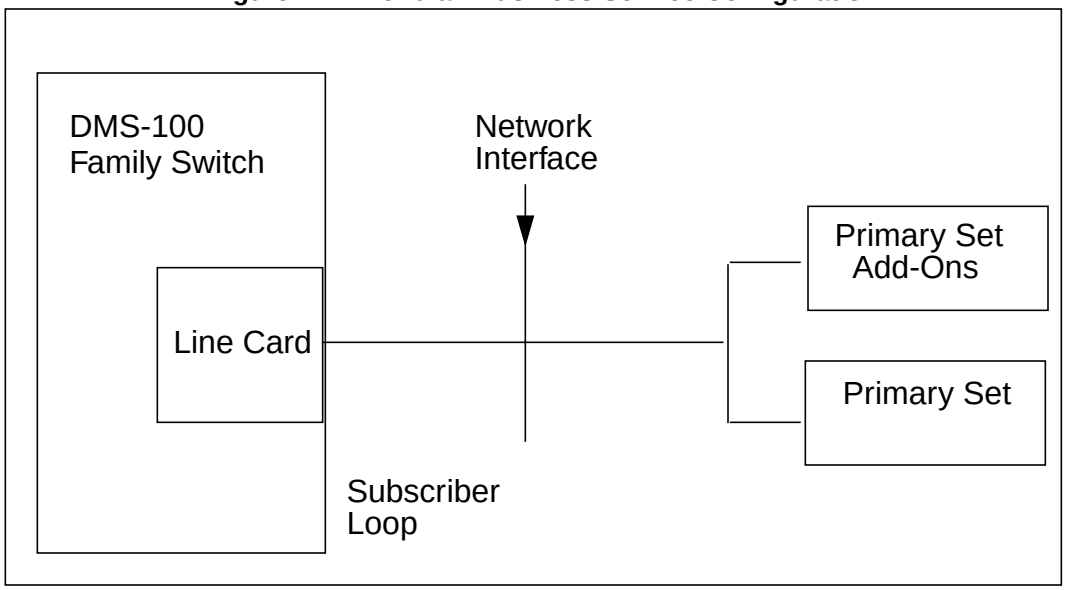
The link protocol specifies that all transmission shall be formatted into a 16 bit message envelope. Within the envelope, eight bits are used to convey data specified by the command protocol. The remaining bits are used for timing reference, addressing, direction control, and message integrity. The protocol specifies positive acknowledgment to valid messages, and retransmission on parity error and collision.

Details are provided in Section 4.

The command protocol provides the rules for the actual supervisory and signaling information passed over the interface. It specifies a set of commands appropriate to each direction of information flow, and it specifies the binary content of the associated command byte that is conveyed by the link message envelope.

The command protocol is described in detail in Section 5.

Figure 2-1 Meridian Business Service Configuration



GENERAL

Modes	voice & signalling
Voice Transmission bandwidth	approximately 3.4 kHz
Call setup, disconnect and special features.....	uses an above voiceband channel, centered at 8 kHz
Signaling Rate.....	1 kbits/s, half duplex
Signal Message Format.....	amplitude shift keying (ASK) 16 bit envelope

PHYSICAL AND ELECTRICAL

Connector.....	Miniature 6-position Jack
Power Requirements	
Primary Set (Basic).....	may be loop powered or by local commercial source
Primary Set with a Display or Handsfree.....	may be loop powered or by local commercial source (Fail to POTS supported when loop powered)
Add-Ons.....	local commercial power
Voice Signals.....	electrical characteristics similar to those of a Public Switched Network voice pair
Signaling and Supervision Channel	8 kHz ASK into 900 OHMS

Table 2-1 Summary of Interface Characteristics

3. Network Interface Physical & Electrical Connection Requirements

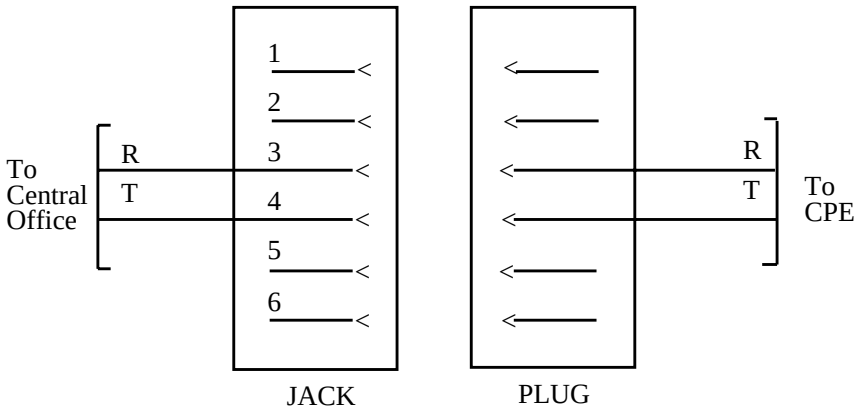
3.1 Physical Connection Requirements

Tip and Ring leads are provided on a miniature six position jack. Specification for the jack can be obtained from the "FCC Rules For Registration of Telephone Equipment, Part 68, Subpart F, Section 68.500(b)."The same requirements can be obtained from the “CS-03 Standard For Terminal Equipment, and Connection Arrangements Systems, Network Protection Devices, Supplement A, Section A.4.1”.

The following are the pin assignments for the jack and plug.

Note: Pins 1, 2, 5 & 6 of the jack are reserved for telco use.

Figure 3-2 Meridian Business Service Interface



NETWORK INTERFACE

3.2 Electrical Connection Requirements

3.2.1 AC Impedance

The NI presents an AC impedance to the customer that appears electrically as 900 ohms, catenated with zero to 15,000 feet (26AWG) of non-loaded twisted wire pair cable.

The terminal equipment shall present a 900 ohm AC impedance to the Network Interface. This impedance shall be present at all times, even during the idle or on-hook state.

3.2.2 Balance

Balance on a two-wire transmission media is the similarity of impedance of each conductor to ground. It is an AC quantity that usually has both resistive and reactive components. It may, and probably will, vary with frequency. Good balance minimizes the conversion of mutually coupled longitudinal disturbances - such as 60Hz AC and its harmonics - to audible metallic sounds. It also greatly reduces the incidence of interfering crosstalk coupling between adjacent facilities.

On account of the difficulty of measuring balance as an impedance ratio, it is found as the decibel (dB relationship between a disturbing longitudinal voltage and the resulting metallic voltage of the same frequency. To avoid significantly degrading service, the longitudinal-to-metallic balance of Meridian Business Service terminal equipment should be in the acceptable region of Fig 3.2 for all frequencies from 60 to 4,000 Hz. Measurements shall be made in accordance with IEEE Standard 455-1976.

3.2.3 Voiceband Channel

(a) Transmission

Voice and voiceband data may be passed over the NI in both directions as analogue electrical signals. The transmission requirements for speech and data transducers are essentially the same as those for telephones and modems intended to operate over the Public Switched Network.

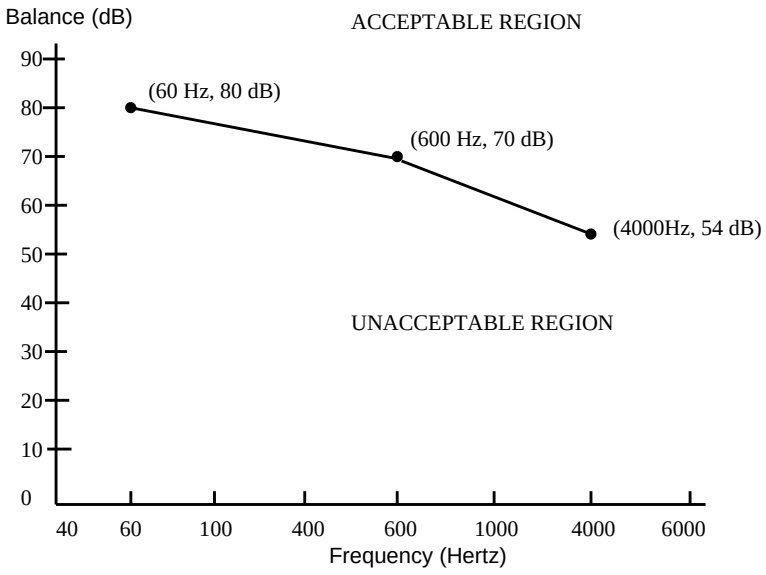
One measurable difference is a permanent 3 dB loss inserted by the DMS linecard to signals from the network to the NI. The loss is normally imperceptible to the CPE user, but may be overcome by the addition of a 3 dB gain, in the receive path only, in the CPE itself, with overall considerations given to OLR's (Overall Loudness Rating) and sidetone. Changes in network pads can also compensate.

(b) Alerting Signal

The audible alerting signal from the DMS Switch over the voiceband channel consists of 500 Hz plus 666 Hz with a 10 Hz warble rate, and it is transmitted at a level of -10 dBV. The signal received at the NI shall be no lower than -18 dBV into 900 ohms.

(c) Filtering

To prevent interference with the secondary channel, any voiceband transmitted signals shall have a minimum rolloff of 42 db/octave above 4 KHz.



Note: Balance = 20 log/Vs/Vm, where:

Vs=disturbing longitudinal voltage

Vm=resulting metallic voltage

Figure 3-3 Longitudinal - to - Metallic Criteria

3.2.4 Signaling Channel Requirements

(a) Modulation

The Secondary channel is implemented by Amplitude Shift Key (ASK) an 8 KHz sinusoidal carrier. A logical one is represented by the presence of an 8 KHz carrier. A logical zero is represented by its absence.

Each transmitted bit has a duration of 1 msec, and the logical one consists of eight complete cycles of the 8 KHz carrier. Each logical one shall begin and end at the zero crossing to prevent the generation of noise in the voiceband.

(b) Transmit Specifications

The modulated carrier transmitted into the NI from the CPE shall be at a level of 1.3 + 0.2V, 8 KHz peak-to-peak. This level should not be exceeded as the terminal equipment may then not be compatible with the requirements for the DMS switch. The level should also not be reduced as it may allow the signal arriving at the DMS switch to fall below the recovery range of the receiver.

The transmitted carrier shall be of sinusoidal waveform at a frequency of 8 KHz + 2% and modulated at a rate of 1 Kbit/s + 2%.

(c) Receive Specifications

The modulated carrier level received from the NI into the linecard or set shall be a minimum of 50 mV Peak to Peak at 20˚C. It shall be a minimum of 55 mV Peak to Peak at 70˚C for the linecard and a minimum of 55 mV Peak to Peak at 50˚C for the set. It will be at a frequency of 8 KHz + 2% and modulated at a rate of 1 Kbit/s + 2%.

The carrier will be received with a signal to noise margin no less than 20 dB, at the minimum receive level. Noise in the 6KHz to 10 KHz band, only, will be considered. Transmit and Receive specifications are summarized in Table 3.1.

(d) Filtering

In order to avoid a disturbing interference to voiceband communications, any secondary channel transmission shall have a minimum roll-off of 24 dB/octave below 7 KHz.

Table 3-1 Secondary Channel CPE Transmission Specifications

Characteristic	Value	Tolerance
Modulation Scheme	ASK	----------
Carrier Frequency - Transmit - Receive	8000 Hz 8000 Hz	± 2% ± 2%
Bit Rate	1Kbit/s	± 2%
Network Impedance	900 Ohms	Nominal
CPE Impedance	900 Ohms	± 10%
Maximum Transmit Level (Into 900 Ohms)	1.3 V P/P	± 200 mV
Minimum Receive Level (into 900 Ohms)	50 mV P/P 55 mV P/P	Min. 20°C Min 70°C
Balance (@ 8000 Hz)	38 dB	Min.
RMS Signal - to - Noise* (Receive)	20 dB	Min.
* Flat weighted noise in 6KHz to 10 KHz		

3.2.5 DC Battery Feed and Equalization

The DMS line card provides a balanced 440 ohm battery feed from the central office to the network interface. The power available at the network interface can be used to power the CPE with the provision that its DC signature conforms to the requirements detailed in Table 3.2.

The voltage supplied over the subscriber loop to the interface is nominally 52 volts, with a minimum of 42.75 volts and a maximum limit of 56 volts between tip and ring. Under normal operating conditions, the DC potential shall be negative on the right relative to the tip. The current drawn by the primary voice terminal from the subscriber loop when the set is in the standby mode, shall be less than or equal to the limit specified in Table 3.2. When in the active state, the current drawn from the loop interface by the primary set shall be within the limits specified in Table 3.2. See Section 5 on the primary set for further information on what constitutes active and standby modes.

In addition to powering the primary set the voltage present at the interface is used to establish the required equalization to compensate for the voiceband transmission losses introduced by the loop when the set is active.

The subscriber loop must be non-loaded. The loop range limit for a particular loop is determined by one of two factors: either the DC resistance of the loop or the attenuation at 8 kHz. The controlling factor being the one that restricts the range the most. The DC resistance of the loop must be limited to ensure the primary set has sufficient power supplied from the line card battery feed (see Table 3.2 for the DC resistance limit). The attenuation at 8 kHz cannot exceed the value given in Table 3.2 to ensure satisfactory operation of the signal channel. The attenuation at 8 KHz is dependent on both the loop length and the amount of bridge tap present. Any range reduction due to the bridge tap is dependent on the length of the bridge tap and on its location.

Table 3-2 Summary of Electrical Interface Characteristics

Characteristic	Value
Primary Set - Current Drawn in Standby Mode - Current Drawn in Active Mode	18 mA Max. 15 mA Min. 38 mA Max.
Normal Battery Feed Polarity	
DC Resistance - Add Ons (T to R)	2 MOhms Min
DC resistance for an terminal equipment with the polarity of T and R reversed	2 MOhms Min
ASK (into 900 ohms) - Transmit Level (8 Khz) - Receive Level (8 Khz) .	650mV peak Max 25 mV peak Min. 20°C 27.5 mV peak 70°C
Loop Range - Attenuation at 8KHz from Line Card to Set or Add Ons. - Loop DC Resistance Limit	24dB Max 1230 Ohms Max.
Voiceband AC Impedance - Primary Set Impedance (T to R) - Auxiliary Set Impedance (T to R) - Add Ons (T to R)	 900 Ohms Nominal 25 KOhms Min. 25 KOhms Min.

3.2.6 Add On Modules Electrical Connection Requirements

The intended purpose of the Add-on modules is to provide additional features to the primary set.

The Add-ons are designed to bridge the Tip and Ring network interface association with the primary set.

The Add-ons are uniquely addressable and have a high AC and DC impedance between tip and ring (see Table 3.2 for the requirements). The Add-ons depend on the 900 ohms termination of the primary voice terminal to provide their terminating impedance. The high impedance of these devices ensures that the 900 ohms AC terminating impedance of the primary set is not significantly altered. The high DC resistance of any Add-ons is required to ensure the primary set loop powering requirements can be met.

4. Network Signaling Protocol

4.1 General

DMS-100 Meridian Business Service Signalling capabilities are provided via the above voiceband channel. The messages sent over the channel use the protocol outlined below.

4.2 Message Envelope Structure

Both incoming and outgoing messages consist of 16 bits contained within a basic two byte structure as shown in Figure 4-1.

Figure 4-1 Basic Structure (16 bits)

Start	Direction	Address	Cmd. Bits M7-M5
(Bit 0)	(Bit 1)	(Bit 2-4)	(Bit 5-7)

Cmd. Bits M4 -M0	Repeat	Collision	Parity
(Bit 8-12)	(Bit 13)	(Bit 14)	(Bit 15)

Start Since the transmission scheme is asynchronous, a start bit is required. This bit is always 1 and represents the beginning of transmission.

Direction The direction bit indicates which direction the message is being passed over the loop. This bit when set to 0 indicates that the message is from the terminal device to the linecard. When the bit is set to 1, the message is from the line card to a device on the loop.

Address The address of the sending or receiving terminals. The primary voice terminal is always address 0 with any Add-ons being restricted to addresses 1 through 3. An auxiliary voice terminal, if provided as a service, is given address 4 with any Add-ons being restricted to addresses 5 through 7. The three bits of the binary address are sent or received in order of decreasing significance with the most significant bit first.

Command The actual control command to be acted upon by the set, Add-on or the line card, (bits M7-M0). The eight bit command is sent or received in order of decreasing significance with the most significant bit first.

Repeat The repeat bit is normally set to 0 and will be set to 1 on retransmission not occurring as a result of collisions. If a positive acknowledgment is not received, the transmitter will repair the command only one more time with the repeat bit set.

Collision The collision bit is normally set high and is brought low when the transmitting device detects a collision.

Parity The parity bit is calculated such that the total number of ones in the message including the start bit is odd.

4.2.1 Message Format

The transmitted message is 16-bits long and the bit length is 1 ms. The message consists of a start bit, a message direction bit, a 3-bit address field, an 8-bit transaction code and 3 error-detection bits named repeat, collision and parity. The start bit is a logic one, the idle state of the line being zero or no carrier. The direction bit is zero for set-to-linecard transactions and one in linecard-to-set transmission. The direction bit will ensure that collisions are detected early where the linecard message address field matches the address of the transmitting set. This choice of polarity also reduces the possibility of set wake-up on a noise glitch. If the bit was low for linecard-to-set transmission, noise could wake-up set zero. The set would remain awake even though the false message would be rejected by the error bit checks.

All Meridian Business sets on a line are given an address unique to that line. This allows for a maximum of 8 terminal devices (primary sets and add-ons). Each message contains the address of the originating device (transmitter) in the case of terminal devices or the destination device (receiver) for messages from the linecard. The linecard has no true address code but is identified by the direction bit. The main set is given address zero.

When a set is receiving a message, it checks to see that the address field of the incoming message matches its own address. If not, the set continues to monitor the line but ignores the message (does not act upon it). The 8-bit transaction code is used to communicate information for the implementation of set features, dialled digits and hook switch reporting.

To reduce the effects of noise and collisions, the 3 status bits (error detection, supervisory bits) were included in the protocol. The repeat bit is brought high on retransmission not occurring as a result of collisions. This normally low bit works in conjunction with an internal flag to judge whether received message, free from errors, is to be accepted. When a device receives a message with incorrect parity, it sets the just mentioned flag (the "previous message in error flag"). If parity is correct, the flag is reset. The timing of retransmissions is such that a retransmission should always be received immediately following a message with a parity error. The action of flag and repeat bit can be summarized as follows:

(a) Flag and repeat are both set - message is accepted (retransmission assumed).

(b) Flag set and repeat reset - message is accepted (new message assumed).

(c) Flag reset and repeat set - message is ignored (it is assumed that the retransmitting device failed to detect a pack for a correct message).

(d) Flag and bit are both reset - message is accepted (new message assumed).

The "previous message in error flag" and repeat bit are not set for the reception of collided messages and collision retransmissions, respectively.

4.3 Collision Procedures

Successful operation under any half duplex protocol necessitates that only one intercommunicating device be allowed to transmit at a time. The Meridian Business Service line protocol does not accommodate this directly, but rather provides rules which insure that incidents of collision will be efficiently resolved.

The rules define three operating modes in which a device may be at any instant.

(1) Transmitting-The device is sending a message to, or replying to a message from, an intercommunicating device.

(2) Receiving-The device has detected a start bit and is in the process of sampling the remaining bits of the message envelope at their midpoints.

(3) Idle-The device is monitoring the line for a start bit.

(a) Avoidance

All devices on the Meridian Business Service loop, monitor the loop when they are not transmitting. If any one of them detects a valid start bit, its transmit mode shall be inhibited for the period of time it takes to receive a valid message plus the time required for a positive acknowledgment to be returned, together with a guard time that is used to resolve line contention, should errors occur. This characteristic eliminates the majority of collisions. Resolution of the infrequent situation where more than one device begins transmitting at the same time as another is required. The collision bit and the procedure associated with it shall be used to resolve such an occurrence.

(b) Detection

During the transmission of a message, the transmitting device shall monitor the loop while sending any zero bits to check that the loop has the correct level on it. All bits within the message envelope that are zero preceding the collision bit shall be evaluated for collisions. If the transmitting device detects a collision, the normally high collision bit shall be set low. This is an indication to the receiving device to ignore the message and therefore, not to return a positive acknowledgment. It also indicates that the transmitting device has detected a collision and will proceed with the collision procedure.

(c) Resolution

To avoid a collision recurring, the devices on the loop are assigned a set priority, in terms of how long they should wait after the collision is detected, before the message can be retransmitted. The DMS switch is given the top priority i.e. it can repeat the message with no time delay. The other devices on the loop are required to delay their retransmission a period of time (T) equal to one millisecond plus a length of time proportional to their address, i.e., T=(1+Address)ms. This gives the primary set, with address 0, the second highest priority with the lowest going to device 7. By giving each device on the loop a different priority, the probability of a collision reoccurring is very low. However, the protocol states that messages are to be repeated until the collision has been resolved.

4.4 Parity Error Detection & Retransmission Rules

The parity bit is calculated such that the total number of ones in the message including start bit is odd. The receiving set checks the parity bit and compares the line value with its calculated parity value. If there is a match and the collision bit is high, the message is considered valid and a positive acknowledgment is transmitted. A transmitter not receiving a positive acknowledgment and not detecting a collision, assumes a parity error and retransmits the message with the repeat bit set. The transmitter begins retransmission before other sets can initiate any new transmission. Only a single transmission attempt is made.

Failure of the transmitting device to receive a positive acknowledgment the second time will cause the attempt at transmitting the message to be canceled. Figure 4.2 gives the flow chart outlining how collisions and parity errors are handled by a device on the loop or the linecard in the receive mode. Figure 4.3 gives the flow chart outlining the protocol for the transmission of a message by a device on the loop or the line card.

Figure 4-2 Parity Error & Collision Detection Flow Chart

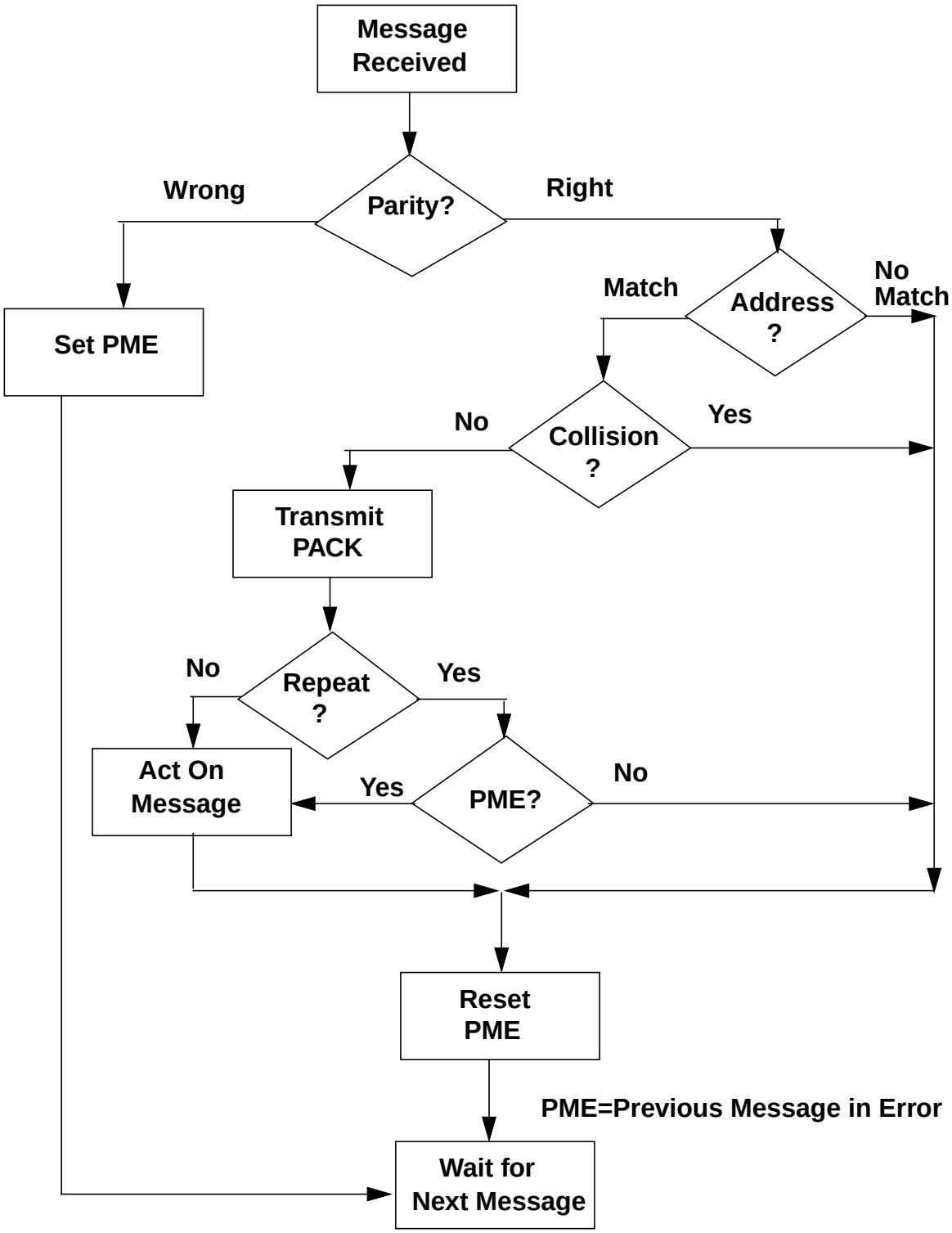
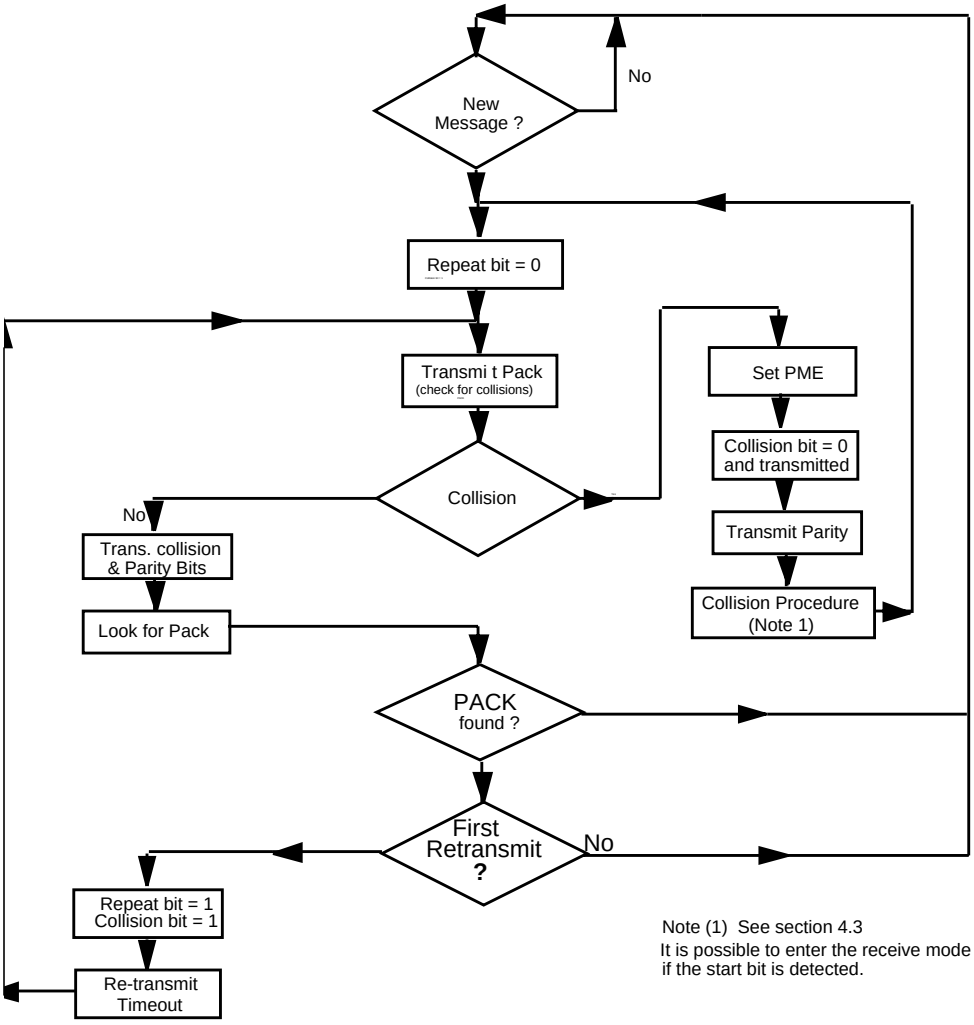


Figure 4-3 Message Transmission Protocol Chart



4.5 Timing Considerations

The bit length is nominally one millisecond. Start bits must exceed 500 microseconds to be valid. When a valid start bit is detected, the device will enter the receive mode and the remaining bits in the message will be sampled in the second half of the bit.

4.5.1 Transmitting Device Timing

A transmitting set looks for a positive acknowledgment on the line between 17 and 18 milliseconds into the transmit sequence. The positive acknowledgment must be present for 500 microseconds to be considered valid (see Figure 4.4).

All timing is relative to t=0 and this is at the instant in time the transmitter begins to send the envelope.

If the decision is made to retransmit because of a non-collision error, the retransmit sequence begins 22 ms into the transmit sequence. Retransmission because of collisions commences 23 + set address ms into the message transmission for set devices and 22 ms for the linecard. Transmission of new data is enabled at count 23 ms. In all case the set and linecard receive portions are enabled at transmit count 21. If a valid start bit is detected before a set begins retransmission or a new transmission, the receive mode will be entered and the transmit message will be held for transmission at a later time. Figure 4-4 illustrates the transmit sequence.

a) Valid Message Acknowledged

For a valid message sent and positive acknowledgment received, the earliest a new message may be sent is at 23 ms relative to t=0 (the beginning of the pervious message).

b) Valid Message Not Acknowledged

For a valid message where no collision is detected and a positive acknowledgment is not detected.

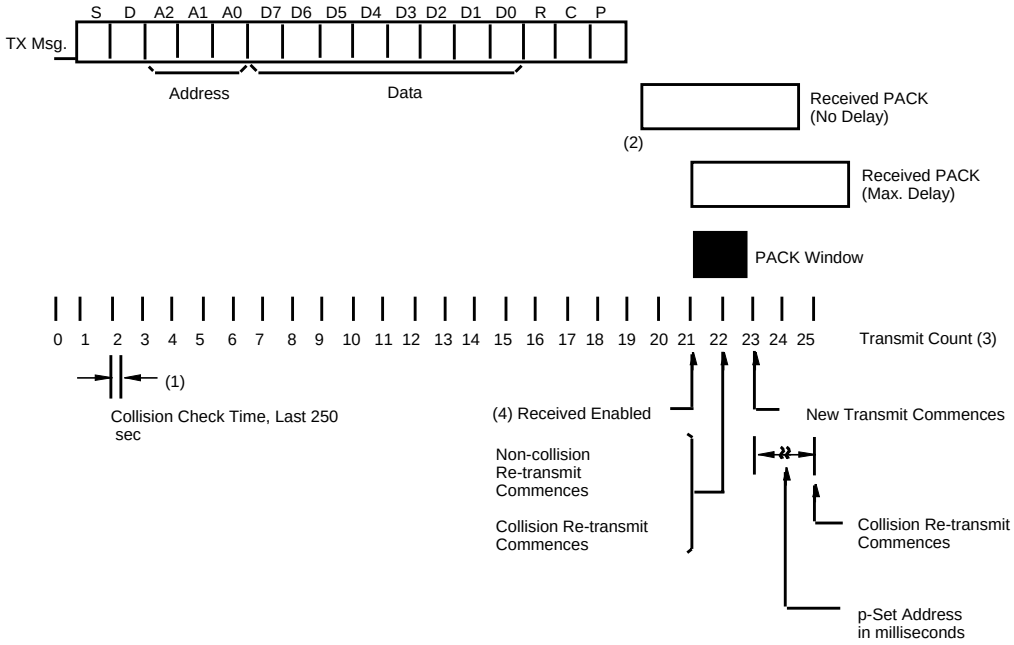
- Retransmission for non-collision error begins at t=22 ms relative to t=0.

c) Collision Detected

For a message transmitted where a collision has been detected (collision bit set).

- Retransmission due to a collision begins at t=22 ms for the line card.
- Retransmission for all devices on the loop due to collisions begins at t=23 + (address x 1 ms). Therefore for the main set with address 0, t=23 ms

Figure 4-4 Transmit Sequence



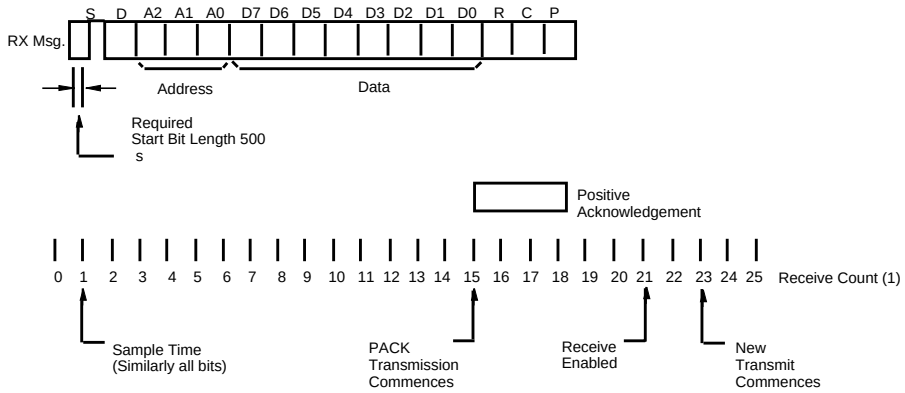
Notes:
1. Collision checks are performed on the start, direction, address, transaction code and repeat bits.
2. Received PACKS are shown for illustrative purposes only.
3. The transmit count is referenced to the beginning of the transmitted start bit and is in milliseconds.
4. ëReceive enableí refers to the enabling of start bit detection and subsequent message reception circuits.

4.5.2 Receiving Device Timing

- The receiver begins timing after it has detected a valid start bit for 500 microseconds.
- Therefore, t-0 at 0.5 ms into the receive message envelope.

- Positive acknowledgment is returned from the receiving device when its timer is at t=15 ms until the timer is at t=18 ms if there are no errors in the message.
- Negative acknowledgment is indicated by no acknowledgment.
- Receive is enabled at t=21 ms.
- A new message may be transmitted any time after t=23 ms.

The receive sequence is shown in Figure 4.5.



Note: (1) Receive count is referenced to valid start bit detection time and is therefore delayed approximately 500 microseconds with respect to the Transmit count.

Figure 4-5 Receive Sequence

4.5.3 Maximum Message Rate

The full available message rate bandwidth (23 ms per message) may not be used, depending on the switch software real-time requirements. It may be subject to switch throttling (flow control mechanism) depending on the circumstances. When the limit of six messages per second is exceeded, all messages from the CPE after the first six will be ignored by the switch.

5. Command Protocol

5.1 General

The Command Protocol specifies the rules for the exchange of switch control, signalling and status information between CO and Meridian Business Service CPE. The rules provide command definition and include both requirements and restrictions on use within the context of call setup or other normal telephone functions. The rules include mapping of commands to eight bit binary codes for transmittal in the message envelope previously described in Section 4.4

Some of the commands transmitted or received by both the CO and the CPE have specific predefined meanings as outlined in this section. However, the feature key commands may be assigned different interpretations by the CO based on the customer's feature profile in CO software. The specific use of these key commands is established when the service is installed by the Telco.

The network can support up to fourteen feature keys with associated indicators on the basic primary set.

As an example, the Operating Company assigns a specific customer the list of features he or she wants:

Key 1 Primary Directory

Key 2 Directory Number

Key 3 Conference 6

Key 4 Ring Again

Key 5 Speed Call

Key 6 Call Waiting

Key 7 Unused

Key 8 Unused

Key 9 Unused

Key 10-14 Unused

5.2 CO To CPE Commands

(see Tables 5.1 - 5.2)

Indicators — The indicator commands are transmitted in response to stimulus signalling from the CPE or to enable the CO to indicate a change in a feature state. Each feature key no. 1 through 14 has four commands associated with it that the CO can send to indicate one of four possible indicator states. These are designated as on, off, flash and wink. For example, in the case of a DN feature key, such as key no. 1, off = line inactive, on = line in use, flash = incoming ringing and wink = hold state. These commands are also used to indicate the state of special features such as Call Forward and Ring Again.

Voice (On/Off) — These commands are sent by the CO to the CPE to indicate when a line monitor in the CPE should be enabled (Voice-On) or disabled (Voice-Off). These commands may be used, for example, in conjunction with on-hook dialing to hear call progress tones. See Section 5.4 Handset Interlock for the interlock requirements the CPE shall provide between the line monitor and the handset.

Handset (On/Off) — The Handset (On) command is sent by the CO in response to a Hook Switch status (off-hook) command from the CPE. It is intended to be used to enable the CPE handset - or an attached speakerphone - receive and transmit pairs.

The Handset (Off) command is used in conjunction with the DMS "Listen on Hold" feature. With this feature activated, the CO will issue the Handset (Off) command and follow it with the Voice (On) command. This will accommodate user monitoring of a call in the Hold state.

The Command Protocol does not require that Handset (off) be sent by the CO in response to a change in Hook Switch status to on-hook. If the CPE handset is placed back on-hook, the CPE is expected to automatically reset the handset to its off state.

The Hook Switch status (On-hook, Off-hook) commands are described in section 5.3.

Hard Reset

This command is sent to the CPE to place it in a known state after the CO has completed line diagnostics. Diagnostics are normally performed on a daily basis during a low traffic condition. This command shall reset CPE hardware. That is, place it in the idle state, indicators off and echo mode option, if implemented, in Echo (Close) state.

Soft Reset

This command is used by the CO to perform an indicator audit, wherein the CO will refresh the CPE status indicators to agree with current memory. Echo mode is closed.

The indicator audit is only performed when there are no calls active or in a hold state. This reset differed from the hard reset in only one respect and that is the CPE is left active.

Save Indicator Reset This command is sent after all calls are disconnected, i.e., no DN's are active or in the hold state. It should be interpreted by the CPE as an indication to go from the active into the idle mode with the indicator states remaining unchanged. Echo mode is closed.

Alert (On/Off) The Alert (On) command is sent by the CO prior to the voiceband alerting signal being passed over the voiceband channel (see section 3.2.3. Alerting Signal). The Alert (Off) command is sent if the CO detects the originating party has abandoned the call attempt or when the CPE indicates the call has been answered by an Off-hook or a Feature key (DN) command sent by the CPE to the CO (see section 5.4 Handset Interlock). The CPE shall provide 10 dB attenuation when the handset is in the off-hook state.

Buzzer (On/Off) The Buzzer (On/Off) commands are sent by the CO to indicate an incoming call when the handset is Off-hook or the voice path is active. This will be used for special features such as call waiting. It will also be used as an indication for some special features such as Ring Again to indicate that a busy number is now free. The CPE shall provide 10 dB attenuation when the handset is in the Off-hook state.

Handsfree-On This command is sent by the CO either on a full time basis or on the basis of a feature key assignment that allows the user to select when it is activated on the CPE.

This feature can only be used on the DN appearing on feature key no. 1. For incoming calls on DN key no 1, if this feature (known as Auto Answer Back) is active (ON) the transmission of the Handsfree-On command by the CO, after a short interval of ringing, will indicate an incoming call. If the Off-hook command is returned by the CPE in response to his command, the CO recognizes it as an indication a connection has been established.

Handsfree-Off

Where a call is answered using the above command, the call will be terminated by either the originating or answering end. If it is by the originating end hanging up, the CO deactivates the Auto Answer Back feature by sending the Handsfree-Off command to the CPE at the answering end. The CPE shall then return the On-hook indication. Termination of the call by the answering end will be handled according to the procedure for such termination, i.e., Release or Hook Switch status (On-hook), and Handsfree-Off will not be transmitted.

Echo (Open/Close)

Although the use of this command by CPE is optional, it is highly recommended since it enables the Operating Company to perform routine diagnostics on the secondary channel from the CO. The command is normally used on a daily basis as part of line diagnostics if subscribed to by the customer.

When the CO transmits the Echo (Open) command, the CPE shall place the secondary channel in a loop back state to the CO. Thereafter, all transmitted commands from the CO shall be retransmitted by the CPE back to the CO. While in the Echo (Open) mode, CPE shall not act on the received commands with the exception of Echo (Close) or any reset command which shall cancel the echo mode. The Echo (Close) command is used after diagnostics in the echo mode are complete.

The following table includes all the basic commands from the network to the Primary set (Address 0)

Table 5-1 CO to CPE Commands:

Function	Command Code								
	M7	M6	M5	M4	M3	M2	M1	M0	Hex
Soft Reset	0	0	0	0	1	0	0	0	08
Save Indicator Reset	0	1	0	0	1	0	0	0	48
Hard Reset	0	1	1	0	1	0	0	0	68
Close Echo	0	0	0	0	1	0	0	1	09
Open Echo	0	1	1	0	1	0	0	1	69
Alert Off	0	0	0	0	1	1	1	1	0F
Alert On	0	1	1	0	1	1	1	1	6F
Voice Off	0	0	0	0	1	1	0	0	0C
Voice On	0	1	1	0	1	1	0	0	6C
Handset Off	0	0	0	0	1	1	0	1	0D
Handset On	0	1	1	0	1	1	0	1	6D
Handsfree Off	0	1	1	0	1	0	1	1	6B
Handsfree On	0	0	0	0	1	0	1	1	0B
Buzzer Off	0	0	0	0	1	1	1	0	0E
Buzzer On	0	1	1	0	1	1	1	0	6E

Table 5-2 CO to Feature Key Indicator Commands (For Address 0)

Telco Key No	Function	Command Code									
		M7	M6	M5	M4		M3	M2	M1	M0	Hex
1	Key 1 Off	0	0	0	0		0	0	0	0	00
	Key 1 Wink	0	0	1	0		0	0	0	0	20
	Key 1 Flash	0	1	0	0		0	0	0	0	40
	Key 1 On	0	1	1	0		0	0	0	0	60
2	Key2 Off	0	0	0	0		0	0	0	1	01
	Key 2 Wink	0	0	1	0		0	0	0	1	21
	Key 2 Flash	0	1	0	0		0	0	0	1	41
	Key 2 On	0	1	1	0		0	0	0	1	61
3	Key 3 Off	0	0	0	0		0	0	1	0	02
	Key 3 Wink	0	0	1	0		0	0	1	0	22
	Key 3 Flash	0	1	0	0		0	0	1	0	42
	Key 3 On	0	1	1	0		0	0	1	0	62
4	Key 4 Off	0	0	0	0		0	0	1	1	03
	Key 4 Wink	0	0	1	0		0	0	1	1	23
	Key 4 Flash	0	1	0	0		0	0	1	1	43
	Key 4 On	0	1	1	0		0	0	1	1	63
5	Key 5 Off	0	0	0	0		0	1	0	0	04
	Key 5 Wink	0	0	1	0		0	1	0	0	24
	Key 5 Flash	0	1	0	0		0	1	0	0	44
	Key 5 On	0	1	1	0		0	1	0	0	64
6	Key 6 Off	0	0	0	0		0	1	0	1	05
	Key 6 Wink	0	0	1	0		0	1	0	1	25
	Key 6 Flash	0	1	0	0		0	1	0	1	45
	Key 6 On	0	1	1	0		0	1	0	1	65
7	Key 7 Off	0	0	0	0		0	1	1	0	06
	Key 7 Wink	0	0	1	0		0	1	1	0	26

Table 5-2 CO to Feature Key Indicator Commands (For Address 0)

	Key 7 Flash	0	1	0	0		0	1	1	0	46
	Key 7 On	0	1	1	0		0	1	1	0	66
8	Key 8 Off	0	0	0	0		0	1	1	1	07
	Key 8 Wink	0	0	1	0		0	1	1	1	27
	Key 8 Flash	0	1	0	0		0	1	1	1	47
	Key 8 On	0	1	1	0		0	1	1	1	67
9	Key 9 Off	0	0	0	1		0	0	1	1	13
	Key 9 Wink	0	0	1	1		0	0	1	1	33
	Key 9 Flash	0	1	0	1		0	0	1	1	53
	Key 9 On	0	1	1	1		0	0	1	1	73
10	Key 10 Off	0	0	0	1		1	1	1	0	1E
	Key 10 Wink	0	0	1	1		1	1	1	0	3E
	Key 10 Flash	0	1	0	1		1	1	1	0	5E
	Key 10 On	0	1	1	1		1	1	1	0	7E
11	Key 11 Off	0	0	0	1		1	1	1	1	1F
	Key 11 Wink	0	0	1	1		1	1	1	1	3F
	Key 11 Flash	0	1	0	1		1	1	1	1	5F
	Key 11 On	0	1	1	1		1	1	1	1	7F
12	Key 12 Off	0	0	0	1		1	0	0	1	19
	Key 12 Wink	0	0	1	1		1	0	0	1	39
	Key 12 Flash	0	1	0	1		1	0	0	1	59
	Key 12 On	0	1	1	1		1	0	0	1	79
13	Key 13 Off	0	0	0	1		1	0	1	0	1A
	Key 13 Wink	0	0	1	1		1	0	1	0	3A
	Key 13 Flash	0	1	0	1		1	0	1	0	5A
	Key 13 On	0	1	1	1		1	0	1	0	7A
14	Key 14 Off	0	0	0	1		1	0	1	1	1B
	Key 14 Wink	0	0	1	1		1	0	1	1	3B
	Key 14 Flash	0	1	0	1		1	0	1	1	5B

Table 5-2 CO to Feature Key Indicator Commands (For Address 0)

14	Key 14 On	0	1	1	1		1	0	1	1	7B

5.3 CPE To CO Commands

(see Table 5.3)

Hookswitch Status — The Hookswitch Status is given by two commands. One indicates the handset has been taken Off-hook while the second indicates the handset has been returned to its On-hook state.

Feature Keys — The command codes for the feature keys are used to provide DN appearances as well as other features that may be provided such as Call Forward, Call Transfer, Conference 6, etc.

Hold — This command is used to place a DN that is active in the hold state.

Release — This command is used to release a DN that is active at the time the Release key is depressed.

Digits — The commands associated with each digit of the dial pad serve the same purpose as the keys on a standard dial pad of a phone, i.e., for network addressing. For call forwarding, the key pad is used to program the DN to which incoming calls should be forwarded.

Table 5.3 - CPE to CO Commands (for Address 0)

FUNCTION	Command Code								
	M7	**M6**	**M5**	**M4**	**M3**	**M2**	**M1**	**M0**	**HEX**
DialPad Keys ‘1’	0	0	0	0	1	0	0	0	08
DialPad Keys ‘2’	0	0	0	0	1	0	0	1	09
DialPad Keys ‘3’	0	0	0	0	1	0	1	0	0A
DialPad Keys ‘4’	0	0	0	0	1	1	0	0	0C
DialPad Keys ‘5’	0	0	0	0	1	1	0	1	0D
DialPad Keys ‘6’	0	0	0	0	1	1	1	0	0E
DialPad Keys ‘7’	0	0	0	1	0	0	0	0	10
DialPad Keys ‘8’	0	0	0	1	0	0	0	1	11

Table 5.3 - CPE to CO Commands (for Address 0)

FUNCTION	Command Code								
DialPad Keys '9'	0	0	0	1		0	0	1	0	12
DialPad Keys '0'	0	0	0	1		0	1	0	1	15
DialPad Keys '*'	0	0	0	1		0	1	0	0	14
DialPad Keys '#'	0	0	0	1		0	1	1	0	16
Hold Key	0	0	0	0		1	0	1	1	0B
Release Key	0	0	0	0		1	1	1	1	0F
Hookswitch Status										
Off-Hook	0	0	0	1		1	1	0	0	1C
On-Hook	0	0	0	1		1	1	0	1	1D

Table 5.4 CPE Feature Key Commands to CO (From Address 0)

Telco Key No.	Function	Command Code								
		M7	M6	M5	M4	M3	M2	M1	M0	Hex
1	Key 1	0	0	0	0	0	0	0	0	00
2	Key 2	0	0	0	0	0	0	0	1	01
3	Key 3	0	0	0	0	0	0	1	0	02
4	Key 4	0	0	0	0	0	0	1	1	03
5	Key 5	0	0	0	0	0	1	0	0	04
6	Key 6	0	0	0	0	0	1	0	1	05
7	Key 7	0	0	0	0	0	1	1	0	06

Table 5.4 CPE Feature Key Commands to CO (From Address 0)

8	Key 8	0	0	0	0	0	1	1	1	07
9	Key 9	0	0	0	1	0	0	1	1	13
10	Key 10	0	0	0	1	0	1	1	1	17
11*	Key 11	0	0	0	1	1	0	0	0	18
12*	Key 12	0	0	0	1	1	0	0	1	19
13*	Key 13	0	0	0	1	1	0	1	0	1A
14*	Key 14	0	0	0	1	1	0	1	1	1B

* For Sets Equipped With These Keys

By the use of the feature keys, the DMS machine is provided with a form of stimulus signalling. The stimulus of the user pressing a given feature key can be used to initiate the DMS machine to perform some function. Where the function is dependent upon the feature key profile contained within the DMS machine.

5.4 CPE Protocol Related Characteristics

5.4.1 Handset Interlock

The network assumes the CPE provides an interlock between the CPE handset and both the ringer and a line monitor, if provided. The CPE ringer is controlled by the command from the network, Alert-On. The line monitor is controlled by the command from the network, Voice-on. The CPE shall switch either of them to their off state automatically, if on, when the handset is taken Off-hook. Thereafter, during the call, either "on" command will not be activated regardless of hookswitch status.

When the handset is On-hook, the CPE shall ignore the command from the network, handset-on.

Alerts from the network will be attenuated by 10 dB when the CPE is Off-hook.

5.4.2 CPE Activation

The network assumes the CPE will enter the active state when any one of the following conditions occur:

•The handset is taken Off-hook

•A valid command from the network, other than hard reset or save indicator reset command, with a valid address, is received.

•Any CPE key depression.

5.4.3 CPE Idle

The CPE shall enter the idle state, if not already in the idle state, when a hard reset or save indicator reset is received from the network.

5.5 CO and CPE Command Interaction

The interaction between the CO and the CPE is performed on the basis of stimulus signalling.

Hence, any attempt by the CPE to act in a manner other than responding as defined by the command protocol may result in the CPE being incompatible with the service offered.

For example, if the CPE sends the feature key command for a key defined as a DN, the CO will respond by sending the associated Indicator-On command and the Voice-On command, assuming the handset is On-hook. In the case of a dumb terminal, the order in which these two commands are received does not matter. Each command should be acted on as defined by the command protocol regardless of the order in which they are received.

The sequence charts that follow, in some cases, indicate a group of commands that will be received from the CO in response to a specific stimulus.

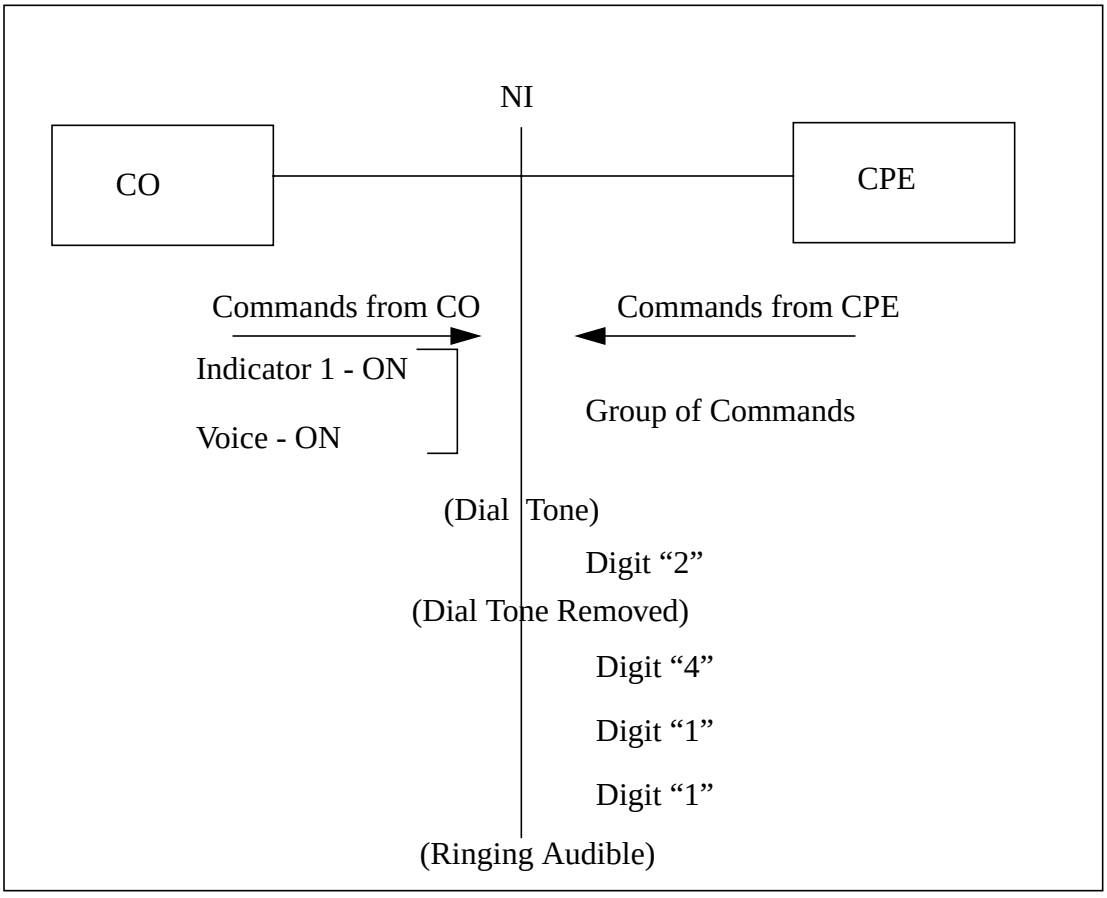
Command Sequence 1

Situation:Use of Feature Key to Originate and Dial

Assumptions: 1. CPE is Idle

2. PDN is on Feature Key No 1

3. Number to be Called is 2411



Command Sequence 2

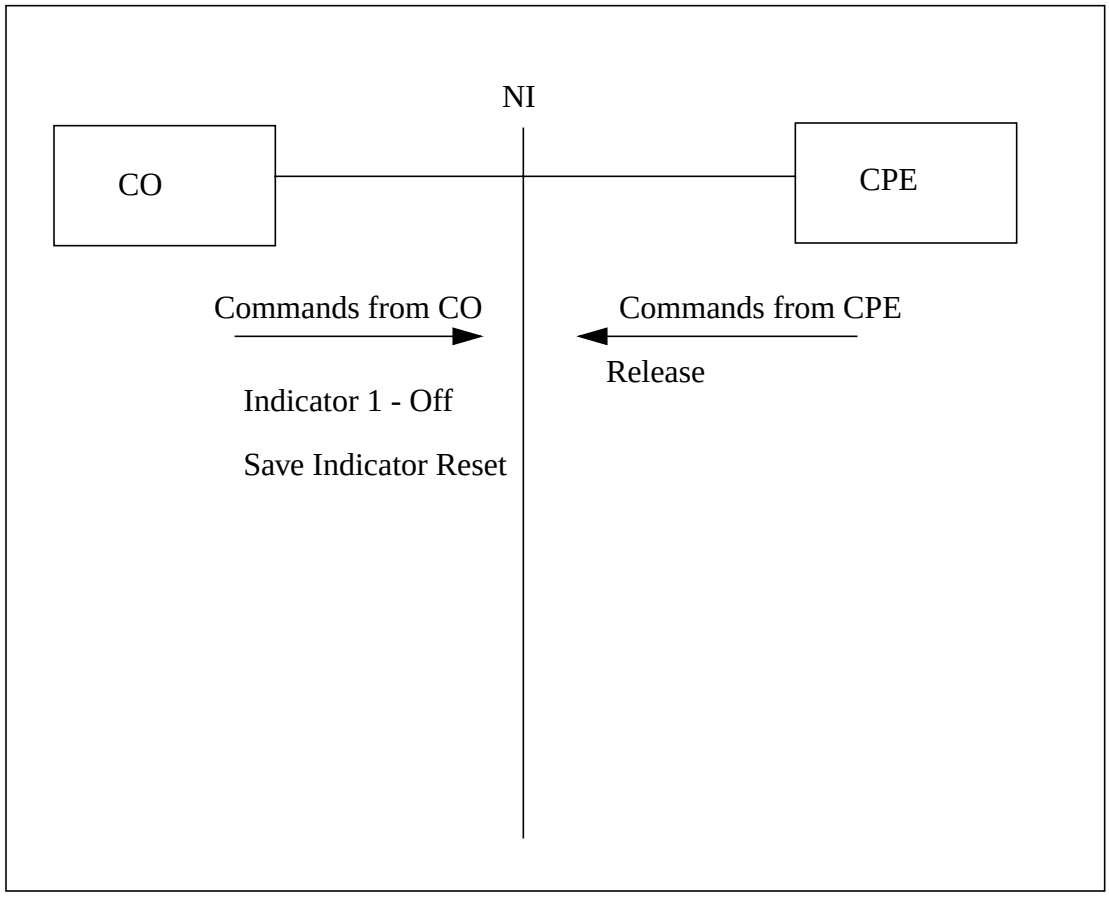
Situation:Use of Release Key

Assumptions: 1. Call Active on PDN

2. Feature Key No. 1 = PDN

3. Indicator 1 - On

4. Only PDN active

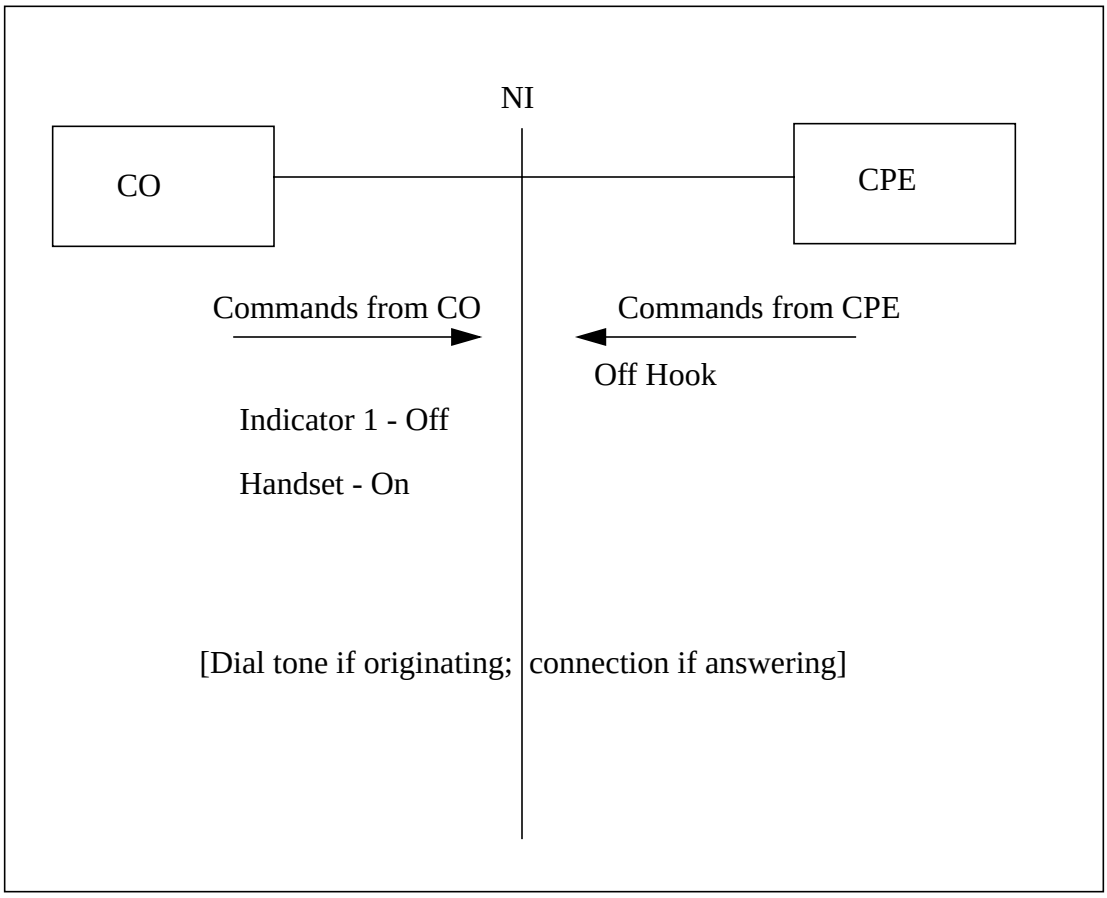


Command Sequence 3

Situation:Use of Off-hook Command

Assumptions: 1. Call Idle

2. PDN = Feature Key No. 1



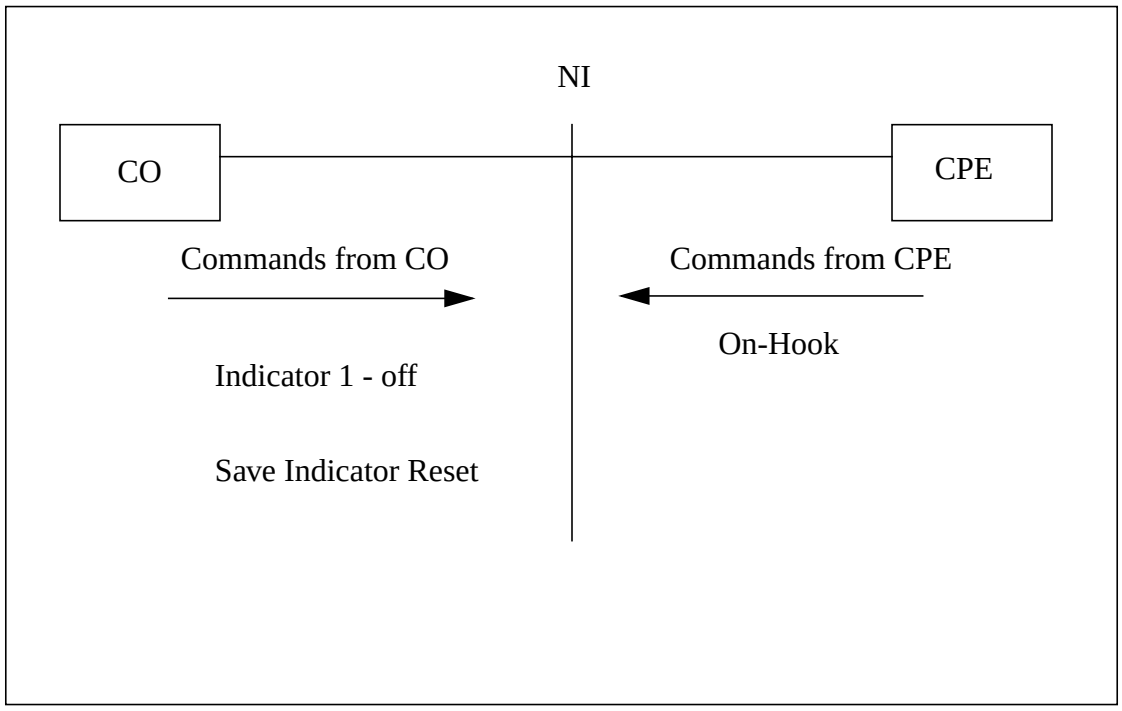
Command Sequence 4

Situation:Use of On-hook Command

Assumptions: 1. PDN = Feature Key No. 1

2. Indicator 1 - On

3. Only one DN active i.e., PDN

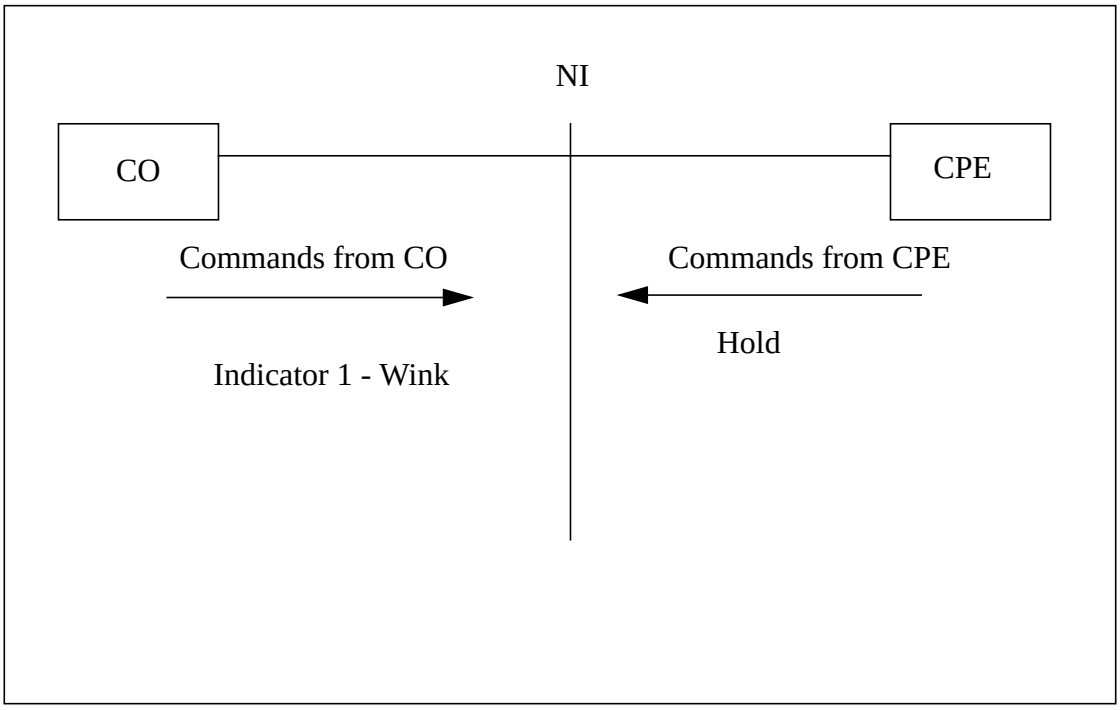


Command Sequence 5

Situation:Use of Hold Command

Assumptions: 1. PDN=Feature Key No. 1

2. Indicator 1 - On



6. Primary Set With A Display

6.1 General

The network is capable of supporting either a thirty-two or a forty-eight character display associated with the primary set. This requires an additional group of primary set display related commands. The display related commands are outlined below. The full set of the commands that the display circuitry can respond to are given.

New display related features will be made available as they are developed for the DMS family of switching machines using these commands in conjunction with assigned primary set keying sequences. The commands are designed to enable the DMS machine to control which features are particular customer has. Hence, the display features provided for a primary set with a display will be based on the customer's needs and the display features made available by the DMS machine software.

The following outline of the characteristics of the alphanumeric displays,

thirty-two character display (2x16) and forty-eight character display (2x24), and their related buffers is given here to aid in the understanding of the commands that are transmitted by the network and the response expected from the CPE display circuitry.

6.2 Displays And Related Buffers

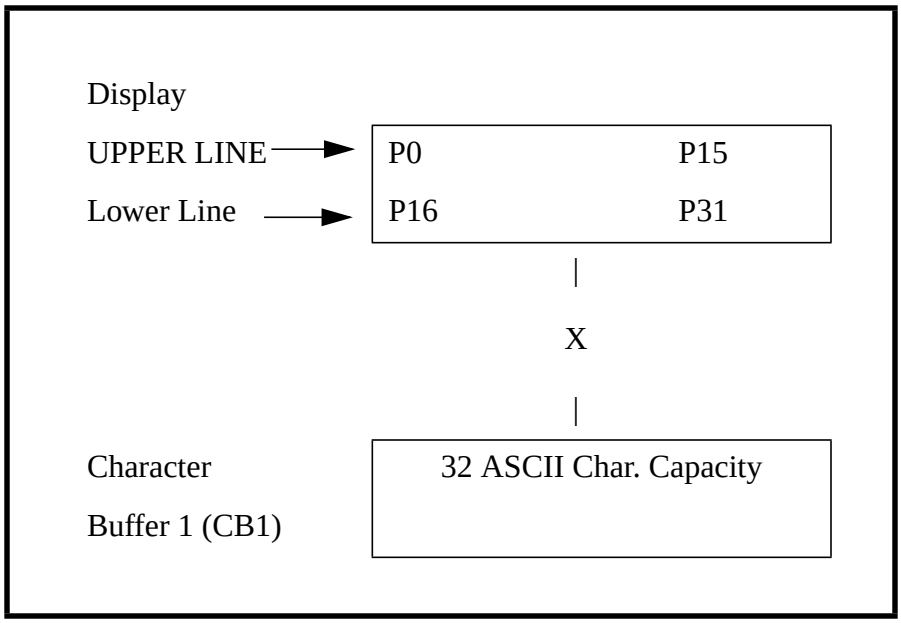
6.2.1 Thirty-Two Character Display (2x16)

When the network is supporting messages to a thirty-two display, it assumes the display consists of thirty-two alphanumeric characters. The top line is referred to as the UPPER LINE and the bottom line as the LOWER LINE. The alphanumeric character positions are numbered sequentially from (PO) position) in the top left of the display to (P31) position 31 in the bottom right as shown in Figure 6.1. Character Buffer 1 (CB1) is a buffer with a thirty-two ASCII character capacity that is always associated with the display. S1 as shown in Figure 6.1 signifies the gates that are under firmware control. It is through the control of S1 that the contents of CB1 are shown on the display.

Character Buffer 2 (CB2) has a thirty-two ASCII character capacity, the same as CB1. The ASCII characters that may be received by or transmitted from these buffers are given in Table 6.1.

When the display circuit is powered up or after the display circuit has been reset, CB1 is designated as the Working buffer. The Working buffer is the only buffer that the DMS machine can transmit ASCII characters to directly. Also, it is the Working buffer that the digits are locally echoed to when the DMS machine enables the digit echo mode. The digits displayed are then removed by commands received from the DMS machine.

Figure 6.1 Display and the Related Buffers

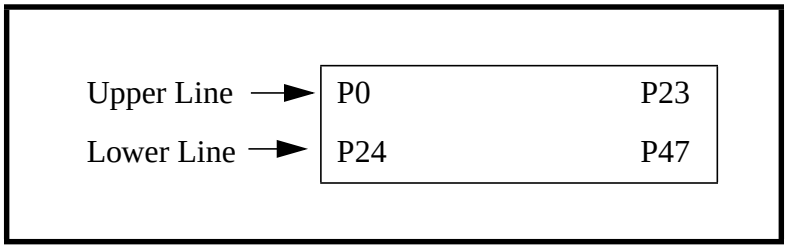


6.2.2 Forty-Eight Character Display (2X24)

The network is also capable of supporting a forty-eight character display. In this case, the network assumes the display. In this case, the network assumes the display consists of forty-eight alphanumeric characters that are arranged in two lines of twenty-four characters each. This larger display offers the user the same network features as the thirty-two character display but with the ability to display more information at once.

The alphanumeric character positions are numbered sequentially from (PO) position 0 in the top left of the display to (P47) position in the bottom right as shown in Figure 6.2.

Figure 6.2 Forty Eight Character Display



The related buffers of this display are functionally similar to the ones in the 32 character display. They are:

-Working buffer, can be viewed as identical to the display buffer.

-Display buffer, governs what appears on the screen.

Table 6-1 ASCII Character Set

ASCII Character	Meaning	Hexadecimal Value (ASCII)	Command Code Trans. or Rec (HEX)
A	Uppercase A	41	E1
B	Uppercase B	42	E2
C	Uppercase C	43	E3
D	Uppercase D	44	E4
E	Uppercase E	45	E5
F	Uppercase F	46	E6
G	Uppercase G	47	E7
H	Uppercase H	48	E8
I	Uppercase I	49	E9
J	Uppercase J	4A	EA
K	Uppercase K	4B	EB

Table 6-1 ASCII Character Set

ASCII Character	Meaning	Hexadecimal Value (ASCII)	Command Code Trans. or Rec (HEX)
L	Uppercase L	4C	EC
M	Uppercase M	4D	ED
N	Uppercase N	4E	EE
O	Uppercase O	4F	EF
P	Uppercase P	50	F0
Q	Uppercase Q	51	F1
R	Uppercase R	52	F2
S	Uppercase S	53	F3
T	Uppercase T	54	F4
U	Uppercase U	55	F5
V	Uppercase V	56	F6
W	Uppercase W	57	F7
X	Uppercase X	58	F8
Y	Uppercase Y	59	F9
Z	Uppercase Z	5A	FA
0	Zero	30	D0
1	One	31	D1
2	Two	32	D2
3	Three	33	D3
4	Four	34	D4
5	Five	35	D5
6	Six	36	D6
7	Seven	37	D7
8	Eight	38	D8
9	Nine	39	D9

Table 6-1 ASCII Character Set

ASCII Character	Meaning	Hexadecimal Value (ASCII)	Command Code Trans. or Rec (HEX)
SP	Space	20	C0
!	Exclamation Point	21	C1
“	Quotation Mark	22	C2
#	Number Sign (Octothorpe)	23	C3
$	Dollar Sign	24	C4
%	Percent Sign	25	C5
&	Ampersand	26	C6
‘	Apostrophe	27	C7
(	Opening Parenthesis	28	C8
)	Closing Parenthesis	29	C9
*	Asterisk	2A	CA
+	Plus Sign	2B	CB
,	Comma	2C	CC
-	Hyphen (minus)	2D	CD
.	Period (decimal)	2E	CE
/	Slant (slash)	2F	CF
:	Colon	3A	DA
;	Semi-colon	3B	DB
<	Less Than	3C	DC
=	Equals	3D	DD
>	Greater Than	3E	DE
?	Question Mark	3F	DF
@	Commercial Art	40	E0

Table 6-1 ASCII Character Set

ASCII Character	Meaning	Hexadecimal Value (ASCII)	Command Code Trans. or Rec (HEX)
[	Left Square Bracket	5B	FB
/	Reverse Slant	5C	FC
]	Right Square Bracket	5D	FD
X	Circumflex	5E	FE
_	Underscore	5F	FF

6.3 Display Modes

The network supports two modes of interacting with a display on the CPE. The two display modes are as follows:

6.3.1 Normal Display Mode

This mode applies to the display whenever digit echoing is off. This is used for character data as it is received from the DMS machine and is stored in the Working Buffer. The rules of "Normal Display" mode are as follows:

-No scrolling occurs.

-The cursor wraps around, i.e., it decrements past 0 to 47 (31) and increments past 47 (31) to position 0.

-Characters are entered at the cursor position.

-The cursor is advanced after each character is entered.

6.3.2 Digit Echoing Update Mode

This mode applies to the working buffer when one of the two digit echoing modes has been enabled by the DMS machine. The rules of "Digit Echoing Update" mode are as follows:

-Dial pad key depressions are locally echoed by the display circuit as they are entered. Removal of displayed digits is controlled by commands received from the DMS machine.

-Digit entry begins at the current cursor location.

-The cursor is advanced after each digit is entered until the cursor reaches position 15 or 31.

-When a digit is entered in position 15 (23) or 31 (47), for the first time, the line 0 is cleared and a shift left is performed. The contents of the display i.e., the working buffer, is shifted left one position for each subsequent digit entry to position 15 (23) or 31 (47).

Figure 6.2 and 6.3 illustrates the relative location of digits entered where the numbers shown indicate the order in which the digits have been entered i.e., 0 first and 30 last. See the description of the "Enable Digit Echoing-Type 1" and "Digit Echoing-Type 2" in Section 6.6 for further details.

Figure 6.3 Display (2X16) In Digit Echo Mode

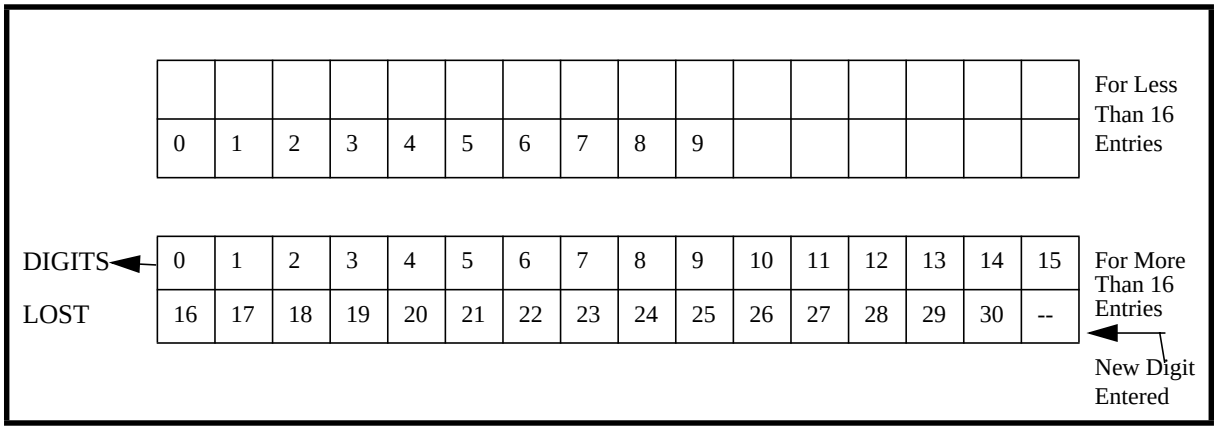
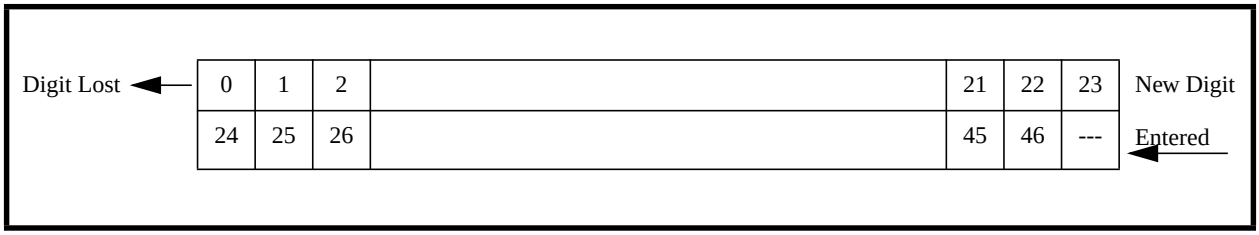


Figure 6.4 Display (2X24) in Digit Echo Mode



6.4 Received Display Command Handling

The network assumes the CPE display is capable of storing a second command while it is in the process of acting on the first one received. If the first one is still in the process of being acted on when a third one is received, the third one will be lost. this characteristic is restricted to the display related commands that are received by the set.

The DMS machine can use the above display circuit characteristic to determine when the display circuit is idle. If the DMS machine transmits a command for the display circuit and required to know when the task has been completed, the first command may be followed by a "Status Request" command. The reply to the "Status Request" will then guarantee the display circuit is now idle. This rule does not apply for the "Reset" command since part of the reset process is to clear any pending command that is stored.

6.5 Transmission Of Display Commands

For certain received display commands from the network, it is required that a response be transmitted back to the DMS machine from the CPE. This may be the ASCII characters in the Working Buffer. It is required that the CPE display data be merged with any basic primary set commands take priority over the display related commands. If, for example, the contents of the Working buffer are being transmitted when a feature key is pressed. The message indicating the key has been pressed shall be sent while the transmission of the buffer contents is momentarily interrupted.

6.6 CO To Display Circuit Commands

See Table 6-2

Note:

The description of the commands that follow applies to both the 48 and 32 character displays. Where the command places the cursor in a specific location on the display, the position given in brackets applies to 32 character display, e.g., position 24 (16).

1. Clear Working Buffer	The buffer currently designated as the Working Buffer shall be filled with blanks with the cursor left in position 0.
2. Clear Display	The contents of CB1 regardless of its designation shall be cleared with the related cursor left in position P1. See Sec. 6.9 for an example of the commands use.

3.	Clear Working Buffer Line 0	Line 0 (P0 to P15 or P0 to P23) of the buffer currently designated as the Working Buffer shall be filled with blanks with the cursor left in position 16 (24).
	Clear Working Buffer Line 1	Line 1 (P16 to P31 or P0 to P47) of the buffer currently designated as the Working buffer shall be filled with blanks with the cursor left in position 0.
4.	Enable Digit Echoing - Type 1	Set enters digit echoing mode, dial pad key depressions are echoed to the display according to digit echoing update mode. When the first dial pad key is pressed, the entire display is cleared, the cursor assigned to position 24 (16) and the digit echoed. when the 24th (16th) digit is echoed, line 0 is cleared, the digit is echoed and a shift left performed.
5.	Enable Digit Echoing - Type 2	Set enters digit echoing mode, dial pad key depressions are echoed to the display according to digit echoing update mode. When the first dial pad key is pressed, line 1 of the display is cleared; the cursor assigned to position 24 (16) and the digit echoed when the 24th (16th) digit is echoed line 0 is cleared; the digit is echoed and a shift left performed.
6.	Clear Working Buffer in 12 Seconds	The contents of the Working Buffer shall be filled with blanks with the associated cursor left in position 0. This shall occur either 12 seconds after the command is received or when the next command that represents an ASCII character is received whichever occurs first. This command is used for example when a Time and Date feature key is provided. When the Time and Date are requested, the character data is transmitted to the Working Buffer followed by this command to clear the display in 12 seconds.

7. Disable Display Cursor	The display cursor shall be disabled if the CB1 is designated as the Working Buffer, otherwise the command is to be ignored. See Section 6.9 for an example of the commands used.
8. Disable Digit Echo Mode	Whichever type of digit echoing that was previously enabled for the display circuit shall be disabled by this command. The normal display mode for the working Buffer shall be enabled. See Section 6.9 for an example of the commands used.
9. Disable Display	The display character elements shall be disabled. This can be used to allow the loading of a message into CB1 without the user seeing the characters as they fill the display. See Section 6.9 for an example of the commands used.
10. Power Down Display	This shall place the display circuitry in the low power or standby mode. The display circuitry shall then be powered up whenever a valid display circuit command is received. See Section 6.9 for an example of the commands used.
11. Enabled Display	The display character elements shall be enabled to reveal the contents of CB1 See Section 6.9 for an example of the commands used.
12. Enable Display Cursor	The display cursor shall be enabled. See Section 6.9 for an example of the commands used.
13. Display Reset	This shall reset the display circuitry placing it in the same state as is required after power up. This includes the following:

- CB1 is filled with blanks
- CB1 is designated as the Working Buffer
- the cursor for the buffer is set to position 0

- the display cursor is disabled
- normal display mode applies for the Working Buffer
- status bits are reset

14. Resume Digit Echoing	This shall initiate the resumption of the type of digit echoing that was most recently disabled, continuing on from the current cursor location. See Section 6.9 for an example of the commands used.
15. Transmit Display Status	This shall initiate the set transmitting the display circuit status. See the Transmitted Display commands for the format and content of the reply. This command is used for diagnostics when it is necessary to determine if the display circuit is active i.e., powered.
16. Working Buffer Cursor to P0	The Working Buffer shall have its associated cursor moved to position 0.
17. Working Buffer Cursor to P24 (P16)	The working Buffer, regardless of its location, shall have its associated cursor moved to position P24 (P16). See Section 6.9 for an example of the commands used.
18. Character Data	Any command that has the two MSB set to 1 shall be interpreted as character data. The character set the DMS machine can send or receive is limited to a subset of the ASCII character set. The sixty-four valid characters and their respective command codes are given in Table 6.1. The characters shall be loaded into the Working Buffer starting at the current cursor location. The number of character commands received in any one sequence

can vary from on e to several characters. If more than thirty-two (display version 2*16) are received, the Working Buffer will retain the last 32 characters received. When character data is being received the Working Buffer cursor is in the Normal Display mode. The display circuit shall be capable of storing ASCII characters at the maximum rate the DMS machine can transmit them as per the signalling protocol. See Section 6.9 for an example of the commands used.

Table 6-2 CO to Display Circuit Commands (For Address 0)

Function	COMMAND CODE									
	M7	M6	M5	M4		M3	M2	M1	M0	HEX
Clear Working Buffer	1	0	1	0		1	0	0	1	A9
Clear Display	1	0	1	0		1	1	0	1	AD
Clear Working Buffer - Line 0	1	0	0	0		1	0	0	1	89
Clear Working Buffer - Line 1	1	0	0	1		1	0	0	1	99
Enable Digit Echoing - Type 1	1	0	0	1		1	0	1	1	9B
Enable Digit Echoing - Type 2	1	0	1	0		1	0	1	1	AB
Clear Working Buffer in 12 sec	1	0	1	1		1	0	0	1	B9
Disable Display Cursor	1	0	0	0		1	1	0	0	8C
Disable Display Echoing	1	0	0	0		1	0	1	1	8B
Disable Display	1	0	0	0		1	1	0	1	8D
Power Down Display	1	0	0	1		1	0	0	0	98
Enable Display	1	0	0	1		1	1	0	1	9D
Enable Display Cursor	1	0	0	1		1	1	0	0	9C
Display Reset	1	0	0	0		1	0	0	0	88
Resume Digit Echoing	1	0	1	1		1	0	1	1	BB
Transmit display Status	1	0	1	1		0	1	1	1	B7

Table 6-2 CO to Display Circuit Commands (For Address 0)

Function	COMMAND CODE									
Working Buffer Cursor to P0	1	0	1	0		0	1	0	1	A5
Working Buffer Cursor to P16	1	0	1	1		0	1	0	1	B5
(or to P24)										
Character Data	(See Note)									

6.7 Display Circuit to CO Commands

(see Table 6.3)

The commands transmitted from the display circuit via the primary set signalling protocol are as follows:

Character Data — The contents of the Working Buffer shall be transmitted to the DMS machine when requested (See CO to Display commands, Sec 6.6) The command codes used to represent the sixty-four valid ASCII characters are given in Table 6.1.

Display Status — This response shall be transmitted when the set receives the Transmit Display Status command. the Display Status command format is 0011S3S2S1S0 where the four MSB are always as shown in Table 6.3. S3, S1 and S0 are "don't care". S2 shall normally be 0 and is set to 1 by the display circuit when there has been a power failure since the last Transmit Display Status command was received. This bit shall be reset to 0 after the first status request reply is given subsequent to the power being restored.

Table 6-3 Display Circuit to CO COmmands

Function	Command Code									
	M7	M6	M5	M4		M3	M2	M1	M0	Hex
Display Reset	0	0	1	1		1	x	x	x	3X
Character Data	(See Note)									XX

Note: The sixty-four valid ASCII characters that may be transmitted as part of the contents of one of the character buffers and the command codes used to represent them are given in Table 6-1.

6.8 Power Failure Mode

If the CPE provides the basic primary set features by using the DC current available from the network interface (see Table 3-2) and depends on the local commercial power for the display circuit, the following power down procedure is recommended to provide graceful interruption of the provision of the display features.

When the local commercial power source fails, the display circuit should power down in the following manner:

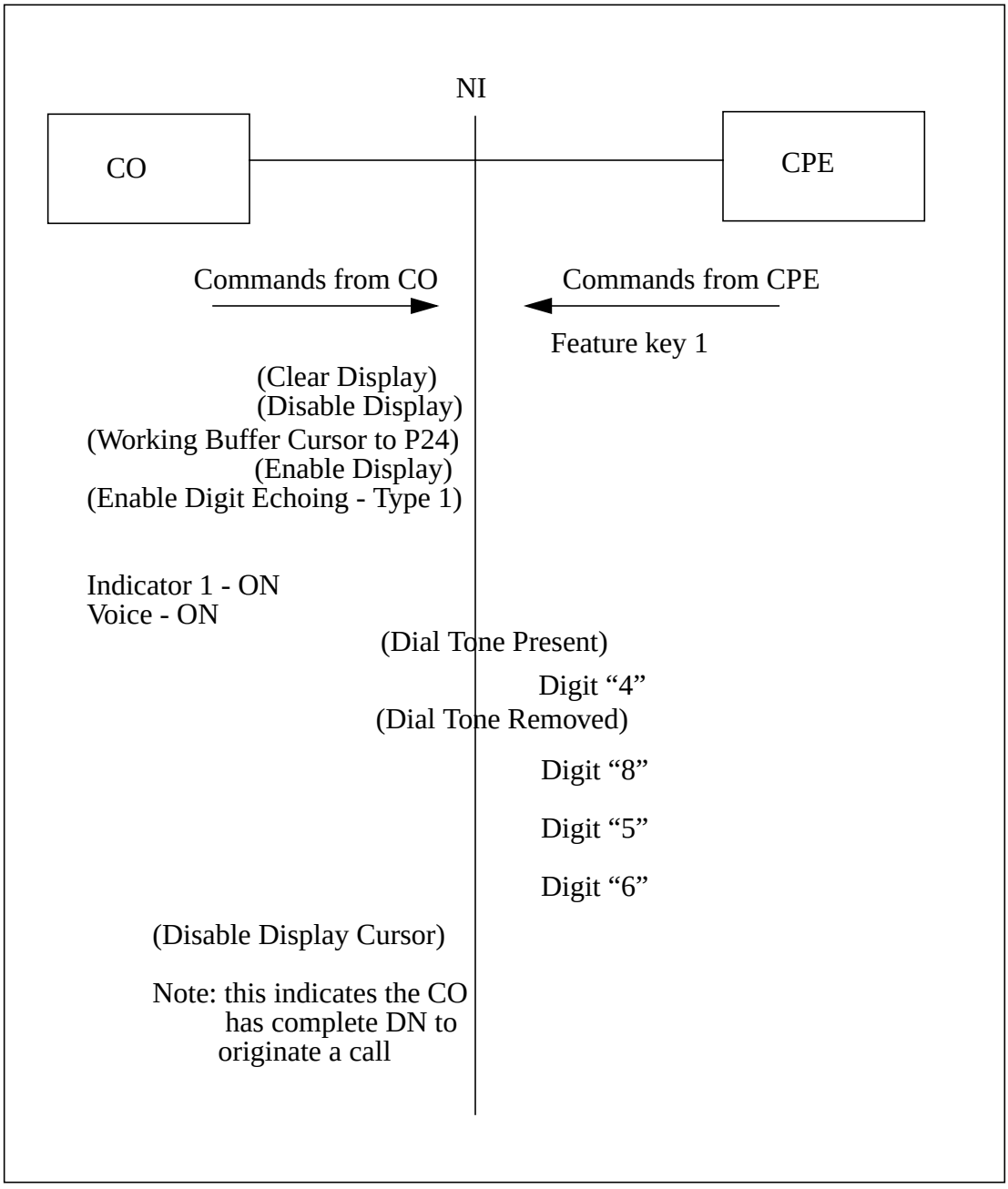
- complete any action on a command that is being acted on with the exception of ProgramLast Number command or the Program Digit Buffer command.
- retain any command that is in the register for commands that are awaiting another command action to be completed.
- store the state of the display when power failure occurred i.e., Digit echo Mode etc.
- the set shall revert to operation as a basic set with no display features available.
- the display status command from the DMS machine shall receive no reply while the power remains off.

When the local power source is restored, the bit in the display status byte that indicates a power failure has occurred shall be set to one. This bit shall remain set until after the first reply is given to a status request command from the DMS machine. It is then reset to zero. When the local power source is restored, the display circuit shall be re-enabled to the state it was left in when power failure occurred.

6.9 Hypothetical Command Sequences

The following hypothetical call sequences illustrates how the display commands are used to control the display. The first sequence assumes the CPE is idle when a call is to be originated from the directory number assigned to Feature Key No 1. In the sequences that follow, all commands within parentheses, (),i.e., are commands only transmitted to CPE designated in CO software as having a display with the remaining commands being relevant to CPE with or without a display.

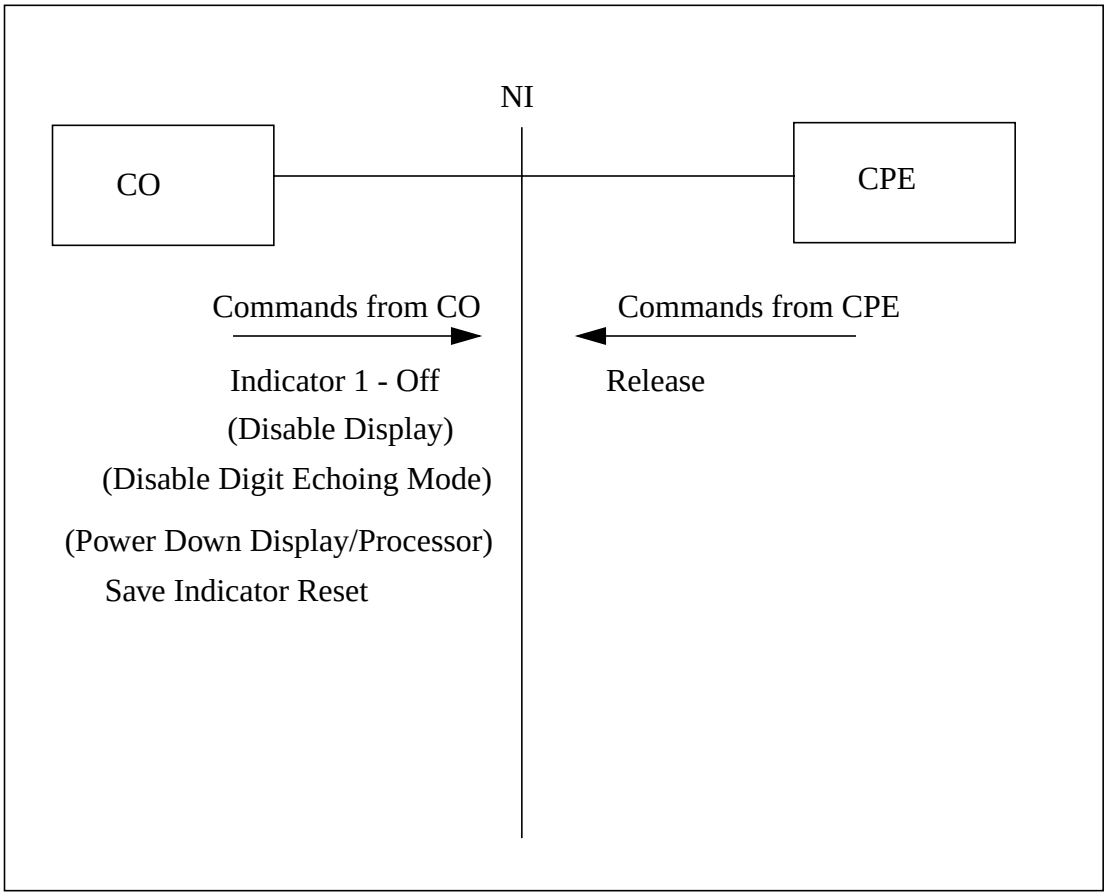
A Situation:Call Origination Sequence



B Situation:No Answer On An Originated Call

Assumptions: 1. Only active call on Feature Key 1

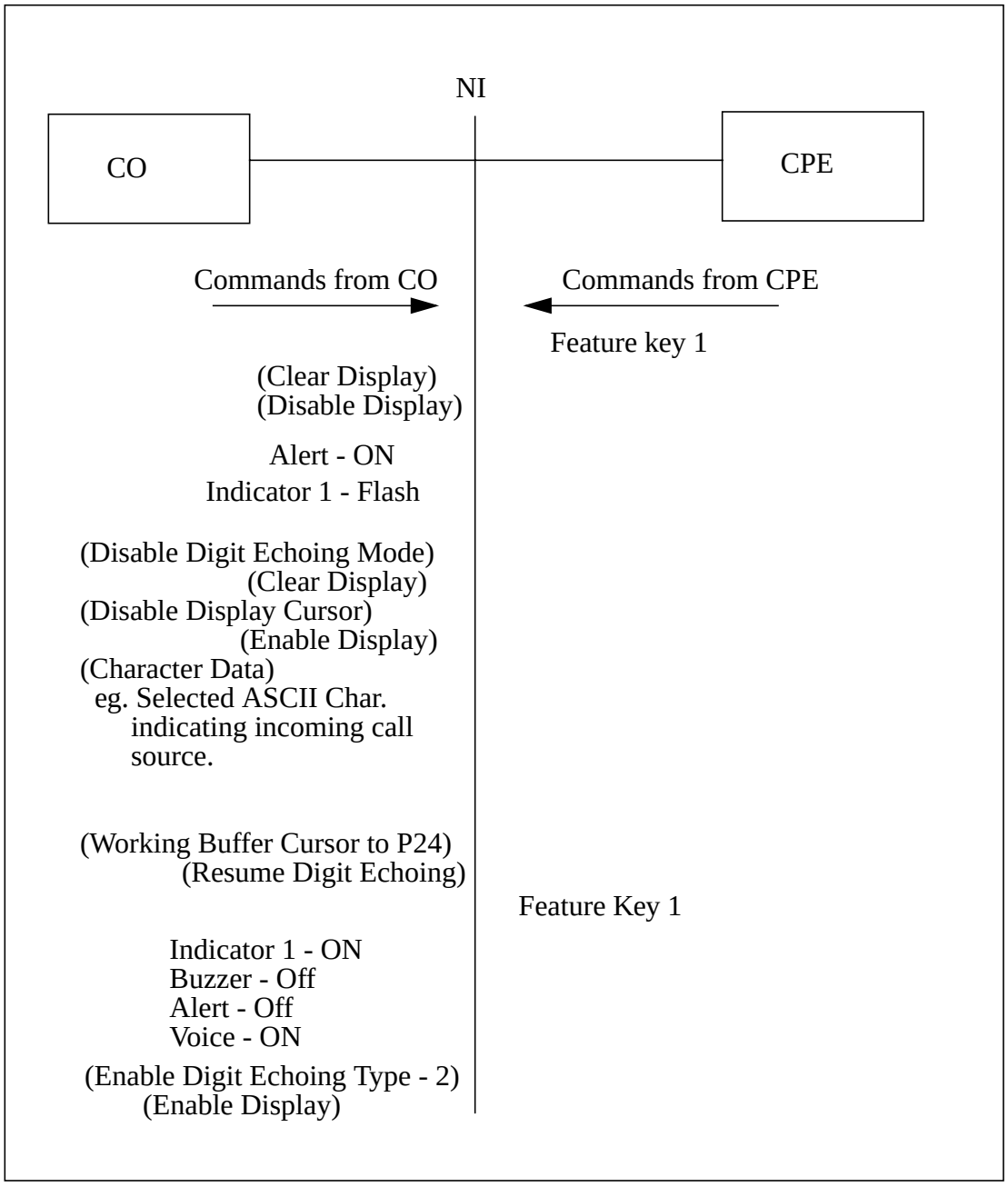
2. Indicator 1 - ON



C Situation:Answering An Incoming Call

Assumptions: 1. Set in idle

2. Incoming call is on Feature Key 1



7. Add-On Modules

7.1 General

The network can support various add-on modules to the primary set.

The Add-on units are designed to function in parallel with any one of the primary sets. Their purpose is to provide additional feature keys where the number of keys on the primary set are insufficient for the application. One such application is a secretarial position that requires the ability to answer incoming calls for a group of individuals. As in the case of the feature keys on the primary set, the command codes for the keys of an Add-on module may be assigned different interpretations by the CO based on the customer's feature profile in the CO software. The specific use of these key commands is established when the service is installed by the Telco. The network supports three Add-on configurations. the commands associated with each of these configurations are covered.

7.2 Twenty Button Add-On Modules

The twenty button add-on configuration enables the network to place sixteen indicators in the same four states as the feature key indicators on the primary set. The other four keys do not have associated indicators that can be addressed by the DMS machine.

As in the case of the feature keys on the primary set, the command codes for the twenty keys of an Add-on module may be assigned different interpretations by the CO based on the customer's feature profile in the CO software. The specific use of these key commands is established when the service is installed by the telco. The translation table, Table 7-1, enables the Telco to specify which features are going to be assigned to the available key command codes. Using the key numbers 10 to 29 for the first module, 30 to 49 for the second one and 50 to 69 for the third one. The fact that the same Telco key numbers apply to two different model addresses is because if an extension set is used the same features will appear on the extension set twenty button Add-on module keys, if the extension set module octal address that is used corresponds

to the second address shown in the respective columns of Table 7-1 i.e.,e.g., the primary set address 1, 2, and 3 correspond to the extension set addresses 5, 6, and 7 respectively. Hence, if you want a primary set with one set of features on an Add-on module and also an extension set but with an Add-on module with a different set of features, the octal addresses selected must be from different columns of Table 7-1, e.g., octal address 1 and 6.

Table7-1 Translation Table for CPE 20 Button Add-On Modules

Telco Key No. for Modules with Add-On 1 or 5	Telco Key No. for Modules with Add-On 2 or 6	Telco Key No. for Modules with Add-On 3 or 7	Function Key Number (See Table 7-3)
10	30	50	8
11	31	51	9
12	32	52	10
13	33	53	11
14	34	54	12
15	35	55	13
16	36	56	14
17	37	57	15
18	38	58	16
19	39	59	17
20	40	60	0
21	41	61	1
22	42	62	2
23	43	63	3
24	44	64	4
25	45	65	5
26	46	66	6
27	47	67	7
28	48	68	18
29	49	69	16

7.2.1 CO to 20 Button Add-On Commands

The three bit octal address for the twenty button Add-on modules are address 1 (001), address 2 (010) or address 3 (011) for the primary set or address 5 (101), address 6 (110) or address 7 (111) for the extension set. This enables the use of more than one module where required. For the indicators numbered 0 to 15, the same four indicator states as was defined for a set apply. Also, the Hard, Soft and Power Down reset commands serve the same purpose as for a set and operate in the same manner as for a set.

See the description of Hard Reset, Soft Reset, Power Down Reset, Close Echo and Open Echo commands given Section 5 for a description of how and when they are used.

Table 7-2 CO to 20 Button Add-On Command Codes

Function		Command Code									
		M7	M6	M5	M4		M3	M2	M1	M0	HEX
Indicators	OFF	0	0	0	0		0	D	D	D	0X
0 to 7	WINK	0	0	1	0		0	D	D	D	2X
	FLASH	0	1	0	0		0	D	D	D	4X
	ON	0	1	1	0		0	D	D	D	6X
Indicators	OFF	1	0	0	0		0	D	D	D	8X
8 to 15	WINK	1	0	1	1		0	D	D	D	AX
	FLASH	1	0	0	0		0	D	D	D	CX
	ON	1	0	0	0		0	D	D	D	EX
**Hard Reset & Synchronization		0	1	1	0		1	0	0	0	68
Soft Reset		0	0	0	0		1	0	0	0	08
Save Indicator Reset		0	1	0	0		1	0	0	0	48
Close Echo (optional)		0	0	0	0		1	0	0	1	09
Open Echo (optional)		0	1	1	0		1	0	0	1	69

** After message 68H Hard Reset is received, synchronization takes place and WINK & FLASH wave forms are synched to the set connect. No message can be received or generated for 1 second after 68H has been received.

Note: For the indicators 0 through 15 "DDD" (M0, M1, M2) corresponds to the three least significant bits of the command code for the corresponding key as defined in the 20 button Add-on to CO key commands given in Table 7-3.

7.2.2 Twenty Button Add-On To CO Commands

Table 7-3 20 Button Add-On To CO Commands

Function	Command Code									
	M7	M6	M5	M4		M3	M2	M1	M0	HEX
Key No. 0	0	0	0	0		0	0	0	0	00
1	0	0	0	0		0	0	0	1	01
2	0	0	0	0		0	0	1	0	02
3	0	0	0	0		0	0	1	1	03
4	0	0	0	0		0	1	0	0	04
5	0	0	0	0		0	1	0	1	05
6	0	0	0	0		0	1	1	0	06
7	0	0	0	0		0	1	1	1	07
8	0	0	0	0		1	0	0	0	08
9	0	0	0	0		1	0	0	1	09
10	0	0	0	0		1	0	1	0	0A
11	0	0	0	0		1	0	1	1	0B
12	0	0	0	0		1	1	0	0	0C
13	0	0	0	0		1	1	0	1	0D
14	0	0	0	0		1	1	1	0	0E
15	0	0	0	0		1	1	1	1	0F
16	0	0	0	1		0	0	0	0	10
17	0	0	0	1		0	0	0	1	11
18	0	0	0	1		0	0	1	0	12
19	0	0	0	1		0	0	1	1	13

Note: The keys numbered 0 to 15 have associated indicators with the status of the indicators being controlled by the messages outlined in the "CO to 20 Button Add-on", Table 7-2.

7.3 Thirty Six Button Add-On Modules

The thirty-six button add-on configuration enables the network to place thirty-six indicators in the same four states as the feature key indicators on the primary set.

The Telco key designations enable the Telco to specify which features are going to be assigned to the available key command codes, using the key numbers 30 to 65.

7.3.1 CO to Thirty Six Button Add-on Commands

The three bit octal addresses for the thirty six button Add-on modules are address 2 (010) and address 3 (011). For the indicators numbered 30 to 65, the same four indicator states as were defined for a set apply. Also, the Hard, Soft and Power Down reset commands serve the same purpose as for a set and operate in the same manner as for a set.

See the description of Hard Reset, Soft Reset, Power Down Reset, Close Echo and Open Echo commands given for the primary set for a description of how and when they are used.

Table 7-4 CO to Thirty-Six Button Add-On Commands

Telco Key No. Design	Address (Octal)	Indicator Command Codes (Hex)			
		Off	On	Wink	Flash
30	2 (010)	00	60	20	40
31	2 (010)	01	61	21	41
32	2 (010)	02	62	22	42
33	2 (010)	03	63	23	43
34	2 (010)	04	64	24	44
35	2 (010)	05	65	25	45
36	2 (010)	06	66	26	46
37	2 (010)	07	67	27	47
38	2 (010)	80	E0	A0	C0
39	2 (010)	81	E1	A0	C1

Table 7-4 CO to Thirty-Six Button Add-On Commands

Telco Key No. Design	Address (Octal)	Indicator Command Codes (Hex)			
		Off	On	Wink	Flash
40	2 (010)	82	E2	A0	C2
41	2 (010)	83	E3	A0	C3
42	2 (010)	84	E4	A0	C4
43	2 (010)	85	E5	A0	C5
44	2 (010)	86	E6	A0	C6
45	2 (010)	87	E7	A0	C7
46	2 (010)	90	F0	B0	D0
47	2 (010)	91	F1	B0	D1
48	3 (011)	00	60	20	40
49	3 (011)	01	61	21	41
50	3 (011)	02	62	22	42
51	3 (011)	03	63	23	43
52	3 (011)	04	64	24	44
53	3 (011)	05	65	25	45
54	3 (011)	06	66	26	46
55	3 (011)	07	67	27	47
56	3 (011)	80	E0	A0	C2
57	3 (011)	81	E1	A0	C3
58	3 (011)	82	E2	A0	C4
59	3 (011)	83	E3	A0	C5
60	3 (011)	84	E4	A0	C6
61	3 (011)	85	E5	A0	C7
62	3 (011)	86	E6	A0	D0
63	3 (011)	87	E7	A0	D1
64	3 (011)	90	F0	B0	C2
65	3 (011)	91	F1	B1	C3

Table 7-5 CO to Thirty Button Add-on Commands

Function	Address	Command Code									
	(octal)	M7	M6	M5	M4		M3	M2	M1	M0	Hex
Soft Reset	2 (010)	0	0	0	0		1	0	0	0	08
	3 (011)	0	0	0	0		1	0	0	0	08
**Hard Reset	2 (010)	0	1	1	0		1	0	0	0	68
	3 (011)	0	1	1	0		1	0	0	0	68
Save Indicator	2 (010)	0	1	0	0		1	0	0	0	48
Reset	3 (011)	0	1	0	0		1	0	0	0	48
Open Echo	2 (010)	0	1	1	0		1	0	0	1	69
(optional)	3 (011)	0	1	1	0		1	0	0	1	69
Closed Echo	2 (010)	0	0	0	0		1	0	0	1	09
(optional)	3 (011)	0	0	0	0		1	0	0	1	09

** Provides HARD RESET (LCD's out, power down) plus i.e.,synchronization to address 2 Wink & Flash cycles. A device can not receive or transmit messages for 1 second after Hard Reset is received.

7.3.2 Thirty-Six Button Add-on to CO Commands

Table 7-6 Thirty-Six Button Add-on to CO Commands

Telco Key Designation	Address(octal)	Command Codes (HEX)
Key No. 30	2 (010)	00
31	2 (010)	01
32	2 (010)	02
33	2 (010)	03
34	2 (010)	04
35	2 (010)	05
36	2 (010)	06
37	2 (010)	07
38	2 (010)	08
39	2 (010)	09
40	2 (010)	0A
41	2 (010)	0B
42	2 (010)	0C
43	2 (010)	0D
44	2 (010)	0E
45	2 (010)	0F
46	2 (010)	10
47	2 (010)	11
Key No. 48	3 (011)	00
49	3 (011)	01
50	3 (011)	02
51	3 (011)	03
52	3 (011)	04

Table 7-6 Thirty-Six Button Add-on to CO Commands

Telco Key Designation	Address(octal)	Command Codes (HEX)
53	3 (011)	05
54	3 (011)	06
55	3 (011)	07
56	3 (011)	08
57	3 (011)	09
58	3 (011)	0A
59	3 (011)	0B
60	3 (011)	0C
61	3 (011)	0D
62	3 (011)	0E
63	3 (011)	0F
64	3 (011)	10
65	3 (011)	11

7.4 Twenty-Two Button Add-On Modules

The twenty-two button add-on configuration enables the network to place twenty-two indicators in the same four states as the feature key indicators on the primary set. The twenty-two keys can be assigned specific features through the use of Telco key designations.

The Telco key designations enable the Telco to specify which features are going to be assigned to the available key command codes, using the key numbers 15 through 36 for Add-on No 1 and key numbers 37 through 58 for Add-on No 2.

7.4.1 CO To Twenty-Two Button Add-On Modules

The twenty-two button Add-on is designed to auto select its loop address. As soon as the Add-on is plugged into the loop it selects the Add-on address with the lowest number that is still available. The folowwing codes will be used will be used with address 1, and 2 producing 22 key/LCD pairs for each Add-on.

Table 7-7 Indicator Control Commands

Telco Key No. Designation	Indicator Command Codes (HEX)			
	OFF	ON	WINK	FLASH
15	00	60	20	40
16	01	61	21	41
17	02	62	22	42
18	03	63	23	43
19	04	64	24	44
20	05	65	25	45
21	06	66	26	46
22	07	67	27	47
23	80	E0	A0	C0
24	81	E1	A1	C1
25	82	E2	A2	C2
26	83	E3	A3	C3
27	84	E4	A4	C4
28	85	E5	A5	C5
29	86	E6	A6	C6
30	87	E7	A7	C7
31	90	F0	B0	D0
32	91	F1	B1	D1
33	92	F2	B2	D2
34	93	F3	B3	D3
35	94	F4	B4	D4
36	95	F5	B5	D5

Table 7-8 Reset And Echo Commands

	Command Code								
FUNCTION	M7	M6	M5	M4	M3	M2	M1	M0	HEX
SOFT Reset	0	0	0	0	1	0	0	0	08
HARD Reset	0	1	1	0	1	0	0	0	68
Save Indicator Reset	0	1	0	0	1	0	0	0	48
Open Echo (optional)	0	1	1	0	1	0	0	1	69
Closed Echo (optional	0	0	0	0	1	0	0	1	09

7.4.2 Twenty-Two Button Add-On To CO Commands

Table 7-9

Telco Key Designation	Command Code (HEX)
15	00
16	01
17	02
18	03
19	04
20	05
21	06
22	07
23	08
24	09
25	0A
26	0B
27	0C
28	0D
29	0E
30	0F
31	10
32	11
33	12
34	13
35	14
36	15

7.5 Eighteen Button Add-On Modules

The eighteen button add-on configuration enables the network to place eighteen indicators in the same four states as the feature key indicators on the primary set. The eighteen keys can be assigned specific features through the use of Telco key designations.

The Telco key designations enable the Telco to specify which features are going to be assigned to the available key command codes, using the key numbers 12 through 29 for Add-on No 1 and key numbers 30 through 47 for Add-on No 2 and key numbers 48 through 57 for Add-on No 3.

7.5.1 CO to Eighteen Button Add-on

The eighteen button Add-on is designed to auto select its loop address. As soon as the Add-on is plugged into the loop, it selects the Add-on address with the lower number which is still available. The following codes will be used with address 1, 2 and 3 producing 18 key/LCD pairs for each Add-on.

Table 7-10 Indicator Control Commands

Telco Key No. Design	Indicator Command Codes (HEX)			
	Off	On	Wink	Flash
12	00	60	20	40
13	01	61	21	41
14	01	62	22	42
15	03	63	23	43
16	04	64	24	44
17	05	65	25	45
18	06	66	26	46
19	07	67	27	47
20	80	E0	A0	C0
21	81	E1	A0	C1
22	82	E2	A0	C2
23	83	E3	A0	C3
24	84	E4	A0	C4

Table 7-10 Indicator Control Commands

Telco Key No. Design	Indicator Command Codes (HEX)			
	Off	**On**	**Wink**	**Flash**
25	85	E5	A0	C5
26	86	E6	A0	C6
27	87	E7	A0	C7
28	90	F0	B0	D0
29	91	F1	B0	D1

Table 7-11 Reset and Echo Commands

Function	Command Code									
	M7	**M6**	**M5**	**M4**		**M3**	**M2**	**M1**	**M0**	**HEX**
Soft Reset	0	0	0	0		1	0	0	0	08
Hard Reset	0	1	1	0		1	0	0	0	68
Save Indicator Reset	0	1	0	0		1	0	0	0	48
Open Echo (Optional)	0	1	1	0		1	0	0	1	69
Closed Echo (Optional)	0	0	0	0		1	0	0	1	09

7.5.2 Eighteen Button Add-on to CO Commands

Table 7-12 Eighteen Button Add-on to CO Commands

Telco Key Designation	Command Code (HEX)
12	00
13	01
14	02
15	03
16	04
17	05
18	06
19	07
20	08
21	09
22	0A
23	0B

Table 7-12 Eighteen Button Add-on to CO Commands

Telco Key Designation	Command Code (HEX)
24	0C
25	0D
26	0E
27	0F
28	10
29	11

8. Network Maintenance

8.1 General

Telephone operating companies have routine maintenance testing plans which make electrical tests on subscriber loops from the DMS machine. For Enhanced Business Service to determine the condition of the loop and the termination (signature) of the terminal equipment the following tests will apply.

8.2 DC Resistance

The primary set shall have DC resistance characteristics in the standby and active modes as specified in Section 3.2.5 to enable evaluation of the terminal and subscriber loop condition.

8.3 Loop Back Of Signaling Channel

The terminal equipment that is connected to this network interface may optionally support loop backs. It is highly recommended since it allows the Telco to perform routine diagnostics from the CO. If provided, the CPE shall be capable of looping back messages received on the signal channel (echo mode). This shall apply for each device which has a unique address as per the signalling protocol. This allows testing of both the loop and the terminal equipment by the DMS machine on the above voiceband channel.

8.4 Loop Tests

If any abnormal condition is detected during the routine tests available as outlined in 8.2 and 8.3 above, remote testing can be done through the testing facility. by the use of this facility, it is possible to check the subscriber loop for foreign potentials, the resistance from tip or ring to ground, the DC resistance across tip and ring with the normal CO supply polarity and with the polarity reversed.

The momentary interruption of the loop battery feed associated with the remote testing capability makes it necessary that the primary voice terminal be capable makes it necessary that the primary voice terminal be capable of generating the equivalent of a hard reset (see Section 5.2) when the terminal is reconnected to the line card battery feed (= power up reset).

List of terms

ASK
Amplitude Shift Keying

C
Counter

CO
Central Office

CPE
Customer Premise Equipment

CPSN
Current Processed Sequence Number

DB1
Display Buffer 1

DB2
Display Buffer 2

DDB
Digit Display Buffer

DMS-100
Digital Multiplex System 100, A Northern Telecom DMS-100 Family Switching System

DN
Directory Number

DSN
Digit Sequence Number

DSPC
Display Control

DST
Destination

DT & DR
Data Tip and Ring Transmit Pair

DT1 & DR1
Data Tip and Ring Receive Pair

FSK
Frequency Shift Keying

IBN
Integrated Business Network

IPM
Interruptions per Minute

Lp
Lamp

LSB
Least Significant Bit

LTMR
Long Timer

MBS
Meridian Business Services

MSB
Most Significant Bit

Nortel
Northern Telecom, Inc.

NT
Northern Telecom, Inc.

NTPs
Northern Telecom Practices

opcode
operation code

PACK
Positive Acknowledge

PC
Personal Computer

PEC
Product Engineering Code

PDN
Primary Directory Number

POTS
Plain Old Telephone Service

Primary Set
The first voice terminal that is connected to the interface. This is the one device that may be loop powered as well as providing the loop termination.

R
Ring

RTP
Research Triangle Park

Rx
Receive

Sn
State for lamp number specification

SRC
Source

St
State

STMR
Short Timer

T
Tip

Tx
Transmit

TBD
To Be Determined

VO

Verification Office

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Public Carrier Networks

Meridian Business Services

Network Access

Interface Specification

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